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KNOWLEDGE TRANSFER THROUGH ACADEMIC SPIN-OFFS AND UNIVERSITY TO INDUSTRY COOPERATIONS

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Siegen, den 20 Februar 2020

Stefan Marc Hossinger

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List of abbreviations

ASO	Academic Spin-Offs
ABS	Association of Business Schools
AUTM	Association of University Technology Managers
CSR	Corporate Social Responsibility
EPO	European Patent Office
ESE	Entrepreneurial Self-efficacy
EVC	External Venture Capital
IP	Intellectual property
IPR	Intellectual Property Rights
LCSM	Local-Context Support Mechanisms
STEM	Science, Technology, Engineering, Mathematics
OI	Organizational Identity
OLS	Ordinary Least Squares
POC	Proof-of-Concept
SME	Small and Medium Enterprises
TTO	Technology Transfer Office
ULSM	University-Level Support Mechanisms
VC	Venture Capital
VHB	Verband der Hochschullehrer für Betriebswirtschaftslehre

Summary

Since the second academic revolution, a 'third mission' has been integrated into the traditional functions of universities (Miranda et al., 2017a; Etzkowitz, 2003) that is targeted to transfer universities' research-based knowledge to industrial sectors and society as a whole (Van Looy et al., 2011; Miranda et al., 2017a; Visintin and Pittino, 2014; Moog et al., 2015). In this regard, university-to-industry cooperation and the creation of academic spin-offs (ASOs) are becoming increasingly popular within the university technology transfer process, regional politics and current research (Wright et al., 2006; Shane, 2004a; Vohora et al., 2004; Hossinger et al., 2020; Mustar et al., 2006; Bishop et al., 2011; Perkmann et al., 2011).

ASOs are regarded as central drivers of economic, social and ecological changes, and they lead to economic stability and social prosperity (Santini, 2017; O'Shea et al., 2008; O'Shea et al., 2005; Vincett, 2010; Block et al., 2017). Nonetheless, a high discrepancy exists between the propensity to found a company and actual implementation in the academic context (Kollmann et al., 2017; Fritsch and Krabel, 2012; Mueller, 2010). This so-called intention–action gap has been systematically overlooked and deserves more research (Miranda et. al., 2017a; Djokovic and Souitaris, 2008; Hossinger et al., 2020; Rothaermel et al., 2007). As such, this dissertation analyses how the intention–action gap in academic entrepreneurship can be bridged. In this regard, **Chapter 2** provides a systematic literature review of the drivers, barriers and success factors of ASOs. Although studies on entrepreneurial barriers have been conducted (Vohora et al., 2004; Parker and Belghitar, 2006; Van Gelderen et al., 2011), the results reveal that the understanding of the driving forces behind these barriers remains in its infancy (Hossinger et al., 2020). As such, **Chapter 3** analyses how individual attitudes and behavioural patterns affect the extent of perceived entrepreneurial obstacles. The results indicate that the perception of entrepreneurial obstacles depends (a) positively on the degree of individual decision paralysis and the attitude towards science and (b) negatively on entrepreneurial self-efficacy and individual risk-taking propensity. Van Gelderen et al. (2015) suggest that the key to overcoming the intention–action gap may lie in a person's individual motivation for various purposes. Hence, **Chapter 4** focusses on exploring the effects of individual founding motives on the venturing progress of ASOs. The results suggest that transfer motives (application of research ideas, self-realisation and knowledge and skill utilisation) matter most, followed by economic (monetary rewards and necessity motives) and lifestyle motives (work–life balance). Moreover, the results also show that self-realisation and

the desire for application, as well as necessity motives, affect the venturing progress positively, whereas the desire for better utilisation of professional knowledge has a negative effect. To bridge the intention–action gap in academic entrepreneurship, **Chapter 5** provides and tests a theoretical model which brings together scientists' characteristics, organisational mechanisms and external stakeholders in supporting academic entrepreneurship. The results identify the following combinations of knowledge collaborations which facilitate academic entrepreneurship: technology transfer offices (TTO) enable collaboration with private industry; patent agencies facilitate collaboration with other scientists and potential customers; university incubators facilitate collaboration with capital investors and develop new business contacts; and support programmes at universities facilitate collaboration with customers.

In addition to the means of ASO creation, another channel for conducting the 'third mission' is knowledge transfer via cooperation with industry (Perkmann et al., 2011; Wright et al., 2008b; Huyghe et al., 2014; Van Looy et al., 2011). Therefore, recent policy has encouraged universities to become proactive in commercialising research-based knowledge (Perkmann et al., 2011; Siegel et al., 2007; Bercovitz and Feldman, 2006) through collaborative research, contract research or scientific consultancy (Perkmann et al., 2011). However, it remains unclear, particularly in the context of small and medium-sized enterprises (SMEs), how university-to-industry cooperation can improve the learning capabilities for recognising, assimilating and applying new knowledge for commercial ends. As such, **Chapter 6** analyses how university-to-industry cooperation could enhance SMEs' absorptive capacity. The results reveal that university cooperation leads to a stronger manifestation of realised absorptive capacity for the following reasons: firstly, university-to-industry cooperation enhances a company's awareness of new research and technological opportunities (Gibbons and Johnston, 1974; Salter and Martin, 2001; Bishop et al., 2011), which in turn contributes to the development of explorative learning capabilities. Secondly, university cooperation positively affects a company's capacity to exploit new or existing knowledge to create product and/or process innovation (Bishop et al., 2011). Thirdly, university-to-industry cooperation enhances a company's problem-solving, as well as analytical, capabilities (Bishop et al., 2011; Salter and Martin, 2001).

In summary, this dissertation contributes to the understanding of knowledge transfer through ASOs and university cooperation and provides several implications for researchers, university administrators, SMEs' managing directors and policymakers.

1 Introduction

1.1 Research motivation and context

Since the second academic revolution, a 'third mission' has been integrated into the traditional functions of universities (Miranda et. al., 2017a; Etzkowitz, 2003). This new mission is targeted to transfer knowledge derived from various research fields to industrial sectors and society as a whole (Van Looy et al., 2011; Miranda et. al., 2017a; Visintin and Pittino, 2014; Moog et al., 2015). As such, the traditional scientific and teaching missions of universities has been supplemented with commercialisation activities, such as contract and collaborative research, consulting, patent and licensing activities, university-to-industry cooperation and the creation of academic spin-offs (ASOs) (Perkmann et al., 2011; Wright et al., 2008a; Huyghe et al., 2014; Van Looy et al., 2011). In recent years, such commercialisation activities have received considerable attention (Huynh et al., 2017; Van Looy et al., 2011). In particular, cooperation between external industry partners and ASO creation are becoming increasingly popular within the university technology transfer process, regional politics and current research (Wright et al., 2006; Shane, 2004a; Shane, 2004b; Vohora et al., 2004; Hossinger et al., 2020; Mustar et al., 2006; Bishop et al., 2011; Perkmann et al., 2011).

ASOs are regarded as central drivers of economic, social and ecological changes, and they lead to economic stability and social prosperity (Block et al., 2017; Santini, 2017; O'Shea et al., 2008; O'Shea et al., 2005; Vincett, 2010). However, these welfare–economic benefits can only be realised if scientists who are interested in self-employment successfully overcome the challenges and obstacles associated with the venturing process and actually implement their founding plans. The best entrepreneurial concept, at least from a welfare–economic point of view, is worthless if it cannot be commercialised. Although around 15% of all German start-ups are founded by universities or research institutions (Kollmann et al., 2017), much entrepreneurial potential is yet to be discovered. Fritsch and Krabel (2012) indicate that around 28% of all scientists at universities or research institutions consider start-ups an attractive employment alternative. However, only 3.2% of all scientists ultimately found their own companies. Furthermore, Mueller (2010) show that most ASOs have been founded by academics after they had been away from the university for at least four years. Taking the findings of the aforementioned studies together, a relatively large number of start-up-interested scientists exist, compared to a significantly small number of actual company

founders. This phenomenon suggests that a high discrepancy remains between the propensity to found a company and actual implementation in the academic context. This so-called intention–action gap has been systematically overlooked and deserve more research (Miranda et. al., 2017a; Djokovic and Souitaris, 2008; Hossinger et al., 2020; Rothaermel et al., 2007). To improve the foundation conditions in the academic context and explain the high discrepancy between the propensity to start a business and its final implementation, it is necessary to determine which factors are critical for the successful implementation of ASOs. Understanding which factors are causal for abortion, postponement or implementation would help university administrators and policymakers who are interested in facilitating academic entrepreneurship make their support programmes and subsidies more effective. Therefore, this dissertation investigates how the intention–action gap in academic entrepreneurship can be bridged.

In addition to the means of ASO creation, another channel for conducting the 'third mission' is knowledge transfer via cooperation with industry (Perkmann et al., 2011; Wright et al., 2008a; Huyghe et al., 2014; Van Looy et al., 2011). Universities often form the basis of the regional and cross-regional innovation policies and are regarded as central drivers for technological innovation and change (Miranda et al., 2017a; Hossinger et al., 2020; Bishop et al., 2011). However, beneficial uses of university-specific knowledge can only be realised if the knowledge derived from universities is actually transferred into practice and applied to commercial ends (Miller et al., 2014). Therefore, recent policy has encouraged universities to become proactive in commercialising research-based knowledge (Perkmann et al., 2011; Siegel et al., 2007; Bercovitz and Feldman, 2006). The knowledge transfer between universities and industries adopts many forms, such as collaborative research, contract research or scientific consultancy (Perkmann et al., 2011). Prior studies suggest that firms can benefit from these forms of cooperation in several ways. Firstly, university cooperation can improve a firm's understanding of theories, laws and scientific or technical principles (Gibbons and Johnston, 1974; Salter and Martin, 2001; Bishop et al., 2011). Moreover, university cooperation also can improve both a firm's problem-solving expertise (Salter and Martin, 2001) and its innovative performance (Bishop et al., 2011; Link and Rees, 1990; Mansfield, 1991; George et al., 2002).

However, it remains unclear, particularly in the context of small and medium-sized enterprises (SMEs), how university-to-industry knowledge transfer may be beneficial for a firm's ability to recognise, assimilate and apply new knowledge for commercial ends (Agrawal, 2001). Understanding the antecedents of absorptive capacity can provide SMEs' managing directors the help necessary to outdistance the competition.

1.2 Research questions

The crucial role of ASOs in accelerating technological innovation and promoting economic development has drawn numerous scholars' attention to exploring the factors that influence their development (O'Shea et al., 2005, Vincett 2010; Block et al., 2017; Santini, 2017; O'Shea et al., 2008). The body of literature pertaining to this topic is growing. However, findings from prior studies have been relatively controversial and fragmented due to the nature of the specific samples, time or context. Moreover, several existing reviews pertaining to this topic (e.g. Miranda et al., 2017a or Rothaermel et al., 2007) only describe the general phenomenon of ASOs, instead of focussing on precise areas. More importantly, prior studies did not outline the entire review process, which reduces the credibility of their findings. This calls for a more transparent and in-depth review. To close this gap, one objective of this dissertation is to provide a holistic and in-depth exploration of the factors that drive, impede and are critical for the success of ASOs, by posing the following three research questions:

RQ 1: *What drives academics to become entrepreneurs?*

RQ 2: *Which barriers must academics overcome during the venturing process?*

RQ 3: *Which factors influence the success of academic spin-offs?*

The phenomenon of why many academic entrepreneurs cease or postpone pursuing their business ideas has not yet been answered convincingly in previous research (Hossinger et al., 2020). Empirical findings indicate that this discrepancy can essentially be explained by the challenges and obstacles perceived by academic founders throughout the venturing process (Mueller, 2010; Block et al., 2008). However, studies pertaining to this subject remain incomplete. Most literature regarding the topic of academic spin-offs focusses almost exclusively on factors that influence either the propensity to start a business or its early success, whereas only a paucity of research explores what prevents them from implementing founding plans (e.g. Kollmann et al., 2017; Hossinger et al., 2020).

Moreover, what role founders' individual attitudes and behaviour play in this context is unknown as well. Therefore, it remains unclear, particularly in the academic context, how academics' individual decision-making behaviour, self-efficacy and risk-taking propensity, combined with their attitude towards science, affect the extent of perceived entrepreneurial obstacles. This leads to the following research question:

RQ 4: *How do individual psychological factors affect the extent of entrepreneurial obstacles perceived?*

Previous studies indicate that 28% of all scientists have the propensities to found a company, whereas only 3.2% actually implement their plans (Fritsch and Krabel, 2012). Thus, a gap exists in explaining why some academics make more entrepreneurial progress than others. This so-called intention–action gap has been systematically overlooked and deserves more research (Miranda et. al., 2017a; Djokovic and Souitaris, 2008; Hossinger et al., 2020; Rothaermel, 2007). Several studies suggest that the key to overcoming the intention–action gap may lie in a person's individual motivation for various purposes (Van Gelderen et al., 2015). Since entrepreneurship is a purposive behaviour propelled by intentions (Lee et al., 2011), the success of entrepreneurial activities depends, to a great extent, on the involvement and commitment of individuals. Variations in entrepreneurial commitment exert differing degrees and forms of impact on individuals' decisions and behaviours, which affect each specific stage of the entrepreneurial process – ranging from the company formation phase to the post-establishment phases (Shane, 2004a; 2004b). The academic context is no exception. Academics decide to engage in entrepreneurial activities due to a variety of motives, such as intrinsic satisfaction, financial rewards or peer recognition. Hence, understanding the motivations that drive academics to become entrepreneurs can better explain the venturing progress. Therefore, it is important to answer the following questions:

RQ 5: *Which motivating factors play the most significant roles for academic entrepreneurship?*

RQ 6: *How do motivating factors affect the venturing progress of academic entrepreneurship?*

Since the second academic revolution, a 'third mission' has been integrated into the traditional functions of universities (Miranda et. al., 2017a). This new mission is targeted to transfer knowledge from various research fields to the industrial sector and society as a whole (Van Looy et al., 2011; Miranda et. al., 2017a; Visintin and Pittino, 2014). As such, universities around the world are currently implementing far-reaching changes to become more entrepreneurial (Audretsch, 2014; Guerrero and Urbano, 2012; 2014; Block et al., 2017; Urbano and Guerrero, 2013). These changes have attracted the attention of researchers willing to commercialise their research. As a result, a growing need exists for universities and industries to develop more 'rapid' linkages between scientists in universities and external stakeholders (Algieri et al., 2013; Cunningham and Link, 2015; Miller et al., 2014). While commercialising inventions and facilitating knowledge spill-over, the scientists are embedded in the universities' organisational structures in which they collaborate with external stakeholders (Miller et al., 2014; Audretsch and Belitski, 2017). This embeddedness results in more efficient knowledge commercialisation as a combination of in-house activities and the external facilitation of knowledge transfer (Muscio, 2010; Siegel et al., 2003; 2007; Kenney and Patton, 2009; Abreu et al., 2016). However, very limited evidence exists on how the university context complements these contacts and collaboration between scientists and external stakeholders to advance the knowledge spill-over of academic entrepreneurship. As such, this thesis addresses the following research questions:

RQ 7: *How does the interplay between scientists, the organisational (university) context and the collaboration between external stakeholders advance academic entrepreneurship?*

The 'third mission' that has been integrated into universities since the second academic revolution is targeted to enhance the knowledge transfer from the university to the industrial sector (Van Looy et al., 2011; Miranda et. al., 2017a; Visintin and Pittino, 2014). In the German context in particular, knowledge transfer from universities to SMEs has become increasingly important. In 2017, approximately 99.5% of all German companies were categorised as SMEs. With a total turnover of around €2.33 trillion – which corresponds to around 35.0% of the total GDP of Germany – SMEs comprised the bedrock of the German economy. Compared to large firms, SMEs are often more innovative and customer-oriented and employ flat organisational structures (Liao et al., 2003; Singh et al., 2008; Lisboa et al., 2011).

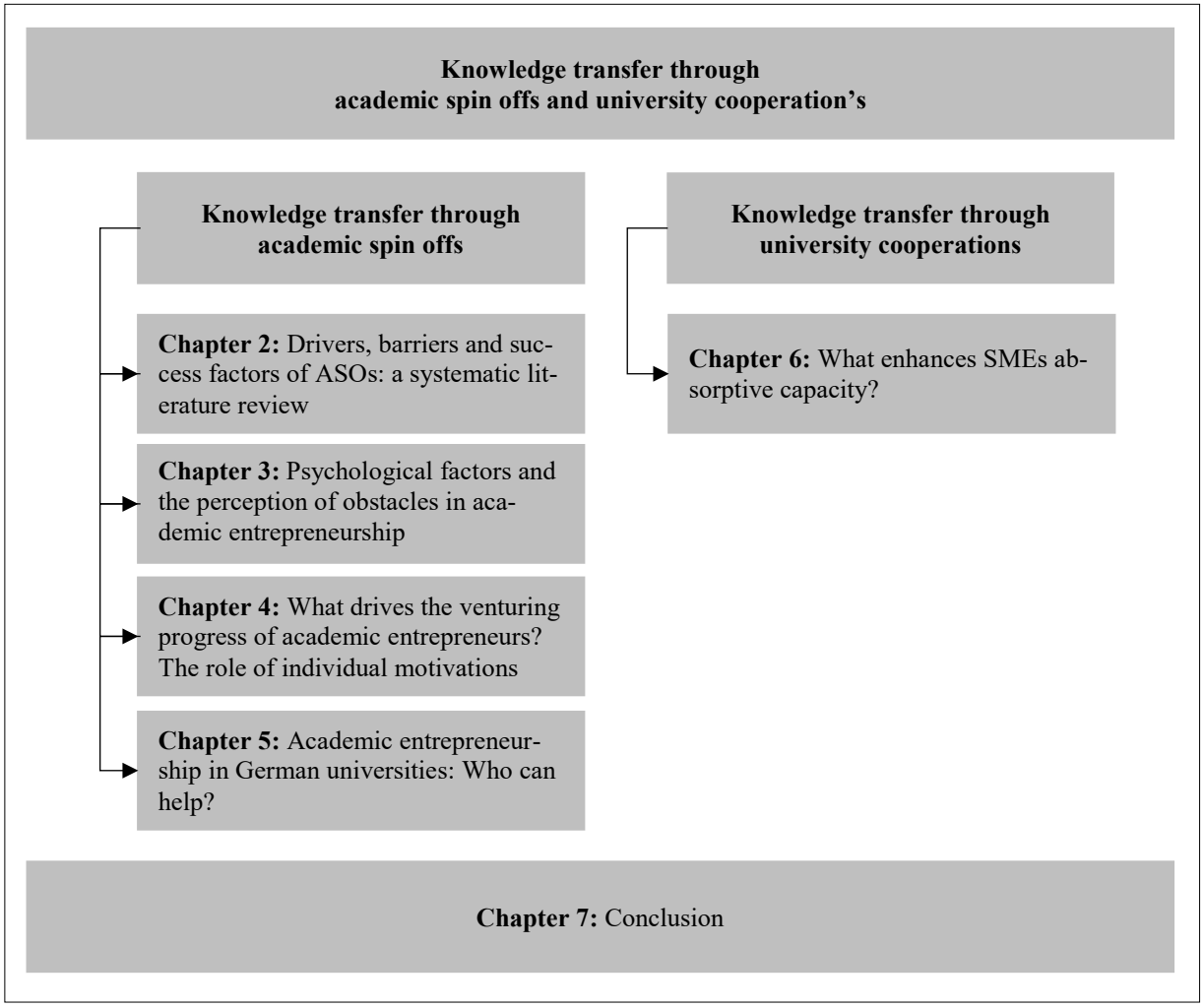
Such organizational structures, positively effects SMEs ability to respond to a changing environment and implement far-reaching changes (Garengo et al., 2005; Liao et al., 2003). However, in times of increased competition, many SMEs require constant and ongoing innovation to elicit a steady revenue flow and subsequently make enough profit to survive. In this respect, the transfer of knowledge from external sources, particularly universities, plays a fundamental role. The 'ability to recognise the value of new information, assimilate it, and apply it to commercial ends', or the so-called absorptive capacity, will, in the end, be the deciding factor (Cohen and Levinthal, 1990). Previous studies suggest that absorption capacity improves organisational responsiveness (Liao et al., 2003), facilitates the formation of strategic alliances with other companies (Flatten et al., 2011) and enhances both innovation performance and economic success (Kostopoulos et al., 2011; Leal-Rodríguez et al., 2014). Thus, companies with an increased absorptive capacity are more likely to outdistance the competition. Although the outcomes of absorptive capacity have been researched in depth (Zahra and George, 2002), surprisingly, however, we still know little about the antecedents of absorption capacity in SMEs. In this regard, university cooperation, particularly university-to-industry knowledge transfer, may comprise an important antecedent for a firm's absorption capacity. Bishop et al. (2011) note that university-to-industry cooperation enhances a company's awareness of new research and technological opportunities, which in turn contributes to the development of explorative learning capabilities. However, it remains unclear how university-to-industry knowledge transfer may be beneficial to absorptive capacity (Agrawal, 2001). To provide SMEs' managing directors and policymakers the help necessary to enhance SMEs' absorptive capacity, the following research question must be explored:

RQ 8: *What enhances the absorptive capacity of small and medium-sized enterprises?*

1.3 Structure of the dissertation and chapter outlines

This dissertation is structured in seven chapters that address the topic of knowledge transfer via ASOs and university-to-industry cooperation. Whereas Chapters 2–5 focus on knowledge transfer via ASOs, Chapter 6 contributes to the recent research on knowledge transfer through university cooperation. Figure 1 illustrates the structure of this dissertation to provide an overview of the chapters. The chapter structure is described in detail below.

Figure 1 Structure of the dissertation



Chapter 2 provides a comprehensive overview of the current state of research in the field of academic entrepreneurship. Following the basic procedure for conducting a systematic literature review according to Tranfield et al., 2003, Chapter 2 selects, evaluates, summarises and synthesises 193 relevant articles in the field. These articles were coded based on their research objectives and units of analysis. The results were summarised in a conceptual framework, which shows the drivers, barriers and success factors of academic entrepreneurship from the micro-, meso- and macro-levels. Thus, compared to prior systematic literature reviews in the field, Chapter 2 provide a more transparent and in-depth review procedure. Moreover, the phenomenon of academic entrepreneurship is analysed from a more holistic perspective. This chapter offers a basic understanding of academic entrepreneurship and provides several potential promising directions for future research.

Chapter 3 addresses the obstacles associated with the venturing process of ASOs, and more precisely, how individual attitudes and behavioural patterns affect the extent of perceived entrepreneurial obstacles. In this regard, decision conflict theory from Janis and Mann (1977) is applied in this paper; this theory builds upon an important construct from behavioural science, namely decision paralysis, whose influence has, until now, been systematically overlooked in entrepreneurship research. In addition to this theoretical approach, Chapter 3 also applies three other important psychological theories: the theory of planned behaviour from Ajzen (1991), the need for achievement theory from McClelland et al. (1953) and institutional theory from Meyer and Rowan (1977). The objective of this study is to examine how decision paralysis, entrepreneurial self-efficacy, risk-taking propensity and attitudes towards science affect the extent of perceived entrepreneurial obstacles. From a theoretical perspective, Chapter 3 offers potential new and valuable insights into the determinants of entrepreneurial implementation. From a practice-oriented perspective, the findings primarily serve university administrators, TTOs and potential investors as guidance to develop and implement new strategies that could facilitate the development of academic entrepreneurship and increase the number of ASOs.

Chapter 4 focusses on exploring the effects of individual founding motives on the venturing progress of ASOs. Previous research notes that scientists are driven by a diverse set of motivations to engage in entrepreneurial activities (Lam, 2011; Shane, 2004b; Göktepe-Hulten and Mahagaonkar, 2009; Hayter, 2011). Building upon this research stream, Chapter 4 examines which founding motives are most crucial for academic entrepreneurship and how

transfer, economic and lifestyle motives affect the venturing progress of academic entrepreneurship. This chapter contributes to the literature of the intention–action gap. Furthermore, it provides university administrators and policymakers the help necessary to offer differentiated support programmes to meet the diverse needs of academic entrepreneurs.

Chapter 5 deals with the knowledge spill-over of academic entrepreneurship from a stakeholder-oriented perspective. Building upon endogenous economic growth and the knowledge spill-over of entrepreneurship theory, Chapter 5 provides a model which explains the interplay between scientist's individual characteristics, the organisational (university) context and the collaboration between scientists and external stakeholders. Thus, this chapter aims to identify the combinations of organisational structures and external stakeholders that facilitate the start-up activities of academics. Finally, Chapter 5 provides implications for scholars, scientists, university managers and investors aiming to support start-up activities and invest in research commercialisation.

While the previous chapters deal with the knowledge transfer through ASOs, **Chapter 6** further contributes to recent research on knowledge transfer between universities and the private sector. The transformation of knowledge into innovation, or so-called absorptive capacity, is essential for the economic success of SMEs. Examining knowledge transfer from stakeholders, sources of innovation such as the university, particularly university-to-industry knowledge transfer, may be beneficial for absorptive capacity. As such, Chapter 6 examines to what extent university cooperation can contribute to a stronger manifestation of SMEs' realised absorptive capacity. This chapter both contributes to the literature regarding the antecedents of absorptive capacity and highlights the role of university cooperation for enhancing the innovativeness of SMEs. Furthermore, Chapter 6 informs SME managers how to create a knowledge-friendly environment within a company to achieve a competitive advantage.

Finally, **Chapter 7** provides a summary and discussion of the primary results of the previous chapters and provides several implications for theory and practice. The dissertation concludes with a brief outlook on promising future research avenues.

1.4 Publication status of the chapters and contribution of the author

As mentioned in the previous section, this dissertation is based on five papers dealing with the topic of knowledge transfer via ASOs and university-to-industry cooperation. Of these five papers, four have been published or submitted to international peer reviewed journals ranked in the 2015 VHB-JOURQUAL 3[1]. One remaining paper is currently under submission. Table 1 provides an overview of the publication status and the co-authors of the papers used in this dissertation. Furthermore, Table 1 also includes papers by the author that directly or indirectly contribute to the papers included in this dissertation.

Table 1 Publication status of the papers used in this dissertation

Title	Publication status	Authors	Reference
Manuscripts used in this dissertation			
1 Drivers, barriers and success factors of academic spin offs: a systematic literature review	Published in: *Management Review Quarterly* (VHB: C)	Hossinger, S.; Chen, X.; Werner, A.	Hossinger et al., 2020
2 Psychological factors and the perception of obstacles in academic entrepreneurship	Under preparation for-submission to: *Research Policy* (VHB: A)	Hossinger, S.; Belitzki, M.; Chen, X.; Werner, A.	Hossinger et al., 2020
3 What drives the venturing progress of academic entrepreneurs? The role of individual motivations	Submitted to: *The Journal of Technology Transfer* (VHB: B)	Hossinger, S.; Chen, X.; Block, J.; Werner, A.	Hossinger et al., 2020
4 Academic entrepreneurship in German universities: who can help	Submitted to: *Research Policy* (VHB: A)	Audretsch, D.; Belitski, M.; Chen, X.; Hossinger, S.; Werner, A.	Belitzki et al., 2020
5 What enhances SMEs absorptive capacity?	Under preparation for-submission to: *Review of managerial science* (VHB: B)	Hossinger, S.; Scholz, T.; Stein, V.; Werner, A.	Hossinger et al., 2020

(**Table 1** continues on the next page)

[1] The VHB-JOURQUAL 3 is a journal ranking of the Association Verband der Hochschullehrer für Betriebswirtschaft e.V. (VHB).

Table 1 (continued)

Other manuscripts of the author				
6	Gründungserfolg von Wissenschaftlern an deutschen Hochschulen	Published in: *Institut für Mittelstandsforschung Bonn (Hrsg.): IfM-Materialien Nr. 257.*	Bijedić, T.; Chlosta, S.; Hossinger, S.; Kasdorf, A.; Schneck, S.; Schröder, C.; Werner, A.	Bijedić et al., 2017
7	Abbrecher, Aufschieber oder doch Gründer: was beeinflusst den Gründungsprozess im akademischen Kontext?	-	Bijedić, T.; Chlosta, S.; Hossinger, S.; Kasdorf, A.; Schneck, S.; Schröder, C.; Werner, A.	Bijedić et al., 2017
8	The Familiness effect on CSR of privately owned SMEs: Empirical evidence from German Mittelstand firms	Submitted to: *Journal of Small business Management* (VHB: B)	Stock, C.; Hossinger, S.; Werner, A.	Stock et al., 2019
9	The role of corporate social responsibility and absorptive capacity in the digital transformation of SMEs	-	Stock, C.; Hossinger, S.	Stock and Hossinger, 2020

Since the papers used in this dissertation were co-authored by Univ.- Prof. Dr. Joern Block, Prof. Dr. Maksim Belitski, Prof. Dr. David Audretsch, Xiangyu Chen, Dr. Tobias Scholz, Univ.- Prof. Dr. Volker Stein and Univ.- Prof. Dr. Arndt Werner, the following paragraphs briefly describe the contributions of the author to these papers.

Chapter 1: This chapter was written independently by the author of the dissertation.

Chapter 2: Large portions of the work in this chapter were completed by the author of this thesis. The author was jointly responsible for the data collection process and wrote large parts of the introduction and the method, as well as the content part of the paper. Furthermore, the author contributed to the development of the conceptual framework and the discussion portion of the paper. This paper was presented and nominated for the best paper award at the 2018 G-Forum (Gründerforum) in Stuttgart. The publishing process involved three rounds of major and minor revisions, which were largely conducted by the author of this dissertation. This paper was accepted for publishing in *Management Review Quarterly* in April 2019.

Chapter 3: The majority of this chapter was written by the author of this thesis. The author wrote the theoretical framework and the method portion, as well as large parts of the introduction and conclusion. Moreover, the author collected all of the necessary data, in cooperation with the IfM Bonn (Institut für Mittelstandsforschung Bonn). In addition, the author was responsible for conducting both the descriptive and multivariate statistics. This paper was presented and nominated for best paper award at the 2018 16th IECER entrepreneurship conference in Innsbruck. Moreover, this chapter was also presented at the 2018 G-Forum in Stuttgart, the 2019 Babson College Entrepreneurship Research Conference in Boston (US) and the 17th IECER entrepreneurship conference in Utrecht (NL). This chapter was submitted to *Research Policy* in July 2020 and is currently under review.

Chapter 4: In this chapter, the author drafted and wrote large parts of the introduction, the literature overview, the hypothesis development and the conclusion. In addition, the author collected the necessary data, in cooperation with the IfM Bonn (Institut für Mittelstandsforschung Bonn). The author was also responsible for performing and enhancing the empirical analysis and writing the method and conclusion parts. This paper was submitted to *The Journal of Technology Transfer* in February 2020. The paper was invited for revise and resubmission

Chapter 5: In this chapter, the author was responsible for the data collection process and for performing the empirical analysis. The author reported the empirical models and linked the results to the current research literature. Moreover, the author also contributed to the conclusion by interpreting and discussing the empirical results. Furthermore, the author helped to improve and revise the theory and hypothesis. This paper was submitted to *Research Policy* in January 2020 and is currently under review**.**

Chapter 6: Large parts of this chapter were drafted and written by the author of the dissertation. The author drafted the introduction and the literature overview, performed the hypothesis development, collected all of the necessary data and wrote the method part of the paper. In addition, the author was responsible for conducting the empirical analysis and the interpretation of the findings. This paper was submitted to *Review of managerial science* in March 2020. Initial decision is pending.

Chapter 7: This chapter was written independently by the author of the dissertation.

2 Drivers, barriers and success factors of academic spin-offs: a systematic literature review[2]

Stefan Hossinger • Xiangyu Chen • Arndt Werner

Abstract

The considerable economic contribution of academic spin-offs (ASOs) has drawn numerous scholars' attention to explore the factors that influence their development. The body of literature pertaining to this topic is growing, though the findings remain relatively controversial and fragmented. Existing literature reviews only describe the general phenomenon instead of focusing on precise areas. Therefore, the main objective of this review is to provide a holistic and in-depth exploration of the factors that drive, impede and are critical for the success of ASOs by posing three specific questions: (1) What drives academics to become entrepreneurs? (2) Which barriers must they overcome during the venturing process? (3) Which factors influence the success of ASOs? Following the basic procedure outlined by Tranfield et al., (2003) for conducting a systematic literature review, this research selected, evaluated, summarised and synthesised 193 relevant articles. The findings indicated that individual factors carried significantly higher explanatory power in relation to the entrepreneurial behaviour of academics. However, the venturing process and the success of ASOs are influenced not only by factors at the micro-level, but also strongly depend on factors at the meso and macro-levels such as relationships with parent organisations and regional contexts. Furthermore, factors that impede the ASO venturing process and factors at the macro-level are still under-researched and deserve further investigation. In addition, this review discusses several potential promising theoretical and practical implications for stakeholders at different levels, which should be helpful to further promote the development of ASOs in the future.

Keywords: academic spin-offs, academic entrepreneurship, technology transfer, literature review

[2] As a part of this dissertation, this paper is published in *Management Review Quarterly*. Received: 23 August 2018 / Accepted: 11 April 2019 / Published online: 25 April 2019 © Springer Nature Switzerland AG 2019

2.1 Introduction

A ‘third mission’ has been integrated into the traditional functions of universities since the second academic revolution. This new mission attempts to transfer the knowledge from different research fields to the industrial sector and society (Van Looy et al., 2011; Visintin and Pittino, 2014). As one of the various forms of academic entrepreneurial activities, academic spin-offs (ASOs), also commonly known as university spin-offs (USOs), are considered important mediators in achieving this mission (Miranda et al., 2017b). An ASO is a new company that is established by the exploitation of a core technology or technology-based idea generated within a university, where the founding member(s) may or may not be affiliated to the academic institution (Smilor et al., 1990; Nicolaou and Birley, 2003a; 2003b). Meanwhile, considering their substantial economic contributions, including creating employment opportunities, enhancing economic stability, forming industrial clusters, as well as stimulating innovation processes, the crucial role that ASOs play in accelerating technology innovation and promoting economic development has been globally recognised (Block et al., 2017; Visintin and Pittino, 2014; Berbegal-Mirabent et al., 2015; Guerrero et al., 2015). Nevertheless, the venturing process of an ASO is complex, long-term and dynamic, involving influencing factors from multiple dimensions (Rasmussen, 2011; Miranda et al., 2017b). Fritsch and Krabel (2012) indicated that even though one third of scientists believe it is very attractive to establish a spin-off, just one in three of these eventually devotes him or herself to the process. The fact is that the formation of ASOs requires not only the existence of individual motivations, but also the involvement of parent organisations and various participants from society (Rasmussen et al., 2014).

Despite an extensive volume of studies devoted to exploring the ASO phenomenon over the last decade, the findings have been reasonably controversial and fragmented. This is due to the nature of specific samples, the time or context. Different research designs and definitions have also undermined the consistency of findings, which have consequently reduced the fulfilment of their objectivities. This investigation found several bibliographical reviews on the subject (O’Shea et al., 2004; Mustar et al., 2006; Rothaermel et al., 2007; Djokovic and Souitaris, 2008; Miranda et al., 2017a). However, these reviews either only described the general phenomenon or screened too few samples. More importantly, they did not outline the entire review process, which reduced the credibility of their findings. Thus, this research gap calls for a more transparent and in-depth review with respect to the aforementioned questions. Compared to the most recent review by Miranda et al. (2017a), the review herein

adopted a more targeted coding strategy and seeks to present a more holistic overview by focusing on three specific questions: (1) What drives academics to become entrepreneurs? (2) Which barriers must they overcome during the venturing process? (3) Which factors influence the success of ASOs? By evaluating, extracting and summarising the content of each article included, common themes will be clustered into several dimensions. Based on the variables identified in each cluster, synthesis of further content will be conducted in order to establish a conceptual framework, which will deepen the understanding of those drivers, barriers and factors in multiple dimensions that determine the successful development of ASOs.

The review findings show that the ASO venturing process is influenced by factors at multiple levels. Factors that impede the development of ASOs and factors at the macro-level are still under-researched and deserve further investigation in the future. From a theoretical perspective, this paper attempts to provide researchers with potentially valuable research opportunities for the future. From a practical perspective, it aims to assist university administrators, policy makers and investors in more effectively recognising factors that determine the venturing process and performance of ASOs so that they may develop and implement more appropriate strategies to facilitate academic entrepreneurship.

The structure of this paper is as follows: section two elaborates the review process in detail, followed by a presentation of the descriptive results and in-depth content analysis in section three. A conceptual framework will be presented in section four and the final section will reveal the implications.

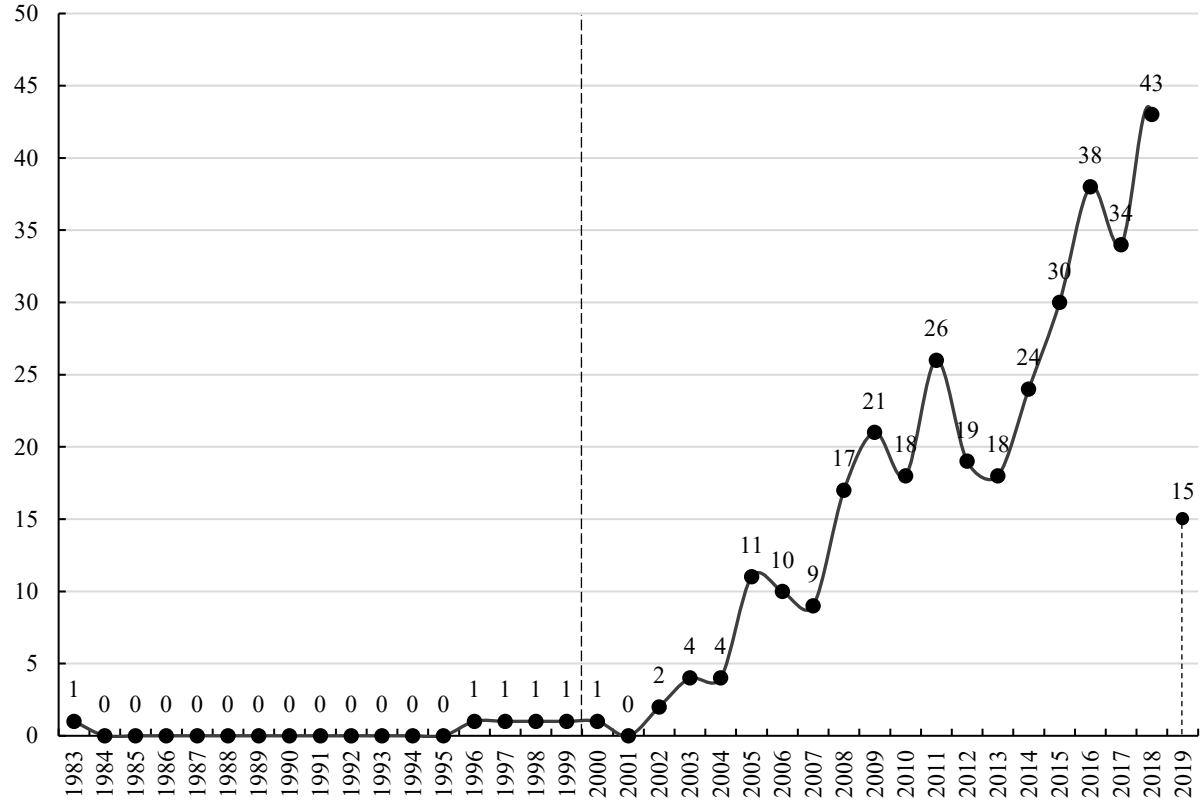
2.2 Methodology

This paper followed the basic procedure summarised by Tranfield et al. (2003) for conducting a systematic literature review. Such a review comprises three principal stages: planning, conducting and reporting. Each stage is divided into multiple sub-phases with different purposes (Tranfield et al., 2003). Prior to conducting the review, a rigorous and explicit search protocol was developed in order to retrieve sufficient relevant evidence for a transparent and holistic investigation. The search began by restricting the literature type to English language scholarly articles published in refereed journals on topics relating to academic spin-offs. Six recognised scientific electronic databases were used:

(1) EBSCO Business Source Complete; (2) Elsevier Science Direct; (3) Springer Link; (4) Emerald; (5) Wiley Online Library; (6) ISI Web of Knowledge. These were searched using the following terms: ('academic spin-off' OR 'university spin-off'; 'academic spin*' OR 'university spin*'; 'academic entrepreneur*' OR 'university entrepreneur'; 'academic' AND 'entrepreneurial intention' OR 'entrepreneurial motivation' OR 'entrepreneurial inclination'; 'determinant' OR 'success' OR 'performance' OR 'obstacle' OR 'barrier' OR 'inhibitor' AND 'university spin*'). The preliminary selection was refined by screening the titles and abstracts to ascertain their eligibilities; articles were excluded when they failed to answer the specific research questions of this review or due to duplication. Consequently, 349 articles were identified after the initial screening.

Further selection was conducted by applying the following two inclusion criteria. The first was journal quality – articles were included if they were published in journals listed as having an impact factor in Thomson Reuters' 2017 journal citation reports or if they were ranked by the Association of Business Schools (ABS) or the Verband der Hochschullehrer für Betriebswirtschaftlehre (VHB). The second criterion was the publication timeframe – articles were included if they were published from 2000 onwards. The main reason for choosing this criterion was that the number of published articles on the topic of academic entrepreneurship have increased exponentially since 2000 (as shown in Figure 2). Therefore, commencing from the year 2000 was deemed long ago enough to maximise the likelihood of capturing up-to-date articles whilst simultaneously minimising the effects of publication biases.

Figure 2 Number of articles published since 1983[3]



Based on the pre-defined search strategies, the combined results ultimately yielded 193 articles for further in-depth analysis. Before summarising and synthesising the findings of the selected articles, a data extraction sheet was created with detailed information regarding the author(s), year, title, journal, type of work, research method, unit of analysis, geographical scope(s), and key findings, which served as a solid foundation for the subsequent data synthesis for identifying common issues that had been addressed and categorising them accordingly.

The articles included were coded based on their research objectives and units of analysis. Starting from the research questions, the articles were classified into three general categories: drivers, barriers and success factors. Articles that focused on drivers and investigated the key determinants promoting the formation of ASOs fell into the first category. Articles that focused on examining the barriers and their effects during the different ASO development stages were coded as 'barrier' research, whilst the third category included articles that focused on success factors and analysed the influencing factors critical to sustainable ASO

[3]Note: Given the fact that the year 2019 is still ongoing, only articles published till March 2019 have been included.

development. For a better understanding of the coding underlying the conducted review, see Table 2. Each general category consisted of three sub-classifications according to the units of analysis, namely: micro-, meso- and macro-level. Articles at the micro-level (55.44%) addressed individual academic entrepreneurs or ASOs. Meso-level articles (25.91%) focused on parent organisations such as universities or other academic institutions. Macro-level articles (6.22 %) analysed the role of the social economic environment in the ASO venturing process. Accordingly, articles that covered multiple dimensions (12.43 %) were coded as multi-level studies. With the help of this citation coding, articles could be easily identified and categorised. The patterns and recurring themes revealed in the resulting data will be discussed in detail in the following section.

Table 2 Sample research questions for coding

	Multi-Dimension: (12.43%)		
	Micro-level: (55.44%)	Meso-level: (25.91%)	Macro-level: (6.22%)
Drivers: (43.52%)	*'How does entrepreneurial self-efficacy affect the emergence of entrepreneurial intentions in academics?'*	*'What influence does the organisational structure of universities have on the entrepreneurial intentions of scientists?'*	*'Which contextual factors encourage or discourage academics to engage in entrepreneurial activities?'*
Barriers: (8.81%)	*'Why do tendencies towards paralysis lead to a stronger perception of obstacles in the early stages of spin-out creation?'*	*'Are university support programmes able to reduce perceived barriers in the spin-off process?'*	*'How do barriers in the regional and national contexts influence the performance of academic spin-offs?'*
Success factors: (47.67%)	*'To what extent does human capital leverage the effect of bridging ties on the early growth of academic spin-offs?'*	*'Do university-level support mechanisms complement or substitute for each other in fostering the creation of academic spin-offs?'*	*'How do government-funded academic spin-offs perform compared to peers and does the EBSG have a positive impact on firms' performance?'*

2.3 Findings

The findings are presented in two main sections: the first provides an overview of the characteristics of all the articles included in terms of their publication distribution, research methods used, geographical distribution and units of analysis. The second section provides the in-depth content findings, which form the core of this review.

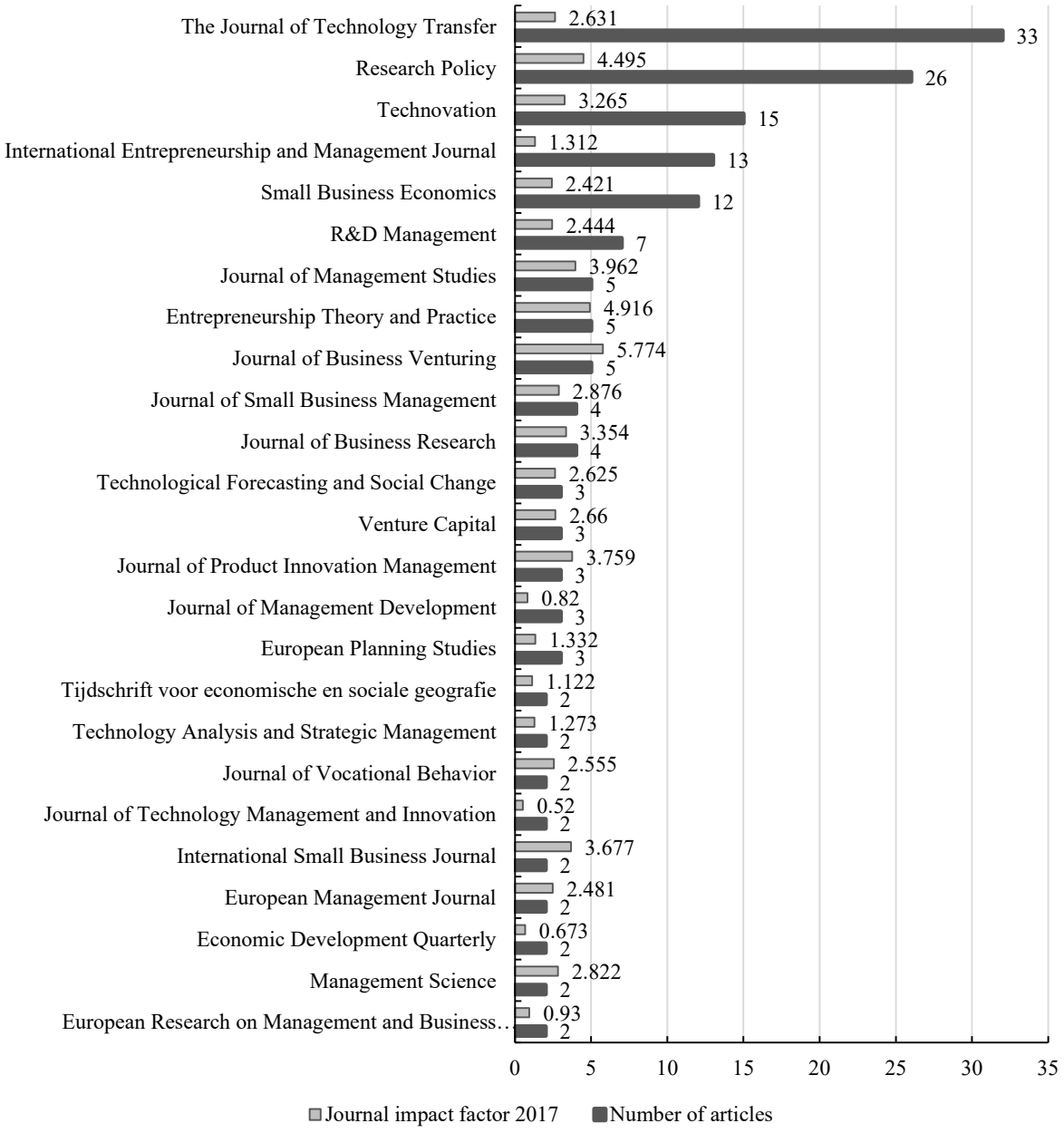
2.3.1 Descriptive characteristics

2.3.1.1 Publication distribution

With respect to the total number of articles published in this research field (349 since 1983), Figure 1 shows that their number increased exponentially over the last two decades. While little research on this topic was conducted during the period from 1983 to 2000, the number of publications increased slightly till the end of the year 2004. Following a notable increase in articles published during the period 2006 to 2011, there was a decline in 2012. As shown in Figure 3, a total of 26 articles was published in 2011 compared to only 19 in 2012. At first glance, this represents a decline of around 27% from the previous year, 2011. Upon closer examination, however, considering Research Policy published a special issue on academic entrepreneurship in 2011, of which nine articles from this single edition were captured, it seems that there was, in fact, a significant increase from 2010 to 2011 due to this outlier. Looking at the timeframe from 2012 to 2019, Figure 2 shows that the number of articles increased exponentially from 2013, which indicates that researchers were paying ever more attention to the topic of academic entrepreneurship over the ensuing five years. If the entire timeframe is taken into account, only approximately 13% (46) of the total number of articles pertaining to this topic were published in the first three decades (1983 to 2007). However, the number of publications rose rapidly from 2007. Around 87% of the articles were published in the last decade (2008 to 2019), which corresponds to a total of 303 articles. Overall, these statistical results are in line with the findings of Miranda et al. (2017a).

The database used for the final analysis comprised 193 articles published in 55 different journals. As shown in Figure 3, considering at least two of the articles published are a cut-off point, the distribution among the journals was fairly skewed. The three journals with the largest output were The Journal of Technology Transfer (17.10%), followed by Research Policy (13.47%) and Technovation (7.77 %). Roughly 38% of the articles reviewed were published in these three journals alone; accordingly, the other 62% were published in the remaining 52 journals.

Figure 3 Number of articles published by journal



Regarding journal quality, based on the latest rankings in the German VHB Index of 2017, the majority of the journals in the underlying samples were rated as a 'B' (47.06%) whilst two journals were rated as 'A*' (5.88%), namely Administrative Sciences and Management Science. With respect to the three journals with the largest outputs, Research Policy was given an 'A' rating, The Journal of Technology Transfer a 'B' rating and Technovation a 'C'. A further criterion for evaluating journal quality is to assess the impact factor according to the Thomson Reuters (2017) journal citation reports. As shown in Figure 2, 53 journals presented an average impact factor of 2.570 with 21 journals exceeding this factor. The most highly ranked journal in the selected samples was the Journal of Business Venturing with an impact factor of 5.774. As can be seen from Figure 2, a great majority of the reviewed articles were published in journals ranked as 'C' or higher.

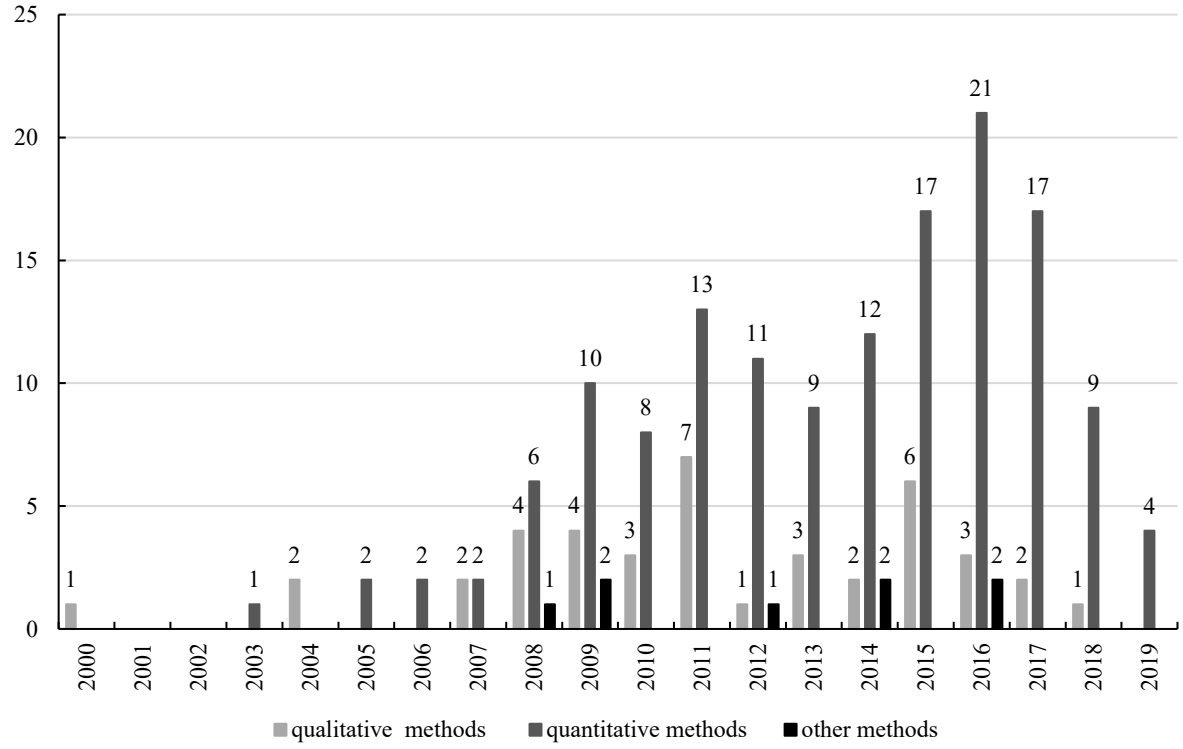
This finding indicates that ASO research is well-recognised and represents a current study topic in academia. Moreover, the results show that the impact factors of the included journals were, on average, relatively high, which suggests that published articles in the ASO field are often cited by other scholars. More importantly, the distribution among the journals provides information for academics about which journals are most relevant to the ASO topic, enabling them to develop an improved publication strategy. With regard to the number of published articles, the results show that the most relevant journals in this research field were Research Policy and The Journal of Technology Transfer.

2.3.1.2 Research method

The majority of the articles reviewed adopted the quantitative method (74.61%), whereas 41 articles (21.24%) relied on the qualitative and a mere eight articles were theory-based (4.15%). Considering this finding, Figure 4 shows the number of articles reviewed based on the research methods adopted over time. It is noticeable that the gap between qualitative and quantitative research widened even further over time. This indicates that researchers increasingly shifted their attention from qualitative to quantitative research methods over the last decade. A possible explanation for this phenomenon, according to Rothaermel et al., (2007), may be that in the early stages of academic entrepreneurship research, scholars lacked fine-grained reliable data, theories and frameworks by which to conduct quantitative analyses; therefore, the qualitative method was a more effective means of describing phenomena and exploring influencing factors. However, with a deeper understanding and growing maturity

in this research field coupled with the availability of high-quality quantitative data from institutions such as the European Patent Office (EPO), the Association of University Technology Managers (AUTM), different theories and frameworks emerged and were constructed by scholars. Consequently, scholars have shifted their research attention from qualitative to quantitative analysis in more recent decades (Rothaermel et al., 2007).

Figure 4 Number of articles reviewed based on research methods

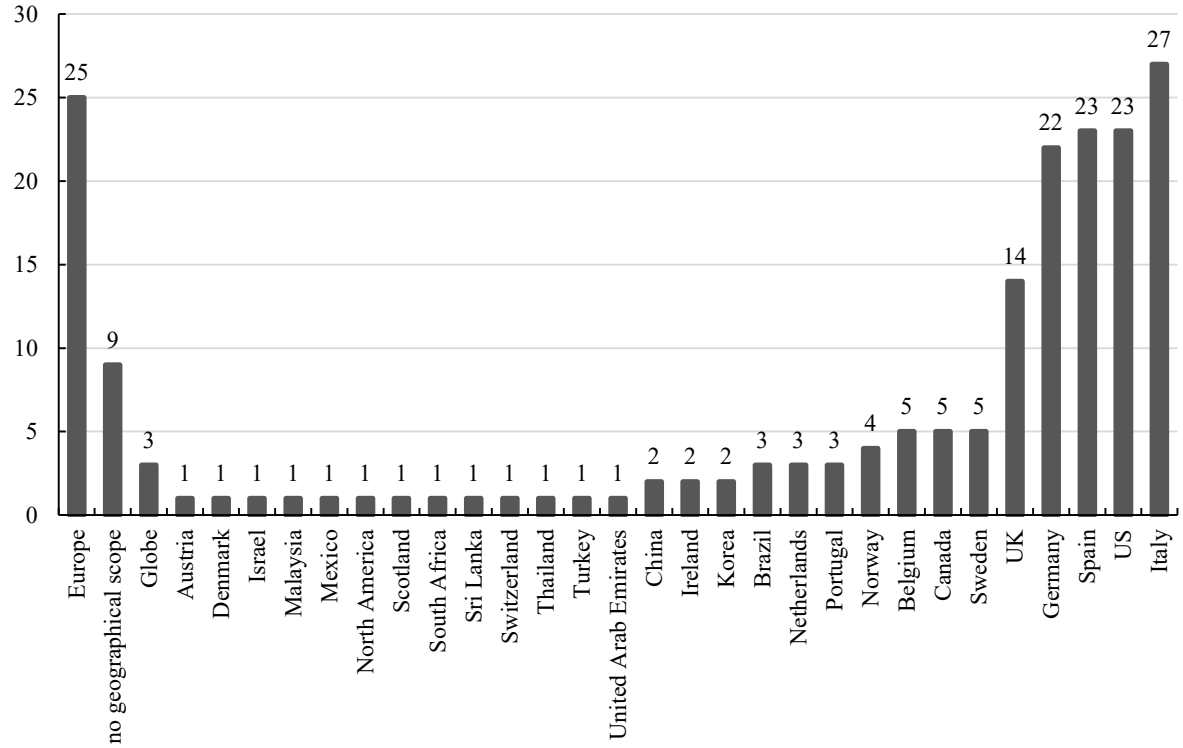


2.3.1.3 Geographical distribution

Regarding the geographical distribution of the included articles, Figure 5 shows that the total 193 articles covered 28 countries in Europe, the Americas, the Middle East and Asia. Nonetheless, the distribution is reasonably skewed as the great majority of articles focused on European countries, followed by the US, while very few articles were based in Asian or Middle Eastern contexts. This result is consistent with the findings in previous literature reviews on the topic of ASOs (e.g. Rothaermel et al., 2007; Miranda et al., 2017a; Djokovic and Souitaris, 2008). This said, none of these reviews offered explanations for the skewed distribution.

It appears that there are several possible explanations for this phenomenon. Firstly, the concept of ASOs was known earlier in European countries and in America. As a consequence, their development was faster in these areas compared to in other continents. For this reason, scholars paid more attention to these 'hotspots' where ASO development was more mature and fruitful. Secondly, the skewed distribution may also be explained by the origins of the authors and universities. The most prolific scholars in the sample are mostly of European origin and work in European universities. For example, Einar Rasmussen hails from the University of Nottingham (UK), Riccardo Fini from the University of Bologna (IT) and Mike Wright from the Imperial College Business School, London (UK). Considering the available resources and databases, the scholars of Italian or British universities would certainly primarily focus on the development of ASOs in European regions instead of in other remote continents.

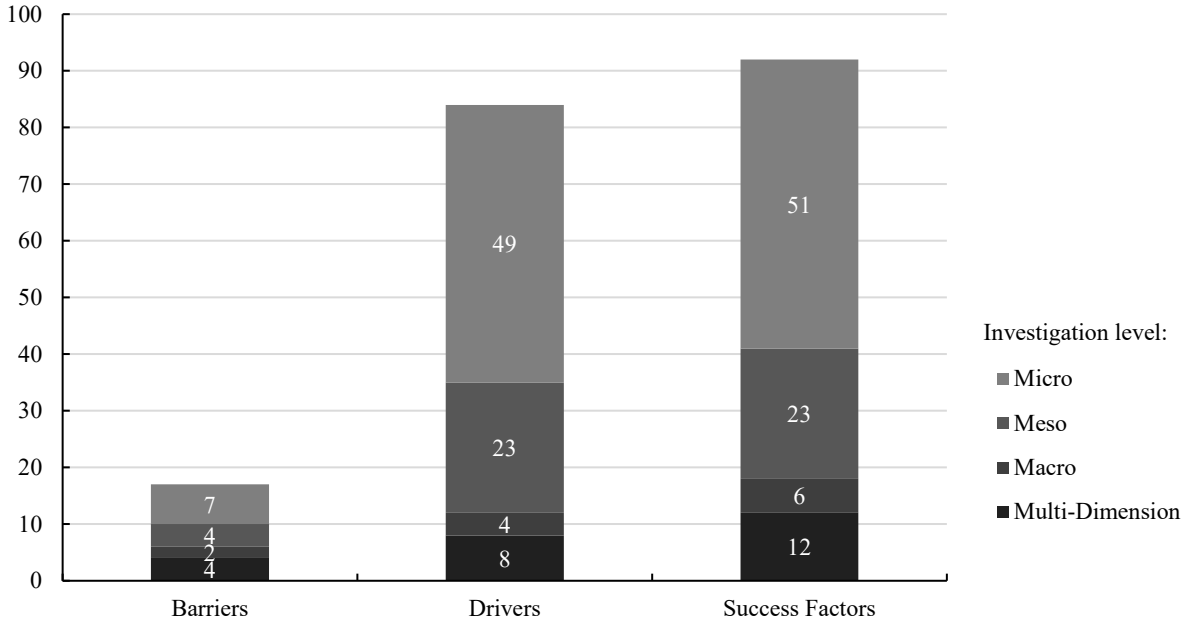
Figure 5 Geographical distribution of reviewed articles



2.3.1.4 Unit of analysis

Based on in-depth content analysis of the 193 articles, Figure 6 shows that the majority focused on exploring the success factors (47.67%) and drivers (43.52%) of ASOs. In contrast, only 17 articles (8.81%) addressed the barriers. With respect to the level of analysis, Figure 5 further illustrates that most of the articles attempted to explore the drivers, barriers and success factors at the micro-level (55.44%), followed by those at the meso- (25.91%), multi- (12.44%) and macro-levels (6.22%). Consequently, these findings indicate that up until now, very little research has scrutinised the central barriers and their effects in both the early and late stages of the spin-out formation process. Furthermore, there is a lack of research on those factors that influence the development of ASOs at the macro-level. The in-depth content analysis of the 193 articles in this study was performed based on the data extraction sheet and common issues were categorised and synthesised for the purposes of drawing general conclusions.

Figure 6 Number of articles related to the investigation level



2.3.2 Content findings

2.3.2.1 Drivers

2.3.2.1.1 The micro-level

Starting at the micro-level, the articles included in this review explored individual motivations via three principal approaches. The first approach emphasised the importance of taking into account both intrinsic ('Puzzle') and extrinsic ('Gold' and 'Ribbon') motivations when interpreting the entrepreneurial behaviours of academics (Lam, 2011). On the one hand, academics decide to engage in entrepreneurial activities so as to pursue an intrinsic source of rewards, such as independence, a sense of achievement, skill enhancement, inner satisfaction, self-realisation and self-esteem (Guerrero et al., 2008; Hoye and Pries, 2009; Hayter, 2011; Lam, 2011; Antonioli et al., 2016; Iorio et al., 2017; Barba-Sánchez and Atienza-Sahuquillo, 2018). In addition, they may feel a sense of social responsibility or of having a 'mission' to be of public service, to improve living standards by applying and disseminating technology or they may have a 'need for utilisation'; these are all potential critical forces driving some academics to establish their own ASOs (Morales-Gualdrón et al., 2009; Berggren, 2017; Iorio et al., 2017). On the other hand, academics' entrepreneurial behaviours are also motivated by rewards that emerge from the external environment. These extrinsic motivations can be generally grouped into two categories based on their tangibility.

An important determinant for a great majority of researchers is the expectation of additional academic benefits from founding spin-off ventures, such as the generation of further stimuli for research activities, access to funding opportunities (grants) or the possibility of obtaining new infrastructures and facilities for their research activities. They consider spin-offs as a platform for obtaining these resources to support their research (Fini et al., 2009; Lam, 2011; Goethner et al., 2012; Hayter, 2015a; Antonioli et al., 2016; Iorio et al., 2017). As for the financial rewards, although 'Gold' does have an influence in motivating academics to engage in entrepreneurial activities; the influence is however limited and its importance often depends on the age and position of the academic or on other personal concerns (Rizzo, 2014; Antonioli et al., 2016). Overall, these factors have been demonstrated as being of relatively little importance compared to other motivating factors and most scientists would not consider them the primary goal, but as collateral compensation for the time and effort they have devoted (Morales-Gualdrón et al., 2009; Hayter, 2011; Lam, 2011; Goethner et al., 2012).

Instead, intangible extrinsic rewards, such as traditional academic recognition, reputation and promotion, are the primary motives for most academics when participating in entrepreneurial activities (Fini et al., 2009; Hayter, 2011; Lam, 2011; Hayter, 2015a).

The second approach adopted a resource-based perspective and highlighted the critical role of academics' human capital and social capital profiles in shaping their spin-off propensity and performance. Compared to general human capital variables such as age, career status and seniority, entrepreneurship-specific human capital variables have higher explanatory power regarding entrepreneurial opportunity exploration and exploitation (Ucbasaran et al., 2008). Prior commercial and entrepreneurial experience, prior industrial work experience, business management experience, domain-specific research experience and a diverse and balanced skillset will improve the entrepreneurial opportunity identification capability of academics and increase the likelihood of actually pursuing these opportunities (Guerrero et al., 2008; Liñán, 2008; Raposo et al., 2008; Ucbasaran et al., 2008; Hoye and Pries, 2009; Krabel and Mueller, 2009; Prodan and Drnovsek, 2010; Clarysse et al., 2011a; Rasmussen, 2011; D'Este et al., 2012; Goethner et al., 2012; Grimm and Jaenicke, 2012; Marion et al., 2012; Abreu and Grinevich, 2013; Goel and Göktepe-Hultén 2013; Moog et al., 2015; Scholten et al., 2015; Zapkau et al., 2015; Fini and Toschi, 2016; Huyghe et al., 2016b; Miranda et al., 2017b). In addition, academics' social capital profile is another critical determinant in promoting spin-off creation propensity (Krabel and Mueller, 2009; Karlsson and Wigren, 2012; Fernández-Pérez et al., 2014; Fernández-Pérez et al., 2015; Hayter, 2015b; Iorio et al., 2017). Professional social networks consisting of elements such as mentors or business associates could offset academics' insufficient market knowledge and financial resources by providing professional assistance; for example, by raising early-age financing and connecting potential business partners and customers (Hayter, 2013; Fernández-Pérez et al., 2014). Nevertheless, personal social networks (e.g. family, friends and colleagues) may provide academics with emotional support by fostering an immediate entrepreneurship-oriented environment (Fernández-Pérez et al., 2014). Similarly, the spin-off process also contributes to the development of academic entrepreneurs' social capital (Borges and Filion, 2013).

The third approach focused on examining the psychological activities of academics that affect their entrepreneurial attitudes, values and behaviours. A great number of scholars employed Ajzen's (1991) theory of planned behaviour (TPB) to examine the entrepreneurial motivations of academics and encountered robust positive empirical support (Krabel and Mueller, 2009; Obschonka et al., 2010; Goethner et al., 2012; Maes et al., 2014). The three independent concepts – namely, attitudes, perceived behavioural control and social norms – have strong explanatory power in relation to the entrepreneurial intentions of academics (Guerrero et al., 2008; Krabel and Mueller, 2009; Díaz-García and Jiménez-Moreno 2010; Obschonka et al., 2010; Haeussler and Colyvas, 2011; Hayter, 2011; Goethner et al., 2012; Obschonka et al., 2012; Brettel et al., 2013; Mathieu and St-Jean, 2013; Maes et al., 2014; Thomas et al., 2014; Fernández-Pérez et al., 2015; Moog et al., 2015; Obschonka et al., 2015; Feola et al., 2019; Urban and Chantson, 2019). Another psychological theory, the regulatory focus theory (RFT), has been adopted by a number of scholars to explain academics' entrepreneurial behaviours as well. RFT suggests that individuals regulate their behaviours based on one of the following two principles: either by having a promotion focus (i.e. striving to achieve positive goals) or a prevention focus (i.e. seeking to avoid negative outcomes) (Higgins, 1987). Coupled with favourable working and family environments, a strong promotion focus generally leads to a high propensity to engage in entrepreneurial activities (Guerrero et al., 2008; Johnson et al., 2017).

Besides variables from psychological theories, a great number of scholars also emphasise the vital role that entrepreneurial self-efficacy (ESE) plays in predicting academics' intentions to start their own businesses. Academics with higher ESE are more likely to establish their own firms (Guerrero et al., 2008; Díaz-García and Jiménez-Moreno 2010; Prodan and Drnovsek, 2010; Mathieu and St-Jean 2013; Shinnar et al., 2014; Fernández-Pérez et al., 2015; Huyghe and Knockaert, 2015). In addition, individual personality, value orientation and academics' cognitive perception could also affect their entrepreneurial intentions (Krabel and Mueller, 2009; Lam, 2011; Douglas, 2013; Meek and Wood, 2016). Based on the 'big five' personality model, scholars suggest that academics with higher levels of conscientiousness, extraversion, emotional stability, openness to experience and lower levels of agreeableness have a stronger intention to become entrepreneurs (Obschonka et al., 2010; Kolb and Wagner, 2015). Furthermore, academics' spin-off intentions are determined by their value orientations, such as their proactiveness, risk-taking propensity, innovativeness, entrepreneurial passion and commercialisation-friendly attitudes (Hoye and Pries, 2009;

Krabel and Mueller, 2009; Haeussler and Colyvas, 2011; Libaers and Wang, 2012; Mathieu and St-Jean, 2013; Knockaert et al., 2015; Huyghe et al., 2016a). Academics who possess a hybrid role identity (i.e. a focal academic self and a secondary commercial persona) are more likely to engage in entrepreneurial activities (Jain et al., 2009; Obschonka et al., 2015) whilst individual demographic characteristics such as age, gender, career status and seniority could also determine the likelihood of an academic's involvement in different types of entrepreneurial activities (Abreu and Grinevich, 2013). The relationship between gender differences and academics' entrepreneurial intentions is a popular study topic for many scholars. Generally, male and female academics are driven by distinct motivations and interpret supports differently; perceived behavioural control and role models have more influence on the fostering of female academics' entrepreneurial intentions (Fernández-Pérez et al., 2014; Maes et al., 2014; Shinnar et al., 2014; Alonso-Galicia et al., 2015). Haeussler and Colyvas (2011) claimed that senior male academics with close entrepreneurial orientation possess sufficient material and social resources and, therefore, are more likely to engage in various entrepreneurial activities. Moreover, compared to their female counterparts, male academics are more willing to develop external social contacts and demonstrate greater initiative and optimism, which leads to stronger intentions of starting their own businesses (Díaz-García and Jiménez-Moreno, 2010; Abreu and Grinevich, 2013; Alonso-Galicia et al., 2015; Iorio et al., 2017).

Further to the three principal research streams, the faculty quality of academics and their research disciplines also affect their entrepreneurial intentions (Perkmann et al., 2011; Huyghe and Knockaert, 2015; Moog et al., 2015; Fini and Toschi, 2016). Scientists with diverse and balanced skill sets tend to have higher entrepreneurial intentions (Moog et al., 2015). Moreover, academics who work in applied research areas and in the disciplines of science, engineering and physics tend to participate in all types of entrepreneurial activities, while academics in the social science, education and business disciplines prefer to engage in informal commercial activities such as consultancy and contract research (Prodan and Drnovsek, 2010; Abreu and Grinevich, 2013; Moog et al., 2015; Fini and Toschi, 2016). Additionally, the relationship between scientific and entrepreneurial activities is worthy of note. Previous studies have argued that there is a trade-off effect between the two; that is, engaging in knowledge transfer activities comes at the expense of scientific productivity (Czarnitzki et al., 2014).

However, the articles included in this review did not provide evidence for such a conflict of interests between these activities, but rather demonstrated a complementary relationship (Huyghe et al., 2016a). Academic excellence and entrepreneurial activity go hand-in-hand (Clarysse et al., 2011a). Scientific productivity is a precondition for engaging in commercialisation activity, and spin-off experiences enhance academics' opportunity identification capabilities (Goel and Göktepe-Hultén, 2013; Huyghe et al., 2016b). Faculty entrepreneurs demonstrate greater scientific productivity than their colleagues, even prior to founding firms (Abramo et al., 2012). Table 3 provides an overview of micro-level drivers.

Table 3 Drivers covered by articles reviewed at the micro-level

Perspective	Key elements (variables)	Representative studies
Intrinsic motivations	Desire for independence, achievement, skill enhancement, intrinsic satisfaction, self-realisation etc.	*Guerrero et al., 2008; Hoye and Pries, 2009; Hayter, 2011; Lam, 2011; Antonioli et al., 2016; Barba-Sánchez and Atienza-Sahuquillo, 2018*
Extrinsic motivations	Additional academic benefits, financial rewards, academic recognition, reputation and promotion	*Fini et al., 2009; Lam, 2011; Goethner et al., 2012; Rizzo, 2014; Hayter, 2015a; Antonioli et al., 2016; Iorio et al., 2017*
Human capital	Prior commercial and entrepreneurial experience, prior industrial work experience, business management experience, a balanced skillset etc.	*Clarysse et al., 2011a; D'Este et al., 2012; Abreu and Grinevich, 2013; Goel and Göktepe-Hultén, 2013; Fini and Toschi, 2016*
Social capital	Professional, personal and business social networks	*Krabel and Mueller, 2009; Karlsson and Wigren, 2012; Fernández-Pérez et al., 2014; Fernández-Pérez et al., 2015; Hayter 2015b; Iorio et al., 2017*
Psychological factors	Theory of planned behaviour, regulatory focus theory, entrepreneurial self-efficacy, cognitive perception, role identity etc.	*Jain et al., 2009; Krabel and Mueller, 2009; Díaz-García and Jiménez-Moreno, 2010; Obschonka et al., 2010; Goethner et al., 2012; Douglas 2013; Obschonka et al., 2015*
Personality and demographic characteristics	Extraversion, emotional stability, openness to experience, age, gender, career status and seniority	*Obschonka et al., 2010; Fernández-Pérez et al., 2014; Maes et al., 2014; Alonso-Galicia et al., 2015; Kolb and Wagner, 2015*
Faculty quality, research types and disciplines	Diverse and balanced skillsets, applied research, science, engineering and physics disciplines	*Prodan and Drnovsek, 2010; Perkmann et al., 2011; Abreu and Grinevich, 2013; Huyghe and Knockaert, 2015; Moog et al., 2015; Fini and Toschi, 2016*

2.3.2.1.2 The meso-level

Due to the peculiar nature of ASOs, the venturing process is influenced not only by factors at the micro-level, but also depends significantly upon its relationship with parent organisations, particularly universities. Walter et al. (2013) argued that academics' entrepreneurial intentions may be increased by four factors at the organisational level, namely entrepreneurship support programmes, industry ties, research orientation and entrepreneurship education. This conclusion was found to be generally consistent with the findings of this review. As shown in Table 3, the influencing factors at the meso-level can be broadly classified into three major categories: university characteristics, research orientations, and university support mechanisms. Firstly, the characteristics and orientations of a university could significantly shape the entrepreneurial decisions of academics and influence the venturing process of ASOs. It has been demonstrated that universities with a focus on applied research and with prior industry cooperation experiences and traditions have a higher propensity to engage in technology transfer activities (Arvanitis et al., 2008; Fischer et al., 2017). Universities with solid resource bases with regard to the financial, human, social, physical and technological have also been shown to markedly facilitate the formation and further development of ASOs (O'Shea et al., 2005; Algieri et al., 2013; Heblich and Slavtchev, 2014; Avnimelech and Feldman, 2015; Berbegal-Mirabent et al., 2015; Ramaciotti and Rizzo, 2015; Jung and Kim, 2017) Moreover, some investors consider the reputation and prestige of universities as positive signals for commercial technology potential (Gómez Gras et al., 2008). Therefore, a university's status facilitates academic entrepreneurs in acquiring resources and networks to start their businesses by enhancing their credibility in the market (Avnimelech and Feldman, 2015).

Another critical determinant is the entrepreneurial culture and climate within universities and departments. A favourable university entrepreneurial milieu could encourage academics to engage in spin-off creation and other entrepreneurial activities (Hayter, 2011; Grimm and Jaenicke, 2012; Huyghe and Knockaert, 2015; Foo et al., 2016; Feola et al., 2019; Zollo et al., 2017). Besides the positive influence of university entrepreneurial culture and climate, Rasmussen et al. (2014) emphasised that the influence of departmental support should also not be neglected and that this is equally, perhaps even more, important in the initial ASO development phase compared to general university support. Riviezzo et al. (2018) indicated that the number of spin-offs generated is positively related to the entrepreneurial orientation, age and size of a department.

Furthermore, departments could provide more direct assistance in enhancing opportunity identification, championing and increasing the resource acquisition competencies of academics and ASOs (Rasmussen et al., 2014). Supporting this view, Huyghe et al., (2015) noted that department membership explains more variations with regard to the entrepreneurial intentions of academics than the university as a whole, with the adhocracy culture of departments found to be positively related to the entrepreneurial intentions of academics. This effect becomes even stronger for universities with well-established entrepreneurial infrastructures (Huyghe et al., 2015). Antonioli et al. (2016) confirmed that the immediate working environment moderates the entrepreneurial intentions of academics. In a similar vein, Bercovitz and Feldman (2008) also emphasised that the individual behaviours of academics are strongly affected by the social norms within departments. The orientation and behaviour of department leaders ('role model') and peers ('peer effect') play a vital part in influencing an academic's individual entrepreneurial behaviour (Bercovitz and Feldman, 2008; Nelson, 2014; Alonso-Galicia et al., 2015; Nicolaou and Souitaris, 2016; Johnson et al., 2017) and academics are more likely to participate in entrepreneurial activities when they cooperate with entrepreneurship-oriented peers (Stuart and Ding, 2006; Moog et al., 2015). Informal support such as encouragement and professional assistance from former colleagues also increases academics' entrepreneurial intentions (Mueller, 2010).

Thirdly, having a well-established university entrepreneurship support mechanism is also critical in facilitating the formation of ASOs (Landry et al., 2006). Fini et al., (2011) examined the joint impact of university-level support mechanisms (ULSMs) and local-context support mechanisms (LCSMs) in fostering the creation of ASOs and suggested that both have a significant influence in this regard. The marginal effect produced by ULSMs in incentivising the creation of ASOs is more efficient and effective when the regional context is also largely in favour of high-tech entrepreneurship (Fini et al., 2011). Moreover, university internal policies and regulations could play a crucial role in influencing the ASO venturing process (Meoli et al., 2017). The immediate working conditions in which academics are embedded are shaped by the design of internal university policies and regulations, which necessarily affect the decisions of academics who are contemplating founding their own firms (Muscio et al., 2016). Clear and specific regulations and policies that favour academic entrepreneurship, such as conflict of interest policies (Muscio et al., 2016), leave of absence policies (Caldera and Debande, 2010), inventor ownership policies (Kenney and Patton, 2011), legislative regulations (Fini et al., 2011), and administrative support (Meoli and

Vismara, 2016) may significantly stimulate the enthusiasm of scholars to participate in spin-off creation activities. Furthermore, establishing an entrepreneurship-oriented reward system within a university could also affect academics' spin-off intentions (Huyghe and Knockaert, 2015; Kolb and Wagner, 2015).

Another important element of the university entrepreneurship support mechanism is the availability of well-established and well-functioning incubation infrastructures and services, as well as easy accessibility (Landry et al., 2007; O'Shea et al., 2007; Guerrero et al., 2008; Algieri et al., 2013; Conceição et al., 2017; Fini et al., 2017). Incubation infrastructures such as technology transfer offices (TTOs) and science parks are established to encourage the transformation of research results into commercial markets (Algieri et al., 2013) and to foster the creation of ASOs (Gómez Gras et al., 2008; Caldera and Debande, 2010; Grimm and Jaenicke, 2012; Abreu and Grinevich, 2013; Berbegal-Mirabent et al., 2015; Moog et al., 2015; Fini et al., 2017). The technology transfer performance of universities has also been found to be positively associated with the size and experience of TTOs as well as the quality and expertise of TTO staff (O'Shea et al., 2005; Powers and McDougall, 2005; Gómez Gras et al., 2008; Caldera and Debande, 2010; Van Looy et al., 2011; Berbegal-Mirabent et al., 2015; Ramaciotti and Rizzo, 2015; Jung and Kim, 2017). Many scientists consider TTOs to be an important source of delegation in exchange for the preservation of their role identity (Jain et al., 2009; Hayter, 2016).

More importantly, TTOs significantly improve the performance of ASOs by providing a set of valuable services such as complementary technical and management support (Fernández-Alles et al., 2015; Rodríguez-Gulías et al., 2016; Slavtchev and Göktepe-Hultén, 2016), contacts to external funding sources (Berbegal-Mirabent et al., 2015), and training and mentoring to foster entrepreneurial mind-sets (Gómez Gras et al., 2008). Also worthy of note is the role of entrepreneurship education programmes provided by universities in affecting academics' propensity for business creation and performance (Raposo et al., 2008). Numerous scholars have emphasised the significant contribution of entrepreneurship education in the improvement of academics' ESE and EI (Liñán 2008; Turker and Selcuk, 2009; Prodan and Drnovsek, 2010; Shinnar et al., 2014; Alonso-Galicia et al., 2015; Moog et al., 2015; Huynh, 2016). Regarding the content of entrepreneurship education, academics tend to prefer more practically-oriented curriculums (Shah and Pahnke, 2014; Piperopoulos and Dimov, 2015).

Meanwhile, some push factors at the organisational level should also be noted, considering some academics leave universities to found their own firms due to reasons such as current workloads, high levels of bureaucracy and low-risk orientation in the parent organisation (Morales-Gualdrón et al., 2009). Table 4 provides an overview of meso-level drivers.

Table 4 Drivers covered by articles reviewed at the meso-level

Perspective	Key elements (variables)	Representative studies
University characteristics	Applied research, prior industry cooperation experiences, solid resource bases, reputation, university prestige	*O'Shea et al., 2005; Arvanitis et al., 2008; Gómez Gras et al., 2008; Algieri et al., 2013; Heblich and Slavtchev, 2014; Avnimelech and Feldman, 2015; Berbegal-Mirabent et al., 2015*
Entrepreneurial orientations	Entrepreneurial culture and climate within universities and departments	*Hayter 2011; Grimm and Jaenicke, 2012; Huyghe and Knockaert, 2015; Foo et al., 2016; Feola et al., 2019; Zollo et al., 2017*
Support mechanisms	University regulations, incubation services, financial support and entrepreneurship education	*Landry et al., 2006; Caldera and Debande, 2010; Fini et al., 2011; Algieri et al., 2013; Alonso-Galicia et al., 2015; Muscio et al., 2016; Meoli et al., 2017*

2.3.2.1.3 The macro-level

With respect to factors at the macro-level (Table 5), Davey et al. (2016) claimed that the extent of academic entrepreneurship is closely associated with the level of regional economic development, as well as cultures and histories. The existence of a favourable entrepreneurial atmosphere and support mechanisms within a region, including the availability of individuals with open-minded attitudes (regional openness) may significantly promote the creation of ASOs (Guerrero et al., 2008; Fini et al., 2011; Grimm and Jaenicke, 2012; Davey et al., 2016; Ghio et al., 2016). Further the presence of agglomeration economies within a region may be an important determinant in explaining the variation in ASO formation and their geographical distribution (Conceição et al., 2017).

In terms of the national context, it is also possible that government instruments and policies may shape the entrepreneurial intentions of academics by providing necessary resources, networks, infrastructures and favourable regulations (Rasmussen, 2008; Botelho and Almeida, 2010). Government support programmes contribute to reducing agency problems in adverse selections and moral hazards in the relationships between the government and the actors involved in the commercialisation of research (Rasmussen and Gulbrandsen, 2012). Lifting or easing restrictive regulations could also stimulate the creation of ASOs (Kroll and Liefner, 2008).

Table 5 Drivers covered by articles reviewed at the macro-level

Perspective	Key elements (variables)	Representative studies
Regional context	Level of economic development, culture and histories, geographical location and entrepreneurial environment	*Guerrero et al., 2008; Fini et al., 2011; Grimm and Jaenicke, 2012; Davey et al., 2016; Ghio et al., 2016; Conceição et al., 2017*
National context	Government instruments, regulations and support programmes	*Kroll and Liefner, 2008; Rasmussen, 2008; Botelho and Almeida, 2010; Rasmussen and Gulbrandsen, 2012*

2.3.2.2 Barriers

2.3.2.2.1 The micro-level

The development of ASOs is constrained by several internal and external barriers. Geenhuizen and Soetanto (2009) examined the nature of obstacles faced by ASOs during different development phases and to what extent these obstacles affect the performance of highly innovative spin-offs compared to other types of spin-offs. They suggested that different types of obstacles to growth exist and that these may be market-related (e.g. marketing knowledge, sales skills and customer base), finance-related (e.g. cash flow and capital investment), management-related (e.g. management capacity) and physically related (e.g. accommodation and infrastructure). For ASOs, market-related obstacles tend to be the most resistant over time whilst financial thresholds may be overcome fairly quickly. Compared to other types, highly innovative spinoffs could solve the credibility and sustainable returns problem more quickly due to first-mover advantages (Vohora et al., 2004; Geenhuizen and Soetanto, 2009; Zhou et al., 2011; Agarwal and Shah, 2014). Additionally, several studies have demonstrated that insufficient resources for technology transfer, the costs associated with innovation and a lack of applicability of knowledge impede the emergence of individual entrepreneurial intentions and the performance of ASOs (O'Gorman et al., 2008; Davey et al., 2016; Neves and Franco, 2016). Moreover, conflicted objectives, internal corporate governance issues, as well as a lack of entrepreneurial competences among the founding teams may disrupt the consistent development of ASOs (Vohora et al., 2004; Zhou et al., 2011; Davey et al., 2016; Neves and Franco, 2016). With regard to the individual attitude of academic founders, Singh Sandhu et al., (2011) found that risk and stress aversion as well as the fear of failure were also key barriers in the early stages of the venturing process. Consistent with this view, Maes et al. (2014) pointed out that female researchers perceive entrepreneurial obstacles in the spin-out formation process much more acutely than male researchers (Abreu and Grinevich, 2017).

Consequently, female researchers are less likely to become entrepreneurs than their counterparts (Ebersberger and Pirhofer, 2011). Additionally, homogeneous social network composition was found to be a hurdle to entrepreneurship (Hayter et al., 2017).

A further major barrier for scientists in the initial stages of the spin-off formation process is the academic system itself. Scientific acceptance and recognition within the scientific community may be achieved almost exclusively through the publication of research results; therefore, the success and recognition of a scientist is measured primarily by the number and ranking of his publications ('publish or perish'). Due to the fact that the scientific community has up to now rarely been made aware of the issues of starting a business, there is a lack of appreciation for the commercialisation of research results. Subsequently, scientists focus more on publishing their research findings and less on the opportunity to commercialise them. As a consequence, some start-up projects are not further substantiated and are even rejected (O'Gorman et al., 2008; Lacetera, 2009; Wright et al., 2009). Table 6 provides an overview of the micro-level barriers.

Table 6 Barriers covered by articles reviewed at the micro-level

Perspective	Key elements (variables)	Representative studies
Lack of entrepreneurial capabilities, knowledge and resources	Marketing knowledge, sales skills, customer base and financial resources	*Vohora et al., 2004; Geenhuizen and Soetanto, 2009; Zhou et al., 2011; Agarwal and Shah, 2014*
Lack of applicability of knowledge	Type of research	*Davey et al., 2016; Neves and Franco, 2016; O'Gorman et al., 2008*
Internal governance conflicts	Conflicting objectives	*Vohora et al., 2004; Zhou et al., 2011; Davey et al., 2016; Neves and Franco, 2016*
Attitude of the founders	Fear of failure, risk and stress aversion	*Maes et al., 2014; ; Hayter et al., 2017; Abreu and Grinevich, 2017*
Academic system	'Publish or perish'	*O'Gorman et al., 2008; Lacetera, 2009; Wright et al., 2009*

2.3.2.2.2 The meso-level

Regarding barriers at the meso-level (Table 7), a few studies have suggested that an organisation with rather weak entrepreneurial culture, infrastructure and support mechanisms has a significant negative impact on the emergence of entrepreneurial intentions as well as the growth potential of ASOs (Botelho and Almeida, 2010; Zhou et al., 2011; Bhayani, 2015; Neves and Franco, 2016). Supporting this, several studies in the review indicated that bureaucratic procedures, a lack of organisational support and encouragement for researchers engaging in the adaptation of new knowledge, as well as negative pressure from colleagues, may inhibit the emergence of individual entrepreneurial intentions and the sustainable development of ASOs (Davey et al., 2016; Neves and Franco, 2016). Furthermore, internal governance issues and Management style within the faculty were also found to be a hurdle for academics to entrepreneurship (Bhayani, 2015).

Table 7 Barriers covered by articles reviewed at the meso-level

Perspective	Key elements (variables)	Representative studies
Organisational characteristics	Weak entrepreneurial culture, lack of incubation infrastructure and services	*Botelho and Almeida, 2010; Zhou et al., 2011; Neves and Franco, 2016*
Bureaucracy	Bureaucratic procedures	*Davey et al., 2016; Neves and Franco, 2016*
Internal governance issues	Conservative management style	*Bhayani, 2015*

2.3.2.2.3 The macro-level

With regard to the macro-level, the limited availability of private funding sources represents a major barrier to effectively commercialising university technologies (Munari et al., 2018). Attracting external venture capital (EVC) support is seen as the biggest challenge with most ASOs due to the problem of information asymmetries from both the demand and the supply sides. On the one hand, it is difficult for academic entrepreneurs to attract suitable EVC investments. On the other hand, different types of venture capitalists have distinct preferences regarding investment in targeted selections. In addition, the heterogeneity of ASOs renders it more difficult for investors to make correct investment decisions (Knockaert et al., 2010; Zhou et al., 2011).

Another barrier to the success of ASOs is applying for and receiving state subsidies. Considering the fact that scientists' start-up projects are normally technologically based and highly capital-intensive, in most circumstances, applications for funding have to be submitted and granted before the start-up project proceeds. However, the application process is often extremely complex and time-consuming with various bureaucratic formalities that have to be observed during the process. Compared to private venture capital funding, the inferior financial contracting structure of public funding programmes may also negatively affect the commercial performance of ASOs (Ayoub et al., 2017). Hence, a lack of state subsidies can be seen as a context-specific barrier that may decrease the entrepreneurial intention of scientists, whilst also compromising the successful development of ASOs (Bhayani, 2015; Davey et al., 2016).

Furthermore, with regard to the perception of barriers in the ASO venturing process, the empirical evidence in the reviewed articles suggested the existence of country- and regional-specific differences. Countries and regions with superior market and financial situations are considered to have more successful opportunities for entrepreneurship. As such, the perceived entrepreneurial barriers are lower than in less-developed countries and regions (Davey et al., 2016; Neves and Franco, 2016). Table 8 provides an overview of these barriers at the macro-level.

Table 8 Barriers covered by articles reviewed at the macro-level

Perspective	Key elements (variables)	Representative studies
Financial supports	Limited availability of federal and private funding sources	*Knockaert et al., 2010; Zhou et al., 2011; Munari et al., 2018*
Bureaucracy	Complicated and time-consuming application and granting process	*Bhayani, 2015; Davey et al., 2016; Ayoub et al., 2017*
Country- and regional-specific differences	Level of economic development	*Davey et al., 2016; Neves and Franco, 2016*

2.3.2.3 Success factors

Before analysing the influencing factors that are critical to the success of ASOs, it is necessary to understand how scholars have evaluated their success in the past. As shown in Table 9, most scholars have only adopted conventional performance indicators such as survival rate, growth rate and profitability when assess them, which is consistent with the findings of Corsi and Prencipe (2015).

Table 9 Measurements of ASO success

	Success measurement indicator(s)	Author(s)
Financial performance	• Total Sales • Return on net assets • Number of products and or service innovation • Cash flow • Profitability • Market share • Commercialisation	*Hayter, 2013; Helm et al., 2016; Huynh, 2016*
Growth rate	• Growth rate in terms of sales • Growth rate in terms of employees	*Clarysse et al., 2011b; Geenhuizen and Soetanto, 2013*
Survival rate	• Survival rate	*Zhang, 2009*

2.3.2.3.1 The micro-level

With regard to the factors that are critical for the sustainable development of ASOs, the articles included in this review revealed that a great majority of researchers had adopted a resource-based approach to explore the relevant determinants, which could be generally categorised into internal conditions (ASO resources, strategies and capabilities) and external conditions (relationship with parent organisations and external supports). In terms of internal variables (Table 9), firstly, successful ASO development could be explained by firms' genetic characteristics as well as their initial competence endowments. Sufficient and diverse human, social and technological knowledge resource bases are key predictors of ASO success (Clarysse et al., 2011b; Colombo and Piva, 2012; Cho and Sohn, 2017; Hayter et al., 2017). Another determinant is innovation capability (such as the number of patents) (Ferri et al., 2018). A higher level of innovativeness helps ASOs overcome credibility and sustainable returns thresholds more quickly and easily (Geenhuizen and Soetanto, 2009; Helm et al., 2016).

Secondly, the composition and characteristics of the founding team also play a critical role in determining ASO performance. Roberts (1991) claimed that spin-offs with multiple founders outperform those with only one founder in terms of multiple performance indicators. Supporting this view, the articles in this study indicated the importance of having a founding team with a balanced demographic structure and diverse expertise in order to achieve ASO success. A founding team that includes members with both academic and non-academic backgrounds facilitate ASOs in balancing the relationship between pursuing research and economic goals (Visintin and Pittino, 2014).

Such composition also significantly improves ASO performance in terms of survival and growth by providing complementary human and social capital such as business management expertise or market and technological knowledge, which are exactly what most ASOs lack but need (Toole and Czarnitzki, 2009; Gimmon and Levie, 2010; Knockaert et al., 2011; Wennberg et al., 2011; D'Este et al., 2012; Borges and Filion, 2013; Criaco et al., 2014; Visintin and Pittino, 2014; De Cleyn et al., 2015; Fernández-Pérez et al., 2015; Nielsen, 2015; Ciuchta et al., 2016; Helm et al., 2016; Huynh, 2016; Huynh, et al., 2017; Ben-Hafaïedh, Micozzi and Pattitoni, 2018; Ferretti et al., 2018b). Gimmon and Levie (2010) discovered that founders' human capital, such as business management, technological expertise and academic status, could enhance their ability to attract external investments and improve ASO survival rate. Consistent with this, Huynh (2016) highlighted the importance of industrial, managerial and entrepreneurial experience of founding teams for improving early-age ASO fundraising ability. Such capabilities could be seen as valuable signals to investors (Huynh, 2016).

In addition, the quality, diversity, density and reciprocity of founding teams' social capital help ASOs overcome the problems of uncertainty and asymmetric information in the fundraising process (Huynh, 2016). Mosey and Wright (2007) addressed the notion that differences in the human capital of academic entrepreneurs could influence their ability to develop social capital and thus overcome barriers to venture development. Academics who have business ownership experience are more adept at building relationships with experienced managers and potential equity investors (Mosey and Wright, 2007). The development of ASOs' entrepreneurial competencies and innovativeness are also positively associated with the network ties of academic founders (Rasmussen et al., 2011; Walter et al., 2011; Rasmussen et al., 2015; Scholten et al., 2015). It is worth noting that founding teams co-evolve with ASO development and that such evolvement also influences ASO performance in terms of survival and growth (Clarysse and Moray, 2004).

Besides the characteristics of founding teams, an ASO management team comprised of heterogeneous knowledge and perspective may also enhance the entrepreneurial orientation and performance of ASOs (Knockaert et al., 2011; Hayter, 2013; Diánez-González and Camelo-Ordaz, 2016; Prencipe, 2016). Recruiting experienced professional non-academic managers in the management team could offset the commercial experience deficiency by providing ASOs with valuable commercial mind-sets and perspectives; such a combination may significantly improve ASO performance (Diánez-González and Camelo-Ordaz, 2016).

However, Ferretti et al. (2018b) suggested that despite all the benefits brought about by a heterogeneous team composition, the ratio of academic to non-academic individuals requires careful attention.

Thirdly, ASO performance could be shaped by the strategies and objectives that they adopt and a firm's structure (Zahra et al., 2007; Geenhuizen and Soetanto, 2009; Rasmussen, 2011; Colombo and Piva, 2012; Freitas et al., 2013; Hayter, 2013; Hayter, 2015b; Huynh, 2016; Soetanto and Jack, 2016). Given the genetic differences between ASOs and non-ASOs, the financing and collaboration strategies adopted by each are also different (Roininen and Ylinenpää, 2009; Colombo and Piva, 2012). ASOs prefer internal investments and collaboration with various external existing and potential partners to enlarge their technical advantages (Geenhuizen and Soetanto, 2009; Colombo and Piva, 2012; Hayter, 2013; Hayter, 2015b; Huynh, 2016). Various performance objectives such as proactiveness, risk-taking and competitive aggressiveness could also lead to varied ASO performance in the areas of growth and survival (Huynh, 2016). As regards a firm's structure, ASOs may improve early-stage fundraising ability by convincing investors of well-established mechanisms – for example internal communication and formal control mechanisms – coupled with a well-designed staff training process (Huynh, 2016). Diánez-González and Camelo-Ordaz (2017) noted that the structure of social networks also decisively influences ASO entrepreneurial orientation and behaviour. Consequently, such influence should not be ignored, especially when it could eventually affect ASO strategies and objectives. Table 10 provides an overview of the micro-level success factors.

Table 10 Success factors covered by articles reviewed at the micro-level

Perspective	Key elements (variables)	Representative studies
Initial competence endowments	Sufficient and diverse human, social and technological knowledge resource bases, innovation capability	*Geenhuizen and Soetanto, 2009; Clarysse et al., 2011b; Colombo and Piva, 2012; Cho and Sohn, 2017; Ferri et al., 2018*
Characteristics of founding and management teams	A team with a balanced demographic structure and diverse expertise	*Knockaert et al., 2011; D'Este et al., 2012; Hayter, 2013; Visintin and Pittino, 2014; Ciuchta et al., 2016; Huynh et al., 2017; Ferretti et al., 2018b*
Firm strategies, objectives and structures	Financing and collaboration strategies, different performance objectives	*Geenhuizen and Soetanto, 2009; Rasmussen, 2011; Colombo and Piva, 2012; Freitas et al., 2013; Hayter, 2013; Hayter, 2015b; Huynh, 2016*

2.3.2.3.2 The meso-level

As for external variables, the relationship with parent organisations in terms of size, density, strength, duration and multiplicity play an extremely important role in determining ASO performance regarding growth, survival rate and early-age fundraising ability (Steffensen et al., 2000; Rasmussen, 2011; Soetanto and Geenhuizen, 2015; Fackler et al., 2016; Huynh, 2016; Rao and Mulloth, 2017; Lukeš et al., 2019; Soetanto and Geenhuizen, 2019). Rasmussen et al., (2014) observed that ASOs demonstrate differing performance due to variations in initial departmental supports and that they gain momentum and exhibit superior performance if the department contributes to the development of entrepreneurial competencies. In contrast, a lack of department supports constrains the development of spin-offs regardless of the university's policies and practices. (Rasmussen et al., 2014). Different interaction patterns with parent organisations resulted in distinct modes of technology transfer (Wood, 2009; Treibich et al., 2013). Moreover, the social networks established through contacts with universities create a synergy effect and facilitate ASOs in obtaining the necessary technological knowledge and financial support (Huynh, 2016). ASOs with a higher level of university research cooperation and located in close proximity to parent organisations demonstrate superior innovation performance compared to non-ASOs (Stephan, 2014; Calcagnini et al., 2016; Ghio et al., 2016; Jung and Kim, 2017). Nonetheless, having the ability to balance the level of proximity to universities also affects ASO performance (Semadeni and Cannella, 2011; Soetanto and Geenhuizen, 2019). Ferretti et al., (2018a) also suggested a proper strategy that is 'neither absent nor too present' is necessary for parent universities to support the sustainable development of ASOs.

Moreover, sustainable ASO development depends on a university's capabilities (Rasmussen and Borch, 2010). Different capabilities play complementary roles at different development stages of the ASO venturing process (Rasmussen and Borch, 2010). Universities with excellent scientific productivity and innovation capability demonstrate superior entrepreneurial performance (Rasmussen and Borch, 2010; Van Looy et al., 2011; Bonaccorsi et al., 2014; Jung and Kim, 2017). Having the capability to integrate newly obtained resources could facilitate the ASO venturing process (Rasmussen and Borch, 2010; Borges and Filion, 2013). Furthermore, universities with more R&D expenditure increase the probability of spin-off generations (Patzelt and Shepherd, 2009; Avnimelech and Feldman, 2015). Table 11 provides an overview of the success factors at the meso-level.

Table 11 Success factors covered by articles reviewed at the meso-level

Perspective	Key elements (variables)	Representative studies
Relationship with parent organisation	Size, density, strength, duration and multiplicity	*Steffensen et al., 2000; Rasmussen et al., 2014; Soetanto and Geenhuizen, 2015; Fackler et al., 2016; Huynh, 2016; Lukeš et al., 2019; Soetanto and Geenhuizen, 2019*
University capabilities	Scientific productivity, innovation capability, resource integration capability etc.	*Rasmussen and Borch, 2010; Van Looy et al., 2011; Borges and Filion, 2013; Bonaccorsi et al., 2014; Jung and Kim, 2017*

2.3.2.3.3 The macro-level

Regarding the macro-level factors, Sternberg (2014) suggested that compared to regional government support programmes, the regional environment in which an individual establishes a firm demonstrates more explanatory power in ASO success. This was consistent with the findings of Geenhuizen and Soetanto (2013) who indicated that even within urban regions, ASO performance may vary between metropolitan areas and isolated small cities. Metropolitan areas could maximise the potential of learning networks to benefit ASO open innovation and performance in employment growth. This said, firms in isolated small cities are constrained by limited resources and contacts (Soetanto and Geenhuizen, 2009; Geenhuizen and Soetanto, 2013). In addition, the presence of high levels of human and social capital, as well as the innovation intensity of a region, could also significantly determine the location choice for ASOs (Calcagnini et al., 2016; Conceição et al., 2017). Governmental support policies affect ASO survival and growth performance more effectively when the entrepreneurial environment is weak within a region (Botelho and Almeida, 2010). Specific funding programmes with different rationales provided by governments have proved to be effective instruments in helping ASOs overcome financing problems (Rasmussen and Sørheim, 2012). Three different government programmes have been identified: Proof-of-Concept (PoC), pre-seed funding and seed funding. Each programme plays a different role in different stages of ASO development (Rasmussen and Sørheim, 2012). The PoC programme is aimed at reducing the uncertainty of initial university technologies, while the pre-seed programme enhances the commercial competence of ASOs. The purpose of both is to attract the attention of investors by enhancing the ASO entrepreneurial capacities (Rasmussen and Sørheim, 2012). In addition, government finance may be obtained for ASOs through a seed-funding programme, which fulfils the financial gap faced by most ASOs (Rasmussen and Sørheim, 2012).

Another important determinant is EVC support. As important financial resource providers for ASOs in their early-stage development, sufficient EVC support facilitates ASOs to reach economic milestones more efficiently (Knockaert et al., 2010). ASOs with EVC support demonstrate higher survival rates as well as superior employment and revenue growth than non-venture capital-backed spin-offs (Zhang, 2009; Bock et al., 2018). In certain circumstances, the presence of VC partners also enhances the growth of ASOs (Rodríguez-Gulías et al., 2017; Rodríguez-Gulías et al., 2018). Bock et al. (2018) noted that this superior performance could be attributed to venture capitalists' coaching capabilities. Furthermore, venture capitalists serve as valuable resource intermediaries connecting ASOs to other resource providers (Hayter, 2013) and may, themselves, provide academic entrepreneurs with valuable managerial skills (Ortín-Ángel and Vendrell-Herrero, 2010). Meanwhile, positive evaluation by EVCs has the power to enhance ASO credibility in the market, which also facilitates their ability to acquire additional key resources and services for their evolution in later development stages (Chugh et al., 2011; Fernández-Alles et al., 2015). Table 12 provides an overview of the macro-level success factors.

Table 12 Success factors covered by articles reviewed at the macro-level

Perspective	Key elements (variables)	Representative studies
Regional context	Level of economic development, geographic location, entrepreneurial culture, support from VCs	*Zhang, 2009; Knockaert et al., 2010; Chugh et al., 2011; Geenhuizen and Soetanto, 2013; Sternberg, 2014; Fernández-Alles et al., 2015; Calcagnini et al., 2016; Bock, Huber and Jarchow, 2018*
National context	Government policies, funding programmes	*Botelho and Almeida, 2010; Rasmussen and Sørheim, 2012*

2.4 Conceptual framework

As previously noted, an ASO's venturing process is complex, long-term and dynamic, involving influencing factors from multiple dimensions (Rasmussen, 2011). The following conceptual framework developed from previous findings provides an overview of ASO drivers, barriers and success factors at three different levels (see Table 13). It should serve as a helpful instrument for stakeholders embroiled in this process to make appropriate decisions. Starting with the driving factors, academics' entrepreneurial intentions and behaviours could be motivated by distinct intrinsic (Puzzle) and extrinsic (Ribbon and Gold) rewards (Lam, 2011). Furthermore, psychological and cognitive factors such as attitude, perceived behavioural control, ESE, role identity and value orientation could significantly affect academics' entrepreneurial propensity (Krabel and Mueller, 2009; Prodan and Drnovsek, 2010; Prodan and Lam, 2011; Knockaert et al., 2015). Another key determinant is an academic's human and social capital. In addition, research disciplines and the type of research also affect the likelihood of academics becoming entrepreneurs.

Meanwhile, given their peculiar nature, ASO creation may be determined by the characteristics and orientation of parent organisations. The existence of well-established university support mechanisms could significantly facilitate the ASO venturing process (Fini et al., 2011). At the macro-level, performance and intensity variations in academic entrepreneurship may be attributed to the different levels of regional economic development (Davey et al., 2016), location factors (Geenhuizen and Soetanto, 2013; Calcagnini et al., 2016), government support instruments and specific policies (Rasmussen, 2008; Botelho and Almeida, 2010). Specialised government funding programmes with different rationales could help ASOs overcome thresholds encountered in different development phases (Rasmussen and Sørheim, 2012).

With regard to the barriers, the sustainable development of ASOs is constrained by several internal and external barriers. Different types of obstacles to growth exist that are market-related (e.g. marketing knowledge, sales skills and customer base), finance-related (e.g. cash flow and capital investment), management-related (e.g. management capacity) and physical-related (e.g. accommodation and infrastructure) (Geenhuizen and Soetanto, 2009). Furthermore, the limited availability of private funding sources represents a major barrier to effectively commercialising university technologies (Munari et al., 2018). Attracting EVC support is seen as the biggest challenge faced by most ASOs due to the problem of information asymmetries from both the demand and the supply sides.

Complicated and time-consuming application and granting processes for governmental subsidies also impede the ASO venturing process. In addition, conflicting objectives, internal corporate governance issues, as well as a lack of entrepreneurial competences among founding teams may interfere with the consistent development of ASOs. Academics with conservative attitudes towards entrepreneurship, such as being risk and stress averse or fearful of failure, are less likely to start their own businesses. A further major barrier for scientists in the early stage of the spin-off formation process is the academic system itself, which has a lack of appreciation for commercialisation activities in academia. As for external barriers, the emergence of entrepreneurial intentions as well as ASO growth potential may be restricted when the parent organisation consists of a rather weak entrepreneurial culture, infrastructure and support mechanisms. Meanwhile, a paucity of state subsidies tends to be considered another major development barrier and specific regional and country contexts also determine the perception of barriers in the ASO venturing process.

In terms of factors that are critical for sustainable development, ASO performance is closely related to the endogenous factors and external conditions that it encounters. Due to the 'peculiar genetic characteristics' of ASOs, they are endowed with different initial competence configurations in terms of resources, capabilities and business models compared to non-ASOs, which determine their development strategies, and their objectives are different from their counterparts (Zahra et al., 2007; Colombo and Piva, 2012; Soetanto and Jack, 2016). Moreover, the composition and characteristics of the founding and management teams play a vital role in determining the development path and success of ASOs (Knockaert et al., 2011; Visintin and Pittino, 2014). A balanced demographic structure, coupled with heterogeneous and complementary expertise backgrounds could lead to superior ASO performance in regard to survival rate and growth (Gimmon and Levie, 2010; Hayter, 2013; Fernández-Alles et al., 2015; Nielsen, 2015). Rich industrial, managerial and entrepreneurial experience of founding team members, combined with close industry ties could be viewed as positive signals to investors, which significantly increases the possibility of ASOs obtaining early-age funding support (Huynh, 2016). With respect to external factors, ASO performance could be influenced by the ties with the parent organisation in terms of intensity, duration and multiplicity (Rasmussen, 2011; Fackler et al., 2016; Huynh, 2016).

Geographical proximity to research institutions and industrial districts could develop synergy and cluster effects, which further enhance ASO innovativeness (Stephan, 2014; Soetanto and Jack, 2016).

Furthermore, venture capitalists play a critical role throughout the venturing process as important financial resource providers for ASOs in their early development stages (Samila and Sorenson, 2010). Venture capitalists also serve as valuable resource intermediaries connecting ASOs to other resource providers (Hayter, 2013). A positive evaluation by VCs could enhance ASO credibility in the market, facilitating their ability to acquire additional key resources and services for their evolution in later development stages (Chugh et al., 2011; Fernández-Alles et al., 2015).

Table 13 Conceptual framework

	Micro-level	Meso-level	Macro-level
Drivers:	*Individual academic* • Intrinsic and extrinsic motivations • Human and social capital • Demographic characteristics • Psychological factors: Attitude, ESE, etc. • Cognitive factors: role identity, value orientation • Personality characteristics • Research type, quality, discipline	*University* • University characteristics • Research orientations • Support mechanisms: policies, incubation services, financial support and entrepreneurship education programmes	*Regional and national context* • Level of economic development • Geographical location, Entrepreneurial environment • Government instruments, Subsidy programmes and policies
Barriers:	*Individual academic* • Lack of entrepreneurial capabilities, knowledge and resources • Lack of applicability of knowledge • Team or governance conflicts • Fear of failure • Aversion to risk and stress • Attitude towards science: 'Publish or perish'	*University* • Lack of entrepreneurial culture • Bureaucracy • Management style • Lack of incubation services	*Regional and national contexts* • Limited availability of federal and private funding sources • Complicated and time-consuming application and granting processes for state subsidies • Country- and regional-specific differences
Success factors:	*A firm's internal factors* • Initial competence endowments • Composition and characteristics of founding and management teams • Firm strategies, objectives and structures	*University* • Relation with parent organisations, geographical proximity • University capabilities: scientific productivity, resource integration, innovation etc.	*Regional and national contexts:* • Regional environment and openness • Governmental policies • Support from venture capitals (VCs)

2.5 Implications

2.5.1 Theoretical Implications

According to the conceptual framework, this review has suggested several potential promising directions for future research. Firstly, as the ASO phenomenon is becoming more mature and ASO life cycles are becoming more transparent, further studies should adopt a more dynamic view to analyse the ASO venturing process. Researchers should primarily consider longitudinal analysis in the future given the fact that entrepreneurship is a long, complex and multi-level process. Academics' human and social capital, cognitive styles and capabilities evolve over time during the spin-off process; hence, longitudinal analysis could be adopted to track how the evolution of academics' profiles affect this process. Furthermore, researchers should adopt a more integrated perspective, paying more attention to joint impact, the interplay between different predictors across various levels (i.e. of the individual, firm, organisation and macro-environment), as well as within a certain level, so that an optimal combination might be found (Nolzen, 2018).

Secondly, it is worth noting the relationship between scientific output and entrepreneurial engagement. The papers included in this review emphasise the complementary relationship between these two activities. However, to what extent and in exactly what way academics and universities benefit from technology transfer activity deserves further investigation. Meanwhile, knowledge transfer also depends on certain contingent factors. Therefore, more empirical research is needed to explicitly identify and explain these factors in order to better predict the process (Landry et al., 2007). With regard to ASO performance, besides conventional performance measures, ASO heterogeneity in terms of objectives and types suggests that future research should consider expanding the selection scope of performance indicators and include those that are more in line with the peculiar characteristics of ASOs to better evaluate the benefits of different ASO types.

Thirdly, besides focusing on success factors, future studies should also shed more light on the obstacles and thresholds that impede ASO development by learning about the mistakes made by failed firms. This could, on the one hand, prevent ASOs from repeating past errors, while on the other hand, it could offer administrators and policy makers a more comprehensive overview for developing improved support mechanisms and programmes by which to facilitate commercialisation activities (Hueske and Guenther, 2015). In terms of theories, a great number of researchers have employed Ajzen's (1991) theory of planned behaviour to

explain the entrepreneurial intentions and behaviour of academics from a psychological perspective. Further studies should consider whether there are new psychological characteristics such as habits or preferences that are more suitable to explain academics' entrepreneurial intentions and behaviours. Moreover, based on the genealogical imprinting theories adopted by Ciuchta et al. (2016), explicitly exploring the following questions would prove promising: What is the link between the genetic characteristics of the parental organisation and ASO performance? To what extent do inherited characteristics affect ASO development paths? To what extent do department and university ethics affect the value orientation of academics? What are the consequences – what kinds of ASOs are most likely to establish second generation spin-offs?

Finally, more attention should be paid to multi-national comparisons, especially of those less researched but rapidly developing continents such as Asia (Fisch et al., 2016). Considering the variety of regional and national cultures and traditions, academics with different backgrounds could be motivated to start their own businesses for distinct reasons.

2.5.2 Practical Implications

There are also several practical implications for stakeholders at different levels. Firstly, differentiated and customised policies and support programmes are required to adapt to the different regional contexts and to meet the diverse needs of different types of ASOs. As for human factors, university administrators should specifically target academics who exhibit strong inclinations towards engagement in entrepreneurial activities. University internal policies based on diverse individual objectives and motives, such as leave of absence, conflict of interest and intellectual property (IP) ownership, could more effectively recruit and retain high-quality personnel. Such entrepreneurship-oriented policies could also significantly stimulate the entrepreneurial propensities of academics and facilitate them to start their own businesses.

Moreover, with regard to tenure and promotion policies, academics' promotion and tenure assessments remain primarily based upon scientific productivity and quality such as publications. Such orientation constrains the entrepreneurship involvement of academics, particularly those who are younger and non-tenured. Hence, to encourage academics to participate in commercialisation activities, university administrators should reconsider existing promotion policies and consider adjusting reward systems by including more entrepreneurial accomplishments as measurable indicators for promotion and tenure.

In addition, to facilitate ASO creation, government and university policymakers should consider reducing transaction costs, such as simplifying bureaucratic administrative procedures, breaking down organisational hierarchies and providing tax incentives. More importantly, the benefits or outcomes created by ASOs might also be observed over a long period of time. Subsequently, it is necessary for policymakers to adopt a long-term and dynamic perspective when designing and implementing policies. Furthermore, policies need to adapt over time rather than remain static. Besides merely focusing on designing policies and support mechanisms, establishing follow-up mechanisms to evaluate the effectiveness and efficiency of implemented policies and support mechanisms at different stages could, in time, help policymakers and university administrators adjust their support, thereby maximising the utility of policies in the long run. Fostering favourable department and university environments towards entrepreneurship could be achieved by appointing department leaders who are strong role models. For academics who are more sensitive to the influence of their peers, university administrators should increase the awareness of role models among their subordinates. Spiritual and material support are equally or perhaps more important for female academics because they perceive support from their colleagues as more valuable. Another solution for university administrators is to create more industry collaboration opportunities for academics, especially for those in technology-oriented disciplines, and maintain these relationships in the long-term. Universities aiming at increasing entrepreneurial involvement should also encourage academics to participate in both informal and formal commercialisation activities.

In addition to exerting external influences by developing and implementing policies and support mechanisms, fostering academics' entrepreneurial mind-sets and enhancing their internal entrepreneurial potential could also significantly increase their propensities for self-employment. Introducing entrepreneurship education is an effective way to achieve this goal. Not only could the entrepreneurial skills of academics be strengthened through education and training programmes, but also their "entrepreneurial drive" would be fostered (Walter and Block 2016; Raposo et al., 2008). Besides providing tailored entrepreneurship education programmes, different entrepreneurship-related events, such as lectures from successful academic entrepreneurs, workshops and seminars, should be regularly introduced. Such events not only impart new knowledge to academics, but also provide them with valuable opportunities to extend their networks.

However, university administrators should be aware that the consequences of participation in commercialisation activities are not always positive. Therefore, they should not promote entrepreneurial activities blindly and unconditionally. Instead, it is necessary for them to carefully consider the entrepreneurial proposals and interests of both academics and universities before they decide to take the step. To ensure the sustainable development of ASOs, ASO managers should pay more attention to the composition of the founding and management team, recruiting experienced individuals with a commercial background outside academia would offset the market knowledge deficiencies among academics. In addition, ASO managers should be aware of the social norms that academics inherited from their parent organisations as different objectives and orientations among team members could jeopardise the development consistency of ASOs (Visintin and Pittino, 2014). As one of the most important external supporters, ASOs often failed to attract venture capital investments due to the existence of the information asymmetry problem (Köhn, 2018). Therefore, from the demand side, ASOs and universities should eliminate this barrier to convince potential investors by proactively signalling their capabilities and objectives. From the supply side, before venture capitalists make investment decisions, applying more comprehensive measures to assess the characteristics and compositions of ASO founding teams during the due diligence process would be needed. In addition to the skills and capabilities of the founding team, evaluating the cognitive styles and objectives of founder(s) is liable to predict the future development paths of ASOs, which could predict whether the results are in line with the expectations of VCs.

3 Psychological factors and the perception of obstacles in academic entrepreneurship

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Abstract

The question why so many academic entrepreneurs postpone or stop their new venture creation plans has not been answered in detail by previous entrepreneurship literature. Our study helps to close this gap in research by focusing on psychological factors. We argue that specific responsive psychological factors have important impacts on the perception of entrepreneurial obstacles especially for academic entrepreneurs. Drawing on a comprehensive longitudinal dataset of 711 German university scientists, we find that the perception of entrepreneurial obstacles depend (a) positively on the degree of individual decision paralysis and the attitude towards science and (b) negatively on entrepreneurial self-efficacy and individual risk-taking propensity. In sum, our results help to understand if and how strong these psychological factors affect a scientist's perception of start-up obstacles and, thus, can assist university administrators and policy makers to make their entrepreneurship support programs more effective.

Keywords: academic spin-offs, academic entrepreneurship, technology transfer, entrepreneurial obstacles; Self-efficacy

JEL classification: M130 L260 O310 O320

3.1 Introduction

The phenomenon of why scientists start their own new venture has drawn considerable attention in entrepreneurship literature (e.g., Fritsch and Krabel, 2012; Van Gelderen et al., 2015). Nonetheless, the question of why many academic entrepreneurs stop or postpone pursuing their business ideas has not yet been answered convincingly by previous research. While existing studies have advanced our understanding which factors drive academics to start their own businesses (e.g., Hayter, 2015a; Iorio et al., 2017; Lam, 2011), only a paucity of research explored the reasons what prevent so many researchers from bringing their founding plans into action (e.g., Kollmann et al., 2017; Hossinger et al., 2020). Our study helps to close this gap in research literature in parts by focusing on the psychological mechanisms behind such researcher's avoidance reactions. Specifically, we argue that certain responsive psychological factors which are more common at universities have important effects on the obstacles perceived. This in turn leads to different subsequent entrepreneurial decisions of opportunity evaluation and exploitation.

Using a comprehensive two wave dataset of 711 academic entrepreneurs from 73 German universities, we therefore investigate the following research question: How do psychological factors of university scientists affect the extent they perceive entrepreneurial obstacles? By doing so, our analysis is focused on individual decision paralysis, self-efficacy, individual's attitude towards science and his or her risk-taking propensity and how these specific factors affect the extent of perceived entrepreneurial obstacles. Accordingly, our hypotheses are built on three well-known psychological theories, namely the decision conflict theory from Janis and Mann (1977), the theory of planned behaviour from Ajzen (1991) and institutional theory drawn from Meyer and Rowan (1977).

In line with our hypotheses, our findings show that the extent of entrepreneurial obstacles perceived by scientists depend strongly on the degree of individual decision paralysis, self-efficacy, attitude towards science and risk-taking propensity. Whereas decision paralysis and attitude towards science are positively associated with the extent of obstacles perceived, self-efficacy and risk-taking propensity show a negative relationship.

From the theoretical and practical perspective, our study sheds more light on the avoidance phenomenon of academic entrepreneurship and, thus, helps to understand the psychological mechanisms that are responsible for the avoidance decisions of academic entrepreneurs

when facing start-up obstacles. Moreover, we contribute to research in this stream of literature by showing that the extent of obstacles perceived can be explained to some extent by multiple psychological factors of academic scientists. In particular, this is the first study to focus on the concept of decision paralysis to explain entrepreneurial avoidance decisions by university scientists and thus provides future research with a new perspective to assess the reaction of individuals to obstacles encountered during the entrepreneurial process. From a practical perspective, our study contributes to literature by providing university administrators, technology transfer offices and potential investors with information how to develop targeted knowledge commercialization strategies based on the psychological mechanisms to help scientists leverage their perception of obstacles as objectively and accurately as possible.

The remainder of the paper is structured as follows: in the second section, the empirical findings of related prior research are summarized, and our theoretical framework and hypotheses are introduced. Subsequently, our empirical design is presented. The final section discusses our findings and presents limitations and suggestions for future research.

3.2 Theoretical background and hypotheses

The path of academic entrepreneurship is iterative as well as non-linear so that challenges from both internal and external dimensions have to be faced (Druilhe and Garnsey, 2004; Rasmussen et al., 2014; Rothaermel et al., 2007; Miranda et al., 2017a; Djokovic and Souitaris, 2008). According to Vohora et al. (2004), for example, the development of ASOs generally experience five successive development phases. Due to the deficiency of social capital, weaknesses of resources and inadequacy of internal capabilities, the transition between each phase is separated by "critical junctures" (thresholds) that need to be overcome in order to move forward to the next phase (Vohora et al., 2004). In this context, Geenhuizen and Soetanto (2009) emphasize that these obstacles that are faced by ASOs in different development phases could be either market- (e.g. marketing knowledge, sales skills and customer base), management- (e.g. management capacity), finance- (e.g. cash flow and capital investment) or physically related (e.g. accommodation and infrastructure). Previous studies also identify the factors that impede the creation of ASOs from multiple dimensions. For example, conservative attitudes and perceptions of academics such as fear of failure, risk and stress aversion will trigger their avoidance reactions which, in turn, will have a detrimental effect on the way academics evaluate and exploit entrepreneurial opportunities (Abreu and

Grinevich, 2017; Hayter et al., 2017; Kollmann et al., 2017; Maes et al., 2014; Singh Sandhu et al., 2011). Additionally, insufficient resources for technology transfer, the costs associated with innovation and a lack of applicability of knowledge impede the emergence of ASOs as well (O'Gorman et al., 2008; Davey et al., 2016; Neves and Franco, 2016). Weak entrepreneurial culture, lack of support within the organization, combined with the bureaucratic procedures were also found to be the key hurdles of ASO creation (Davey et al., 2016; Botelho and Almeida, 2010; Neves and Franco, 2016). To sum up previous research results: Though the role of obstacles in the entrepreneurial context has been examined before, too little is known about how and how strong specific factors affect the way individuals perceive entrepreneurial obstacles. Especially the psychological mechanisms underlying such avoidance decisions in the venturing process have been neglected so far by research literature. We therefore aim to fill this gap in this stream of research literature by applying three well-known psychological theories, namely the decision conflict theory from Janis and Mann (1977), the theory of planned behaviour from Ajzen (1991) and the institutional theory drawn from Meyer and Rowan (1977).

3.2.1 Decision paralysis

Decision conflicts occur when decision makers have to choose between multiple alternatives (Huber et al., 2012; Luce et al., 2000). Based on the individual objectives, the decision maker evaluates the "pros and cons" of each alternative subjectively (Anderson, 2003). Preference uncertainty appears when the individuals are unable to choose between the alternatives with sufficient certainty (Huber et al., 2012; Anderson, 2003). This can lead to an appetence-aversion or approach-avoidance conflict (Dhar, 1996; O'Neil et al., 2015; Berelson and Steiner, 1964). Simultaneously, the consequences of each decision have to be considered as well. Hence, individuals need to weigh this in advance. As a result, ambivalence may arise due to the advantages and disadvantages of each alternative (O'Neil et al., 2015). Finally, such ambivalence may either be resolved or trigger avoidance reactions (Berelson and Steiner, 1964; O'Neil et al., 2015). Based on the decision conflict theory from Janis and Mann (1977), psychological stress can be triggered by such an appetence-aversion conflict, which then can result in the failure of high-quality decision-making (Janis and Mann, 1977; Mann et al., 1998; Dhar, 1996). Furthermore, decision-makers usually attempt to explain a decision both to themselves and to third parties (Redelmeier and Shafir, 1995; Huber et al., 2012).

Therefore, psychological stress can be explained by factors originating from two different sources: (a) either the fear of heavy personal, material or social losses due to the decision making and (b) or by the loss of individual reputation and self-esteem if the decision goes wrong (Mann et al., 1998). According to the decision conflict theory (Janis and Mann, 1977), there are two main reaction patterns when dealing with psychological stress under complex and difficult decision-making circumstances, namely vigilance and procrastination. Vigilance describes the state of increased alertness of a decision maker. The decision maker meticulously searches for more relevant information at high analytical expense and repeatedly compares the advantages and disadvantages of the relevant alternatives based on his personal objectives. (Janis and Mann, 1977; Mann et al., 1998). Procrastination describes the attempt made by the decision maker to deliberately escape the decision conflict by delaying or avoiding a decision making (Anderson, 2003). Due to incomplete and distorted information, the decision maker searches for an optimal alternative and hesitates to take responsibility for the decision or to develop wish rationalizations (Luce, 1998; Mann et. al., 1998). Put differently, the decision maker fears the negative consequences of his decision so that it can become more attractive to him to avoid making decisions instead of making a wrong decision which could lead to failure (Ferrari, 1991; Janis and Mann, 1977; Mann et al., 1998). Moreover; existing literature indicates that the more complicated and extensive a decision conflict is perceived by a decision maker, the more pronounced both vigilance and procrastination tendencies will be (Tversky and Shafir, 1992; Redelmeier and Shafir, 1995). In addition, the degree of vigilance also has a positive effect on the degree of procrastination (Mann et. al., 1998). Thus, by combining both vigilance and procrastination, a new holistic construct can be implemented to explain the difficulty to make such decisions. While previous studies focused on the choice procrastination or avoidance in decision making, the degree of vigilance associated with it has systematically been overlooked. The degree of vigilance which causes procrastination effect can be defined as decision paralysis (Luce, 1998; Janis and Mann, 1977; Mann et al., 1998). How does this body of research now relate to entrepreneurial decisions in the academic context? The act of entrepreneurship puts academic founders under a series of complex decisions, such as selection of suitable cooperation partners, determination of distribution channels, arrangement of patents and copyrights or searching for optimal financing sources and other. All these decisions require a high level of commitment, concentration and rational behaviour from the founder-side. Moreover, another factor that has decisive influence on decision making is the fear of a founder to make suboptimal deci-

sion and the possible negative consequences of such decision. Due to the professional characteristics and backgrounds, especially academic entrepreneurs are expected to be particularly analytical, considerate and tend to behave more rationally than other types of entrepreneurs. Therefore, academic entrepreneurs will attempt to collect as much information as possible during the decision-making process. That is, they will search intensively for the best solutions with a high analytical effort. However, due to the special innovative nature of academic entrepreneurship, the decision situation will change constantly, and perfect decision solutions will often not exist. This, eventually, will lead to confusion, helplessness and procrastination and result in a higher perception of entrepreneurial obstacles. Based on these arguments, we therefore propose the following hypothesis:

Hypothesis 1: An increase in decision paralysis by academic entrepreneurs is positively related to the extent of perceived entrepreneurial obstacles

3.2.2 Entrepreneurial self-efficacy (ESE)

Based on the theory of planned behaviour, the concept self-efficacy describes the extent of one's self-confidence to successfully complete specific tasks based on her/his capabilities and skills (Bandura, 1977; Gist and Mitchell, 1992; Wilson et al., 2007; Obschonka et al., 2015). An important feature of self-efficacy is that it is task- and domain-specific (Zimmerman et al., 1992) Individuals may have a low self-efficacy in one area but a high self-efficacy in another (Bandura, 1977; Bandura, 1982). The extent of self-efficacy is determined by two factors: the psychological belief if an individual has the necessary skills and capabilities to solve a specific task (Gist and Mitchell, 1992; Bandura, 1989), and the individual's belief that these skills and capabilities can be converted into an effective outcome (Bandura, 1977; Bandura, 1990). Current studies show that individuals with a strong self-efficacy are more likely to pursue and successfully complete specific tasks than those with relatively lower degrees of self-efficacy (Bandura, 1997; Wood and Bandura, 1989; Bandura, 1982). Furthermore, Bandura (1977) argues that self-efficacy determines, on the one hand, how much effort an individual will invest in order to solve a specific task, and on the other, how long this effort will last due to the perceived obstacles. Thus, with a strong self-efficacy tendencies, even the most difficult obstacles can be overcome by an entrepreneur through a persistent effort. Entrepreneurs with higher self-efficacy are those who are more aware of their skills and capabilities and will therefore also have a stronger conviction that fulfilment of a specific task strongly depends on these capabilities (Bandura, 1997; Fernández-Pérez et al.,

2015). In the context of academic entrepreneurship, previous studies indicate that scientists with a higher entrepreneurial self-efficacy are more likely to found their own firms (Díaz-García and Jiménez-Moreno, 2010; Fernández-Pérez et al., 2015). In the context of academic spin-offs, it can therefore also be expected that the degree of ESE of scientists will influence the extent of the entrepreneurial obstacles perceived. Due to their professional characteristics, scientists usually possess a diverse set of theoretical expertise and abstraction capabilities (Zimmerman et al., 1992). Regarding their strong abstraction capabilities, scientists are more likely to successfully apply their specialist knowledge than other types of founders when establishing a company. Scientists with a higher level of entrepreneurial self-efficacy are therefore more confident and believe that they have the capabilities to achieve the entrepreneurial objective on their own. As a result, we expect entrepreneurial obstacles to be less strongly perceived. Thus, we hypothesize:

Hypothesis 2: An increase in entrepreneurial self-efficacy by academic entrepreneurs is negatively related to the extent of perceived entrepreneurial obstacles

3.2.3 Risk-taking Propensity

Entrepreneurial decision and risk are inextricably connected (Brindley, 2005; Caliendo et al., 2014). Previous studies show that the ability to bear risks is often seen as one of the main characteristics of an entrepreneur, which has a decisive influence on the success of the foundation of new ventures as well (Haeussler and Colyvas, 2011; Hoye and Pries, 2009; Singh Sandhu et al., 2011). Risk-taking propensity is defined as an individual's current tendency to take or avoid risks (Sitkin and Weingart, 1995). Thus, risk-taking propensity is based on an internal subjective interpretation of expected losses compared to the expected rewards under uncertainty (Brockhaus, 1980). According to social learning theory, risk-taking propensity can be considered as a learned behaviour that can change over time (Brindley, 2005). Therefore, risk-taking propensity is an emergent property of the decision maker which depends decisively on both personal traits and the socio-cultural environment (Sitkin and Weingart 1995; Brindley, 2005). Macko and Tyszka (2009) indicate that it is also necessary to distinguish the types of risks, namely purely chance-related and skill-related risks. People are willing to take more risks only if the outcome of their decision depends on skills instead of chance (Macko and Tyszka, 2009). The risks associated with starting a venture are mainly skill-related, which are perceived subjectively by individuals' personal experiences and abilities.

People without prior entrepreneurial experience will evaluate the risks and obstacles higher, which would prevent them from pursuing it eventually (Sitkin and Weingart, 1995). This applies to academics as well. Academic founders have to constantly make decisions under uncertainty in the venturing process. However, the consequences of the decisions cannot be foreseen and may results in losses. Most of academics lack market knowledge or entrepreneurial expertise in terms of founding a firm (Agarwal and Shah, 2014; Geenhuizen and Soetanto, 2009). In this situation, they have no control of the outcomes and will perceive the difficulty of the decision much higher. Consequently, they are less likely to take the risks that come along. Thus, we expect that the risk-taking propensity of academics is negatively associated with the entrepreneurial obstacles perceived. We therefore hypothesize:

Hypothesis 3: Risk-taking propensity of academic entrepreneurs are negatively related with the extent of entrepreneurial obstacles perceived

3.2.4 Attitude towards science

According to the institution theory (Meyer and Rowan, 1977), individuals adjust themselves according to the expectations and norms of the institutions they belong to. Thus, an important factor that affect the extent of perceived entrepreneurial obstacles may derive from the socialization process in a scientific context. For example, at the beginning of their careers, young scientists may still quite open to the topic of entrepreneurship. However, this openness is will gradually be lost as their career continues. The explanation for this phenomenon is that the junior researchers at universities will be taught quite quickly and clearly that the future of their academic careers depend almost exclusively on their publication quality (Wright et al., 2009; Lacetera, 2009). With the increasing emergence of the "publish or perish culture" in academia, both junior and established researchers perceive their future opportunities and recognition to be closely associated with the number and the quality rank of their academic publications (O'Gorman et al., 2008; Wright et al., 2009; Lacetera, 2009). Viewed negatively, there is still a lack of appreciation for the knowledge commercialization within the science community in the university context (Bijedić et al., 2017). Furthermore, for scientists who believe that academia and industry should be distinguished and perceive research findings as public goods will focus more on publishing their studies rather than commercializing them or applying for patents (Guerrero et al., 2015; Kruss and Visser, 2017). Put differently, scientists are locked in publishing their studies instead of searching for potential

commercialization opportunities (Johnson et al., 2017). Consequently, some start-up projects are not further specified by scientists or proceed very slowly (O'Gorman et al., 2008; Wright et al., 2009; Bijedić et al., 2017). Moreover, once a scientist has achieved a certain recognition within the academic community, the lock-in effect persists. In a related vein, previous studies also argue that there is a trade-off effect between knowledge transfer and scientific activity; that is, getting engaged in knowledge transfer activities at the expense of scientific productivity (Czarnitzki et al., 2014; Shane, 2004). Since establishing a new company requires extra time and personal resources, scientists have to balance their resources and time between these activities (i.e. opportunity costs) (Neves and Franco, 2016), which could undermine their scientific careers due to lack of scientific outcomes (Aldridge and Audretsch, 2011). The balance and the potential opportunity cost will make it for scientists more difficult to switch from research to entrepreneurship. Hence, entrepreneurial obstacles will be perceived more strongly. We therefore hypothesize:

Hypothesis 4: An increase in attitude towards science by academic entrepreneurs is negatively related to the perception of entrepreneurial obstacles.

3.3 Methodology

3.3.1 Sample and data

Our empirical study is based on a dataset that was conducted in cooperation with the IfM Bonn (Institut für Mittelstandsforschung Bonn) in 2013 and 2016 covering 73 German universities. In the initial survey in 2013, 36,918 scientists from different types of universities of higher education (research and teaching / universities of applied sciences), from a variety of faculties (including information and computer science, medicine, engineering and biology) and holding different positions (i.e. from a researcher to a full professor positions) were surveyed with a focus on their entrepreneurial propensities and actions they have undertook to start a new business (gestation activities) and obstacles they have perceived. Responses from 7,342 scientists were received. The scientists who have been surveyed in 2013 were then invited to participate a follow-up survey in 2016. Out of the questionnaires that have been sent out, a total of 1,252 completed the questionnaire, which correspondents to a response rate of approx. 17%. After excluding those with missing values on start-up activities (e.g. for example those who abandoned their plans on commercialization), information is

available from 771 scientists. We use this sample to estimate the empirical models and test our four hypotheses.

Our sample of 771 scientists are at different start-up stages: 73% were in the pre-market entry stage, 11% in the market entry stage and around 15% were in the post market entry stage. Our sample covers scientists from different types of universities. 84% of them work for research-based universities, while 16% work in universities of applied science. Almost 18% of the sample had prior start-up experience and approximately 20% of the sample have made inventions based on their research activities at their research institutes. Field-wise around 72% of the scientists in our sample are members of the STEM faculties (science, technology, engineering, and mathematics), 13% of our sample are economics or social scientists, 0.5% are architects, 1.8% are in medicine and health management, less than 1% are artists and 11% of the scientists in our sample are members of other faculties.

3.3.2 Dependent and explanatory variables

Table 1 describes the variables at the individual and organizational level that we use in our regression models with their summary statistics. The third column of Table 14 also includes the year in which the scientist's characteristics were observed (2013 or 2016).

Table 14 Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max	VIF
Dependent variable					
Entrepreneurial obstacles	3.358	.867	1	5	.
Start-Up progression					
Pre market entry stage	.735	.442	0	1	.
Market entry stage	.113	.316	0	1	1.12
Post market entry stage	.153	.360	0	1	1.31
University characteristics					
Invention at university	.204	.404	0	1	1.23
University type	.843	.364	0	1	1.47
Faculties					
STEM	.718	.450	0	1	2.28
Economics/ Social science	.133	.340	0	1	2.04
Architecture	.005	.072	0	1	1.07
Medical technology	.018	.133	0	1	1.17
Arts	.009	.095	0	1	1.12
Other faculty	.116	.321	0	1	.

(**Table 14** continues on the next page)

Table 14 (continued)

Positions					
Professor	.146	.354	0	1	2.96
Assistant professor	.210	.407	0	1	3.28
Research assistant	.565	.496	0	1	4.21
Other position	.079	.270	0	1	.
Research types					
Basic research	3.405	1.407	1	5	1.67
Applied research	3.765	1.258	1	5	1.73
Interdisciplinary research	3.408	1.287	1	5	1.23
Individual Characteristics					
Age	36.492	10.130	23	65	2.15
Gender	.322	.468	0	1	1.14
Migration background	.088	.283	0	1	1.03
Married	.671	.470	0	1	1.32
Children	.396	.489	0	1	1.68
Entrepreneurial Contacts	.264	.441	0	1	1.35
Start-Up promotion offer	.299	.458	0	1	1.11
Start-Up experience	.182	.386	0	1	1.20
Self-employed colleagues	.338	.473	0	1	1.15
Self-employed parents	.300	.459	0	1	1.05
individual attitudes					
Decision paralysis (H1)	3.431	.532	1	5	1.09
Self-efficacy (H2)	2.955	1.032	1	5	1.54
Risk taking propensity (H3)	2.745	.974	1	5	1.30
Attitude towards science (H4)	3.097	.817	1	5	1.07

Note: N= 771

Our dependent variable is the extent of perceived entrepreneurial obstacles. In order to measure this, scientists from both the initial and the follow-up surveys were asked to provide information about what impedes them from further advancing their start-up project. The items used to measure these obstacles were taken from the ISCE survey 2006 (International Survey on Collegiate Entrepreneurship). A total of nine different items (entrepreneurial obstacles) were examined (self-report), which range from the business model, the work time load and the deficiency of foundation knowledge or financial resources. All items were measured in a 5-point Likert scale (1=strongly disagree; 5=strongly agree). The reliability coefficient of Cronbach's alpha across all nine items was α=0.8040. All items were aggregated to an average index and included in our regression models.

The following four variables are our main explanatory variables to test our hypotheses: decision paralysis, entrepreneurial self-efficacy, risk-taking propensity and attitude towards science. The measurement of decision paralysis was based on the Melbourne decision making questionnaire from 1997 that was developed by Mann et al. (1998). Two sub-variables, namely vigilance and procrastination were also examined in the original study based on six different items (Mann et al., 1998). The results showed that the reliability coefficient Cronbach's alpha achieved in this study deviates only slightly from that of the original study. Looking at both variables separately, the Cronbach alpha of the sub-variable vigilance is $\alpha=0.780$ and Cronbach alpha of the procrastination is $\alpha=0.780$. If both sub-constructs were to be combined for decision paralysis, Cronbach's alpha for all 12 items is $\alpha=0.7469$. Another important variable is the risk-taking propensity. According to the measurement method from Caliendo et al. (2014), scientists interviewed were asked if they were rather a risk seeking or a risk averse person. To measure the entrepreneurial self-efficacy, scientists surveyed were asked to evaluate their success expectations to the entrepreneurial project on the basis of their personal capabilities. More specifically, the measurement was based on the construct developed by Zellweger et al. (2011) for measuring the ESE. This construct was based on four different items. The reliability coefficient Cronbach's alpha for these items was $\alpha=0.9039$. The measurement of attitudes towards science was based on the construct from Ding et al. (2006) and Haeussler and Colyvas (2011). Scientists interviewed were asked to evaluate various statements with regard to the scientific publication system and the balance between research and entrepreneurship (self-report). All items from these measures (decision paralysis, ESE, risk taking propensity, attitude towards science) were measured in a 5-point Likert scale (1=strongly disagree; 5=strongly agree). To develop the regression model, the items were subsequently condensed by using an average index and included as our main independent variables. Since the underlying survey was conducted in German, all items were translated into English in advance with the help of three different translators.

3.3.3 Control variables

By following the contextualized research approach (Welter, 2011), we control for several variables from multiple dimensions that may affect our dependent variables as well as the extent of perceived entrepreneurial obstacles. Starting from the organizational level, we controll for the degree of start-up progression. To identify the potential phase-specific barriers, we control for three different progress stages. We measure a stage by the extent to which a spin-off project has been progressed. Given the fact that there is a spectrum of activities, associated with different degrees of exploration or exploitation of spin-off project steps, we control for the following three progress stages, namely the pre-market entry stage, the market entry stage and the post-entry stage. Moreover, we control for invention at the university. Scientists with inventions based on their research at the university could consider the inventions as a potential entrepreneurial opportunity to pursue. We therefore assume that scientists with an invention will perceive the entrepreneurial obstacles much less compared to their peers without an invention. In terms of the university-specific influencing factors, we control for the types of university. Former studies show that having contacts with private sectors in research projects would increase the propensities of scientists involved to found new companies and to establish more networks (Arvanitis et al., 2008). Since research projects with the private sector are more common at universities of applied sciences than at universities, academics at universities of applied sciences will also benefit more from these networks. As a consequence, this could lead to a lower level of perceived entrepreneurial obstacles. Additionally, previous studies show that the type of research (basic or applied research), the position within the university as well as the research disciplines affect academics' entrepreneurial behaviours. Perkmann et al. (2011) indicate that the entrepreneurial commitment of scientists from the medical technology field is far more pronounced than scientists from the economic-/ social sciences. While scientists from the medical technology field and STEM are active in all entrepreneurial areas, scientists from the economic-/ social sciences tend to concentrate on consulting services and/or contract research for industry (Abreu and Grinevich, 2013; Fini and Toschi, 2016; Moog et al., 2015; Prodan and Drnovsek, 2010). Start-up projects from the STEM, bio- and medical technological faculties are usually technology-oriented and capital intensive. Furthermore, scientists from the aforementioned research fields usually do not have sufficient business management and legal knowledge (Zhou et al., 2011; Davey et al., 2016; Neves and Franco, 2016).

This makes the implementation of their own entrepreneurial project even more difficult. Therefore, scientists from the STEM, bio- and medical technology fields are expected to perceive entrepreneurial obstacles much more strongly than their colleagues from other fields. To control this effect, the faculties STEM, economics/ social science, architecture, medical technology as well as arts were compared with the other faculties. Moreover, we control for the positions of scientists within the university. Due to the social and financial securities, scientist with tenure positions are expected to perceive entrepreneurial obstacles much less. With regard to the research types, Arvanitis et al. (2008) and Fischer et al. (2017) indicate that universities with a focus on applied research have a higher propensity to engage in technology transfer activities than universities with a focus on basic research, which in turn could reduce the extent of perceived entrepreneurial obstacles. As for the demographic characteristics of scientists, previous studies show that female scientists are less likely to commercialize their research results compared to their male colleagues and consequently they have lower entrepreneurial propensities (Ding et al., 2006; Díaz-García and Jiménez-Moreno, 2010). Abreu and Grinevich, 2017) indicates that female researchers perceive entrepreneurial obstacles in the spin-out formation process much more acutely than their male counterparts. Due to this reason, we control for a potential gender-specific effect. In addition, age has a decisive influence on the extent of perceived entrepreneurial obstacles as well. Considering the nature of academic career, scientists could only gather sufficient capital stock for setting up a company at a relatively late stage. Moreover, as age increases, the period in which profits can be achieved through entrepreneurial activities decreases as well (Bijedić et al., 2017; Lévesque and Minniti, 2006). As a result, the entrepreneurial obstacles could be perceived much more strongly with increasing age. Therefore, we control for a scientists age. Another control variable is the original background of the founder. Previous research results suggest that people with a migration background are more likely to be self-employed than those without (Constant and Zimmermann, 2006; Siegel and Waldman, 2019). In addition, Krabel and Mueller (2009) found that academics with work experience in different cultural environments possess a greater diversity of ideas, perspectives and creative techniques than those with few culture backgrounds (Krabel and Mueller, 2009; McEvily and Zaheer, 1999). Hence, we control for migration backgrounds of scientists. Given the fact that stress aversion is a key barrier in the early stages of academic entrepreneurship, academics with conservative attitudes toward entrepreneurship, such as being stress averse or fearful of failure, are less likely to start their own businesses (Hossinger et al., 2020; Singh Sandhu et al., 2011; Huynh, 2016; Rasmussen et al., 2015; Walter et al.,

2011). Consequently, the extent of perceived entrepreneurial obstacles could be higher as well. To proxy the effect of stress and fear we additionally control for, children and marital status. Regarding the entrepreneurial networks, a number of studies argue that the variety and intensity of entrepreneurial networks change entrepreneurial skills of the founders, but also the sustainable development of the company (Rasmussen et al., 2011; Walter et al., 2011; Rasmussen et al., 2015; Scholten et al., 2015). Hence, it is to be expected that founders who have already established networks or contacts would perceive entrepreneurial obstacles much less. Therefore, we control for the entrepreneurial contacts of scientists. We also control if a scientist attended a start-up promotion offer. Start-up promotion offers provided by such as technology transfer offices, patent agencies or incubators significantly improve the performance of ASOs due to a set of valuable services such as complementary technical and management supports (Fernández-Alles et al., 2015; Rodríguez-Gulías et al., 2016; Slavtchev and Göktepe-Hultén, 2016), contacts to external funding sources (Berbegal-Mirabent et al., 2015), and training and mentoring programs (Gómez Gras et al., 2008). Hence, it is to be expected that scientists who attended the start-up promotion offers would perceive entrepreneurial obstacles much less. Furthermore, entrepreneurial skills and experiences also enhance the capabilities of scientists in identifying and exploiting entrepreneurial opportunities (Abreu and Grinevich, 2013; Acs et al., 2013; Erikson et al., 2015; Fini and Toschi, 2016; Fini et al., 2011; Krabel and Mueller, 2009; Shane, 2004). Mosey and Wright (2007) argued that founders who failed to establish a company in the past would repeatedly benefit from the experience they have gained, and the networks established when they decide to found a new company again. Based on their previous experience, scientists who have already founded a company would perceive the entrepreneurial obstacles much less. Thus, we control for the prior entrepreneurial experience of scientists. Previous research also suggests that the entrepreneurial behaviour of scientists is closely influenced by the local entrepreneurial culture. The existence of a favourable entrepreneurial atmosphere within a local environment and the availability of people with open minds would significantly encourage academics to be self-employed (Davey et al., 2016; Fini et al., 2011; Ghio et al., 2016). In this regard, Stuart and Ding (2006) and Moog et al. (2015) indicate that role models and peers affect the likelihood of academics to engage in entrepreneurial activities. A supportive entrepreneurship environment would help scientists perceive the entrepreneurial obstacles less. Hence, we control for both self-employed colleagues and parents.

3.3.4 Analytical procedure

In the empirical models, which will be discussed in detail in the next section, the hypotheses derived from the theories were tested by using multiple linear regression. Two regression models were developed (see Table 16). In the first regression model (model 1), the influence of the control variables regarding the extent of perceived entrepreneurial obstacles has been examined firstly. A further regression model (model 2) has been developed to test the hypotheses H1, H2, H3 and H4, which included both the independent variables and the control variables. The underlying correlations between the variables used are shown in Table 15. We find only weak correlations between the independent variables. The variance inflation factors (VIF) range from 1.03 (lowest value) to 4.21 (highest value). We analysed all variables histograms and found that the errors are identically and independently distributed with constant variance. Overall, these results only suggest the presence of moderate multi-collinearity.

Table 15 Correlation matrix

	Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)
(1)	Entrepreneuial obstades (DV)	1																																
(2)	Pre market entry stage	.24	1																															
(3)	Market entry stage	-.10	-.59	1																														
(4)	Post market entry stage	-.21	-.71	-.15	1																													
(5)	Invention at university	-.01	-.16	.01	.19	1																												
(6)	University type	.07	.05	-.02	-.04	.02	1																											
(7)	STEM	.18	.04	.00	-.05	.16	.20	1																										
(8)	Economics/ Social science	-.26	-.03	-.01	.05	-.16	-.06	-.63	1																									
(9)	Architecture	-.02	-.08	.09	.02	-.04	-.07	-.12	-.03	1																								
(10)	Medical technology	-.06	.02	-.05	.02	.00	-.05	-.22	-.05	-.01	1																							
(11)	Arts	-.03	.00	-.03	.04	-.02	.00	-.15	-.04	-.01	-.01	1																						
(12)	Other faculty	.07	-.01	.02	-.01	-.04	-.18	-.58	-.14	-.03	-.05	-.04	1																					
(13)	Professor	-.16	-.10	-.02	.14	.11	-.39	-.08	.10	-.03	.00	.00	.01	1																				
(14)	Assistant professor	.03	.01	-.02	.01	.08	.20	.11	-.06	-.04	-.05	-.02	-.05	-.21	1																			
(15)	Research assistant	.06	.06	.05	-.11	-.14	.17	.01	.02	.06	-.02	.00	-.05	-.47	-.59	1																		
(16)	Other position	.06	.01	-.03	.01	-.01	-.10	-.08	-.07	-.02	.10	.02	.15	-.12	-.15	-.33	1																	
(17)	Basic research	.12	.05	-.02	-.04	.03	.34	.21	-.17	.02	-.01	-.07	-.10	-.09	.19	-.01	-.15	1																
(18)	Applied research	-.09	-.10	.00	.13	.15	-.26	-.10	.09	-.04	-.03	-.09	.10	.17	-.15	.02	-.01	-.53	1															
(19)	Interdisciplinary research	-.10	-.15	.02	.17	.17	.01	-.07	.00	.02	.05	-.03	.09	.07	.11	-.10	-.08	-.05	.30	1														
(20)	Age	-.08	-.04	-.06	.10	.21	-.30	-.01	-.06	-.05	.08	.05	.04	.54	.09	-.53	.13	-.06	.09	.06	1													
(21)	Gender	.10	.11	-.03	-.12	-.19	-.02	-.15	.03	.07	.09	.02	.12	-.12	-.03	.06	.09	.06	-.10	-.04	-.14	1												
(22)	Migration background	-.02	-.05	.02	.05	.06	.06	.03	-.04	-.02	.03	-.03	.00	-.05	.03	.01	.01	.01	.03	.04	-.04	-.01	1											
(23)	Married	-.04	-.05	.01	.06	.10	-.12	-.04	-.02	.01	.05	.01	.04	.18	.04	-.18	.03	-.07	.06	.05	.30	.02	.01	1										
(24)	Children	.00	-.05	-.03	.09	.15	-.18	.04	-.07	-.02	.01	.03	.00	.30	.14	-.35	.04	-.05	.08	.07	.53	-.08	-.05	.47	1									
(25)	Entrepreneurial Contacts	-.24	-.38	.14	.34	.13	-.07	-.11	.11	.04	-.02	-.03	.05	.17	-.04	-.09	.00	-.12	.20	.14	.13	-.13	.05	.06	.08	1								
(26)	Start-Up promotion offer	.06	.12	-.02	-.14	-.14	.04	-.04	-.06	.03	.02	.06	.08	-.10	-.01	.07	.03	.05	-.08	-.14	-.14	.10	.05	-.07	-.10	-.10	1							
(27)	Start-Up experience	-.19	-.15	.05	.15	.00	-.16	-.17	.13	.11	.01	.06	.05	.17	.02	-.16	.05	-.15	.11	.08	.23	-.01	-.03	.14	.15	.17	-.05	1						
(28)	Self-employed colleagues	-.03	-.10	.00	.12	.18	.04	-.01	.03	-.01	-.04	-.01	.00	.12	.02	-.09	-.01	-.09	.15	.13	.15	-.02	.01	.07	.14	.20	-.19	.12	1					
(29)	Self-employed parents	-.12	-.06	.03	.04	-.07	.06	-.04	.03	-.01	.02	-.06	.03	-.09	.04	.03	.02	.04	-.01	.05	-.08	.02	.00	-.01	-.04	.08	.04	.02	-.02	1				
(30)	Decission paralysis (H1)	.21	-.01	.04	-.02	.01	-.01	.01	-.05	-.05	.04	.03	.03	-.10	-.04	.08	.05	.01	-.02	-.03	-.04	-.04	.04	-.07	-.01	-.07	.05	-.01	-.09	-.05	1			
(31)	Self-efficacy (H2)	-.51	-.32	.15	.25	.06	-.09	-.24	.29	.03	-.07	-.01	.06	.10	-.09	.06	-.09	-.16	.19	.12	-.02	-.12	.07	.03	-.02	.34	-.08	.22	.09	.08	-.09	1		
(32)	Risk taking propensity (H3)	-.35	-.17	.05	.17	.12	-.01	-.06	.10	-.02	-.03	-.05	.00	.15	.01	-.11	-.02	-.02	.07	.08	.11	-.10	.07	.07	.06	.23	-.05	.11	.11	.11	-.21	.40	1	
(33)	Attitude towards science (H4)	.18	.07	.00	-.09	-.09	.06	.03	-.08	-.03	.06	.03	.02	-.05	.04	-.05	.10	.11	-.09	-.06	.01	.02	-.03	.00	-.01	-.05	.06	.05	-.04	-.03	.05	-.16	-.08	1

Note: N= 771

Table 16 Regression results

DV: Entrepreneurial obstacles	Model 1			Model 2		
	Coef.	St. Err.	P>|t|	Coef.	St. Err.	P>|t|
Start-Up progression						
Pre market entry stage	.	.		.	.	
Market entry stage	-.275	(.088)	***	-.155	(.081)	*
Post market entry stage	-.317	(.094)	***	-.151	(.082)	*
University characteristics						
Invention at university	.020	(.082)		.082	(.072)	
University type	-.022	(.105)		-.032	(.090)	
Faculties						
STEM	-.115	(.092)		-.190	(.086)	**
Economics/ Social science	-.649	(.118)	***	-.455	(.105)	***
Architecture	-.236	(.313)		-.156	(.347)	
Medical technology	-.583	(.282)	**	-.836	(.266)	***
Arts	-.446	(.451)		-.566	(.310)	*
Other faculty	.	.		.	.	
Positions						
Professor	-.365	(.151)	**	-.161	(.133)	
Assistant professor	-.162	(.121)		-.060	(.105)	
Research assistant	-.142	(.112)		-.002	(.101)	
Other position	.	.		.	.	
Research types						
Basic research	.045	(.026)	*	.031	(.023)	
Applied research	.019	(.030)		.028	(.028)	
Interdisciplinary research	-.031	(.025)		-.020	(.021)	
Individual Characteristics						
Age	-.004	(.004)		-.006	(.004)	
Gender	.113	(.064)	*	.064	(.060)	
Migration background	-.065	(.108)		.019	(.094)	
Married	-.031	(.067)		.004	(.060)	
Children	.139	(.081)	*	.105	(.069)	
Entrepreneurial Contacts	-.226	(.078)	***	-.045	(.068)	
Start-Up promotion offer	.010	(.063)		-.013	(.056)	
Start-Up experience	-.204	(.086)	**	-.120	(.077)	
Self-employed colleagues	.067	(.064)		.092	(.055)	*
Self-employed parents	-.200	(.063)	***	-.121	(.057)	**

(**Table 16** continues on the next page)

Table 16 (continued)

individual attitudes						
Decision paralysis (H1)				.220	(.052)	***
Self-efficacy (H2)				-.301	(.033)	***
Risk-taking propensity (H3)				-.117	(.032)	***
Attitude towards science (H4)				.107	(.035)	***
Constant	3.894	(.265)	***	3.830	(.355)	***
N	771			771		
F-test	7.767	***		16.408	***	
R-squared	.196			.377		

Note: Robust standard errors in parentheses;
* p ≤.10, ** p ≤ .05, *** p ≤ .01

3.4. Results

The results in model 1indicate that the extent of perceived entrepreneurial obstacles is lower in the market entry stage (β=-.275; p> p<0.01) and the post-market entry stage (β=-.317; p<0.01) compared with the pre-market entry stage. With regard to the university-related characteristics such as university types, faculties, positions, and research types, we could not find a significant effect for the types of university. Similarly, the invention at the university also has no influence on the extent of perceived of entrepreneurial obstacles. However, the regression results show that scientists from the economics/social science (β=-.649; p<0.01) and medical technology faculties (β=-.583; p<0.05) perceive entrepreneurial obstacles much less than their colleagues from other faculties. Regarding the position at the university, our results indicates that professors (β=-.365; p<0.05) perceive entrepreneurial obstacles much less than their colleagues in other positions. In terms of research types, our results show a significant positive correlation between the extent of basic research (β=-0.04; p<0.10) and the extent of perceived entrepreneurial obstacles. With regard to the individual characteristics of the founders, the results indicate that female scientists perceive entrepreneurial obstacles more strongly than their male colleagues (β=.113; p<0.10). These results are consistent with the findings of Ding et al. (2006) and Bijedić et al. (2017). However, the age-specific effect proposed by Bijedić et al. (2017) and Lévesque and Minniti (2006) could not be proven in our study. We also could not find supporting evidence for the cultural diversity effect that suggested by Krabel and Mueller (2009). Regarding the previous entrepreneurial experience and social capitals of scientists, the regression results show a highly significant negative effect for the founders' social capitals (β=-.226; p<0.01) and a significant positive effect for prior entrepreneurial experience (β=-.204; p<0.05).

Thus, our results are in line with the findings of Hayter (2015b), Huynh (2016), Caliendo et al. (2014) and Fritsch and Krabel (2012). Additionally, our results show that the extent of perceived entrepreneurial obstacles is significantly lower for founders with self-employed parents (β=-.200; p<.01), which indicate that an entrepreneurial-friendly environment could reduce the extent of perceived entrepreneurial obstacles.

In model 2, we included our explanatory variables next to the control variables. The result shows that the extent of decision paralysis has a highly significant positive effect on the perceived entrepreneurial obstacles (β=.220; p<0.01), which indicate that as the decision paralysis enhanced, entrepreneurial obstacles would be perceived much more strongly. This finding supports our first hypothesis. In addition, the regression results also suggest that both the ESE (β=-.301; p<0.01) and the individual risk-taking propensity (β=-.117; p<0.01) demonstrates a significantly positive effect on the perceived entrepreneurial obstacles. This finding confirms our second and third hypothesis and supports the theoretical assumption that scientists with a higher ESE and risk-taking propensity perceive entrepreneurial obstacles much less. Furthermore, the results suggest that there is a positive correlation between attitude towards science and the perceived entrepreneurial obstacles. The estimated results show that academics who are more interested in research activities instead of commercialisations perceive entrepreneurial obstacles more strongly (β=.107; p<0.01). This finally supports our fourth hypothesis. Table 17 provides an overview of the accepted and rejected hypothesis.

Table 17 Accepted and rejected hypotheses

Assumed hypotheses		
H1:	*The stronger the decision paralysis, the higher the perceived entrepreneurial obstacles.*	✓
H2:	*The higher the entrepreneurial self-efficacy, the lower the perceived entrepreneurial obstacles.*	✓
H3:	*The more positive the attitude towards science, the stronger the perceived entrepreneurial obstacles.*	✓
H4:	*The higher the risk-taking propensity, the lower the perceived entrepreneurial obstacles.*	✓

Regarding the beta values of all variables, the independent variables demonstrate relatively high explanatory power. Comparing the results with those from model 1, it can be observed that by taking into account behavioral scientific constructs, the effects of the established controls decreased. However, the effective direction and significance remain unchanged. This supports both the theoretical foundation and the robustness of the established regression models.

3.5 Discussion

In this study, we investigated how individual psychological factors affect the extent of perceived entrepreneurial obstacles of university scientists. Based on the representative dataset, this paper shows that the perception of entrepreneurial obstacles in the venturing process of ASOs is significantly determined by four major psychological variables, namely decision paralysis, entrepreneurial self-efficacy, risk-taking propensity and attitude towards science.

Our study shows that the perception of obstacles in academic entrepreneurship is determined less by entrepreneurial and/or university-specific factors, but rather by the individual factors of the founders. The empirical findings suggest that the extent of perceived entrepreneurial obstacles is strongly related to the degree of decision paralysis. As decision paralysis increases, entrepreneurial obstacles are perceived more strongly by the scientists. We argue that this is due to the fact that scientists tend to make more rational and analytical decisions than other types of founders. They attempt to avoid personal, material and social losses as much as possible. As a result, scientists constantly seek for more optimal and safer solutions when planning their founding project. However, such perfect conditions do not exist in reality, and scientist reconsider their decisions or solutions continually, which in turn leads to confusion, helplessness and eventually paralysis. Consequently, this dilemma makes scientists perceive the entrepreneurial obstacles more strongly. Furthermore, the empirical results also suggest that the extent of perceived entrepreneurial obstacles depends strongly on entrepreneurial self-efficacy.

Scientists who have a higher level of entrepreneurial self-efficacy perceive the obstacles less strongly. The explanation we present in this paper is that scientists generally possess a very broad spectrum of knowledge and a high level of abstraction capability. In the course of their professional careers, scientists are constantly being introduced to new subjects and circumstances, which require them to learn new knowledge and skills continually. In addition, since scientists are specialists in their research field, they are aware of their expertise and they can

exploit their expertise when they decide to be self-employed. Consequently, scientists with a high ESE will found a company with an open mind and full self-confidence. Furthermore, these scientists are also in a better position to overcome serious entrepreneurial obstacles.

With regard to the individual risk-taking propensity, our findings show that the risk-taking propensity of academics is negatively associated with the extent of perceived entrepreneurial obstacles, which also means that academic entrepreneurs are moderate risk takers. A possible explanation for this finding could be that the individual risk-taking propensity might come along with lower perception of the anticipated losses resulting from complex decision situations. Academic founders have to constantly make decisions under uncertainty in the venturing process. However, the consequences of the decisions could not be foreseen and could results in losses. Individuals with a higher risk-taking propensity would be less afraid of the negative consequences of their decisions as they have taken them into account. Accordingly, the obstacles would be perceived less.

Regarding the effect of attitudes towards science, our findings suggest that scientists who are strongly socialized to the scientific community perceive entrepreneurial obstacles more strongly. This finding could be explained by the role identity of scientists and the pressure from scientific publishing system. Academics are constantly under a strong publication pressure due to the fact that promotion and recognition depend on it (O'Gorman et al., 2008; Wright et al., 2009; Bijedić et al., 2017). Hence, scientists will perceive the entrepreneurial obstacles more strongly and tend to concentrate more on publishing their research results rather than seeking for potential commercialisation opportunities.

From a theoretical perspective, our study sheds more lights on the avoidance phenomenon of academic entrepreneurship and helps to understand the psychological mechanisms that are responsible for the avoidance decisions of academic entrepreneurs when facing these obstacles. In this regard, our study provides evidence that the perception of obstacles in academic entrepreneurship is determined less by entrepreneurial and/or university-specific factors, but rather by the individual attitudes of the researchers and potential founders. As mentioned above, we believe that focussing on decision paralysis in the academic context provides a very interesting and new perspective to explain why many academic entrepreneurs stop or postpone pursuing their start-up plans. Hence, the potential causes and consequences deserve further analysis in the future. For example, to what extent do paralysis tendencies vary between different types of founders or to what extent may the effect of decision paral-

ysis on start-up progress be mediated and/or moderated by perceived entrepreneurial obstacles and/or attitude towards science. In addition, if decision paralysis persists, an interesting research question would be if and how it continues to affect entrepreneurial venture at later stages. Last but not least our study also provides evidence that several of the well-established influencing factors of academic entrepreneurship play a less important role when individual psychological factors are taken into account, such as the gender effect and the effect of human and social capital that have been often mentioned in the entrepreneurship literature diminishes once the individual psychological factors were included.

From a practical perspective, our results can be valuable for university administrators when reconsidering their coaching and mentoring programmes. The empirical findings suggest that coaching programmes should be customized and focused more on the analysis of the decision behaviour of the founders. For example, the extent of decision paralysis may be reduced if targeted as a training principle. Moreover, universities can provide necessary financial supports for establishing and expanding networks and training start-up coaches. These coaches could support scientists within the university to implement their founding projects and decrease the uncertainty of scientists by providing professional advices and compensating possible knowledge shortages. In order to further increase the number of university start-ups, a stronger entrepreneurial culture should be implemented within the universities. To achieve this goal, university administrators can reconsider their promotion systems and knowledge transfer should also be considered as an indicator alongside research and teaching missions at universities. As for the policy makers, they may reconsider the process and conditions for applying funding programmes. The application process could be simplified and the restrictions should be eased so that the spectrum of eligible start-up projects can be expanded. This would relieve scientists from the heavy financial burdens and promote their start-up projects forward, which would, in turn, increase the number of ASOs eventually.

Our study is also not without limitations. Firstly, our research design is based on self-reported surveys, in which academics participate voluntarily. Therefore, a potential selection bias could exist. Secondly, our data is from only one country (Germany), which means our findings may not be generalizable to other countries with different cultural and regulatory backgrounds.

Appendix 1 Variable description

Variable	Variable description	Year	Mean	Std.Dev.	Min	Max	VIF
Entrepreneuial obstacles	What prevent you from further advancing your start-up project? (1= strongly disagree; 5= strongly agree): 1) I don't consider myself as an entrepreneur. 2) The risk of failing as an entrepreneur is too high. 3) The time load is too high for me. 4) I do not have enough financial resources. 5) I do not have enough support from the private environment. 6) For the implementation I need a partner as co-founder. 7) I do not (yet) have a clear business model. 8) For the implementation I need (more) market knowledge. 9) For the implementation I need (more) managerial/legal knowledge.	2016	3.358	.867	1	5	.
Pre market entry stage	Binary variable=1 if the founding prohejct is in the pre market entry stage, zero otherwise	2016	.735	.442	0	1	.
Market entry stage	Binary variable=1 if the founding prohejct is in the market entry stage, zero otherwise	2016	.113	.316	0	1	1.12
Post market entry stage	Binary variable=1 if the founding prohejct is in the post market entry stage, zero otherwise	2016	.153	.360	0	1	1.31
Invention at university	Binary variable=1 if founder has made an invention based on an research project at the university, zero otherwise	2013	.204	.404	0	1	1.23
University type	Binary variable=1 if founder works at university of applied science, zero otherwise	2013	.843	.364	0	1	1.47
STEM	Binary variable =1 if founder works at the faculty of mathematics, natural science, technique or physics , zero otherwise	2013	.718	.450	0	1	2.28
Economics/ Social science	Binary variable =1 if founder works at the faculty of economics/ social science, zero otherwise	2013	.133	.340	0	1	2.04
Architecture	Binary variable =1 if founder works at the faculty of architecture, zero otherwise	2013	.005	.072	0	1	1.07

(**Appendix 1** continues on the next page)

Appendix 1 (continued)

Medical technology	Binary variable =1 if founder works at the faculty of medicine/ health management, zero otherwise	2013	.018	.133	0	1	1.17
Arts	Binary variable =1 if founder works at the faculty of Music, design, art, zero otherwise	2013	.009	.095	0	1	1.12
Other faculty	Binary variable =1 if founder works in an other as aforementioned faculty, zero otherwise	2013	.116	.321	0	1	.
Professor	Binary variable =1 if founder is a full professor, zero otherwise	2013	.146	.354	0	1	2.96
Assistant professor	Binary variable =1 if founder is an assistant professor, zero otherwise	2013	.210	.407	0	1	3.28
Research assistant	Binary variable =1 if founder is a research assistant, zero otherwise	2013	.565	.496	0	1	4.21
Other position	Binary variable =1 if founder works in an other as aforementioned position, zero otherwise	2013	.079	.270	0	1	.
Basic research	How would you characterize your research activities at the university? (1= strongly disagree; 5= strongly agree)	2013	3.405	1.407	1	5	1.67
Applied research	How would you characterize your research activities at the university? (1= strongly disagree; 5= strongly agree)	2013	3.765	1.258	1	5	1.73
Interdisciplinary research	How would you characterize your research activities at the university? (1= strongly disagree; 5= strongly agree):	2013	3.408	1.287	1	5	1.23
Age	Metric variable. Please state your age	2013	36.492	10.130	23	65	2.15
Gender	Binary variable =1 if founder male and zero if the founder is female	2013	.322	.468	0	1	1.14
Migration background	Binary variable =1 if founder has a migration background; zero otherwise	2013	.088	.283	0	1	1.03
Married	Binary variable =1 if founder is married; zero otherwise	2013	.671	.470	0	1	1.32
Children	Binary variable =1 if the founder has at least one child; zero otherwise	2013	.396	.489	0	1	1.68
Entrepreneurial Contacts	Binary variable =1 if the founder has contacts which are helpful for the implementation of the founding project; zero otherwise	2013	.264	.441	0	1	1.35
Start-Up promotion offer	Binary variable =1 if the founder attendet a start-up promotion offer; zero otherwise	2013	.299	.458	0	1	1.11
Start-Up experience	Binary variable =1 if the founder has prior start-Up experience offer; zero otherwise	2013	.182	.386	0	1	1.20

(**Appendix 1** continues on the next page)

Appendix 1 (continued)

Self-employed colleagues	Binary variable =1 if the founder has self-employed colleagues; zero otherwise	2013	.338	.473	0	1	1.15
Self-employed parents	Binary variable =1 if the founder has self-employed parents; zero otherwise	2013	.300	.459	0	1	1.05
Decission paralysis	Please indicate to what extent you agree with the following statements (1= strongly disagree; 5= strongly agree): 1) I try to be clear about my objectives before making decisions. 2) I spend a lot of time to think before making decisions. 3) I attempt to collect as much information as possible before making decisions 4) I try to compare all alternatives with each other 5) I attempt to find the advantages of all alternatives. 6) I try to find the best way to make a decision 7) I wasted a lot of time on trivial matters before getting to the final decision. 8) I tend to put off making decisions 9) Even after I have made a decision, I delay acting upon it. 10) When I have to make a decision, I wait a long time before starting to think on it. 11) I delay making decisions until it is too late.	2016	3.431	.532	1	5	1.09
Self-efficacy	Please indicate to what extent you agree with the following statements (1= strongly disagree; 5= strongly agree): 1) I have the capability to establish my own firm. 2) I have faith that the launching of my own firm will be a success. 3) I have all the necessary knowledge to start my own firm. 4) I have the entrepreneurial skills to start my own firm.	2016	2.955	1.032	1	5	1.54

(**Appendix 1** continues on the next page)

Appendix 1 (continued)

Risk taking propensity	Are you generally a risk-averse person or do you try to avoid risks? (from 1 to 5): 1= low risk-taking propensity; 5= high risk-taking propensity	2016	2.745	.974	1	5	1.30
Attitude towards science	Please indicate to what extent you agree with the following statements (1= strongly disagree; 5= strongly agree): 1) Science and entrepre-neurship are not compatible. 2) Knowledge should not be commercialized. 3) Knowledge transfer between science and industry leads to social prosperity. 4) In my faculty, entrepreneurial self-employment is not welcomed. 5) In academia, Publication has a higher recognition than the com-mercialization of knowledge.	2016	3.097	.817	1	5	1.07

Note: N= 771

4 What drives the venture progress of academic entrepreneurs? The role of individual motivations[4]

Stefan Hossinger • Xiangyu Chen • Jörn Block • Arndt Werner

Abstract

Academics who decide to engage in entrepreneurial activities are influenced by a variety of entrepreneurial motives. Currently, however, there is a debate concerning how and how strongly different motives affect the venture progress in academic entrepreneurship. Using a comprehensive two wave dataset of academic entrepreneurs from Germany, we find that knowledge transfer motives matter most, followed by economic and lifestyle motivations. For example, and in line with our hypotheses, we show that the desire for self-realization and knowledge application as well as necessity motives affect the venture progress positively, whereas the desire for the better utilization of professional knowledge and financial income motives have a negative effect. In sum, our study contributes to the understanding of the intention-action gap in academic entrepreneurship and can therefore help universities and policy makers make their support programs that foster academic entrepreneurship more effective.

Keywords: Academic entrepreneurship, academic spin-offs, motivation, drivers, venture progress

JEL classification: M130 L260 O310 O320

[4] As a part of this dissertation, this paper was submitted to: *The Journal of Technology Transfere* in February 2020 and has received an invitation to revise and rebusbmit for a second round review.

4.1 Introduction

While knowledge- and technology-based spin-offs are regarded as central drivers of economic, social and ecological development (Block et al., 2017; Santini, 2017; O'Shea et al., 2008; Guerrero et al., 2015), the antecedents of entrepreneurial venture progress have been mostly analyzed in the context of a binary choice model. This approach, however, neglects the fact that only some nascent entrepreneurs continue to work on their business ideas, while others postpone them or abandon them altogether (Grilo and Thurik, 2008; Parker and Belghitar, 2006; Van Gelderen et al., 2011; Werner, 2011). In the academic entrepreneurship context, Fritsch and Krabel (2012) provide empirical evidence pointing to a large intention-action gap. According to their results, 28% of all university scientists have entrepreneurial intentions, whereas only 3.2% actually put their plan into action. Based on their findings, Fritsch and Krabel (2012) conclude that the antecedents of the intention-action gap should deserve more intention in academic entrepreneurship research.

Our study responds to this call and tries to fill an important gap in this stream of research literature by focusing on entrepreneurial motives and how these motives affect the entrepreneurial venture progress of university scientists. Although there have been some studies on motivations in general, the understanding of entrepreneurial motives as important individual driving forces in the academic context is still in its infancy.

Following implementation intention perspectives, we argue that the motives of scientists to become entrepreneurs play an important role in overcoming the intention-action gap because scientists with higher entrepreneurial intentions are also more committed to their goals and plans and therefore more likely to act on their intentions (Gollwitzer, 1999; Obschonka et al., 2010). In a similar fashion, we draw on the theory of planned behavior and propose that a scientist's intention to perform a particular behavior is positively related to a favorable attitude and supportive social norms towards the planned behavior, combined with a stronger perceived behavioral control (Ajzen, 1991). Thus, following these perspectives, both the direction (to do or not to do) and the intensity (how much time and effort) of taking an action are determined by the individual's entrepreneurial motivation (Sheeran, 2002; Van Gelderen et al., 2011).

While both frameworks have been adopted to examine the entrepreneurial motivations of individuals in general, academia has just recently begun to recognize if, how and how strongly specific entrepreneurial motives affect the venture progress for academic entrepreneurs. Moreover, the results from this broader stream of entrepreneurship literature can only be partially transferred to the case of academic entrepreneurship because academic start-ups and spin-offs are at the intersection of science and entrepreneurship and thus constitute a very special contextual environment (Djokovic and Souitaris, 2008; Nicolaou and Birley, 2003a; 2003b). Accordingly, academic entrepreneurs have to be treated as a special group of entrepreneurs that differ in their motives from other entrepreneurs (Lam, 2011; Miranda et al., 2017b).

Using a comprehensive two-wave dataset of 611 academic entrepreneurs from 73 universities in Germany, this paper attempts to answer the following two research questions: 1) what specific motives influence university scientists to engage in entrepreneurship? and 2) how strongly do these motives influence the progress of academic start-ups or spin-offs? Building on the prior literature stream (e.g., Göktepe-Hulten and Mahagaonkar, 2009; Lam, 2011; Hayter, 2011), we classified academic entrepreneurial motivations into three major dimensions, namely, 1) transfer motives (*application of research ideas, self-realization, and knowledge and skill utilization*), 2) economic motives (*monetary rewards and necessity motives*) and 3) lifestyle motives (*work-life balance*). Our findings show that self-realization, knowledge and skill exploitation and the need to apply one's own research ideas are of high importance for academic entrepreneurs, followed by necessity motives. In contrast, monetary and lifestyle motives are found to play a minor role for academic entrepreneurs. With regard to our second research question, we find that self-realization, the desire for application and necessity motives positively affect venture progress, whereas the desire for the exploitation of professional knowledge is found to have a negative effect.

Overall, our study provides several interesting contributions. On the one hand, the persons responsible for universities and their technology transfer programs can learn from our findings how important specific motives are for the individual venture progress of research scientists. Moreover, we show that an interesting group of founders exists in academia that deserves more attention, namely, the necessity founders. University administrators and policy makers should therefore think about offering differentiated support programs to meet the specific needs of necessity founders. On the other hand, our study contributes to the research literature by focusing on the intention-action gap in entrepreneurship.

Based on our findings, universities should prioritize their resources by encouraging and enhancing the motives that are positively related to the venture progress of academic entrepreneurship. By doing so, more effective measures will be implemented to bridge the intention-action gap.

The remainder of the paper is structured as follows. In the second section, the empirical findings of related prior research are summarized, and our theoretical framework and hypotheses are introduced. Subsequently, our empirical study is presented. The final section discusses our findings and presents limitations and suggestions for future research.

4.2 Theoretical background and hypotheses

4.2.1 Motivations in entrepreneurship

To a great extent, the success of entrepreneurship depends on individuals' involvement and commitment (Lee et al., 2011; Shane et al., 2012), i.e., variations among people's motivations and abilities lead to different outcomes (Shane et al., 2012). Specifically, previous studies have shown that individuals decide to undertake entrepreneurial activities due to a variety of motives (Hayter 2015a). Block and Wagner (2010), for example, identify two types of entrepreneurs, namely, the necessity and opportunity entrepreneurs. While opportunity entrepreneurs decide to set up a business voluntarily when they identify a potential entrepreneurial opportunity, necessity entrepreneurs are more likely to be engaged in entrepreneurship because of external factors such as job dissatisfaction and unemployment. Similar to fashion, push and pull perspectives have been adopted to categorize these two central categories of different entrepreneurial motivations. Accordingly, the following three most common pull factors have been found to be central motivators for entrepreneurship, namely, the desire for independence, monetary motivation and the desire for a challenge/need for achievement (Kirkwood, 2009; Rizzo, 2014; Antonioli et al., 2016). Job dissatisfaction, lack of support from an employer and work-life balance issues are found to be the most relevant push factors for entrepreneurship. Along those lines, Iorio et al. (2017) also suggest that motives can be classified according to the following criteria: intrinsic or extrinsic motivations. Intrinsic motivations refer to behaviors that are driven by internal rewards and thus originate within a person because they naturally satisfy the individual. Examples are intrinsic satisfaction (Lam, 2011), the desire for independence (Shane, 2004) and the desire to learn new skills (Benz, 2009; Hayter, 2011).

Extrinsic motivations, in contrast, refer to behaviors that are driven by external rewards that arise from external environmental factors such as pursuing pecuniary or other nonpecuniary forms of rewards (e.g., promotion, gain/increase of reputation) (Fini et al., 2009; Göktepe-Hulten and Mahagaonkar, 2009). For entrepreneurs, monetary returns play an important role in being self-employed (Block and Sandner, 2009). However, entrepreneurs could also be strongly attracted by nonmonetary benefits when they engage in entrepreneurial activities. Accordingly, prior studies have suggested that nonmonetary benefits such as pursuing greater autonomy, broader skill utilization, and the possibility of applying one's own ideas also play an important role in entrepreneurship (Benz, 2009; Hundley, 2001). Interestingly, the study of Block and Sandner (2009) finds that monetary motives are more important for necessity entrepreneurs, while nonmonetary returns have a greater impact on opportunity entrepreneurs.

4.2.2 Motivations in academic entrepreneurship

In contrast to entrepreneurs in general, academic entrepreneurs are driven by a special sense of social responsibility as well as a need for utilization when participating in the technology transfer process. In other words, they devote themselves to improving society by transferring and disseminating technology (Morales-Gualdrón et al., 2009; Berggren, 2017; Iorio et al., 2017; Rizzo, 2014). Another key characteristic of academic entrepreneurship is that additional benefits are aligned with academic entrepreneurial activities such as creating further stimuli for research activities, obtaining access to funding opportunities (grants) or acquiring new facilities for research activities. These motives are important determinants for academics who are engaged in founding and advancing projects (Goethner et al., 2012; Hayter, 2015a; Antonioli et al., 2016). Moreover, in line with what has been discussed above, Lam (2011) employs the following three concepts to classify factors drawing on intrinsic and extrinsic features for academic entrepreneurship: "gold" (financial rewards), "ribbon" (reputational and career rewards) and "puzzle" (intrinsic satisfaction). Focusing on financial rewards, academic entrepreneurs do not seem to consider these as the primary purpose for engaging in entrepreneurship (Göktepe-Hulten and Mahagaonkar, 2009; Lam, 2011). Based on this, and for hypothesis development, our paper classifies the academic motives influencing the likelihood of scientists to engage in entrepreneurial activity into the following three major dimensions: 1) transfer, 2) economic and 3) lifestyle motivations.

4.2.3 Hypotheses development

4.2.3.1 Transfer motivations

According to the current research literature, a scientist's willingness to start a business is determined by a strong inner conviction for their own research (Lam, 2011). That is, "taking care for one's own research" as well as the desire to put one's own ideas or inventions into practice are regarded as the central drivers for academic entrepreneurship (Morales-Gualdrón et al., 2009; Berggren, 2017; Iorio et al., 2017). As such, transfer motives are closely related to the personal expectations and objectives of academics and, consequently, can be seen as the dominant factors of why academics undertake venture activities. Academics in particular are driven by the desire to put their research ideas into practical use when engaging in entrepreneurial activities, given the reason that the original purpose of research is to serve society at large (Iorio et al., 2017; Ramos-Vielba et al., 2016). Moreover, this factor is also the main reason why universities are becoming increasingly entrepreneurial; i.e., the so-called third mission has been integrated as one important university function because of the growing need in society for universities to transfer knowledge outside of academia and to contribute to social and economic development (Etzkowitz, 2003; Huyghe and Knockaert, 2015; Iorio et al., 2017). Iorio et al. (2017) argue that a large number of academics are driven by pro-social or so-called mission motives when engaging in knowledge transfer activities, considering that the aim of these activities is knowledge dissemination that would in turn improve social well-being. In a similar vein, Ramos-Vielba et al. (2016) also show that applying their own research ideas is the primary reason for academics to engage in knowledge transfer activities. Thus, in sum, we posit the following hypothesis:

Hypothesis 1: The motivation to put one's research ideas into practice is positively associated with the progress of academic entrepreneurship.

Another important transfer motive among academics is the desire for self-realization. Specifically, the need for achievements, the desire for independence and the desire for skill enhancement have been suggested to be among the main reasons why academics engage in venture activities, especially in the earlier gestation phases (Antonioli et al., 2016; D'Este and Perkmann, 2011; Hayter, 2011; Huszár et al., 2016; Mueller, 2010). In line with this, a study of German academics shows that the initial purpose of most researchers who engage in commercial activities is to signal their achievements and gain recognition from their peers and industrial communities (Göktepe-Hulten and Mahagaonkar, 2009).

According to Barba-Sánchez and Atienza-Sahuquillo (2012), the need for achievement is seen as an important characteristic of entrepreneurs and has a strong influence on venture progress; individuals with stronger needs for achievement are more likely to make progress. Due to the professional characteristics and backgrounds of academics, they are particularly accustomed to work autonomy and independence. Moreover, academics often pursue their goals with greater ambitions. Thus, academics will also have a higher need for achievement compared with other founder types. Therefore, we formulate the following hypothesis:

Hypothesis 2: Self-realization is positively associated with the progress of academic entrepreneurship.

Academics are also motivated by additional academic benefits, such as the generation of further stimuli for research activities, access to funding opportunities (grants) and the possibility of exchanging new knowledge or obtaining new equipment for research activities. Academics consider spin-offs as platforms for obtaining these resources to support their research (D'Este and Perkmann, 2011; Lam, 2011; Goethner et al., 2012; Antonioli et al., 2016; Iorio et al., 2017; Hossinger et al., 2020; O'Gorman et al., 2008). However, these motivational drivers may also have a negative impact on entrepreneurial progress given that academics only consider these activities as a means for obtaining new resources to better exploit their research and knowledge. In the course of undertaking entrepreneurial activities, we therefore assume that university scientists will concentrate more on their research and less on the actual transfer of knowledge. That is, scientists will use their knowledge and experience more to develop their products and services rather than to concentrate on the commercial exploitation of these products or services. As a result, several important founding steps, such as negotiating with creditors or investors, starting marketing campaigns, evaluating market information or taking care of exploitation rights, will be neglected or postponed, which, in turn, will lead to fewer start-up gestation steps. Based on these arguments, we therefore derive the following hypothesis:

Hypothesis 3: The utilization of one's professional experience/knowledge is negatively associated with the progress of academic entrepreneurship.

4.2.3.2 Economic motivations

Aside from transfer motivations, monetary incentives have been widely discussed as an important entrepreneurial motivational factor in the entrepreneurship research literature. Interestingly, in the academic entrepreneurship context, monetary factors seem to be less influential compared with nonmonetary incentives (Hayter, 2011; Lam, 2011; Goethner et al., 2012). That is, the expected financial income only shows to have an indirect influence on the entrepreneurial intentions of scientists, and no direct impact on entrepreneurial behavior has been found (Goethner et al., 2012). The reason why the influence of financial rewards is limited may depend on the age and position of academics as well as other personal concerns. For example, considering the nature of academic careers, scientists tend to gather sufficient capital stock for setting up a company at a relatively late stage; therefore, it may be difficult for them to establish a new firm in their younger years (Antonioli et al., 2016; Rizzo, 2014; Lévesque and Minniti, 2006). Furthermore, most scientists do not consider financial reward as the primary goal when deciding to engage in entrepreneurial activities because they consider such financial rewards more as a form of collateral compensation for the time and effort they have devoted (Morales-Gualdrón et al., 2009; Hayter, 2011; Lam, 2011; Goethner et al., 2012). Moreover, scientists are considered highly skilled employees. Due to their professional career, scientists usually possess a very broad spectrum of theoretical expertise and strong abstraction capabilities. Academics are aware of their capabilities and skills, and they know that they can also achieve a high net income in the private industry. In other words, scientists who are strongly triggered by the income motive will prefer a position in paid employment relative to becoming an entrepreneur. Along these lines, we therefore propose that financial income motives will have a negative influence in motivating academics to advance their entrepreneurial activities. Accordingly, we posit the following hypothesis:

Hypothesis 4: Increasing financial income as a motivation is negatively associated with the progress of academic entrepreneurship.

As mentioned above, in entrepreneurship research, the distinction between opportunity and necessity entrepreneurs is much debated (Block and Sandner, 2009; Block and Wagner, 2010). Opportunity-driven individuals decide to engage in entrepreneurial activities voluntarily, while necessity-driven individuals are more likely to engage in entrepreneurial activities because of external factors such as job dissatisfaction or unemployment (Block and

Wagner, 2010). In the academic context, necessity motivations are strongly related to working conditions within universities. Essentially, these working conditions are often seen as push factors, such as stability and lifelong employment (i.e., limited work contracts and nontenure positions), the pressure to "publish or perish", bureaucratic routines and procedures and governance issues (Balven et al., 2017; Neves and Franco, 2016). Entrepreneurship as the preferred mode of entry of academics can therefore be traced to the fact that their current working conditions are not truly satisfying (Kirkwood, 2009). Moreover, individuals who choose to undertake entrepreneurial activities due to necessity reasons are generally more motivated and willing to take more steps to prove that they can do better than with their previous employers (Kirkwood, 2009). Especially for skilled individuals, the fear of unemployment is an important motivational factor resulting in more progress along the path of self-employment (Horta et al., 2016). Based on these arguments, we therefore propose that academics are no exception, meaning that this group is also exposed to a high risk of having to leave their prior employer (i.e., the university), which makes them think about taking steps to start a new business. Thus, we formulate the following hypothesis:

Hypothesis 5: Necessity as an entrepreneurial motivation is positively associated with the progress of academic entrepreneurship.

4.2.3.3 Lifestyle motivations

Work-life and role balance in the academic context refers to whether an academic believes that he or she has an appropriate workload compared with the responsibilities that come from other work or personal duties (Balven et al., 2017). This balance is dependent on the coordination of organizational and other personal factors. Although many universities have implemented policies that favor personal balance, such as leave of absence programs and onsite childcare, academics still struggle to balance their work and personal lives (Kirkwood, 2009). The reason for this struggle is that an academic usually has to fill multiple roles simultaneously, such as being a lecturer, an inventor, a mother/father or an entrepreneur, and managing many different roles is difficult (Balven et al., 2017). When work-life balance becomes an issue, academics are most likely to postpone or abandon commercial or entrepreneurial activities and tend to spend more time on other activities (Balven et al., 2017). Based on this, we argue that it is especially difficult for academics to be fully engaged in both research and entrepreneurial activities.

That is, if such work-life balance issues are considered important for academics, they may connect entrepreneurial activities with being lower priority and prefer to allocate their time and effort to research or other personal activities. Hence, the following hypothesis can be derived:

Hypothesis 6: Work-life balance as an entrepreneurial motivation is negatively associated with the progress of academic entrepreneurship.

4.3 Method and data

4.3.1 Sample

Our study is based on a cross sectional dataset with two waves of data collected in 2013 and 2016 at 73 German universities. In the initial survey in 2013, 36,918 scientists from different types of universities, faculties and positions were surveyed regarding the actions they undertook to start a new business. The responses from 7,342 scientists were initially received and thoroughly evaluated. The scientists who were surveyed in 2013 were then invited to participate in a follow-up survey in 2016. A total of 1,252 completed the questionnaire in 2016, which corresponded to a response rate of approximately 17%. After excluding all those cases with missing values in the variables of interest, the information from 611 scientists could be fully evaluated for the following empirical analysis.

4.3.2 Dependent and explanatory variables

Table 18 shows the descriptive statistics and illustrates our dependent, independent and control variables.

Table 18 Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max	Year	VIF
Dependent variable:						
Venture progress	1.115	1.755	0	8	2016	.
University characteristics:						
Invention at university (1=Yes, 0=No)	.273	.446	0	1	2013	1.34
University type (1= university, 0= university of applied science)	.802	.399	0	1	2013	1.67

(**Table 18** continues on the next page)

Table 18 (continued)

Faculties:						
STEM	.653	.476	0	1	2013	2.24
Economics/ social science	.164	.370	0	1	2013	2.04
Architecture	.011	.107	0	1	2013	1.13
Medical technology	.026	.160	0	1	2013	1.21
Arts	.010	.099	0	1	2013	1.14
Positions:						
Professor	.223	.416	0	1	2013	3.74
Assistant professor	.185	.389	0	1	2013	3.18
Research assistant	.516	.500	0	1	2013	4.54
Research types:						
Basic research	3.124	1.425	1	5	2013	1.61
Applied research	4.038	1.160	1	5	2013	1.63
Interdisciplinary research	3.576	1.214	1	5	2013	1.17
Individual Characteristics:						
Age	38.674	10.688	24	67	2013	2.27
Gender (1=Male, 0=Female)	.245	.431	0	1	2013	1.29
Migration background (1=Yes, 0=No)	.085	.279	0	1	2013	1.06
Married (1=married, 0=unmarried)	.722	.448	0	1	2013	1.31
Children (1=Yes, 0=No)	.473	.500	0	1	2013	1.69
Risk taking willingness	2.876	.920	1	5	2013	1.18
Self-employed colleagues	.448	.498	0	1	2013	1.15
Self-employed parents	.313	.464	0	1	2013	1.05
Entrepreneurial Contacts	.491	.500	0	1	2013	1.28
Motivations:						
Apply research idea (H1)	3.489	1.273	1	5	2013	1.40
Self-realization (H2)	3.830	.986	1	5	2013	1.51
Knowledge and skill utilization (H3)	3.534	1.074	1	5	2013	1.56
Monetary (H4)	3.187	1.248	1	5	2013	1.19
Necessity (H5)	2.183	1.111	1	5	2013	1.26
Work-life-balance (H6)	2.540	1.317	1	5	2013	1.40

Note: N= 611

Our dependent variable is venture progress, which is measured by the extent to which a start-up project has been advanced; i.e., the scientists in the follow-up survey in 2016 were asked to provide information about the steps they have taken to advance a start-up project. The corresponding items were developed on the basis of the GUESS survey (Global University Entrepreneurial Spirit Students' Survey, http://www.guesssurvey.org/) that was conducted in 2013 and 2016. On a dichotomous scale (1=yes; 0=no), seventeen different self-reported items were examined, which comprehensively described the venture progress of the scientists (see Appendix 2). Given that there is a spectrum of activities associated with a different degree of exploration or exploitation of start-up project steps, the following seventeen spin-off-related activities were been categorized and aggregated into eight different stages: *Stage 1) if the scientists have a specific founding idea. Stage 2) if the scientists have reserved*

money for the implementation of his/her founding idea, have negotiated with outside creditors and/or inside investors, or have invested their own money in the implementation of the founding idea. Stage 3) if the scientists have started the product or service development or built a prototype. Stage 4) if the scientists have recruited a co-founder/funding team, developed a business plan, collected information about the market and competitors, or have purchased/leased equipment/materials/rooms. Stage 5) if the scientists have a set date for establishment. Stage 6) if the scientists have taken care of the exploitation rights or registered at the tax office. Stage 7) if the scientists have started advertising campaigns and marketing, have met potential customers, or have acquired important business partners. Stage 8) if the scientists have accepted first orders.

Our explanatory variable covers the scientists' individual motivations towards entrepreneurship. More specifically, in the initial 2013 survey, the scientists were asked to provide information about the reasons why they wanted to become self-employed. Specifically, a total of six different motivation items were included in the questionnaire, which we classified into three major dimensions: 1) transfer motives, 2) economic motives and 3) lifestyle motives. Each dimension includes several specific motivation items. Transfer motives consist of a) *applying research ideas*, b) *self-realization* and c) *knowledge and skill utilization*; economic motives consist of a) *monetary motives* and b) *necessity motives*; and lifestyle motives consist of *work-life balance motives*. All items were self-reported and measured on a five-point Likert scale (1=strongly disagree; 5=strongly agree) (see Appendix 2).

As depicted in Table 1, approximately 80% of the scientists work in research-based universities, while 20% work for universities of applied science. Almost 27% of the respondents have made inventions based on their research activities at their research institutes. Fieldwise, 65% of our sample are researchers within STEM faculties (e.g., mathematics, informatics and information technology scientists, natural scientists and technics), 16% are economic or social scientists, 3% are in medicine and health management, and 1% are architects. With regard to their current position at the research institutes, nearly 39% percent of the researchers in the sample are professors (20% are full professors, and 18.5% are assistant professors), and approximately 52% are research assistants (PhD students, post-doctoral students).

Regarding our first research question, the descriptive statistics suggest that the most important motivating factors are self-realization (mean= 3.8), followed by knowledge and skill exploitation (mean= 3.5) and applying research ideas (mean= 3.4). Taken together, the findings suggest that transfer motives play the most important role in the academic entrepreneurship context. In addition, monetary motives (mean 3.1) and work-life balance (mean= 2.5) are more relevant for academics than necessity motives (mean= 2.2).

The correlations between the variables are shown in Table 19. Please note that there are only weak correlations between the independent variables. The variance inflation factors (VIF) range from 1.05 (lowest value) to 4.54 (highest value). We analyzed all the variable histograms and found that the errors are identically and independently distributed with constant variance. Overall, these results only suggest the presence of moderate multicollinearity.

Table 19 Correlation matrix

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)
venture progress	1																												
Invention at university	.104	1																											
University type	.004	.065	1																										
STEM	.059	.177	.164	1																									
Economics/ social science	-.006	-.222	-.113	-.607	1																								
Architecture	.002	.003	-.062	-.148	-.048	1																							
Medical technology	-.046	.014	-.021	-.225	-.073	-.018	1																						
Arts	-.025	.051	.008	-.137	-.044	-.011	-.016	1																					
Professor	.019	.131	-.465	-.073	.125	.016	.011	-.013	1																				
Assistant professor	.048	.048	.226	.073	-.040	-.051	-.025	-.047	-.255	1																			
Research assistant	-.034	-.170	.241	.050	-.023	.043	-.046	.030	-.552	-.491	1																		
Basic research	.051	.024	.378	.187	-.135	-.053	-.014	-.032	-.124	.222	-.017	1																	
Applied research	.041	.180	-.253	-.068	.035	.036	-.005	-.075	.200	-.176	-.022	-.495	1																
Interdisciplinary research	.116	.108	.067	-.034	-.057	.025	.057	.076	.054	.097	-.117	.049	.180	1															
Age	-.039	.185	-.343	-.035	-.035	.002	.100	-.025	.584	-.035	-.540	-.135	.144	.028	1														
Gender	-.048	-.239	-.003	-.207	.056	.117	.121	.136	-.141	-.037	.112	.060	-.140	.005	-.140	1													
Migration background	.087	-.042	.049	.087	-.056	.022	-.050	.029	-.050	.021	.026	-.027	-.025	-.005	-.041	.003	1												
Married	-.030	.127	-.144	-.023	-.002	.033	-.013	.025	.227	-.015	-.207	-.074	.052	-.057	.329	-.002	.032	1											
Children	.004	.213	-.187	.057	-.082	.052	.009	-.028	.344	.072	-.361	-.046	.105	.009	.532	-.091	-.077	.449	1										
Risk taking willingness	.045	.123	-.014	-.024	.065	.065	-.011	-.005	.149	.000	-.153	-.036	.117	.085	.120	-.076	.054	.039	.100	1									
Entrepreneurial Contacts	.208	.169	-.161	-.089	.052	.048	.003	.035	.214	-.029	-.175	-.120	.208	.125	.178	-.149	.041	.091	.119	.218	1								
Self-employed colleagues	.061	.134	.002	-.041	.073	.058	-.004	.010	.174	.011	-.173	-.035	.141	.193	.177	-.017	.020	.090	.134	.129	.174	1							
Self-employed parents	.014	-.097	.016	.017	-.012	.027	-.022	-.031	-.072	.024	.046	-.012	-.001	-.032	-.076	.042	.009	.009	-.024	.091	.044	-.069	1						
Apply research idea (H1)	.156	.212	-.025	.189	-.118	-.029	-.087	-.077	.051	-.021	-.026	.030	.115	.099	-.035	-.118	.044	-.005	.040	.137	.222	.046	-.021	1					
Self-realization (H2)	.125	-.026	.002	-.030	.043	.003	-.050	-.067	-.131	-.057	.115	-.036	-.032	.053	-.138	.014	.023	-.037	-.099	.135	.088	-.021	.095	.296	1				
Knowledge and skill utilization (H3)	.028	.095	-.206	-.100	.079	.090	-.048	-.026	.045	-.082	-.015	-.140	.160	.089	.068	.008	-.045	.054	.077	.129	.287	.086	.039	.358	.403	1			
Monetary (H4)	.051	.011	-.156	-.023	.037	-.016	-.016	.012	.084	-.088	-.020	-.071	.115	.030	.032	-.091	.077	-.015	.019	.107	.121	.058	.015	.157	.244	.278	1		
Necessity (H5)	.059	-.119	.102	-.019	-.045	-.018	.107	.043	-.232	.235	-.048	.091	-.182	-.011	-.023	.185	-.008	.014	-.009	-.171	-.057	-.015	.014	-.129	.035	.027	-.037	1	
Work-life-balance (H6)	-.008	-.168	.079	-.043	-.030	-.009	.034	.035	-.247	.019	.149	.051	-.140	-.003	-.210	.240	.004	-.062	-.077	.031	-.032	-.057	.077	.019	.375	.189	.174	.204	1

Note: N= 611

4.3.3 Control variables

We control for several variables that might simultaneously affect venture progress, both from the individual and the organizational level (Welter, 2011). Starting from the individual level, we control for characteristics such as gender, age, migration background, risk-taking propensity and social capital. Previous studies have indicated that male and female researchers are driven by different types of motives (Maes et al., 2014). Abreu and Grinevich (2017), for example, suggest that female researchers perceive entrepreneurial obstacles in the spin-out formation process more strongly than their male counterparts. Therefore, the venture progress might be less for female researchers than for male researchers. Furthermore, it can be assumed that scientists can only amass the sufficient capital stock for setting up a company at a relatively late stage considering their professional nature. In addition, as age increases, the period in which profits can be made through entrepreneurial activities declines (Bijedić et al., 2017; Lévesque and Minniti, 2006; Hossinger et al., 2020). As a result, the venture progress might become less as age increases. Regarding migration background, Constant and Zimmermann (2006) find that people with a migration background are more likely to be self-employed than their counterparts without a migration background. Moreover, academics with work experience in different cultures possess a greater diversity of ideas, perspectives and creative techniques than do academics who have only worked in few different cultures (Krabel and Mueller, 2009; McEvily and Zaheer, 1999). As a proxy for cultural diversity, we therefore control for migration background. Moreover, risk-taking propensity is also one of the key factors in the early stages of academic entrepreneurship, and academics who are willing to take more risks are more likely to start their own businesses (Singh Sandhu et al., 2011; Hayter, 2015a; Huynh, 2016; Rasmussen et al., 2011; Rasmussen et al., 2015; Scholten et al., 2015; Walter et al., 2011). Thus, we control for risk-taking propensity, in addition to children and marital status. Furthermore, we control for the social capital of scientists because previous studies have indicated that entrepreneurial contacts that facilitate foundation are of fundamental importance for the implementation of an entrepreneurial project (Prodan and Drnovsek, 2010; Hayter, 2015b; Huynh, 2016; Rasmussen et al., 2011; Rasmussen et al., 2015; Scholten et al., 2015; Walter et al., 2011; Hossinger et al., 2020; Rothaermel et al., 2007). Hence, it is to be expected that founders who have already established networks also have made more venture progress. Additionally, role models and peers also affect the likelihood of academics engaging in entrepreneurial activities (Haeussler and Colyvas, 2011; Johnson et al., 2017; Moog et al., 2015). Hence, we control for both parents

and colleagues with prior entrepreneurial experience. From the organizational level, we control for inventions due to the university, the university type, faculties, positions and the research disciplines. Scientists with inventions based on their research at the university could consider their inventions as potential entrepreneurial opportunities to pursue. We therefore assume that scientists with an invention are more likely to engage in entrepreneurial activities than are their counterparts without an invention. Walter et al., (2013) point out that scientists' entrepreneurial intentions are determined by their ties to industry and research disciplines. Since research projects with the private sector are more common at universities of applied sciences than at research-based universities, academics at universities of applied sciences will also benefit more from these industry ties, which might eventually lead to more venture progress. Furthermore, the scientist's faculty or research field could also affect the venture progress (Perkmann et al., 2011; Huyghe and Knockaert, 2015; Moog et al., 2015; Fini and Toschi, 2016; Hossinger et al., 2020). Start-up projects from the STEM, medical and biotechnology fields are usually technology-oriented and capital intensive. Hence, the initial kick-off of a project requires ample financial resources, which could impede further venture progress. Furthermore, scientists from the aforementioned research fields usually do not have sufficient business management and legal knowledge, which makes the implementation of their own entrepreneurial project even more difficult (Zhou et al., 2011; Davey et al., 2016; Neves and Franco, 2016). Regarding position at the university, Haeussler and Colyvas (2011) indicate that scientists with tenure positions at the university are more likely to engage in entrepreneurial activities due to social and financial securities. Hence, we control for university position. Last but not least, Arvanitis et al. (2008) and Fischer et al. (2017) point out that universities with a focus on applied research have a higher propensity to engage in technology transfer activities than do universities with a focus on basic research.

4.3.4 Analytical procedure

In the empirical models discussed below, we test our hypotheses by using hierarchical multiple linear regression. Specifically, we develop two regression models. In the first model, we regress the effects of the control variables on the venture progress. To test hypotheses H1 to H6, the second model additionally includes the scientists' individual motivations. To analyze the validity of our research hypotheses more deeply, we first apply OLS regression. However, please note that we additionally estimate Tobit models (see Appendix 3)

(Greene, 2003; Wooldridge, 2002) to check the robustness of the OLS results, given that some scientists reported that zero activities were undertaken to advance their start-up projects between 2013 and 2016. Because the results only change marginally, the OLS estimation results are reported in the following.

Table 20 Regression Results

DV: Venture progress	**Model 1**			**Model 2**		
	Coef.	Std.	P>|t|	Coef.	Std.	P>|t|
University characteristics						
Invention at university	.323	(.188)	*	.330	(.188)	*
University type	-.177	(.231)		-.216	(.231)	
Faculties						
STEM	.263	(.206)		.201	(.207)	
Economics/ Social science	.247	(.249)		.260	(.244)	
Architecture	.016	(.799)		.178	(.850)	
Medical technology	-.214	(.364)		-.280	(.349)	
Arts	-.543	(.639)		-.386	(.633)	
Others (=reference category)						
Positions						
Professor	.104	(.301)		.232	(.299)	
Assistant professor	.172	(.313)		.183	(.308)	
Research assistant	.040	(.274)		.126	(.263)	
Others (=reference category)						
Research types						
Basic research	.079	(.064)		.077	(.063)	
Applied research	.015	(.071)		.041	(.072)	
Interdisciplinary research	.122	(.053)	**	.111	(.053)	**
Individual Characteristics						
Age	-.016	(.010)	*	-.014	(.010)	
Gender	.031	(.162)		.034	(.169)	
Migration background	.521	(.261)	**	.468	(.265)	**
Married	-.151	(.180)		-.167	(.177)	
Children	.082	(.183)		.110	(.182)	
Risk taking willingness	-.029	(.081)		-.028	(.082)	
Entrepreneurial Contacts	.707	(.147)	***	.696	(.147)	***
Self-employed colleagues	.052	(.149)		.060	(.147)	
Self-employed parents	.041	(.152)		.033	(.147)	
Motivations						
Apply research idea (H1)				.116	(.066)	*
Self-realization (H2)				.237	(.084)	***
Knowledge and skill utilization (H3)				-.201	(.075)	***
Monetary (H4)				.019	(.056)	
Necessity (H5)				.178	(.068)	***
Work-life balance (H6)				-.057	(.058)	
Constant	.478	(.699)		-.562	(.808)	
N	611			611		
F	2.66	***		3.07	***	
R^2	0.0836			0.115		

Note: Robust standard errors in parentheses;
* p ≤.10, ** p ≤ .05, *** p ≤ .01

4.4 Results

In Model 1, we regress the controls on the degree of start-up project advancement. As shown in Table 3, it is worth mentioning that the degree of start-up project advancement is significantly higher for scientists who made an invention based on their research activities compared with their counterparts without such invention. These results are in line with the findings of Stuart and Ding (2006) as well as Krabel and Mueller (2009). Moreover, and in line with prior research (Arvanitis et al., 2008; Fischer et al., 2017), our results indicate that academics who are more involved in interdisciplinary research are also more likely to commercialize their knowledge and implement their founding plans. Moreover, the founder's age is negatively associated with the venture progress, which is consistent with the findings of Bijedić et al. (2017) and Lévesque and Minniti (2006). Interestingly, our results indicate that more venture progress has been made among scientists with a migration background. Regarding founders' social capital, our results show a highly significant effect, which indicates that possessing entrepreneurial contacts will accelerate venture progress. Despite this, we did not find significant effects for the other control variables.

In Model 2, we regress both the controls and the different motivating factors on our dependent variable of venture progress. In sum, we find supporting evidence for hypotheses H1, H2, H3 and H5. However, we have to reject hypotheses H4 and H6. That is, the regression results do not show a significant effect for the independent variable *monetary motives* (β=.019; p= 0.741). Therefore, we have to reject hypothesis 4. Thus, being motivated by financial rewards such as higher and improved earning opportunities is not significantly associated with venture progress. Moreover, the results do not support hypothesis 6. An improved work-life balance (β=-.057; p= .327) as a start-up motive is not significantly related to venture progress. Our regression results do demonstrate a significant positive effect on the variable *applying research ideas* (β=.116; $p<0.10$), which indicates that the extent to which scientists strive for the practical application of their research ideas is positively associated with venture progress. Thus, hypothesis 1 is fully supported by the data. Furthermore, the results show that our independent variable *knowledge and skill exploitation* (β=-.201; $p<0.01$) demonstrates a highly significant negative effect on venture progress. This outcome indicates that stronger transfer motives are related to less venture progress. This finding supports hypothesis 3. Additionally, we also find support for hypothesis 2. The regression results show a positive correlation between the independent variable *self-realization* and the dependent variable of venture progress (β=-.237; $p<0.01$).

Thus, our results indicate that academics who are driven by an intrinsic pursuit of self-realization undertake more venture progress than those who are not. With a beta value of β=.133, this variable demonstrates the highest explanatory power. Last but not least, our results demonstrate a highly significant positive effect on our variable *necessity motives* and venture progress (β=.178; p<0.01). This finding suggests that academics who are driven by necessity motives are more likely to engage in entrepreneurship than those who are not. This finding also supports hypothesis 5. A possible explanation for this finding could be found in the working conditions at the universities.

4.5 Discussion and conclusion

In this study, we investigate which motivating factors play a more important role in academic entrepreneurship and how these motivating factors affect the venture progress of academic entrepreneurship. Our study shows that academics are driven by a diverse set of individual motives that induce them to start a company. We find that the most important motivating factors are self-realization, the need for better knowledge and skill utilization and the desire to apply one's own research ideas. Furthermore, economic motives, such as monetary and necessity motives, are also important motivational drivers for academics to start a company. Surprisingly, we also find that striving for a better work-life balance as a founding motive plays a minor role in academic entrepreneurship. Last but not least, we find that the need for better knowledge and skill utilization impedes the venture progress, while self-realization, the need for application and necessity motives positively affect the venture progress of academic entrepreneurship.

Several implications can be drawn from our results. First, our findings indicate that, compared with entrepreneurs in general, the identity of academics plays a dominant role in their participation in entrepreneurial activities. Academic entrepreneurs are driven by a strong inner self-realization motive as well as a need for utilization. In other words, they strongly devote themselves to improving society by transferring and disseminating technology (Morales-Gualdrón et al., 2009; Berggren, 2017; Iorio et al., 2017). Second, it is worth noting the negative effect between the need for better knowledge and skill utilization and the venture progress. A possible explanation for this finding could be that scientists might consider a start-up as a platform to further advance their research activities.

Hence, scientists may invest their knowledge and skills in their research rather than in concentrating on the commercial exploitation of their research via entrepreneurship. Moreover, an alternative explanation for this finding might be grounded in the scientific system.

Scientific acceptance and recognition within academia is mostly achieved by publishing research results in international journals. Thus, the success and reputation of a scientist is primarily measured within the community by the number and ranking of his or her publications (O'Gorman et al., 2008; Wright et al., 2009). During the start-up process, scientists might therefore concentrate more on their publication activities rather than on their commercialization activities. Hence, academics who are driven by this specific motive may either postpone or quit their new venture plans in favor of using this time for publication. Consequently, some start-up projects either proceed very slowly or are abandoned altogether.

Third, and in line with the previous empirical evidence, we find no significant effect of monetary motives, which partly confirms that compared with nonmonetary incentives, the influence of monetary factors among academic entrepreneurs is rather limited (Hayter, 2011; Lam, 2011). In other words, scientists may consider such financial reward as a primary goal when engaging in entrepreneurial activities only as a form of collateral compensation for the time and effort they have devoted (Morales-Gualdrón et al., 2009; Goethner et al., 2012).

Fourth, our findings highlight that the group of necessity founders tends to make more venture progress than opportunity founders. This is also in line with prior findings (Kirkwood, 2009). We believe that the reason for this effect in our study may be attributed to the working conditions at German universities. Due to the mostly limited and part-time working contracts among scientists, many have to constantly search for new jobs to avoid being unemployed.

Finally, starting a business requires a high degree of personal time and effort. Founders often have to work hard and have only a limited free time. Especially in the start-up phase, company founders have less time for personal matters, such as leisure time, family, or hobbies, as they invest the majority of their time and effort in the founding project. This negatively affects their work-life balance. Surprisingly, however, we did not find a significant effect of work-life balance on venture progress. A possible explanation for this finding could be that the work-life balance as an employed scientist at a university is comparatively well pronounced. Scientists have relatively flexible working schedules and therefore are able to manage their time themselves. Therefore, the issue of work-life balance might be less important for scientists.

This study provides several theoretical and practical implications. From a theoretical perspective, our findings indicate that the intention-action gap in academic entrepreneurship can be bridged by encouraging and enhancing motives that are positively related to academic entrepreneurship. Specifically, our study provides empirical evidence that research-related motives are the most important motives in the context of academic entrepreneurship. Moreover, scientists who are driven by necessity motives are more likely to achieve more progress than are those driven by opportunity. This finding contributes to the literature related to push and pull theory, which also suggests that scholars should focus more on this interesting group of founders. Hence, the potential causes and consequences deserve further analysis. More specifically, future research should analyze how to bridge the gap by encouraging and enhancing the motives that are positively related to academic entrepreneurship and how to readjust or reduce the influence of the motivating factors that show negative effects. Moreover, other issues deserve further study as well, for example, to what extent the different motivation categories vary between the different types of founders and how the effects of the aforementioned motives can be moderated or mediated by the types of founders and their research, faculties and positions within the university. In terms of policy implications, our study shows that research-related motives are the most relevant motives in driving venture progress. Therefore, university administrators and their technology transfer programs should specifically focus on meeting these needs of academics. Regarding the group of necessity founders, universities should readjust their coaching and mentoring programs to provide necessary help.

Our study is also not without limitations. First, our research design is based on self-reported surveys, in which academics participated voluntarily. Therefore, a potential selection bias could exist. Second, our data are from only one country (Germany), which means our findings may not be generalizable to other countries with different cultural and regulatory backgrounds.

Appendix

Appendix 2 Variable description

Variable	Description
Dependent variable:	
Venture progress	Dependent variable: Number of activities undertaken to advance a start-up project by university scientists (from 0 to 8 - all of above described in section model)
University characteristics:	
Invention at university	Binary variable=1 if founder has made an invention based on a research project at the university, zero otherwise
Applied science university	Binary variable=1 if founder works at university of applied science, zero otherwise
Faculties:	
STEM	Binary variable =1 if founder works at the faculty of mathematics, natural science, technique or physics, zero otherwise
Economics/ social science	Binary variable =1 if founder works at the faculty of economics/ social science, zero otherwise
Architecture	Binary variable =1 if founder works at the faculty of architecture, zero otherwise
Medical technology	Binary variable =1 if founder works at the faculty of medicine/ health management, zero otherwise
Arts	Binary variable =1 if founder works at the faculty of music, design, art, zero otherwise
Positions:	
Professor	Binary variable =1 if founder is a full professor, zero otherwise
Assistant professor	Binary variable =1 if founder is an assistant professor, zero otherwise
Research assistant	Binary variable =1 if founder is a research assistant, zero otherwise
Research types:	
Basic research	How would you characterize your research activities at the university? Basic research (from 1 to 5): 1= strongly disagree; 5= strongly agree
Applied research	How would you characterize your research activities at the university? Applied research (from 1 to 5): 1= strongly disagree; 5= strongly agree
Interdisciplinary research	How would you characterize your research activities at the university? Interdisciplinary research (from 1 to 5): 1= strongly disagree; 5= strongly agree

(**Appendix 2** continues on the next page)

Appendix 2 (continued)

Individual Characteristics:	
Age	Metric variable. Please state your age
Gender	Binary variable =1 if founder male and zero if the founder is female
Migration background	Binary variable =1 if founder has a migration background; zero otherwise
Married	Binary variable =1 if founder is married; zero otherwise
Children	Binary variable =1 if the founder has at least one child; zero otherwise
Risk taking willingness	Are you generally a risk-averse person or do you try to avoid risks? (from 1 to 5): 1= low risk-taking propensity; 5= high risk-taking propensity
Entrepreneurial Contacts	Binary variable =1 if the founder has contacts which are helpful for the implementation of the founding project; zero otherwise
Self-employed colleagues	Binary variable =1 if the founder has self-employed colleagues; zero otherwise
Self-employed parents	Binary variable =1 if the founder has self-employed parents; zero otherwise
Motivations:	
Apply research idea	Why do you (would you) want to become self-employed? Practical application of own research ideas (from 1 to 5): 1= strongly disagree; 5= strongly agree
Self-realization	Why do you want to become self-employed? Self-realization and independence (from 1 to 5): 1= strongly disagree; 5= strongly agree
Knowledge and skill utilization	Why do you want to become self-employed? Improved utilization of professional experience/knowledge (from 1 to 5): 1= strongly disagree; 5= strongly agree
Monetary	Why do you want to become self-employed? Higher and better earning opportunities (from 1 to 5): 1= strongly disagree; 5= strongly agree
Necessity	Why do you want to become self-employed? Dissatisfaction with the current work situation and/ or afraid of unemployment (from 1 to 5): 1= strongly disagree; 5= strongly agree
Work-life-balance	Why do you want to become self-employed? Improved work-life balance (from 1 to 5): 1= strongly disagree; 5= strongly agree

Appendix 3 OLS and Tobit Regression

DV: Venture progress	**Model 1** (OLS regression)				**Model 2** (OLS regression)				**Model 3** (Tobit estimation)				**Model 4** (Tobit estimation)			
University characteristics																
Invention at university	.323	(.188)	1.720	*	.330	(.188)	1.760	*	.349	(.399)	.870		.361	(.398)	.910	
Applied science university	-.177	(.231)	-.770		-.216	(.231)	-.940		-.374	(.508)	-.740		-.454	(.508)	-.890	
Faculties																
STEM	.263	(.206)	1.270		.201	(.207)	.970		.577	(.499)	1.160		.493	(.493)		
Economics/ Social science	.247	(.249)	.990		.260	(.244)	1.070		.328	(.613)	.530		.376	(.604)		
Architecture	.016	(.799)	.020		.178	(.850)	.210		-.400	(1.617)	-.250		.049	(1.577)		
Medical technology	-.214	(.364)	-.590		-.280	(.349)	-.800		-1.335	(1.272)	-1.050		-1.552	(1.270)		
Arts	-.543	(.639)	-.850		-.386	(.633)	-.610		-2.197	(2.021)	-1.090		-1.804	(1.979)		
Others (=reference category)																
Positions															1.310	
Professor	.104	(.301)	.340		.232	(.299)	.780		.626	(.760)	.820		1.012	(.771)	1.090	
Assistant professor	.172	(.313)	.550		.183	(.308)	.590		.717	(.751)	.950		.813	(.745)	.850	
Research assistant	.040	(.274)	.150		.126	(.263)	.480		.340	(.710)	.480		.596	(.704)		
Others (=reference category)																
Research types																
Basic research	.079	(.064)	1.230		.077	(.063)	1.230		.087	(.139)	.630		.079	(.137)	.580	
Applied research	.015	(.071)	.210		.041	(.072)	.570		-.020	(.170)	-.120		.039	(.168)	.230	
Interdisciplinary research	.122	(.053)	2.270	**	.111	(.053)	2.080	**	.201	(.139)	1.440		.191	(.137)	1.390	
Individual Characteristics																
Age	-.016	(.010)	-1.650	*	-.014	(.010)	-1.480		-.060	(.023)	-2.600	***	-.058	(.023)	-2.500	**
Gender	.031	(.162)	.190		.034	(.169)	.200		-.056	(.405)	-.140		-.047	(.408)	-.120	
Migration background	.521	(.261)	1.990	**	.468	(.265)	1.770	**	1.148	(.545)	2.110	**	1.018	(.536)	1.900	*
Married	-.151	(.180)	-.840		-.167	(.177)	-.940		-.329	(.398)	-.830		-.345	(.390)	-.880	
Children	.082	(.183)	.450		.110	(.182)	.610		.317	(.407)	.780		.368	(.402)	.920	
Risk taking willingness	-.029	(.081)	-.360		-.028	(.082)	-.340		-.136	(.182)	-.750		-.115	(.182)	-.630	
Entrepreneurial Contacts	.707	(.147)	4.810	***	.696	(.147)	4.750	***	1.559	(.345)	4.510	***	1.570	(.351)	4.470	***
Self-employed colleagues	.052	(.149)	.350		.060	(.147)	.410		.145	(.336)	.430		.152	(.329)	.460	
Self-employed parents	.041	(.152)	.270		.033	(.147)	.220		-.014	(.347)	-.040		-.056	(.341)	-.160	

(**Appendix 3** continues on the next page)

Appendix 3 (continued)

Motivations														
Apply research idea				.116	(.066)	1.770	*				.248	(.144)	1.720	*
Self-realization				.237	(.084)	2.820	***				.501	(.192)	2.610	***
Knowledge and skill utilization				-.201	(.075)	-2.680	***				-.450	(.181)	-2.490	**
Monetary				.019	(.056)	.330					.063	(.136)	.460	
Necessity				.178	(.068)	2.630	***				.424	(.156)	2.720	***
Work-life-balance				-.057	(.058)	-.980					-.124	(.137)	-.900	
Constant	.478	(.699)	.680	-.562	(.808)	-.690			-.365	(1.629)	-.220	-2.807	(1.847)	-1.520
N	611			611				N	611			611		
F	2.66	***		3.07	***			LR chi2	49.15	***		68.56	***	
R^2	0.0836			0.115				Pseudo R2	0.0276			0.0385		

Note: Robust standard errors in parentheses;
* p ≤.10, ** p ≤ .05, *** p ≤ .01

5 Academic Entrepreneurship in German Universities: Who can help?

David Audretsch • Maksim Belitski • Stefan Hossinger • Xiangyu Chen • Arndt Werner

Abstract

This study focuses on the knowledge spillover of academic entrepreneurship in Germany between 2013 and 2016. Building on the endogenous economic growth and the knowledge spillover of entrepreneurship theory, we develop a model which explains the interplay between the individual characteristics of scientists, the organizational (university) context and the collaboration between scientists and external stakeholders. Using a sample of 826 scientists, our results find the following combinations of knowledge collaborations which facilitate academic entrepreneurship: technology transfer offices (TTOs) enable collaboration with private industry; patent agencies facilitate collaboration with other scientists and potential customers; university incubators facilitate collaboration with capital investors and develop new business contacts; support programs at universities facilitate collaboration with customers. The study has implications for scholars, scientists, university managers and investors aiming to support start-up activities and invest in research commercialization in developed economies such as Germany.

Keywords: academic entrepreneurship, technology transfer, private industry, university, commercialization, Germany

JEL classification: M130 L260 O310 O320

5.1. Introduction

Universities around the world are currently implementing far-reaching changes to become more entrepreneurial (Audretsch, 2014; Guerrero and Urbano, 2012; 2014; Block et al., 2017; Urbano and Guerrero, 2013). This has led them to accept more contract-based research, patenting, licencing and spin-off activities to promote the commercialisation of their academic research (Etzkowitz et al., 2000; O'Shea et al., 2005; Grimaldi et al., 2011; Perkmann et al., 2013; Meoli and Vismara, 2016). In particular, these changes have attracted the attention of researchers willing to commercialize their inventions, as well as policy-makers wishing to foster social and economic development and exploit university innovation (Guerrero et al., 2016; Link et al., 2005; Link and Scott, 2005; 2019; Hossinger et al., 2020). As a result, it is apparent that universities and industries aim to develop stronger linkages between scientists and external stakeholders through academic entrepreneurship activity (Siegel et al., 2003; Siegel and Wright, 2015) and other forms of knowledge transfer (Algieri et al., 2013; Cunningham and Link, 2015; Miller et al., 2014). This includes new stakeholders such as incubators, private industry, other business partners[5], venture capitalists, the stock market and professional associations (Mansfield and Lee, 1996; Hague and Oakley, 2000; Rasmussen et al., 2011; Bradley et al., 2013). In this paper, we define academic entrepreneurship as the creation of new businesses by scientists (spin-offs, start-ups) based on university-developed knowledge. This definition is grounded in the context of specific legislative and organizational interventions enacted to foster academic entrepreneurship (Fini et al., 2016). While academic entrepreneurship represents an efficient response to a multifaceted university function (Etzkowitz, 2002; D'Este and Perkmann, 2011; Audretsch, 2014; Guerrero et al., 2015) there is a limited understanding of the mechanisms and channels of knowledge transfer. For instance, the knowledge spillover of academic entrepreneurship often lack clarity (Bradley et al., 2013), when researched within an organizational context (Steffensen et al., 2000; Audretsch, 2014) and environmental -ecosystem context (Siegel et al., 2004; Link and Siegel, 2005; Shu et al., 2014; Audretsch and Belitski, 2017; Heaton et al., 2019).

This study addresses a call to bridge the micro, organizational and environmental divide in university knowledge transfer (Di Gregorio and Shane, 2003; Djokovic and Souitaris, 2008; Lockett et al., 2003; Lockett and Wright, 2005; Rothaermel et al., 2007) with the purpose to examine a range of combinations that connect environmental and organizational contexts

[5] In this study we define other business partners as contractors who are directly involved in companies' business, which can be supplies and potential customers for a scientist.

(Aldridge and Audretsch, 2010) for knowledge creation and commercialization (Mustar et al., 2006; Guerrero et al., 2015) across 73 German universities between 2013 and 2016. We depart by arguing, that researchers have only recently begun to recognize the role different organizational mechanisms (Bercovitz et al., 2001; Schmitz et al., 2017) play in facilitating collaborations between different types of external stakeholders (Muscio, 2010; Kenney and Patton, 2009; Abreu et al., 2016).

This study fills the gap in the extent literature by adopting the endogenous growth and knowledge spillover theory of entrepreneurship (Aldridge and Audretsch, 2010; Acs et al., 2013; Audretsch and Belitski, 2013b; Braunerhjelm et al., 2010). In doing so, we propose and test a multi-level model of university research commercialization via the academic entrepreneurship of 826 scientist-business founders observed between 2013 and 2016 in 73 German universities. Our study makes three contributions to the academic entrepreneurship and knowledge transfer literature. Firstly, it advances our understanding of the interplay between micro, organizational and environmental factors that can facilitate knowledge transfer from the university to the markets (Lockett et al., 2003; O'Kane et al., 2015; Link and Scott, 2019; Walter and Block, 2016). Secondly, it expands the empirical evidence that complementarity between organizational structures and external stakeholders leads to knowledge commercialization (Kenney and Patton, 2009; Markman et al., 2009; Siegel and Wright, 2015). Thirdly, it extends the scope of analysis from the efficiency of knowledge commercialization (Min et al., 2019; Phan and Siegel, 2006) to the variety of external stakeholders and knowledge commercialization channels available for university scientists in Germany.

Our empirical findings confirm that scientists who attend events at university TTOs are more likely to engage in a number of start-up development activities, while the same events organized by patent agencies and university incubators via different support programs do not affect the scientists' entrepreneurship activities (Kolympiris and Klein, 2017). This finding supports prior research on the role of TTOs, emphasising their important role as facilitators of knowledge transfer from a university to industry (Algieri et al., 2013; Grimaldi et al., 2011). Moreover, we provide empirical evidence that private industry partnerships and contacts with capital investors will increase the start-up development activities of scientists in Germany, as was shown for university start-ups in other developed economies (Rasmussen et al., 2011). We also find that: (a) collaborations with external scientists and customers along with activities at patenting agencies, (b) collaborations with business partners and investors along with incubator activities, (c) collaborations with customers within the support

programs as well as (d) collaborations with the private industry and TTOs all have a positive and significant effect on academic entrepreneurship. By focussing on specific combinations of organizational stakeholders (TTOs, patent agencies, support programs and university incubators) on the one side and external stakeholders on the other, several important managerial and policy implications can be derived directly from our hypotheses and model design.

The remainder of this study is structured as follows. The next section introduces the knowledge spillover of academic entrepreneurship and formulates a number of research hypotheses. Section three summarises the data and methodology used in the study. Section four outlines the major findings, while section five discusses the results relevant for policy. Section six concludes.

5.2 Theoretical framework

5.2.1 The knowledge spillover of academic entrepreneurship

Building on the endogenous growth theory and the knowledge spillover literature (Acs et al., 2013; Audretsch and Belitski, 2013a), we distinguish between the multiple layers of the entrepreneurial university (Guerrero and Urbano, 2014; Guerrero et al., 2016) which are associated with three groups of factors known to impact knowledge commercialization by scientists. Several scholars have shown that innovation and knowledge commercialization at university is driven by specific characteristics such as university size, ownership, research quality, technical orientation (or nature of research) and R&D funding level (Gómez Gras et al., 2008; Kirby et al., 2011; Abreu et al., 2016; Huyghe et al., 2014; 2016; Markman et al., 2005; Hossinger et al., 2020). For example, some empirical studies have found that university size is positively related to the rate of spin-off creation (Caldera and Debande, 2010). Besides this, previous researchers have also found that private universities improve their performance in terms of technology transfer activity (Siegel et al., 2003), while research-led universities are more conducive for knowledge spillover than teaching-led universities (Abreu et al., 2016).

In line with our conceptual framework, we understand knowledge spillover from universities as a multilevel phenomenon. The first level of analysis concentrates on the individual characteristics of the scientists promoting knowledge spillover (e.g. age, training, faculty background, entrepreneurship cognition, risk perceptions etc.). Intuitively, we draw here on entrepreneurial theories within the resource-based view of entrepreneurship (Powers and McDougall, 2005). The second level focuses on universities and its organisational structures, such as TTOs, knowledge transfer partnerships and incubators as well as the partners they collaborate with, such as patent agencies (Carayol and Matt, 2004; Guerrero et al., 2016). Accordingly, the organisational level is represented by specific university characteristics and the resource-based view of entrepreneurship - most importantly internal stakeholders such as TTOs, special programs and training at university, university incubators and patenting offices which universities liaise with (Link et al., 2007). Finally, the system level pays attention to environmental factors and external stakeholders, such as technological and industry associations, industry, venture capitalists (VCs), angel investors and banks, customers and suppliers (Bradley et al., 2013). This level emphasizes the role of the external environment on academic entrepreneurship (Aidis et al., 2008; O'Shea et al., 2005; Florida and Kenney, 1988; Perkmann et al., 2013; Guerrero and Urbano, 2012; 2014).

5.2.2 Knowledge spillover theory and the role of stakeholders

Creating a supportive environment to facilitate knowledge transfer can result in higher levels of academic entrepreneurial activity (Clarysse et al., 2011a; 2011b; Hossinger et al., 2020). Over the years, several scholars have studied the process of transferring technology from the university to the marketplace by drawing on the knowledge spillover of entrepreneurship perspective (Guerrero et al., 2015; Audretsch, 2014; Belitski et al., 2018). Their results reveal that knowledge spillover often fails because the bureaucratic procedures within university structures slow down or even block knowledge transfer activities by increasing the uncertainty about available external stakeholders interested in university research (McAdam et al., 2016). This caveat is known as the knowledge filter and can be viewed as a barrier or impediment between investments in knowledge and its commercialization in the marketplace.

However, organizational structures such as incubators, university TTO, patenting offices and specific university support programs are known to play important roles in shaping the development of the local innovation ecosystem for academic entrepreneurship (Korosteleva and

Belitski, 2017; Siegel and Wessner, 2012). Accordingly, combinations of these specific university structures should penetrate the knowledge filter by functioning as an endogenous response to entrepreneurial opportunities (Romer, 1986; Acs et al., 2013). Penetrating the knowledge filter is important as the accumulation of large amounts of knowledge which is not commercialized in the market can drive up costs, intensify uncertainty and reinforce sustainability risks.

Along these lines, Audretsch (2014) therefore suggests that investments in research and teaching alone will only facilitate knowledge commercialization if the knowledge spillover of entrepreneurship can be appropriated to the university scientists; i.e. to those who actually create the knowledge base and are best able to understand the potential of their innovation and promote the knowledge spillover. However, scientists who aim to commercialize knowledge require legal, financial and mentoring support from patent agencies, TTOs, support programs, science parks and incubators in enabling the knowledge to reach the customers. Consequently, greater engagement with a variety of stakeholders (Miller et al., 2014) along with efficient organizational knowledge transfer conduits will bridge information asymmetries between inventors and private sector (Heinzl et al., 2013; Hellmann, 2007) and will enable access to markets (Huyghe et al., 2016b). In this setting, scientists can rely on organizational structure support (Civera et al., 2019) and are able to efficiently search for partners to facilitate the knowledge spillover from university to the market – i.e. by minimizing their operational, transaction and time costs.

Studies seeking to explain the knowledge spillover theory of entrepreneurship in universities have identified a number of internal (organizational) and external (environmental) factors (e.g. tax credits that support technology commercialization) as well as stakeholder activities (Guerrero et al., 2015; 2016) that facilitate the knowledge transfer process (Kirby et al., 2011). These include the establishment of a TTO at the university or research institutes, and collaborations with patent agencies, technological associations or accelerator programmes (Carayol and Matt, 2004; Guerrero et al., 2016). Although university stakeholders will support academic entrepreneurs (Siegel et al., 2007; Abreu et al., 2016), there may be different returns to knowledge collaboration with different stakeholders (Miller et al., 2014).

Since universities have integrated far-reaching changes to become more entrepreneurial (Audretsch, 2014), a generalizable model of knowledge transfers no longer exists (Bradley et al., 2013; Litan et al., 2007).

Consequently, researchers attempted to draw a multilevel entrepreneurial university model with multiple combinations of stakeholders that are continually shaping the knowledge transfer process. In line with this, academic entrepreneurship emerges as a conduit of knowledge between university organizational structures and external stakeholders (Miller et al., 2014; Link et al., 2015). In other words, each stakeholder brings their own unique set of skills, networks, market knowledge and competences which simultaneously affects and enables knowledge spillovers by academic entrepreneurs.

Multiple stakeholders - internal and external to the university - who all attempt to exert influence on the knowledge commercialization have to be considered in this specific knowledge transfer process (Alsos et al., 2011). On the one side, we have client firms, government institutions, venture capitalists and other investors, business partners, other scientists as well as internal institutions (TTOs, patenting offices) which ask for a disclosure of inventions. TTOs, for example, engage in various support services such as partner searches, management of intellectual property rights (Siegel et al., 2003) which increases the chances for an inventor to expose his or her invention to a broader audience including potential investors. TTOs will thus create networks, bringing researchers into contact with experts from industry and VCs (Clarysse et al., 2011a) to expand the pool of inventions with potentially high commercial value and increase the opportunities for cross-fertilization of academic output (Zucker et al., 2002). On the other side, we have science parks, incubators and support programmes (mentoring, accelerators) for cases where the technology is cutting edge but has yet to be tested in the market. The incubation process and venture investment usually take a long time because all assumptions are tested before a valuable IP is given to a separate company. In addition, the incubator program also exposes an academic to formal and highly specialized venture capital funds. Prior research also suggests that the quality of the university environment and its ability to generate and transfer knowledge is measured by the number of disclosures, knowledge transfer staff, patents and incubation processes. Also crucial are the effectiveness of knowledge transfer support programmes with incubators, TTOs and patenting agencies which altogether have a positive effect on academic entrepreneurship (Kolympiris and Klein, 2017). It is thus a combination of organizational factors with other external facilitators which enables university knowledge transfer (Link et al., 2015). For example, collaborations between researchers and university TTOs as well as patent agencies and incubation programs can multiply commercialization channels. Taken together we hypothesize:

Hypothesis 1: Collaboration with organizational stakeholders (TTOs, patent agencies, support programs, incubators) increases academic entrepreneurship (bridging the micro-organizational divide).

5.2.3 External collaboration and academic entrepreneurship

Prior research has identified the role of the entrepreneurial university in knowledge transfer in which knowledge per se is embodied into scientists while relevant business-related information is held by the private sector (Agrawal, 2006). The resulting knowledge asymmetry triggers scientists and the private sector to rearrange their knowledge transfer activities (Link and Scott, 2005). Based on this, we argue that the knowledge transfer is the result of collaborations between scientists and external partners and is therefore an important strategy to obtain access university knowledge. In addition, knowledge asymmetry will intensify collaborations between scientists, leading them to co-create new products and services (Heinzl et al., 2013). It is thus rational to assume that knowledge collaboration has multiple roles in knowledge transfers. First, it enables scientists to recognise market opportunities by sourcing information from different partners. Second, it eases the learning process and makes it easier to access resources, including specialized programs. Third, by easing the market through testing for ideas, information from external stakeholders will further enhance knowledge exploration efforts. Moreover, in cases where knowledge is to be commercialized, knowledge will be further adapted and adopted by external users (von Stamm, 2004).

First, this enables the integration of new ideas and the creation of marketable and commercializable goods and services (Belitski and Desai, 2015; Grandi and Grimaldi, 2005) which otherwise would have never been commercialized (Audretsch and Keilbach, 2005). In fact, previous research has demonstrated that industry-related entrepreneurs are better able to identify valuable market opportunities than academic entrepreneurs, although their degree of technological novelty may be lower (Czarnitzki et al., 2014). Second, such collaborations reduce the cost of market entry by easing the market discovery and appropriation mechanisms (Cassiman and Veugelers, 2002). Third, such knowledge collaborations will help to distribute the costs of academic research between partners (Veugelers, 1997; Bradley et al., 2013) and therefore reduce the costs associated with the product development stage. In fact, external partners facilitate the development of inventions by scientists with higher levels of technological complexity and application (Hoye and Pries, 2009), which reduces the costs and uncertainties associated with the commercial readiness of inventions.

Fourth, sharing information on innovation activities in the industry and with third parties helps to generate networks (West et al., 2014) which otherwise would be unavailable for a focal academic entrepreneur (Siegel and Wright, 2015). Fifth, the collaboration with an external partner can function as a positive signal to non-academic audiences, including investors, associations and companies interested in a newly available technology (Mueller et al., 2012). Finally, collaboration with external stakeholders can function as a core strategy for exploiting the boundaries of university knowledge applicability (Lee, 1996) and for facilitating university-industry linkages (Markman et al., 2009; Rasmussen et al., 2011). We hypothesize:

Hypothesis 2: Collaboration with external stakeholders increases academic entrepreneurship (bridging the micro-macro divide).

5.2.4 Bridging the micro-organizational-macro divide

Bridging the micro-organizational-macro divide requires the alignment of organizational and external mechanisms to facilitate knowledge commercialization (Link et al., 2015; Fini et al., 2016). Scientists will draw on multiple external and organizational sources of knowledge commercialization to different degrees as they reinforce one another. On the one hand, greater interaction with external stakeholders is likely to reinforce a scientist's capacity to identify commercial opportunities and engage with organizational stakeholders to fund and support the idea. On the other hand, increased interaction with non-academic users can lead to the development of inventions with higher levels of technological resolution (Hoye and Pries, 2009), which reduces the uncertainties regarding commercial readiness of inventions. Organizational mechanisms such as TTOs, patent agencies, support programs and business incubators offer market expertise, resources and capabilities to increase researchers' awareness of private industry and market needs. This is an important layer in knowledge transfer from a university, which is the source of knowledge, to the private industry, which is the recipient of knowledge (Bozeman et al., 2015). Several empirical studies (Siegel et al., 2007) have illustrated that the creation of a formal technology transfer/licensing offices is the first step towards increasing the enforcement of intellectual property ownership by and at universities (Grimaldi et al., 2011). Early TTO activity at universities consists of multiple stakeholders from inside and outside of the university (e.g. academics/principal investigators, industry liaison staff and local policy-makers) who met on "a monthly basis to discuss

the technology transfer activities that were taking place within the university" (Miller et al., 2014: 272).

Despite TTOs becoming facilitators of knowledge transfer in many European universities, the spread of TTOs in several countries where universities had owned the IP and the patenting activity was weak (Baldini, 2009). Grimaldi et al., (2011) associates this finding with inadequate internal support mechanisms due to the relatively nascent nature of most TTOs. In Germany, the 'professor's privilege' ('Hochschullehrer-Privileg') was in place until 2002 (Grimpe and Fier, 2010). This privilege entitled academics in Germany to use their scientific results – at least in part – for private commercialization, even if the underlying research was carried out at and financed by the university or other public sources (Kilger and Bartenbach, 2002). Unfortunately, the professors' right to commercialize research directly resulted in a significantly lower number of German university patents (Czarnitzki et al., 2009). Business and technology consulting and cooperation became much more important. However, since the abolishment of the professor's privilege in Germany in 2002 (paragraph 40-42 of "Gesetz über Arbeitnehmererfindungen" - the Law on Employee Inventions)[6], the property rights on an invention are transferred from the scientist to his organization (Bartenbach and Volz, 2019). The role of TTOs in supporting academic research commercialization has therefore fundamentally changed (Hülsbeck, 2010). TTOs at universities aim to provide incentives for academic entrepreneurs, including legal requirements and IP of knowledge, market search, and patent applications and licencing. Even though TTOs have been recently criticized for possessing a number of organizational and human resources issues – including with the recruitment of qualified technology transfer personnel, poor IP protection and too much bureaucracy (Wright et al., 2008a; Siegel and Wright, 2015) - this seems to hold first and foremost for university knowledge transfers in developed and developing economies (Belitski et al., 2018).

[6] According to § 42 of the German Employee Invention Act ("Arbeitnehmererfindungsgesetz") the following special provisions apply to inventions made by university employees: 1) The inventor is entitled to disclose the service invention *(aw-> SH, what exactly is meant by "service invention")* within the scope of his or her teaching and research activities if the inventor has notified the employer in time; i.e., generally two months in advance. 2) If an inventor refuses to disclose his or her service invention, he or she is not obliged to report the invention to the employer. If the inventor wishes to disclose his or her invention at a later time, he or she must immediately notify the employer of the invention. 3) In the case that the job-related invention is claimed, the inventor has a non-exclusive right to use the job-related invention within the scope of his teaching and research activities. 4) If the employer exploits the invention, the remuneration is 30 % of the income generated by the exploitation

In addition, university TTOs can enhance research results by building on direct contacts between scientists, private industry and investors. TTOs have market-related knowledge which is important for academics keen to commercialize their research. Interactions with TTOs and also industry practitioners are shown to be strong predictors of entrepreneurial activity among scientists (Grandi and Grimaldi, 2005; D'Este et al., 2012). Such interactions will keep TTO functions decentralized (Huyghe et al., 2014; 2016b) in order to facilitate connectivity between researchers and private industry, as well as researchers and investors (Link et al., 2005; Siegel et al., 2007; Aldridge and Audretsch, 2011; Perkmann et al., 2013). In sum, we hypothesize:

Hypothesis 3a: University TTOs will facilitate collaborations with private industry and investors for academic entrepreneurship

Although knowledge transfers between external firms and inventors can be lengthy (Audretsch et al., 2019), the inventor will wish to protect innovation by using various intellectual property rights (IPR). Patenting an invention can reduce the opportunistic behaviour of external stakeholders and allows for appropriation of research outcomes. Moreover, strong IPR protection can mitigate the fear of potential opportunistic behaviour between scientists, universities and partners in order to effectively collaborate and transfer knowledge to third parties without free riding (Hellmann, 2007). There are several reasons why poor IP protection will reduce the incentives for academic entrepreneurship. First, poor IP protection is a potential knowledge leakage related to collaboration with other scientists, who may label someone else's work as their own, or may slightly modify the combination of inputs which can result in a completely different and hard to track output. Distinguishing between different types of external collaborators, the probability is high that collaborations between scientists will produce more tacit and complex knowledge, which may grow in value and require a greater level of protection. At the same time the type of protection may remain ambiguous, as co-development and co-creation is common practice in STEM specialities (Helmers and Rogers, 2015).

Although IP protection is required across various collaboration partners, it is a new technology-based protection developed within scientific communities, university-industry consortia and alliances, increased faculty consulting for industry and professional (Lee, 1996) as well as highly specific associations that may require a greater degree of legal IP protection to fully exploit innovation in the market.

An example of "The Bayh-Dole Act" (Grimaldi et al., 2011) turned out to be an accelerator for campus innovation as universities that would previously have let their intellectual property lie fallow (Aldridge and Audretsch, 2011) began filling for IPR and getting patents at high rates. In addition, protection of knowledge may prevent leakage and secure the quality of collaborations within academic communities (Wright et al., 2008b). In this context, we argue that in countries with strong institutions and respect for IPR, like Germany, the use of patenting of inventions is likely to limit free-riding and increase the outcome of academic entrepreneurship. Consequently, this will particularly protect scientists when collaborating within other scientists and research institutes. We therefore hypothesize:

Hypothesis 3b: Patent agencies will facilitate collaboration with scientists and professional associations for academic entrepreneurship

The technologies developed in universities are intended to become a public good with a variety of university support programmes exist to catalyse collaboration among scientists and customers (Mian, 1996). These support programs may include entrepreneurial boot camps, university accelerators, mentoring, TED-talks, business clinics, panels with entrepreneurs and coaching events (Clarysse et al., 2007). These programs play a key role in fostering new ideas by focusing on frequent interactions with customers, which provide critical insights about which markets to enter and which customer problems and needs should be addressed (von Stamm, 2004) by the new inventions or technologies. Entrepreneurship and digital marketing courses offered at business schools to academics and executives are important for new venture creation and promotion (Shane, 2004; Shane and Delmar, 2004). Spin-off support programs at universities can also help external partners to access on- and off-campus facilities and labs in collaboration with other institutions and secure grants, win competitions and awards, and connect researchers to prospective customers (Heaton et al., 2019). This approach to the knowledge-based antecedents of academic entrepreneurship corresponds to a demand-driven approach (Agarwal and Shah, 2014) in which researchers benefit from the market context and customer knowledge.

However, scientists face at least two challenges when collaborating with customers. First, there is a considerable gap between the technologies developed by scientists and those demanded in a market. In this instance, collaboration with customers and other scientists enables more advanced, ready-to-use solutions which can be co-developed (Agarwal and Shah, 2014) and introduced to the market quickly. This form of collaboration with a subsequent protection of knowledge is likely to reduce the risks of unexpected costs and uncertainty (Hellmann, 2007). Second, the successful commercialization of university technology may require the support of other scientists. However, the prior literature suggests that scientists who adhere closely to their institutions may perceive significant barriers to collaboration with other academics such as industry scientists (Sauermann and Stephan, 2013). The coordination of information and communication with other scientists through support programs may help to overcome the misalignment between scientists and facilitate further knowledge development and sharing (Slater and Mohr, 2006). A stock of demand-driven factors is typical of scientists with frequent involvement in programs aiming to establish contacts and agreements with customers, whose research is able to engage both academic and non-academic audiences, and whose work is intended to solve practical problems and address the needs of practitioners (D'Este et al., 2019). Based on these arguments, we therefore hypothesize:

Hypothesis 3c: University support programs will facilitate collaboration with customers and other scientists for academic entrepreneurship.

An alternative measure to provide scientists with access to commercially viable resources is to promote the existence of formal organizational stakeholders like university incubators (O'Shea et al., 2005; Rothaermel and Thursby, 2005). Universities have explored a number of models of university entrepreneurship incubation, including entrepreneurship centres, university incubators and science parks (Link et al., 2005; 2007; Siegel et al., 2003; 2007; Wright et al., 2008a; Kenney and Patton, 2009; Muscio, 2010) which prepare academic spin-offs to enter markets. In addition to collaboration with IP agencies and TTOs, university incubators serve as an important pillar of knowledge exploration, testing and commercialization (Mian, 1996; Heinzl et al., 2013).

University incubators provide office spaces, training, pitching and meetings with entrepreneurs (Schmitz et al., 2017; Kolympiris and Klein, 2017) that also signal to investors (Guerrero and Urbano, 2014; Guerrero et al., 2016). As outlined by Backes-Gellner and Werner (2007), a central problem in the start-up stage is the availability of financial resources because of the high degree of uncertainty. Moreover, especially innovative new ventures like academic spin-offs face severe problems of asymmetric information due to their lack of prior production history and reputation. While the advantages of university incubation include library access, student resources and internships, creative university environments, it is also an exposure to state-of-the-art research (McAdam et al., 2016). Access to technology mentoring and seed-funding is particularly relevant for technology incubators that provide the uniting technical and venture capital hubs (e.g. Berkley's techstars, Telefonica) needed to facilitate new venture formation (Mian, 1996). Moreover, the presence of star scientists and engineers brings more equity investors and attracts science and engineering faculty, potentially increasing university spinoff activity in incubators (Di Gregorio and Shane, 2003). We hypothesize:

Hypothesis 3d: University incubators will facilitate collaboration with investors for academic entrepreneurship.

Our conceptual framework illustrating the interplay between the individual characteristics of scientists and organizational and external stakeholders with potential mechanisms of interaction between them is illustrated in Figure 7.

Figure 7 Conceptual framework

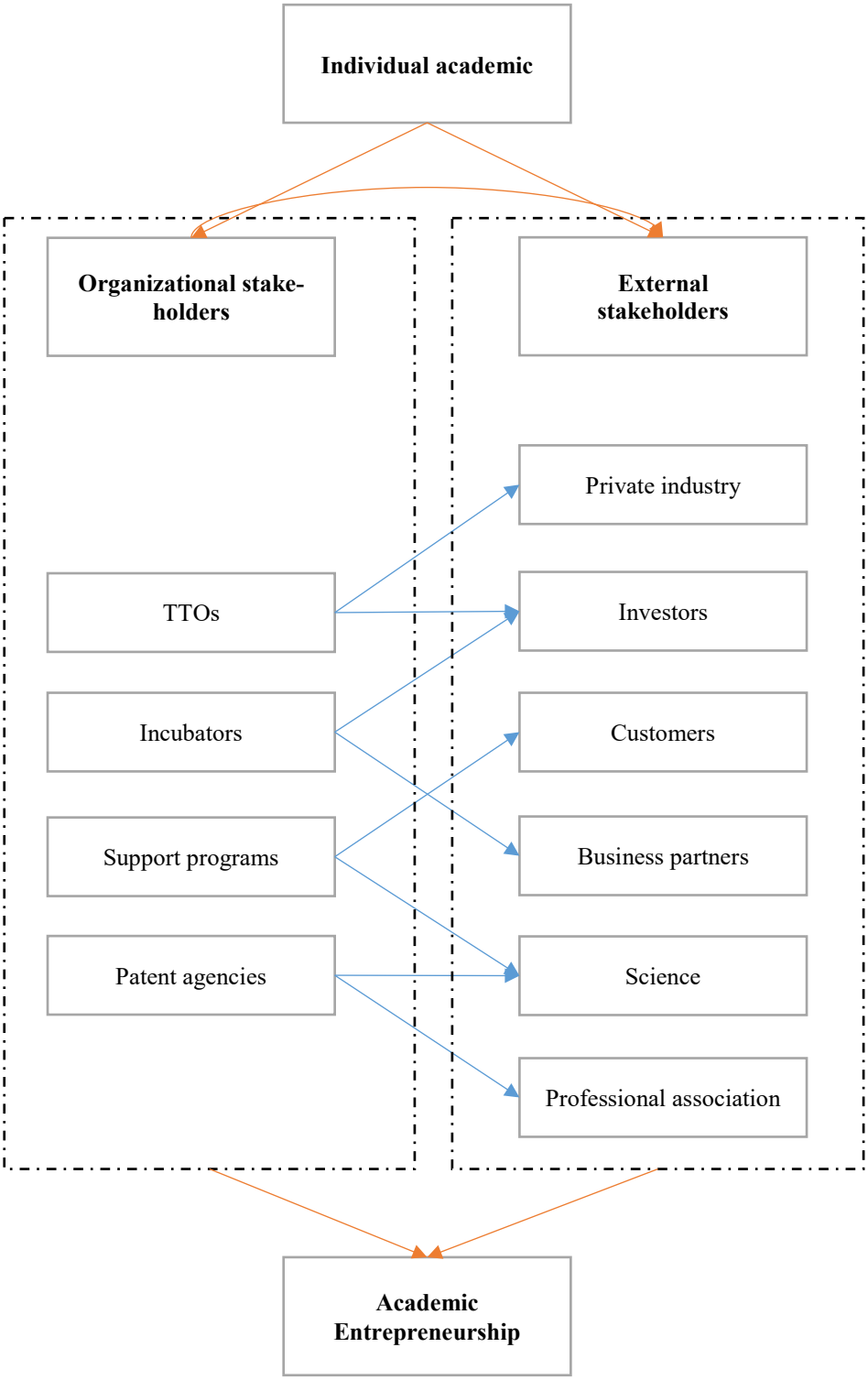
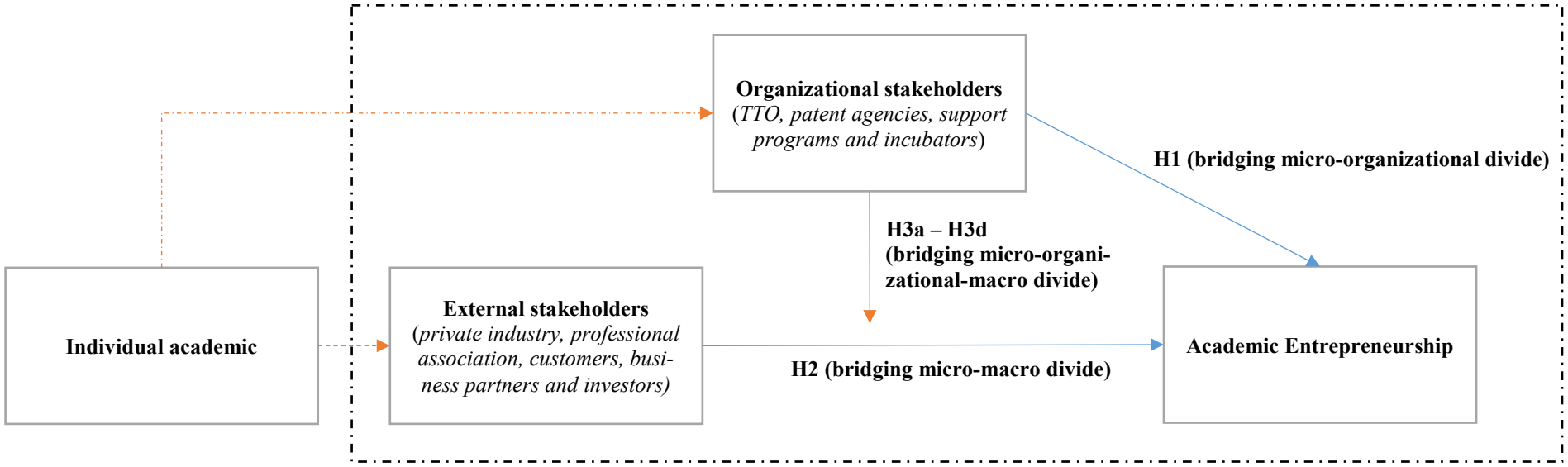


Figure 8 provides the analytical process behind the mechanisms connecting organizational and external stakeholders and illustrates the hypothesized relationships (H1-H3).

Figure 8 Analytical procedure



5.3 Methodology

5.3.1 Data

Our empirical study is based on data collected in cooperation with the IfM Bonn (Institut für Mittelstandsforschung Bonn) in 2013 and 2016 covering 73 German universities. In the initial survey in 2013, 36,918 scientists from a variety of different types of universities of higher education (research and teaching / universities of applied sciences), faculties (including information and computer science, medicine, engineering and biology) and positions (i.e. from researcher to full professor positions) were questioned. The survey focused on their entrepreneurial propensities and any actions they have undertaken to start new businesses (gestation activities). Responses from 7,342 scientists were received. The scientists who were surveyed in 2013 were then invited to participate in a follow-up survey in 2016. A total of 1,252 completed questionnaire were returned, which corresponds to a response rate of approx. 17%. After excluding those with missing values on start-up activities (e.g. for example those who had abandoned their plans on commercialization), information was available from 826 scientists who were observed between 2013 and 2016 at different stages of start-up activity. We use this sample to empirically test our research hypotheses.

5.3.2 Dependent and explanatory variables

Table 21 describes the micro, organizational and macro level variables we use in our regression models with their summary statistics. The first column of Table 21 also includes the year (2013 or 2016) where scientist's characteristics were observed.

Table 21 Variable descriptions

Variable (year observed)	Description	Mean	Std. Dev.	Min	Max
Dependent variable:					
Start-up activities (2016)	Dependent variable: Number of activities undertaken to advance a start-up project by university scientists (from zero to 18). Please refer to section 3 for description of each item.	1.476	2.819	0	18
University characteristics:					
Invention at university (2013)	Binary variable=1 if founder has made an invention based on a research project at the university, zero otherwise	.183	.387	0	1
Applied science university (2013)	Binary variable=1 if founder works at university of applied science, zero otherwise	.792	.406	0	1
Faculties:					
STEM (2013)	Binary variable =1 if founder works at the faculty of science, technology, engineering, math (STEM) as well as physics and other natural sciences, zero otherwise	.702	.458	0	1
Economics/ Social science (2013)	Binary variable =1 if founder works at the faculty of economics/ social science, zero otherwise	.145	.353	0	1
Architecture (2013)	Binary variable =1 if founder works at the faculty of architecture, zero otherwise	.006	.078	0	1
Medical technology (2013)	Binary variable =1 if founder works at the faculty of medicine/ health management, zero otherwise	.017	.129	0	1
Arts (2013)	Binary variable =1 if founder works at the faculty of Music, design, art, zero otherwise	.011	.104	0	1
Positions:					
Professor (2013)	Binary variable =1 if founder is a full professor, zero otherwise	.149	.356	0	1
Assistant professor (2013)	Binary variable =1 if founder is an assistant professor, zero otherwise	.179	.384	0	1
Research assistant (2013)	Binary variable =1 if founder is a research assistant, zero otherwise	.551	.498	0	1
Individual Characteristics:					
Age (2013)	Metric variable. Please state your age	36.929	10.309	23	65
Gender (2013)	Binary variable =1 if founder male and zero if the founder is female	.323	.468	0	1
Migration background (2013)	Binary variable =1 if founder has been migrated from another country; zero otherwise	.086	.280	0	1

(**Table 21** continues on the next page)

Table 21 (continued)

Start-up experience (2013)	Binary variable =1 if founder has ever been self-employed/freelance, zero otherwise	.183	.387	0	1
Risk taking willingness (2013)	Are you generally a risk-averse person or do you try to avoid risks? (from 1 to 5): 1= low risk-taking propensity; 5= high risk-taking propensity	2.686	.990	1	5
Entrepreneurial cognition (entrepreneurial self-efficacy) (2016)	Please indicate to what extent you agree with the following statements: 1) I have the capability to establish my own firm. 2) I have faith that the launching of my own firm will be a success. 3) I have all the necessary knowledge to start my own firm. 4) I have the entrepreneurial skills to start my own firm. (1 - strongly disagree; 5 strongly agree)	2.946	1.033	1	5
Entrepreneurial orientation (attitude towards science) (2016)	Please indicate to what extent you agree with the following statements: 1) Science and entrepreneurship are not compatible. 2) Knowledge should not be commercialized 3) Knowledge transfer between science and industry leads to social prosperity. 4) In my faculty, entrepreneurial self-employment is not welcomed. 5) In academia, Publication has a higher recognition than the commercialization of knowledge. (1 - strongly disagree; 5 strongly agree)	2.500	.639	1	5
Entrepreneurial Obstacles:					
Fear of failure (2016)	What prevented you from further advancing your start-up project: The risk of failing as an entrepreneur is too high (1 - strongly disagree; 5 strongly agree)	3.530	1.332	1	5
Lack of material resources (2016)	What prevent you from further advancing your start-up project?: I do not have enough financial resources (1 - strongly disagree; 5 strongly agree)	3.450	.964	1	5
Lack of support (2016)	What prevent you from further advancing your start-up project?: I do not have enough support from the private industry (1 - strongly disagree; 5 strongly agree)	3.491	1.171	1	5
Lack of time (2016)	What prevent you from further advancing your start-up project? I do not have enough time to further advance my founding plans (1 - strongly disagree; 5 strongly agree)	2.685	1.198	1	5

(**Table 21** continues on the next page)

Table 21 (continued)

Organizational stakeholders:					
TTO (2013)	Binary variable =1 if founders have attended start-up promotion offers by a TTO and were satisfied with them, zero otherwise	.048	.215	0	1
Patent agency (2013)	Binary variable =1 if founders have attended start-up promotion offers by patent agencies and were satisfied with them, zero otherwise	.031	.175	0	1
Support programs (2013)	Binary variable =1 if founders have attended support programs by the university and were satisfied with them, zero otherwise	.056	.229	0	1
Incubator (2013)	Binary variable =1 if founders have attended start-up promotion offers by start-up incubators and were satisfied with them, zero otherwise	.065	.247	0	1
External collaborators (stakeholders):					
Private industry (2013)	Binary variable =1 if an academic has contacts with contacts in private industry which are helpful for the implementation of the project, zero otherwise	.177	.382	0	1
Other scientists (2013)	Binary variable =1 if an academic has contacts with scientific community at her own university or another university (institution) which are helpful for the implementation of the project, zero otherwise	.150	.357	0	1
Associations (2013)	Binary variable =1 if an academic has contacts with professional and industry associations which are helpful for the implementation of the project, zero otherwise	.123	.329	0	1
Customers (2013)	Binary variable =1 if an academic has contacts with potential customers, which are helpful for the implementation of the project, zero otherwise	.067	.249	0	1
Business partners (2013)	Binary variable =1 if an academic has contacts with potential Business partners (e.g. suppliers or service providers), which are helpful for the implementation of the project, zero otherwise, which are helpful for the implementation of the project, zero otherwise	.119	.324	0	1
Investors (2013)	Binary variable =1 if an academic has contacts with capital investors, which are helpful for the implementation of the project, zero otherwise	.139	.346	0	1

Source: Individual scientist data collected by Institut für Mittelstandsforschung (2013-2017)

We measure academic entrepreneurship by an extent to which start-up project has been advanced in 2016. Specifically, the advancement of a start-up project can include one or more out of eighteen related start-up gestation activities we have information about. These are: (1) scientists have a specific founding idea; (2) scientists have reserved money for implementation of my founding idea; (3) scientists have negotiated with outside creditors and/or inside investors; (4) scientists have invested their own money in implementation of their founding idea; (5) scientists have started with the product or service development; (6) scientists have built a prototype/ further developed the company offer; (7) scientists have recruited a co-founder/ funding team; (8) scientists have developed a business plan; (9) scientists have collected information about markets and competitors; (10) scientists have purchased/leased equipment/materials/rooms; (11) scientists have set a date for establishment; (12) scientists have taken care of the exploitation rights; (13) scientists have registered at the at the tax office; (14) scientists have started advertising campaigns and marketing; (15) scientists have met potential customers; (16) scientists have accepted first orders; (17) scientists have acquired/ contacted important business partners; (18) scientists have used start-up supports inside and outside the university. Although there is a spectrum of activities, associated with a different degree of exploration or exploitation of start-up project steps, we constructed an additive index score measure by adding score one for each step undertaken by scientist (zero otherwise) with a minimum number of steps equal to zero and a maximum number of steps equals to 18. Thus, our dependent variable is the overall index which ranges between zero and 18. As part of a robustness check, please note that we excluded items 17 and 18 from the dependent variable because of potential endogeneity issues with the independent variables.[7]

Our first group of explanatory variables include the following collaborations with organizational stakeholders who aim to provide support on how to commercialize academic research. Such support was offered within TTOs, patent agency, support programs and university incubators between 2013 and 2016. We therefore created a set of binary variables which equal "1" if the scientists have participated in such a stakeholder events (TTO, patent agency, support programs and incubator activity) and found that the information provided by the organizational stakeholder was useful, zero otherwise.

[7] Specifically, when estimating regression models with either dependent variable (16 and 18 items), our results remain robust; i.e., the coefficient signs and confidence interval have not changed.

Our second group of explanatory variables include the following external (environmental) stakeholders: private industry, scientific community at scientist's own university or another university, professional and industry associations, potential customers and capital investors. Again, we generated a set of binary variables for each external partner which equals "1" should scientist have these contacts with external partners, zero otherwise. In order to test H3a-H3c, we included interaction terms reflecting different combinations of collaboration of scientists with our organizational and external stakeholders. All thing equal, we expect the number of activities to be higher if the scientists collaborate with different stakeholder types – reflected in positive interaction effects.

In addition to our explanatory variables and in line with prior research (McAdam et al., 2016), we included a rich set of control variables. The scientist's *field of specialization* (e.g. STEM, biology, social sciences, etc.) was included because prior studies have demonstrated that scientists from biomedical and engineering faculties have a higher spin-off creation (Zucker et al., 2002; Gittelman and Kogut, 2003; O'Shea et al., 2005; Abreu et al., 2016). We also control for scientist's perception of *entrepreneurial constraints* such as fear of failure, lack of financial resources (Wright et al., 2003) and entrepreneurial knowledge, time constraints. These variables have shown to affect the creation of spin-offs (Markman et al., 2005; 2009; Agarwal and Shah 2014). Additionally, entrepreneurial challenges affect the perceptions of legitimization of the novel opportunities (Busenitz et al., 2000). For example, *risk-aversion*, *confidence in entrepreneurial skills* and *time availability to start a business* are positively associated with new business start-ups (Arenius and Minniti, 2005). Together, the scientist's perception of opportunities and challenges will influence the recognition and exploitation of entrepreneurial opportunities (Shane, 2000) as well as the combination of activities that a scientist will choose to pursue to start a business. Finally, we control for the scientists' age, gender, migration background, position, start-up experience, entrepreneurial cognition and orientation (Aldridge and Audretsch, 2010). Migration background of scientists has attracted attention in entrepreneurship cognition and commercialization research (Siegel and Waldman, 2019). Table 22 presents a correlation matrix between the variables used in this study. Note that the correlation between the explanatory variables is of only moderate size. Moreover, the variance inflation factors for all variables are less than 10. Thus, multicollinearity should not be an issue.

Table 22 Correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
DV_1: Degree of start-up project advancem	1.00																																	
TTO	.14	1.00																																
Patent agency	.16	.57	1.00																															
Support programs	.14	.49	.41	1.00																														
Incubator	.13	.56	.35	.53	1.00																													
Private environment	.25	.06	.01	.05	.12	1.00																												
Other scientists	.27	.21	.14	.22	.25	.48	1.00																											
Associations	.25	.19	.12	.21	.18	.37	.65	1.00																										
Customers	.18	.10	.04	.06	.17	.31	.28	.33	1.00																									
Business partners	.32	.16	.11	.16	.22	.43	.40	.42	.49	1.00																								
Investors	.30	.22	.15	.22	.22	.43	.47	.39	.41	.61	1.00																							
University type	-.01	-.04	.06	-.02	.03	-.06	.01	.01	-.05	-.12	-.09	1.00																						
F_MINT	-.05	.02	.01	.02	.00	-.12	-.05	-.05	-.12	-.15	-.08	.20	1.00																					
F_Economics/ Social science	.04	.02	.00	.03	.06	.12	.01	.03	.14	.14	.07	-.07	-.63	1.00																				
F_Architecture	.09	-.02	-.01	-.02	-.02	.05	.05	.02	-.02	.02	.06	-.11	-.12	-.03	1.00																			
F_Medical technology	-.02	.06	.08	.01	.00	.01	.00	-.02	.04	.04	.03	-.05	-.20	-.05	-.01	1.00																		
F_Arts	-.01	-.02	-.02	-.03	-.03	-.05	-.01	-.04	-.03	-.04	-.04	.03	-.16	-.04	-.01	-.01	1.00																	
F_Others	.01	-.07	-.04	-.06	-.05	.04	.06	.04	.02	.05	.03	-.17	-.56	-.15	-.03	-.05	-.04	1.00																
Pos_Professor	.13	.27	.16	.12	.15	.07	.06	.14	.20	.18	.13	-.36	-.05	.08	-.03	.02	-.01	-.01	1.00															
Pos_Assistent professor	.00	-.05	-.01	-.02	-.03	-.05	-.03	.00	.00	-.01	-.02	.21	.09	-.06	-.04	-.04	-.02	-.03	-.20	1.00														
Pos_Research assistent	-.05	-.14	-.10	-.04	-.04	.00	.01	-.07	-.15	-.11	-.04	.21	.00	.03	.01	-.03	.02	-.04	-.46	-.52	1.00													
Pos_Others	-.06	-.03	.00	-.06	-.07	-.02	-.05	-.05	.01	-.02	-.04	-.18	-.05	-.07	.07	.07	.00	.10	-.16	-.17	-.41	1.00												
Gender (1=Male, 0=Female)	-.14	-.12	-.05	-.07	-.07	-.04	-.11	-.13	-.05	-.09	-.09	.00	-.10	.02	.05	.09	.00	.07	-.13	-.05	.07	.09	1.00											
Age	.05	.23	.12	.11	.11	.06	.04	.11	.18	.13	.08	-.34	-.04	-.04	-.01	.07	.08	.06	.53	.05	-.53	.17	-.14	1.00										
Migration background (1=Yes, 0=No)	.04	-.01	-.03	.02	.01	.07	.00	.04	.09	.01	.04	.05	.05	-.04	-.02	.03	-.03	-.02	-.04	.00	.03	-.01	-.02	-.06	1.00									
Risk taking willingness	.23	.11	.09	.06	.08	.20	.13	.18	.13	.19	.17	.01	-.04	.10	-.01	-.02	-.04	-.03	.16	.04	-.08	-.10	-.12	.09	.08	1.00								
Self efficacy	.32	.05	.06	.10	.11	.26	.24	.21	.20	.25	.24	-.07	-.22	.25	.06	-.04	-.01	.04	.10	-.04	.04	-.13	-.13	.00	.08	.43	1.00							
Attitude towards science	-.13	-.08	-.06	-.11	-.08	.00	-.02	-.07	-.05	-.10	-.11	.04	.03	-.11	-.01	.08	.07	.03	-.08	.06	-.05	.08	.06	.00	-.03	-.11	-.19	1.00						
Invention at university (1=Yes, 0=No)	.19	.16	.15	.06	.04	.01	.11	.16	.07	.11	.17	.06	.16	-.16	-.04	-.01	-.02	-.04	.11	.10	-.11	-.06	-.18	.15	.04	.14	.07	-.10	1.00					
Start-up experience (1= yes; 0= no)	.12	.08	.00	.09	.07	.13	.10	.06	.13	.09	.15	-.17	-.17	.13	.12	.01	.04	.05	.16	.03	-.16	.03	-.03	.24	-.03	.13	.23	.01	.00	1.00				
Obst1_Fear of failure	-.21	-.07	-.09	-.10	-.11	-.16	-.12	-.11	-.10	-.15	-.19	.02	.08	-.13	-.03	-.06	.02	.05	-.16	-.04	.08	.10	.14	-.11	-.09	-.37	-.40	.13	-.06	-.14	1.00			
Obst2_Lack of material resources	-.16	-.02	-.06	-.05	-.05	-.16	-.03	-.04	-.12	-.19	-.11	.07	.21	-.30	.01	-.07	.04	.04	-.18	.01	.08	.07	.10	-.11	-.02	-.30	-.43	.12	.03	-.19	.49	1.00		
Obst3_Lack of support	-.43	-.08	-.06	-.14	-.13	-.21	-.18	-.18	-.17	-.25	-.28	.03	.08	-.09	-.10	-.03	.01	.02	-.13	.01	.05	.05	.13	-.11	-.10	-.37	-.52	.17	-.08	-.19	.47	.46	1.00	
Obst4_Lack of time	-.04	.04	.00	-.04	-.06	-.05	.02	.04	-.05	-.08	-.05	.03	.10	-.16	.00	-.06	.01	.05	-.04	-.01	.03	.01	-.04	.02	.01	-.13	-.20	.05	.06	-.06	.32	.52	.23	1.00

Note: N= 826

5.3.3 Analysis

As mentioned above, we use two waves of panel data consisting of scientists (founders) who were initially surveyed in 2013 and then again in 2016. In this time frame, these individuals had to decide how much research to commercialize and, consequently, how many steps to take for a start-up, i.e., our q^*. This can be modelled the following way: We use q^* to denote a degree of the start-up project advancement measured on the scale between zero and eighteen. Accordingly, q^* of each individual i is an (observable) indicator function if individual i has (or reports) any activity undertaken, zero otherwise.

$$q_{ij}^* = \alpha_0 + \sum_{k=1}^{p} \beta_k F_{ij} + \sum_{l=1}^{q} \gamma_l R_j + \delta M_t + \sum_{n=1}^{s} \mu_n M_{is} \times R_j + \sum_{h=1}^{n} \beta_h C_{ij} + e_{ij} \quad (1)$$

q_{ij}^* is a censored indicator variable such that a scientist (founder) i decides to perform (or to report) any start-up activity and vary between zero activities to a maximum of 18 start-up advancement activities in 2016; F_{ij} is our set of explanatory individual characteristics of a scientist (founder) i employed at university j, which affect a start-up decision-making. R_j is a vector of binary variables equals to one if a scientist (founder) has attended any start-up promotion offers by TTO, patenting agency, support program or university incubator j in 2013 or earlier and was satisfied with it, zero otherwise [8]. M_{is} is a vector of binary variables equal to one if our scientists (founders) have contacts with external stakeholders s (private industry, scientific community at her own university or another university, professional and industry associations, customers and capital investors) between 2013 and 2016, zero otherwise. C_{ij} is a vector of control variables related to university type, scientists' professional and individual characteristics which were observed from the survey between 2013 and 2016; $e_{ij}$is the error term.

Accordingly, our hypotheses were tested using hierarchical (nested) OLS and TOBIT regression models. That is, we regressed the number of start-up activities on the potential individual, organisational and environmental drivers discussed above with a specific focus on potential interaction effects. We started with the OLS regression as a first test of the hypothesized relationships.

[8] In the questionnaire, scientists were asked if they attended an event, or are currently attending or plan to attend a startup promotion offer at the university. We only considered scientists who attended or are attending a startup promotion offer in 2013 or earlier.

However, given the censored nature of our dependent variable (i.e. a large proportion of scientists have taken no steps to found an academic start-up between 2013 and 2016), Tobit regression models were estimated to mitigate measurement bias (Greene, 2003; Wooldridge, 2002).

First, we calculate a model including only the control variables (Model 1, Table 23 and 24). In Model 2, we then include the organisational indicators. In Model 3-6 we then include all control variables, organisational variables and interactions between external stakeholder and organizational stakeholders piecewise. Finally, in Model 7 (Table 23 and 24) we include all variables and interactions.

5.4 Results

Estimations are presented in Tables 23 (OLS) and 24 (TOBIT). We discuss further results using Tobit estimation.

Table 23 OLS estimation of academic entrepreneurship

DV_1: Degree of startup project advancement	Model 1 (OLS Regression)			Model 2 (OLS Regression)			Model 3 (OLS Regression)			Model 4 (OLS Regression)			Model 5 (OLS Regression)			Model 6 (OLS Regression)			Model 7 (OLS Regression)		
	Coef.	Std.	P>|t|	Coef.	Std.	P>|t|	Coef.	Std.	P>|t|	Coef.	Std.	P>|t|	Coef.	Std.	P>|t|	Coef.	Std.	P>|t|	Coef.	Std.	P>|t|
Controls																					
Invention at university	1.000	(.302)	***	.796	(.288)	***	.809	(.294)	***	.839	(.286)	***	.874	(.287)	***	.888	(.290)	***	.849	(.288)	***
Applied science university	.174	(.259)		.115	(.252)		.161	(.249)		.041	(.246)		.148	(.251)		.143	(.240)		.041	(.237)	
Faculties																					
STEM	-.245	(.298)		-.112	(.295)		-.107	(.292)		-.087	(.292)		-.113	(.293)		-.155	(.295)		-.156	(.296)	
Economics/ Social science	-.135	(.366)		-.163	(.357)		-.177	(.355)		-.236	(.353)		-.160	(.356)		-.155	(.357)		-.268	(.362)	
Architecture	1.734	(.718)	**	1.592	(.765)	**	1.634	(.734)	**	1.588	(.770)	**	1.635	(.749)	**	1.644	(.709)	**	1.607	(.719)	**
Medical technology	-.246	(.636)		-.463	(.584)		-.538	(.533)		-.984	(.564)	*	-.215	(.577)		-.207	(.589)		-.841	(.517)	
Arts	-.006	(.630)		.364	(.592)		.367	(.599)		.401	(.604)		.317	(.589)		.300	(.583)		.370	(.602)	
Other fields				…	…		…	…		…	…		…	…		…	…		…	…	
Positions																					
Professor	.722	(.366)	**	.546	(.358)		.448	(.353)		.508	(.351)		.499	(.351)		.478	(.346)		.534	(.346)	
Assistant professor	.030	(.306)		.092	(.296)		.021	(.296)		.032	(.296)		.048	(.299)		.038	(.298)		-.020	(.290)	
Research assistant	-.102	(.246)		-.048	(.246)		-.125	(.243)		-.049	(.241)		-.115	(.244)		-.141	(.244)		-.116	(.240)	
Others position (Associate)				…	…		…	…		…	…		…	…		…	…		…	…	
Individual Characteristics																					
Age	-.019	(.011)	*	-.265	(.162)		-.232	(.161)		-.229	(.162)		-.265	(.162)		-.266	(.159)	*	-.216	(.161)	
Gender	-.319	(.164)	*	-.021	(.011)	**	-.022	(.011)	**	-.023	(.010)	**	-.020	(.011)	*	-.021	(.010)	**	-.027	(.010)	***
Migration background	-.066	(.327)		-.021	(.315)		-.002	(.320)		-.021	(.317)		-.065	(.324)		.013	(.318)		.059	(.327)	
Start-up experience	.184	(.276)		.197	(.263)		.184	(.266)		.221	(.259)		.206	(.265)		.212	(.253)		.189	(.253)	
Risk taking willingness	.077	(.097)		.027	(.093)		.014	(.095)		.035	(.093)		.010	(.095)		.001	(.094)		.035	(.090)	
Entrepreneurial cognition	.312	(.112)	***	.200	(.108)	*	.202	(.109)	*	.174	(.108)		.227	(.110)	**	.195	(.107)	*	.152	(.102)	
Entrepreneurial orientation	-.133	(.121)		-.123	(.121)		-.102	(.121)		-.130	(.118)		-.103	(.119)		-.104	(.119)		-.078	(.118)	
Entrepreneurial Obstacles																					
Fear of failure	.020	(.090)		.029	(.086)		.008	(.084)		.012	(.083)		.012	(.083)		.019	(.084)		.016	(.084)	
Lack of material resources	.176	(.124)		.169	(.120)		.122	(.120)		.155	(.119)		.133	(.119)		.151	(.120)		.142	(.116)	
Lack of entrepreneurial knowledge	-.875	(.103)	***	-.797	(.102)	***	-.778	(.100)	***	-.793	(.101)	***	-.765	(.101)	***	-.768	(.100)	***	-.776	(.101)	***
Lack of time	.083	(.081)		.065	(.079)		.088	(.078)		.081	(.077)		.084	(.077)		.055	(.078)		.066	(.077)	
Organizational stakeholders																					
TTO				-.242	(.735)		.166	(.117)											.202	(.153)	
Patent agency				1.666	(.917)	*				.262	(.120)	**							.166	(.135)	
Support programs				.146	(.550)								.075	(.102)					-.224	(.106)	**
Incubator				-.125	(.603)											.012	(.092)		.062	(.157)	

(**Table 23** continues on the next page)

Table 23 (continued)

External collaborators																			
Private industry				.502	(.345)		.209	(.143)		.212	(.139)		.157	(.149)		.180	(.147)		.195	(.146)	
Other scientists				.389	(.470)		.128	(.177)		.234	(.171)		.165	(.180)		.118	(.178)		.225	(.175)	
Professional (Associations)				.243	(.540)		.159	(.188)		.041	(.181)		.157	(.193)		.252	(.188)		.160	(.187)	
Customers				-.210	(.581)		-.069	(.166)		-.015	(.158)		-.104	(.166)		-.101	(.167)		-.060	(.167)	
Business partners				1.250	(.474)	***	.418	(.186)	**	.410	(.175)	**	.457	(.185)	**	.352	(.191)	*	.305	(.189)	
Investors				.064	(.422)		.068	(.170)		-.007	(.162)		.046	(.168)		.069	(.176)		.078	(.170)	
Interactions:																					
TTO x Private industry							.247	(.184)											.416	(.150)	***
TTO x Other scientists							.063	(.181)											-.384	(.179)	
TTO x Associations							-.267	(.164)											.210	(.161)	
TTO x Customers							-.149	(.147)											-.390	(.169)	**
TTO x Business partners							.125	(.157)											.027	(.154)	
TTO x Investors							.062	(.121)											.287	(.167)	*
Patent agency x Private industry										.067	(.118)								-.196	(.131)	
Patent agency x Other scientists										.819	(.225)	***							1.075	(.182)	***
Patent agency x Associations										-.792	(.181)	***							-.846	(.140)	***
Patent agency x Customers										.283	(.108)	***							.562	(.165)	***
Patent agency x Business partners										-.281	(.126)	**							-.527	(.138)	***
Patent agency x Investors										-.011	(.148)								-.099	(.146)	
Support Programs x Private industry													.213	(.126)	*				-.119	(.103)	
Support Programs x Other scientists													.051	(.149)					-.057	(.121)	
Support Programs x Associations													-.136	(.135)					.130	(.095)	
Support Programs x Customers													.044	(.120)					.423	(.164)	**
Support Programs x Business partners													.039	(.127)					-.243	(.128)	*
Support Programs x Investors													.064	(.125)					-.335	(.155)	**
Incubator x Private industry																.184	(.104)	*	.123	(.112)	
Incubator x Other scientists																-.002	(.120)		.118	(.152)	
Incubator x Associations																-.288	(.123)	**	-.480	(.136)	***
Incubator x Customers																-.123	(.117)		-.450	(.118)	***
Incubator x Business partners																.309	(.099)	***	.604	(.132)	***
Incubator x Investors																.107	(.098)		.352	(.141)	**
Constant	3.415	(1.009)	***	3.302	(1.007)	***	3.918	(1.005)	***	4.006	(.996)	***	3.679	(1.010)	***	3.837	(.962)	***	4.191	(.948)	***
N	826			826			826			826			826			826			826		
R^2	.2405			.2940			.3013			.3210			.2983			.3154			.3660		
F	9.52	***		7.39	***		7.21	***		8.29	***		7.84	***		8.63	***		11.84	***	

Note: Robust standard errors in parentheses. Other fields of research are a reference category. Other position (Associate) – associate professor is a reference category. * $p \leq .10$, ** $p \leq .05$, *** $p \leq .01$ Source : Authors calculations based on individual scientist data collected by Institut für Mittelstandsforschung (2013-2017)

Table 24 Tobit estimation of academic entrepreneurship

DV_1: Degree of start-up project advancement	Model 1 (Tobit estimation)			Model 2 (Tobit estimation)			Model 3 (Tobit estimation)			Model 4 (Tobit estimation)			Model 5 (Tobit estimation)			Model 6 (Tobit estimation)			Model 7 (Tobit estimation)		
	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|
Controls																					
Invention at university	1.750	(.549)	***	1.380	(.543)	**	1.449	(.537)	***	1.452	(.531)	***	1.554	(.537)	***	1.586	(.532)	***	1.539	(.522)	***
Applied science university	.353	(.614)		.254	(.611)		.347	(.606)		.119	(.600)		.293	(.604)		.305	(.599)		.179	(.591)	
Faculties																					
STEM	-.846	(.669)		-.579	(.645)		-.568	(.643)		-.504	(.632)		-.568	(.647)		-.668	(.637)		-.672	(.616)	
Economics/ Social science	-.748	(.840)		-.860	(.815)		-.854	(.813)		-.963	(.799)		-.822	(.814)		-.812	(.804)		-1.000	(.780)	
Architecture	2.256	(2.302)		1.997	(2.207)		2.078	(2.197)		1.964	(2.164)		2.037	(2.205)		2.072	(2.176)		1.941	(2.089)	
Medical technology	-.594	(1.811)		-1.164	(1.777)		-1.277	(1.794)		-2.233	(1.847)		-.655	(1.754)		-.660	(1.728)		-1.888	(1.784)	
Arts	.377	(2.048)		1.135	(1.963)		1.138	(1.956)		1.220	(1.926)		1.042	(1.964)		.957	(1.940)		1.078	(1.862)	
Other fields	…	…		…	…		…	…		…	…		…	…		…	…		…	…	
Positions																					
Professor	1.676	(.908)	*	1.368	(.886)		1.223	(.891)		1.299	(.872)		1.295	(.886)		1.256	(.874)		1.371	(.863)	
Assistant professor	.573	(.861)		.698	(.830)		.559	(.826)		.575	(.815)		.623	(.827)		.608	(.817)		.387	(.800)	
Research assistant	.281	(.775)		.357	(.749)		.220	(.743)		.336	(.734)		.243	(.746)		.229	(.738)		.166	(.719)	
Others position (Associate)	…	…		…	…		…	…		…	…		…	…		…	…		…	…	
Individual Characteristics																					
Age	-.064	(.029)	**	-.069	(.028)	**	-.070	(.028)	**	-.071	(.028)	**	-.067	(.028)	**	-.066	(.028)	**	-.083	(.027)	***
Gender	-1.179	(.495)	**	-.996	(.478)	**	-.927	(.475)	*	-.937	(.469)	**	-.976	(.477)	**	-.989	(.473)	**	-.856	(.457)	*
Migration background	.118	(.715)		.076	(.698)		.097	(.697)		.056	(.685)		.020	(.699)		.091	(.692)		.159	(.672)	
Start-up experience	1.057	(.548)	*	1.020	(.536)	*	.962	(.538)	*	1.038	(.526)	**	1.018	(.538)	*	.967	(.530)	*	.931	(.521)	*
Risk taking willingness	.177	(.248)		.056	(.241)		.027	(.240)		.065	(.236)		.031	(.243)		.005	(.239)		.084	(.234)	
Entrepreneurial cognition	.888	(.271)	***	.611	(.265)	**	.620	(.265)	**	.567	(.261)	**	.637	(.266)	**	.589	(.262)	**	.503	(.256)	**
Entrepreneurial orientation	-.198	(.358)		-.170	(.346)		-.108	(.345)		-.186	(.340)		-.125	(.347)		-.131	(.342)		-.080	(.334)	
Entrepreneurial Obstacles																					
Fear of failure	.004	(.193)		-.003	(.187)		-.042	(.187)		-.032	(.184)		-.032	(.188)		-.015	(.186)		-.023	(.181)	
Lack of material resources	.671	(.315)	**	.652	(.308)	**	.570	(.307)	*	.594	(.303)	*	.609	(.307)	**	.628	(.304)	**	.529	(.299)	*
Lack of entrepreneurial knowledge	-2.354	(.242)	***	-2.200	(.236)	***	-2.161	(.234)	***	-2.170	(.231)	***	-2.156	(.235)	***	-2.143	(.232)	***	-2.084	(.224)	***
Lack of time	.252	(.215)		.232	(.207)		.271	(.206)		.266	(.203)		.254	(.207)		.194	(.205)		.222	(.201)	
Organizational stakeholders																					
TTO				.078	(1.215)		.271	(.253)											.605	(.346)	*
Patent agency				2.178	(1.328)					.401	(.249)								.093	(.316)	
Support programs				.007	(1.033)								.024	(.257)					-.607	(.321)	*
Incubator				-.286	(.981)											-.098	(.259)		-.077	(.329)	

(**Table 24** continues on the next page)

Table 24 (continued)

External collaborators																
Private industry			1.588	(.582)	***	.669	(.243)	***	.638	(.238)	***	(.250)	.016	.659	(.242)	***	.582	(.242)	**
Other scientists			.584	(.735)		.163	(.279)		.306	(.275)		(.282)	.370	.188	(.279)		.344	(.278)	
Professional (Associations)			.658	(.743)		.331	(.267)		.206	(.263)		(.272)	.245	.423	(.267)		.259	(.271)	
Customers			-.005	(.852)		.010	(.244)		.063	(.237)		(.245)	.784	-.007	(.245)		.019	(.243)	
Business partners			1.775	(.763)	**	.574	(.303)	*	.576	(.290)	**	(.303)	.041	.476	(.305)		.410	(.303)	
Investors			-.308	(.724)		-.028	(.288)		-.141	(.278)		(.291)	.778	-.068	(.287)		.049	(.288)	
Interactions:																
TTO x Private industry						.310	(.220)										.781	(.399)	*
TTO x Other scientists						-.099	(.253)										-.911	(.402)	**
TTO x Associations						-.240	(.204)										.439	(.343)	
TTO x Customers						-.267	(.186)										-.460	(.379)	
TTO x Business partners						.274	(.196)										.171	(.344)	
TTO x Investors						.059	(.192)										.513	(.319)	
Patent agency x Private industry									.043	(.234)							-.353	(.338)	
Patent agency x Other scientists									.901	(.346)	***						1.591	(.454)	***
Patent agency x Associations									-.968	(.308)	***						-1.260	(.393)	***
Patent agency x Customers									.299	(.222)							.703	(.379)	*
Patent agency x Business partners									-.311	(.259)							-1.027	(.404)	**
Patent agency x Investors									-.019	(.217)							-.008	(.271)	
Support Programs x Private industry												.235	(.176)				-.206	(.307)	
Support Programs x Other scientists												-.028	(.211)				-.218	(.382)	
Support Programs x Associations												-.093	(.187)				.449	(.324)	
Support Programs x Customers												.035	(.172)				1.055	(.372)	***
Support Programs x Business partners												.154	(.197)				-.365	(.349)	
Support Programs x Investors												.065	(.190)				-.844	(.354)	**
Incubator x Private industry														.154	(.192)		-.131	(.290)	
Incubator x Other scientists														-.102	(.223)		.363	(.369)	
Incubator x Associations														-.302	(.191)		-.926	(.374)	**
Incubator x Customers														-.238	(.160)		-1.196	(.410)	***
Incubator x Business partners														.492	(.198)	**	1.122	(.355)	***
Incubator x Investors														.207	(.195)		.856	(.336)	**
Constant	2.618	(2.526)		2.805	(2.471)		3.841	(2.470)		4.176	(2.423)	*	3.504	(2.460)		3.769	(2.437)		4.694	(2.377)	**
N	826			826			826			826			826			826			826		
Pseudo R^2	.1015			.1173			.1189			.1216			.1178			.1217			.1348		
LR chi2	253.99	***		293.69	***		297.47	***		304.41	***		294.95	***		304.56	***		337.40	***	

Note: Robust standard errors in parentheses. Other fields of research are a reference category. Other position (Associate) – associate professor is a reference category. * p ≤.10, ** p ≤ .05, *** p ≤ .01 Source : Authors calculations based on individual scientist data collected by Institut für Mittelstandsforschung (2013-2017)

Hypothesis 1 is partly supported: For German scientists, the collaboration with university TTOs is positively associated with start-up project development (β=0.605, $p<0.10$, Table 24 Model 7). Interestingly, the OLS estimation also show a positive and significant effect of collaboration with patent agencies, however the effect disappears once controlled for organizational stakeholders such as TTOs and incubators, with a TTO emerging as the strongest indicator of institutional support in line with a traditional model of knowledge commercialization (Link et al., 2007; Clarysse et al., 2011a; Bradley et al., 2013). Participation in support programs organized in universities is negatively associated with the number of start-up activities. This finding indicates that support programs may be used as substitutes of entrepreneurial action, or it may point to the fact that scientists who participate in such support programs are in more early stages of business creation (β=-0.607, $p<0.10$, Table 24 Model 7). Contacts with patenting agency per se do not facilitate start-up activities. We believe that this finding reflects a lack of scientist' incentives to commercialize the knowledge in the market. As noted above, in Germany intellectual property rights are owned by the universities who participate from commercialization of university knowledge transfer. The scientists' invention is a patentable or utility-eligible invention made by an employee as part of his service for the employer (university). According to the Law on Employee Inventions, the employer is in principle entitled to the rights to the service invention, whereas the employee only has a compensatory right to compensation. Special provisions also apply after the abolition of the so-called university teacher's privilege for the inventions of employees at a university. The law also regulates the treatment of such creative achievements of workers who are not protected by a patent or a utility model or otherwise eligible for intellectual property but who improve the performance of a company ("technical improvement proposals") (Bartenbach and Volz, 2019).

We also find some support for hypothesis 2. However, this support is limited to the effect of private industry on start-up activity (β=0.582, $p<0.05$, Table 24 Model 7). The private industry such as contacts with private firms, industry and capital investors is the most advanced way of a direct engagement of scientists in commercialization (Wright et al., 2006). Some scholars (Di Gregorio and Shane, 2003; O'Shea et al., 2005) find a positive correlation between availability of venture capital in the university area and venture creation by universities. Surprisingly, we find that the private industry effect on start-up activity dominates all other external stakeholders' effects.

The results however confirm Clarysse and Moray (2004), Clarysse et al., (2014) and Miller et al., (2014) that knowledge spillover of academic entrepreneurship to industry is affected by the environmental context, including the opportunities offered by the local industrial sector and private companies (O'Shea et al., 2005).

Our findings support H3a which states that university TTO facilitates collaboration with private industry for academic entrepreneurship for the private industry (β=0.781, $p<0.10$, Table 24 Model) (Siegel and Wright, 2015). However, we do not find empirical evidence that TTO is an efficient conduit for external capital investors to facilitate start-up activity in German universities (β=0.513, $p>0.10$, Table 24 Model 7). This brings us to the literature on challenges related to the "red tape" of TTOs at universities (Siegel et al., 2003; Kolympiris and Klein, 2017), i.e., after .having secured the capital investor, the role of a TTO is likely to be diminished.

Surprisingly, we also do not find TTOs in German universities facilitating commercialization activity based on potential customers and professional associations' contacts. This does not look like an issue of the TTO itself as also other intermediaries such as patent agencies and incubators do not directly affect the scientist's start-up activities. Although, there has been some criticism on the efficacy of TTOs in facilitating university-industry linkages (Siegel et al., 2003; 2007; Kenney and Patton, 2009; Markman et al., 2009), our finding demonstrate that TTOs in German universities in fact facilitate university-industry linkages to help researchers build stronger ties with industry partners, but this does not work with securing contacts with professional associations (Rasmussen et al., 2011). It may be the case that industry and professional associations in Germany are a club-like societies aiming at networking and establishing contacts between various members, including industry and academics. That is, once the contact has been established it will move towards "private industry" contacts which has positive and significant effect supporting H3a. Finally, and rather surprising, we find negative coefficients of TTO and contacts with scientists at university and other universities (scientific community) (β=-0.911, $p<0.05$, Table 24 Model 7).

Given that contacts with scientists are likely to be around basic (highly theoretical study with limited applicability, e.g. Newton laws of motion) than applied research, it limits the mechanisms of the knowledge spillover. The most straightforward route is patenting an invention and later licensing it to industry; however, this will have no effect on scientist's start-up intentions and activity. While TTO leaders may not be able to distinguish between basic and applied knowledge (Audretsch, 2014) and hence they are limited in what help they can offer

to commercialize research through TTO route. A TTO needs to learn how to spill over both basic and scientific knowledge and to embed the scientific collaborations (Meyer, 2003).

Our H3b which states that patent agencies will facilitate collaboration with scientists and professional associations for academic entrepreneurship is partly supported. Scientists who collaborate with patent agency and other scientists will have higher start-up activity (β=1.591, $p<0.01$, Table 24 Model 7). The interaction coefficient of collaboration with patent agency and contacts with professional association is negative (β=-1.260, $p<0.01$, Table 23 Model 7). The result is surprising but understandable and is rooted in the nature and a mission of professional networks as well as scientist's motivation to participate in such networks.

Collaboration between scientists involved in professional networks and association does not target direct commercialization of research, rather than expanding existing professional networks, meeting practitioners, looking for new ways of applicability of the basic research developed within a university. In addition, contacts in professional associations may be an indicator of a scientists aiming to switch its career to working for industry. Legal protection of inventions by members of professional societies are rare (Fosfuri et al., 2012). Scientists which join professional communities may be limited in appropriation of knowledge and the extent they can own and protect it, which limits start-up creation and therefore several steps undertaken to launch a business. Joint patents with professional associations are rare (Helmers and Rogers, 2015).

Our H3c is partly supported as university support programs facilitate collaboration with customers and lead to more start-up activities (β=1.055, $p<0.01$, Table 24 Model 7), while collaboration with scientists and participating in support programs decreases start-up activity (β=-0.844, $p<0.05$, Table 24 Model 7).

Scientists who collaborate with other universities and scientific communities aim at co-creating completely new knowledge, rather than re-producing and disseminating existing one. This purely exploratory activity embedded research work is likely to bring scientists together to the support programs. For the same reason as with patenting, knowledge co-created as a result of such collaboration is unique and may not belong to a single researcher or institution to appropriate. The negative sign demonstrates that support programs include scientists who collaborate on a very niche area and who develop mutual relational trust between each other as a result of such programs (Mosey and Wright, 2007).

Finally, H3d is supported. In fact, scientists that are involved in the incubator and collaborate with capital investors will undertake more steps to launch a business ($\beta=0.856$, $p<0.05$, Table 24 Model 7). In addition, they are more likely to find business partner in the incubator which will also facilitate start-up activity ($\beta=1.122$, $p<0.01$, Table 24 Model 7) (Di Gregorio and Shane, 2003; O'Link et al., 2015). This is an interesting finding as business incubation results in testing of products, market exit as well as discussion and complementarities between residents as a result new merges are likely to happen. These findings are robust using OLS estimation with the coefficient for capital investors ($\beta=0.352$, $p<0.05$, Table 23 Model 7) and for business partners is ($\beta=0.604$, $p<0.01$, Table 23 Model 7). Interesting that the effect of launching business partnership in the incubator is double to what is achieved by investors for start-up activity demonstrates that incubators are an efficient tool for networking in Germany with both co-founders and investors. In addition, collaboration with customers ($\beta=-1.196$, $p<0.01$, Table 24, Model 7) and professional association ($\beta=-0.926$, $p<0.05$, Table 24 Model 7), significantly limits start-up activity by founders if they choose to participate in incubator. Very likely the channel is time and delaying product introduction by an extending incubation period rather than working with a customer directly.

Other interesting findings not related to our research hypotheses should be discussed. First, fear of failure of entrepreneurial venture is the one which decreases start-up development by scientists. Second, a lack of support from the private industry for commercialization perceived as an obstacle have not changed the behaviour or scientists on research commercialization. It is entrepreneurial cognition, rather than entrepreneurial orientation (Ireland et al., 2003; Kuratko et al., 2014; 2015) which facilitates academic entrepreneurship in German universities.

A type of university (applied or research-based) does not change the number of start-activities, neither entrepreneurship experience as self-employed matters for start-up development at university. Interestingly, this demonstrates that academic entrepreneurship is a skill which can be learnt during the academic career, independently whether a scientist has ever experienced doing business or not. Prior research has demonstrated that several industries, such as biological sciences and STEM are more important to licensing activity than other sciences (Thursby and Kemp, 2002). It is also known that areas where inventions are more of applied nature such as engineering have better market opportunities and orientation toward markets in bio-engineering and medical sciences (Aldridge and Audretsch, 2011).

In addition, technological advances in biomedical areas, molecular biology, computer technology, and other sciences became increasingly prominent in university research (Geuna and Nesta, 2006; Siegel and Wright, 2015).

We do not find this for German scientists. Our STEM variable is not statistically significant which means that scientists in all fields in German universities are equally likely to commercialize their knowledge by starting a business. This demonstrates that German university system enables knowledge development and successful commercialization across different fields, from economics, arts to physics and health technology.

5.5 Discussion

We provide some insights for managers and policymakers. The empirical evidence supports the co-occurrence of different channels and mechanisms to knowledge commercialization in German universities. Universities oriented to fostering academic entrepreneurship should therefore take account of these heterogeneous channels through differentiated policies and strategies. Incentive structures, TTOs, incubators and support programs to promote academic entrepreneurship should aim to stimulate various combinations of collaboration with customers, private industry, investors and the scientific community. This is because these external stakeholders can contribute, separately or jointly, to enhancing the exploitation of academic research.

Several important findings have attracted our attention. First, we did not find that TTOs facilitate academic entrepreneurship by being a conduit to capital investors. We explain this is because scientists will not need to liaise with TTO if two conditions hold: scientists appropriate an invention and investors have the capital to bring the product directly to market. A similar result was obtained by Aldridge and Audretsch (2010), who found that 30% of highly-productive scientists tend to choose a ‘backdoor route’ to commercialize their research results.

Our first finding is that university stakeholders such as TTOs may act as bottlenecks rather than facilitators of knowledge spillover (Siegel et al., 2007; Litan and Mitchell, 2010). TTOs at universities are more likely to capitalize on private industry involvement in the start-up process, as private firms often approach university TTOs or knowledge transfer units (Guerrero et al., 2015). Firms may co-apply for public and private grants together with universities, which makes private firms eligible to cover some of the R&D and technology costs.

The role of commercialization units such as university TTOs remains in bridging the micro-macro divide (Aldridge and Audretsch, 2011).

Our second finding was that collaboration with other academic communities and scientists on basic and applied research is beneficial for start-up activity and may be facilitated using the patent agency. Collaboration with other scientists increases the quality of knowledge creation but may also have a risk of free-riding (Wright et al., 2008b). University scientists should be able to protect their inventions via patenting and other legal forms of IP protection so they can exploit their invention further. While patenting remains a post-invention decision of all parties involved, it is often impossible to conclude who owns or co-owns an invention and how the work was distributed. There is the possibility that joint patents protect particularly valuable inventions.

Third, another important finding relates to university incubation programs, most of which aim to become proof of concept centres (POCC) (Gulbranson and Audretsch, 2008). These institutions transform university inventions into commercial applications. To our surprise, we do not find a link between university incubators and scientist's contacts with potential customers and professional associations. First, professional associations serve as incubators of ideas, networks and access to potential investors, with the results commercialized within professional associations or in corporate incubators. Professional associations are likely to be substitutes for incubators providing technical and mentorship to their members in the marketing of invention, consultancy and IP protection, product validation and looking for investors, that are usually also members of professional associations (e.g. meeting at golf or football clubs).

Second, in case of potential customers, it is likely that the product or service has already been developed and what is required is market entry via establishing a firm. Incubation is a pre-start-up and product development stage, when finance and business contacts are required to continue product development. The future of a product may still be ambiguous, and then more time is required to shape the idea, fund product development, create and test prototypes before getting to your prospective customers.

5.6 Conclusion

Entrepreneurial university and knowledge transfer research aims to understand the role that micro, organizational and macro factors play in academic entrepreneurship. For many scientists, efforts to facilitate collaboration within universities and with academic communities as well as external knowledge collaborators have been limited, which has not helped start-up development (Audretsch, 2014). It remains unclear what conduit (TTO, patent agency, support programs, incubator) should be chosen to facilitate start-up activities in collaboration with private industrial funding, capital investment, customers, business partners and academic and professional communities. German academia is one of the world's leading engines of technological progress, economic development and growth in Europe. However, very little is known about the conduit of university knowledge transfer, its channels, financing and external partners. Our results expand the research agenda in Germany and other developed countries on the role of the individual, organizational and ecosystem contexts for academic entrepreneurship (Agarwal and Shah, 2014). This furthers our understanding of how different types of external stakeholders, along with scientists and universities, can shape an individual's decision to engage in firm creation. This study adds to academic entrepreneurship and knowledge transfer literature in the following ways. First, this study develops and tests a theoretical model which brings together scientist's characteristics, organizational mechanisms and external stakeholders in supporting academic entrepreneurship across 73 German universities (2013-2016). Second, this study demonstrates the extent to which organizational structures can serve as direct antecedents to contacts with external stakeholders interested in the results of academic research. Our empirical findings confirm a variety of organizational mechanisms can be employed to maximize returns from external collaborations for start-up activity. The main limitation of the data is its cross-sectional character and self-reporting on steps in starting a business. Therefore, future research could investigate university and patent office data with focus on using longitudinal data as well as look into new channels of knowledge transfer. The results should be tested across different institutional and cultural environments (e.g. other regions in Europe) and across developing and developed countries. Subsequent studies will focus on investigating start-up development activities at universities by splitting them into exploration-oriented and exploitation-oriented groups, as well as home and foreign market oriented, self-employment or enterprise oriented. They can then test the multilevel model of micro-university-macro characteristics which affect each of the outcomes.

6 What enhances SMEs Absorptive Capacity?

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Abstract

The transfer from knowledge into innovation, be it for disruptive or incremental is essential for the economic success of SMEs. The capability to be able to identify and utilized it could make the difference. This "ability to recognize the value of new information, assimilate it, and apply it to commercial ends" or the so-called absorptive capacity will make, in the end, the difference. Although the absorptive capacity is researched in-depth the main focus often lies on the knowledge creation and the way to learn and utilized knowledge from the external stakeholders. Though, there may be other factors promoting the absorptive capacity that may have an indirect or direct effect on the absorptive capacity. Organizations could create a nurturing environment for the employees to use their knowledge and create disruptive or incremental innovations. The culture of a company can exert a positive influence on this process. This is justified by the formation of employee identification, which leads to improved motivation and performance. This can be achieved through corporate social responsibility and organizational identity. Looking at the knowledge transfer from stakeholder, sources of knowledge like the university, especially the university-to-industry knowledge transfer may be a beneficial factor for the absorptive capacity. Deriving a set of hypotheses from this assumption, our study shows that the corporate culture, university cooperations as well as increased use of corporate social responsibility leads to a stronger manifestation of realized absorptive capacity.

Keywords: Absorptive Capacity, Organizational Identity, University Cooperation, Corporate Social Responsibility

JEL Classification: O30, M14, L25

6.1 Introduction

In times of increased competition, many corporation's require constant and ongoing innovations to have a steady flow of revenues and subsequently make enough profit to survive. However, the recent years showed that continuous innovations may not be sufficient and that corporation identifying novel markets as well as creating disruptive innovations could change the market landscape fundamentally. Examples like Uber or Airbnb varied their respective industries considerably. Both of them, being a start-up, are often being described as innovative and disruptive mostly because they were a small organization with a great idea (Christensen et al., 2015; Guttentag, 2015). Especially the aspect of disruption is often seen as a profitable way to achieve economic success rapidly. It is even stated, that small and medium-sized enterprise (SME) strive regarding disruptive innovation (Stringer, 2000). However, not all SME are automatically capable of disruptive innovation, some researcher high-light that SME has to choose between being disruptive or pursuing incremental innovation at the same time (Bower and Christensen, 1995; Lee et al., 2012). This is often linked with the scarcity of resources and the necessity to specialize in certain products. Although, SME can be a source for radical, innovative ideas the risk attached to such innovative endeavours are higher than for big corporation and that may stifle the innovativeness of SME (Assink, 2006). Hence, SME may have higher innovative capabilities but may be confined by the SME restrictions as well (Lisboa et al., 2011). Consequently, a successful SME is capable of dynamically utilize the knowledge of their employees and identify potential innovations efficiently. Therefore, the transfer from knowledge into innovation, be it for disruptive or incremental innovation is essential for the economic success of SMEs. The capability to be able to identify and utilize it could make the difference. This "ability to recognize the value of new information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal, 1990) or the so-called absorptive capacity will make, in the end, the difference. Although the absorptive capacity is researched in-depth (Zahra and George, 2002) the main focus often lies on the knowledge creation (Matusik and Heeley, 2005) and the way to learn and utilized knowledge from the external stakeholders (Lane and Lubatkin, 1998). Though, there may be other factors promoting the absorptive capacity that may have an indirect or direct effect on the absorptive capacity. Looking at the stakeholders, there are other interesting sources of knowledge like the university, especially the university-to-industry knowledge transfer may be a beneficial factor for the absorptive capacity (Agrawal, 2001).

Beside acquiring high potentials directly from the university, university cooperation may also have a beneficial effect on the existing employees (Veugelers and Cassiman, 2005). It is striking that the employees are somewhat neglected regarding absorptive capacity and how organizations could influence the innovative capabilities of the employees to foster their absorptive capacity. Organizations could create a nourishing environment for the employees to utilize their knowledge and create disruptive or incremental innovations. Consequently, organizational antecedents may influence the individual absorptive capacity, but this approach is still under-researched (Lane et al., 2006). Jansen et al. (2005) researched the effect of participation, job rotation, formalization, routinization, and connectedness and how it influenced the absorptive capacity. Although there are some significant positive effects, the participants did not lead to any results concerning the exploitation of knowledge. However, the focus was mostly on the organizational mechanisms within an organization. Participation is often linked with organizational identity and corporate social responsibility. Especially the organizational identity connects the employees with the corporation and how they identify with that corporation, that may lead to an increase in commitment (Edwards, 2005). Corporate social responsibility also affects the employee commitment (Brammer et al., 2007; Collier and Esteban, 2007; Newman et al., 2016) and employees contribute more towards the organization, if there is an authentic CSR available. Especially regarding the boundary spanning literature, the capability of linking internal knowledge with external information (Tushman, 1977) show a beneficial correlation between this capability and CSR (Holmes and Smart, 2009) as well as organizational identity (Bartel, 2001). It is highlighted that CSR and organizational identity may encourage employees to utilize their boundary-spanning capabilities. These antecedents could, therefore, have a positive effect on the absorptive capacity, primarily as the boundary spanning concept only focuses on the linkage of internal and external innovation neglecting the economic outcome of these innovations partially.

This understanding is the premise of the paper, highlighting the potential effect of antecedents like corporate social responsibility, organizational identity, and university cooperation on absorptive capacity. Utilizing the scope of SME, we anticipate a stronger impact as SME have potentially a stronger absorptive capacity and, furthermore, do not have institutionalized innovation management or structured boundary spanning. From this understanding, we developed several hypotheses and tested those with German SMEs (n=256) and testes the hypotheses with multiple linear regression. In the end, we describe the theoretical and practical implications of these results.

6.2 Literature overview

As stated in the introduction, the main focus in this paper lies on the absorptive capacity, the corporate social responsibility, the organizational identity, and the university cooperation. It is important to point out, that all concepts are tackling the question of how internal processes interact with the external environment of an organization. There is a delicate interaction between what happens within an organization and how it influences or is influenced by the situation. Especially in the modern business environment, in which innovation is essential, it becomes abundantly clear that a corporation depends on the interaction to foster innovation and more importantly going beyond the concept of "open innovation" (Chesbrough, 2006; Fleming and Waguespack, 2007). There is an ongoing brokerage between the internal and external which is often done based on the boundary spanning theory crossing organizational boundaries to acquire knowledge (Fleming and Waguespack, 2007). Still, though boundary spanning is often linked with the idea that people act as a gatekeeper of knowledge and, consequently, contribute or harm the innovative capabilities and organizational learning (Easterby-Smith et al., 2008) actively.

Boundary spanning is a theory that is capable of interweaving the internal and external perspective and, subsequently, absorptive capacity with corporate social responsibility, organizational identity, and university cooperation. But boundary spanning is only one part of the absorptive capacity as defined by (Cohen and Levinthal, 1990; Zahra and George, 2002). New knowledge for the organization can be identified and introduced in the organization through those boundary spanners and being motivated to enter such knowledge is potentially positive influenced by corporate social responsibility, organizational identity, and university cooperation. However, the main difference to boundary spanning theory and absorptive capacity is, that absorptive capacity goes beyond the knowledge acquisition and focuses on the creation of new ideas, and innovation that can be translated into new products. Zahra and George (2002) categorized the absorptive capacity in potential absorptive capacity and realized absorptive capacity, by that, implicitly classifying the boundary spanning theory into potential absorptive capacity. Furthermore, Zahra and George expanded the concept of absorptive capacity into four dimensions or four dimensions that are necessary to realize a successful transformation of knowledge into innovation stating the process of acquiring, assimilating, transforming, and exploiting knowledge:

First, is the acquisition dimension as being part of the potential absorptive capacity, focusing on the capability of a corporation to discover new knowledge that may be already available in the organization currently dormant or acquired from external sources like other stakeholders. This capability of acquiring knowledge depends on the intensity, the speed, and the direction. These activities highlight the importance for an organization acquiring new knowledge and could also focus on the acquisition of knowledge for incremental innovation or disruptive innovation.

Second, the assimilation dimension is essential to analyse and understand this new knowledge. Especially in the modern times of big data, there is an abundance of data available, but not everything is even useful. Employees looking for disruptive innovations may also pitch ideas that are "outside of the box." Some corporation even encourages employees to have crazy ideas; however, not all plans will lead to disruptive innovation. Consequently, the process of transformation is to understand, interpret, comprehend, and also discard this new knowledge.

Third, the transformation dimension is part of the realized absorptive capacity and marks the time in which the corporation commits resources to facilitate that new knowledge, combine it with existing knowledge and converse it into a potential contribution for the organization. Especially the aspect of identifying synergies and adaptability will be essential in this dimension as this new knowledge will be introduced in the corporation and might bind dynamic capabilities allocated for innovations.

Fourth, the exploitation dimension is the final and essential one, as here the new knowledge will be harvested for new routines, ideas, innovation, and products. Ideally, this may lead to incremental innovation, disruptive innovation, or even procedural innovation and help the corporation to acquire a unique competitive advantage. Especially the exploitation aspect is relevant, as it also highlights the importance of creating a benefit for the corporation.

As stated by Zahra and George (2002) absorptive capacity can be seen as a dynamic capability connected with the routines, structures, and processes of a corporation. Therefore, if embedded in the corporation, it may be influenced by organizational antecedents already existing in the corporation. Following that premise, corporate social responsibility, organizational identity, and university cooperation could act as organizational antecedents, especially as these characteristics do not change quickly within an organization and will only

slowly transform into different directions. They could be seen as a stable factor. Consequently, those antecedents could have an impact on the absorptive capacity, primarily as being defined as "dynamic capability that influences the firm's ability to create and deploy knowledge necessary to build other organizational capabilities" (Zahra and George, 2002). Therefore, strong absorptive capacity is not only the result of a successful transformation of knowledge into innovation that may lead to competitive advantage (Barney, 1991), but most importantly the ambidextrous balance between exploring new ideas and exploiting innovative concepts (Gibson and Birkinshaw, 2004). Especially the ambidexterity is relevant for SME as they usually have a scarcity of resources that require a certain balance. The dynamic capabilities for the absorptive capacity will be balanced throughout acquisition, assimilation, transformation, and exploitation.

If, however, the resources are finite, any commitment of the employees going beyond the general work would benefit SME greatly. As depicted earlier the employee participation could have an impact on the realized absorptive capacity, and certain antecedents may influence this. For example, the corporate social responsibility impacts the employee perception of the corporation (Rupp et al., 2013). Especially as corporate social responsibility is described as "context-specific organizational actions and policies that take into account stakeholders' expectations and the triple bottom line of economic, social, and environmental performance" (Aguinis, 2011) and has an impact on the employee commitment (Collier and Esteban, 2007). Although there is an ongoing debate about the necessity of corporate social responsibility (e.g., Davis, 1973), the impact on the employee productivity is positive (e.g., Bhardwaj et al., 2018; Smidts et al., 2001, Pruyn and van Riel, 2001). Furthermore, corporate social responsibility has based on the effect on employees, an indirect but positive effect on the profitability (Blasi et al., 2018).

Based on that impact, it becomes evident that corporate social responsibility may have an influence on the organizational culture as well as the organizational commitment (Brammer et al., 2007). Furthermore, the organizational culture or even stronger the organizational identity will impact the potential participation of employees and their understanding of how they can contribute to the corporation. The organizational identity describes the perception of the members of an organization and highlights the knowledge of this organization as well as the difference towards other organizations (Albert and Whetten, 1985). What features make the organization unique and unique compared to other organizations.

Furthermore, these features "are presumed to be resistant to […] attempt at alteration because of their ties to the organization's history" (Gioia et al., 2000). Based on these features' employees do commit towards the corporation (Van Dick, 2001) and may foster a team spirit. A shared organizational identity will motivate employees to invest in the organization as they share the identity with the colleagues, that may help to improve the absorptive capacity beyond the general work environment.

As already stated in Cohen and Levinthal (1990) absorptive capacity is not exclusively within the corporation but resides in various other organizations. Especially the knowledge from universities has a positive effect on the innovativeness of corporations (Cassiman and Veugelers, 2006). Utilizing external knowledge is a valid approach to introduce unique knowledge and foster disruptive innovations. Still, though, university cooperation requires ongoing interaction between corporation and university, it may not be sufficient to acquire young students, but a corporation with the researcher may also be beneficial. However, concerning absorptive capacity university cooperation may have a beneficial effect. In summary, absorptive capacity can be seen as a way to improve the innovative capabilities of a corporation, especially as it is a way to acquire new knowledge within and outside of the corporation through boundary-spanning. However, it becomes evident, especially for SME, that employees would only contribute towards the absorptive capacity if there an interest to participate. To a specific capacity, they will provide, but that would potentially only lead to incremental innovation. Fostering disruptive innovation may be a bit difficult, especially through extrinsic motivation. Therefore, the organizational antecedents may motivate employees to commit to their corporation beyond their general responsibilities. Corporate Social Responsibility and organizational identity could have a positive effect on that and may lead to an exploitation of the absorptive capacity. Still, due to the scarcity of resources compared to a large corporation, SME need to find new sources for acquisition of knowledge and; therefore, university cooperation may be useful.

6.3 Theoretical framework and hypothesis development

6.3.1 Corporate social responsibility and the realized absorptive capacity

By demonstrating good intentions, CSR programs contribute to strengthening stakeholder's confidence in the company (Kervyn et al., 2012). This can lead to the emergence of new networks as well as fostering existing networks with both internal and external stakeholders (Luo and Du, 2015; Sen et al., 2006). This, in turn, enables a company getting greater access to the knowledge and ideas of their stakeholders (Trantopoulos et al., 2017; Luo and Du, 2015). From prior studies we know, that companies which are more likely to promote CSR enjoy greater trust, a higher satisfaction level as well as a higher loyalty among its stakeholders (Luo and Du, 2015; Du et al., 2011; 2007; Klein and Dawar, 2004; Surroca et al., 2010). In addition, we also know, that corporate social responsibility facilitates the network ties between the company and its stakeholders (Luo and Du 2015; Du et al., 2011). In this context, Jansen et al. (2006) pointed out, that companies with broader and stronger networks ties, gain greater access to the knowledge of their stakeholders. Thereby the knowledge of a company's external stakeholders is particularly important. This is due to the fact, that external stakeholders often possess new and non-redundant knowledge, which supplements the company's existing internal knowledge (Luo and Du, 2015). For example, consumers possess knowledge about current and future market trends (Uzzi and Lancaster, 2003; Luo and Du, 2015). Likewise, governments and NGOs are a further important source of new knowledge. They possess extensive knowledge in the field of social, economic and environmental developments (Porter and Kramer, 2011; Luo and Du, 2015). It is to be expected that customers, governments or NGOs will be more likely to share their knowledge with companies which they perceive as trustworthy and responsible. Additionally, the internal knowledge of the employees, as well as their willingness to share and record their knowledge plays, a decisive role. Employees know about the inner working processes of a company. Furthermore, they also know about potential sources of error within the company (Hanna et al., 2000), it depends on the relationship between company and employee if they are sharing this knowledge. From the literature we know, that internal CSR programs enhance the working conditions within a company which increases employee motivation, loyalty, performance and productivity (Skudiene and Auruskevience, 2012; Glavas and Godwin, 2012; Lee et al., 2013; Bhardwaj et al., 2018).

Therefore, it is to be expected, that CSR also enhances the employees' willingness of knowledge creation, sharing as well as implementation. Motivated and loyal employees could be more willing to share their knowledge and ideas with each other and the management than less motivated ones. Overall, increased use of CSR leads to a stronger manifestation of realized absorptive capacity. CSR and the associated responsibilities lead to a positive public image, which enhances the reputation of the company. This leads to more trust towards companies, making it easier to build networks with stakeholders and extract knowledge faster (Luo and Du, 2015). In addition, the positive image improves the attitude of employees to the company. Motivation, loyalty, performance and productivity increase because of the positive image based on CSR (Haslam et al., 2003, Mael an Ashforth, 1995). Hence, companies are more likely to acquire and secure new knowledge as well as to supplement it with existing ones. Following this argumentation, we therefore hypothesize:

Hypothesis 1: Corporate Social Responsibility is positively related to the realized absorptive capacity

6.3.2 Organizational identity and the realized absorptive capacity

The organizational identity covers an organizations core values and beliefs, which its members deem to be the most central, distinctive and enduring (Albert and Whetten, 1985; Zellweger et al., 2013). Those values and beliefs existing in the organization are continuously expressed by the communication, behavior, and symbolism between the members of the organization (Zellweger et al., 2013; Zellweger et al., 2010; Leuthesser and Kohli, 1997; Van Riel and Balmer, 1997). These types of interactions provide an interpretive belief system to the organizational members, which in turn offers meaning to the organization and its members (Gioia, 1998; Zellweger et al., 2010). In this way the organizational identity fulfill both a sense-making and a sense-giving function by reflecting the members' collective perception of "who we are as an organization" and "what we do as a collective" (Fiol, 1991; Weick, 1995; Ravasi and Schultz, 2006; Whetten et al., 2009; Nag et al., 2007). Thus organizational identity contributes to a shared understanding of the inner processes, working and culture of the organization (Ravasi and Schultz, 2006). Therefore, organizational identity can be regarded as a central mechanism that influences the behavior of organizational members (Whetten and Mackey, 2002; Zellweger et al., 2010). Through identification with the organizational value system, the organization becomes an extension of the employee´s self. Furthermore, the feeling of oneness within the organization enhances as well (Ashforth and

Mael, 1996; Zellweger et al., 2010). In the context of SMEs, it is to be expected, that the organizational identity is stronger compared with larger firms. This is because SMEs often operate under a flat organizational structure, which is associated with lack of bureaucracy (Singh et al., 2008). This positively impacts the flexibility, the knowledge adaptability, and rapidity in responding to the changing environment of SMEs (Garengo et al., 2005). Furthermore, it is to be expected the ties between the employees and the management are higher as well. Based on these characteristics, it can be assumed, that the collective behavior and identity of the organization's members is higher compared with large companies. Consequently, the organizational identity for SMEs could be higher as well. From Nag et al. (2007) we know, that the organizational identity creates meanings for, the knowledge-use practices of organization members. Nag et al. (2007) argued, that the organizational identity provides a cognitive framework for the daily work practice of organizational members. Thus, the organizational Identity affects the way, how organizational members use external and internal knowledge to accomplish work. They pointed out that deliberate attempts to change the organizational identity provoke a desire to preserve how knowledge is used in practice (Nag et al., 2007). Furthermore, the atmosphere within an organization influences the exchange as well as the combination of knowledge. If the atmosphere within an organization is open and cooperative, the transfer of knowledge among the organizations members enhances decisively (Smith et al., 2005). The organizational identity could also trigger such an open working atmosphere. Likewise, the organizational identity leads to a pleasant working atmosphere in which employees have more free space to develop and implement new ideas, which in turn could lead to new knowledge (Escribá-Carda et al., 2017). Based on these arguments it can be assumed, that the organizational identity of SMEs is positively associated with the realized absorptive Capacity. Therefore, we hypothesize:

Hypothesis 2: The stronger the organizational identity, the stronger the realized absorptive capacity.

6.3.3 University cooperation and the realized absorptive capacity

Following Cohen and Levinthal (1990) the concept of absorptive capacity refers to a company´s ability to identify, assimilate and apply new external knowledge. In this regard, Cohen and Levinthal (1990) pointed out, that when a company intends to acquire new external knowledge which is unrelated to its current internal knowledge, deliberate efforts are required to create or enhance absorptive capacity. Looking at the company´s stakeholders, there are other potential sources of knowledge like the university. Especially the university-to-industry knowledge transfer may be a beneficial factor for the absorptive capacity (Agrawal, 2001). Prior studies showed, that university-to-industry ties are important sources of new knowledge and innovation (Cassiman and Veugelers, 2006, Bekkers and Bodas Freitas, 2008, Bercovitz and Feldman, 2007). Referring to the research, that the knowledge-based view suggests that a company's possession and utilization of internal and external knowledge enhances its ability to innovation and its economic stability as well as success (Smith et al., 2005; Luo and Du, 2015). With their multidisciplinary research, universities often form the basis of the regional and supraregional innovation policies and are regarded as central drivers for technological innovation and change (Hossinger et al., 2020). However, a beneficial use can only be realized if the knowledge from universities actually is transferred into practice (Miller et al., 2014). Getting access to university's knowledge provides several opportunities to improve a company's absorptive capacity. Bishop et al. (2011) pointed out, that university-to-industry cooperation enhances a company´s awareness of new research and technological opportunities, which in turn contributes to the development of explorative learning capabilities. Furthermore, Bishop et al. (2011) argued, that university cooperation also positively affects a company´s capacity to exploit new or existing knowledge in order to create product and or process innovation. Moreover, we also know from literature, that university-to-industry cooperation enhances a company's problem solving as well as analytical capabilities Bishop et al. (2011). Based on these arguments it is to be expected, that a company´s capacity to assimilate and apply new knowledge is higher when cooperating with a university. Therefore, we hypothesize:

Hypothesis 3: University cooperation is positively related to the realized absorptive capacity.

6.4 Methodology

6.4.1 Sample and data

All required financial, employment and industrial sector information of the SMEs analyzed in this study were taken from the pan-European financial database AMADEUS of the Bureau van Dijk. Further, we complemented this sample with information collected by an online survey conducted between November 2017 and February 2018. The survey included 23,363 privately held companies located in North Rhine-Westphalia (in particular from the regions of South Westphalia and East Westphalia-Lippe) and, among other questions, they were asked about their CSR, their institutional structures their organizational identity and their realized absorptive capacity (self-reported). Concerning sales and employment development, the region of South Westphalia and East Westphalia-Lippe is representative for whole Germany. Another distinctive characteristic of this region is that a majority of the companies located there are among world leaders in their field. Since data from content analysis or reputational rating is often influenced by internal reporting practices, self-reported data is the only possible source of information in terms of the absorptive capacity of privately owned SMEs. Subsequently, the companies surveyed were German-speaking companies, and we had to conduct the survey in German. Therefore, we translated all questions asked into German, and translated them back into English for this article. A total number of 342 companies completed the survey, which corresponds to a response rate of 1.46%. This data set was adjusted by excluding all companies which do not fall under the SME definition of the Institut für Mittelstandsforschung (IfM 2016) Bonn. Thus, our study comprises a final stock of N = 256 privately owned SMEs, which, according to the SME definition of the IfM, employ less than 500 employees and possess an annual turnover less than 50 million euros.

6.4.2 Dependent and Independent variables

The dependent variable derived from our hypothesis is a company's realized absorptive capacity. This variable is measured at the individual level, based on Jansen et al. (2005) (see Appendix 4). To estimate the extent of realized absorptive capacity, firms in our survey were asked to provide information about how they secure, record and manage internal and external knowledge. All items were measured on a 5-point Likert scale (1=strongly disagree; 5=strongly agree). The reliability coefficient Cronbach's alpha across all six items was α=0.611.

To develop the regression model the items were condensed by using an average index. Thus, the extent of the realized absorptive capacity is a count variable with only non-negative integers.

There are three independent variables derived from our hypotheses for the further analysis: 1) the extent of the realized corporate social responsibility, 2) the extent of the organizational identity as well as 3) university cooperation. The measurement of corporate social responsibility is based on the Scale, developed by Turker (2009a) and Turker (2009b) to measure the strength of the implemented corporate social responsibility. Specifically, four sub-scales where queried: a) CSR towards stakeholders, b) CSR towards employees, c) CSR towards customers and d) CSR towards the government. The results showed that the reliability coefficient of Cronbach's alpha achieved in this study deviates only slightly from that of the original study. Thus, Cronbach's alpha across all 17 items is $\alpha=0.764$.

A central variable of our study is the extent of organizational identity. The items used for the measurement are based on the publications of Cole and Bruch (2006) and Milliken (1990). Altogether 6 different items were queried (self-reported). These items relate on the one hand to the attitude of the employees towards the company and on the other side to the goals and history of the company. The reliability coefficient of Cronbach's alpha across all six items is $\alpha=0.703$. All queried items regarding the scales corporate social responsibility and organizational identity were questioned on a 5-point Likert scale (1=strongly disagree; 5=strongly agree) (see Appendix 4). To develop the regression model the items were also condensed by using an average index and included as an independent variable in the regression relationship.

Our third independent variable is university cooperation. This variable is measured at the individual level, whether the surveyed companies cooperate with universities for knowledge exchange and knowledge transfer. The variable is a dummy variable that takes the value one, when the surveyed companies stated, that they are cooperating with universities for knowledge transfer and takes the value zero otherwise.

6.4.3 Control variables

We control for a variety of explanatory variables (see Appendix 5) from prior research on absorptive capacity, CSR and organizational identity. First of all, we controlled for the level of institutionalization. The level of institutionalization is associated with working routines and norms. Such routines and norms provide a context for interactions and could affect the behaviour of individuals within an organization (Sun and Anderson, 2010). Moreover, the level of institutionalization also creates a framework for capturing new learning into patterns of interactions through altered systems, processes and structures (Crossan et al., 1999). This might positively affect a company´s absorptive capacity. To measure the level of institutionalization firms were asked in a 5-point Likert scale to evaluate their hierarchical structures as well as their internal work processes. All in all, a total of ten different items were examined, which comprehensively depict the firm's level of institutionalization. Furthermore, we also control for a firm's competitiveness. This variable reflects a company´s current economic situation. In order to measure the competitiveness, firms were asked to provide us with information about how they asses themselves compared to their main competitors. In this regard, a total of six different items were examined in a 5-point Likert scale, which ranges from economic success, the capital endowment to the innovation capability.

Additionally, we account for the number of employees and firm age. Prior studies suggest that the firm size positively determine a firm capacity to innovate as well as to sustain performance (Jansen et al., 2005; Tsai, 2001). While larger firms may have higher inertia, smaller firms are more likely confronted with a lack of resources and organizational routines (Patel et al., 2012). To control for such a size-dependent effect, we include the number of employees in logged form. Because older firms could have an experience advantage compared with younger firms, the firm age was included as a further control variable (Jansen et al., 2005; Autio et al., 2000). In this regard, we include the logarithm of the number of years the firm existed. From prior research we also know, that family firms differ from non-family firms in the way how they practice CSR and innovate (Block and Wagner, 2014; Doluca et al., 2018). Therefore, we include a dummy variable that takes the value one, when the firm is owned at least to 50% by a family and takes the value zero otherwise. Finally, we control for various industry sectors. It is to be expected, that firms within the manufacturing and service sector naturally demonstrate a higher innovation and absorption capability than firms within the retail or agricultural sector.

6.5 Results

In the empirical model, which will be discussed in detail in following, the hypotheses derived from the theory were tested by using multiple linear regression. Two regression models were developed. In the first regression model (model 1), the influence of the control variables regarding the extent of realized absorptive capacity had been examined firstly. To test hypotheses H1, H2 and H3, a further regression model (model 2) had been developed, which included the independent variables CSR, organizational identity and university cooperation's, as well as the control variables. The correlations between the variables are shown in Table 26. Please note, that there are only weak correlations between the independent variables. The Variance inflation factors (VIF) range from 1.11 (lowest value) to 2.24 (highest value). Overall, these results only suggest the presence of moderate multi-collinearity. The estimation results of the calculated regression models are presented in Table 27. The following Table 25 provides an overview of the descriptive results of our study.

Table 25 Descriptive statistics

variables	Mean	Std. Dev	Min	Max	Items	Cronbach's α
variables of control						
level of institutionalization	3.240	.492	1	5	10	.503
competitiveness	3.511	.542	1	5	6	.716
employees	25.719	40.014	1	250	-	-
firm age	42.219	39.629	1	244	-	-
family firm (1=yes; 0=no)	.691	.463	0	1	-	-
B1: manufacturing sector	.242	.429	0	1	-	-
B2: reference group (others)	.156	.364	0	1	-	-
B3: retail sector	.184	.388	0	1	-	-
B4: service industry	.418	.494	0	1	-	-
independent variables						
CSR	3.639	.654	1	5	17	.822
organizational Identity	3.861	.704	1	5	6	.703
university cooperation	.320	.468	1	1	-	-
dependent variable						
absorptive capacity	3.748	.695	1	5	6	.611

Note: N= 256

Table 26 Correlation matrix

variables	1	2	3	4	5	6	8	9	10	11	12	13	VIF
level of institutionalization	1												1.32
competitiveness	.077	1											1.13
Ln_employees	.021	.008	1										1.21
Ln_firm age	-.011	.039	.222***	1									1.18
family firm (1=yes; 0=no)	-.102	-.057	-.020	.079	1								1.11
B1: manufacturing sector	.019	.023	.161**	.169**	.101	1							2.14
B3: retail sector	-.095	-.007	-.035	.086	.120	-.268***	1						1.83
B4: service industry	.100	-.010	-.056	-.239***	-.120	-.479***	-.402***	1					2.24
CSR	.415***	.173**	.063	.028	.122	-.004	-.018	.007	1				1.56
organizational Identity	.363***	.318***	-.048	-.096	-.043	-.001	-.039	.073	.490***	1			1.60
university cooperation	.065	.115*	.228***	-.119*	-.049	.159**	-.066	.029	.172***	.242***	1		1.19
absorptive capacity	.393***	.215***	.019	-.036	-.121	.036	.017	.080	.467***	.524***	.291***	1	-

Note: N= 256 ; * p<0.05, ** p<0.01, *** p<0.001

Table 27 Multiple linear regression

	Model 1			Model 2		
	Coef.	Std. Err. (robust)	P>|t|	Coef.	Std. Err. (robust)	P>|t|
variables of control						
level of institutionalization	.515	(.089)	***	.220	(.082)	***
competitiveness	.235	(.075)	***	.062	(.062)	
Ln_employees	-.009	(.037)		-.030	(.031)	
Ln_firm age	-.023	(.044)		.016	(.039)	
family firm (1=yes; 0=no)	-.138	(.088)		-.205	(.075)	***
B1: manufacturing sector	.305	(.129)	**	.262	(.118)	**
B3: retail sector	.344	(.142)	**	.323	(.124)	***
B4: service industry	.269	(.122)	**	.239	(.109)	**
independent variables						
CSR	-	-		.267	(.074)	***
organizational identity	-	-		.225	(.080)	***
university cooperations	-	-		.279	(.068)	***
constant	1.1993	(.412)	***	.642	(0.368)	*
N	256			256		
R^2	.22			0.42		
F	7.91	***		16.70	***	

Note: * $p \leq 0.1$, ** $p \leq 0.05$, *** $p \leq 0.01$; robust standard errors; reference category: B2 (others)

In model 1 we regress the controls on the realized absorptive capacity. As shown in Table 27 it is noticeable that the level of institutionalization has a positive effect on the realized absorptive capacity (β= 0.5152; p>0.00). The results indicate that the higher the level of institutionalization, the higher the realized absorptive capacity. Thus, our results are in line with those of Rugman and Verbeke (2001) and Sun and Anderson (2010) which found a similar effect. The competitiveness is one important influencing factors on the realized absorptive capacity (Tsai, 2001) as shown in the regression result being highly significant (β=0.2350; p>0.00), which suggest that competitiveness has a positive effect on the realized absorptive capacity. However, the age-specific impact proposed by Jansen et al. (2005) and Minbaeva et al. (2003), but both focus on the unit age, (β= -0.0229; n. s.) could not be proven. Similarly, the company size (β= -0.0093; n. s.) and type (β= -0.1377; n. s.) also do not influence the realized absorptive capacity. Concerning the sectoral differences, our results indicate, that firms within the manufacturing, retail, and service sector demonstrate a significant higher absorptive capacity than firm within other industries.

In model 2, the independent variables were included in the regression analysis. H1 stated that the stronger the realized corporate social responsibility, the stronger the realized absorptive capacity. The results show that the extent of corporate social responsibility has a highly significant positive effect on the realized absorptive capacity (β=0.2665; p>0.00), which suggests that as the corporate social responsibility enhanced, the extent of the realized absorptive capacity increase. This supports hypotheses 1. Also, the regression results also indicate that the organizational Identity demonstrates a highly significant, positive effect on the realized absorptive capacity (β=0.2248; p>0.00). This finding confirms hypothesis 2 and supports the theoretical assumption that firms with a higher organizational identity can also realize a higher absorptive capacity. Furthermore, the results indicate that there is a positive effect between university cooperation and the realized absorptive capacity. The estimated results show that ceteris paribus, SME´s cooperating with universities can realize a higher absorptive capacity than SME´s which are not corporation with universities (β=0.2785; p> 0.00). This supports hypothesis 3. Regarding the beta values of all variables, the independent variables demonstrate relatively high explanatory power. Compared the results with those from model 1, it can be observed that by taking into account the independent variables CSR, organizational identity as well as university co-operation's, the effect of institutionalization level decreases. However, the effective direction and significance remain unchanged. On the other hand, the impact of competitiveness is no longer observable after including the independent variables (β= 0.0617; n.s.). In contrast to model 1, the results presented in model 2 indicate that ceteris paribus, family firms realize a significant lower absorptive capacity than non-family firms (β= -0.2045; p> 0.00). Moreover, it can be observed that firms within the manufacturing, retail and service sector also demonstrate a significant higher absorptive capacity than firm in other industries. Finally, the following Table 28 provides an overview of the hypotheses that have been accepted and rejected.

Table 28 Accepted and rejected hypotheses

H1:	*Corporate Social Responsibility is positively related to the realized absorptive capacity*	✓
H2:	*The stronger the organizational identity the stronger the realized absorptive capacity.*	✓
H3:	*University cooperation is positively related to the realized absorptive capacity.*	✓

6.6 Discussion and conclusion

The results of the regression model give several interesting insights into the possible understanding of the realized absorptive capacity, especially as the independent variables have significant positive effects. Supporting this result the explanatory power of R2 increased as well by adding the independent variables in model 2. It becomes evident, that the environment of an, as well as their antecedents, may indeed have an impact on the way the potential absorptive capacity is transformed into realized absorptive capacity as theorized by Lane et al., 2006. Focusing on the innovation management may, consequently, not be sufficient, but rather the company should also create a nourishing environment for the employees to have a space to be innovative. Thereby, the results imply, that the willingness of sharing their knowledge or their innovative capabilities with the organization can be linked with antecedents that are not directly linked with innovation or knowledge management at all.

Although corporate social responsibility is highly debated concerning the usefulness for SME (e.g., Morsing and Perrini, 2009), the results indicate that fostering corporate social responsibility may lead to a beneficial spillover effect concerning realized absorptive capacity. This connection can be explained by the positive impact of CSR on the perception of the organization (Rupp et al., 2013), but also in the positive effect on the employee commitment (Collier and Esteban, 2007). Employees choose and commit to an organization because of their CSR strategy (Lee et al., 2013). In the literature, such employee commitment may lead to fostering organizational citizenship behavior and, therefore, encourage employees to go the extra mile (Donavan et al., 2004). Consequently, organizations with a functioning CSR strategy will encourage motivated people to apply and, furthermore, will encourage existing employees to share their knowledge. Both aspects lead to the creating of an environment that increases the transformation of potential absorptive capacity into realized absorptive capacity. However, as stated in the beginning, corporate social responsibility is intertwined with the organizational culture and, subsequently, with the organizational identity (Brammer et al., 2007). The reason for this link is that a CSR strategy needs to be perceived authentic (McShane and Cunningham, 2012). Therefore, the organizational identity has an impact on the motivation for an employee to consider sharing their knowledge. At the same time, the organizational identity also benefits the antecedents for creating a knowledge-friendly environment as observed by Harrington and Guimaraes (2005). Creating and sustaining an organizational identity that fosters the knowledge sharing will, as found in our results, lead to

an organizational identity that encourages the employees to share their knowledge to increase the realized absorptive capacity. Still, it is important to highlight, that the organizational identity should cover the core values and beliefs; therefore, the aspect of knowledge sharing should be part of the core values. Creating such an environment that fosters knowledge may require an extensive and long-running change in the organization, mainly as the organizational identity is rooted in the history of the organization. The organizational identity is an enabler for an increase in the realized absorptive capacity. Furthermore, the university cooperation and its positive affect on the realized absorptive capacity seems to be proven by the results. This aligns with the research that university cooperation has a positive impact on the innovativeness (Cassiman and Veugelers, 2006). Especially in the acquisition of new knowledge university cooperation are a useful source, consequently, a reliable way to introduce potential absorptive capacity. Still, the results highlight that university cooperation also has a beneficial effect on the realized absorptive capacity. That can be linked to an increase in the innovative capacities by cooperating with universities (Bishop et al., 2011). Knowledge is not only transferred from university to organization, but, additionally, the organization utilizes the existing competences of a university to create a product out of this knowledge. Especially the problem-solving capability increases in university-to-industry cooperation (Bishop et al., 2011) enabling the organization to have access to more capabilities to achieve an increase in realized absorptive capacities.

The results highlight that the environment in which the employees work and how this environment is perceived have a positive impact on the realized absorptive capacity. Consequently, the employee participation is a factor that have an impact on the realized absorptive capacity. Working on an increase of employee participation will lead to more knowledge sharing. Therefore, focusing on the antecedents may impact the innovative capabilities and, consequently, encouraging the employees to commit towards the organization. The boundary spanning highlights the importance of the employee as a potential source of new knowledge, the results, furthermore, reveal that the goal of an organization should be to foster an environment in which they want to share their knowledge and transform this knowledge into innovations. One core contribution of this paper is that organizations can influence the realized absorptive capacity through a fostering environment. Still, research often focuses on knowledge creation (Matusik and Heeley, 2005), and the utilization of external knowledge (Lane and Lubatkin, 1998).

As stated by Lane et al. (2006) the organizational antecedents are often neglected, despite the understanding that the employee is a valuable source for innovative ideas. Jansen et al. (2005) researched potential ways to influence the employee's innovative capabilities by focusing on operational methods like job rotation. They also neglected the focus on the environment in which the employees are working. Research in the organizational citizenship behaviour high-light that the employees are influenced by the way the organization is treating their employees and the social environment (Newman et al., 2016). Creating a knowledge-friendly and socially comfortable environment, additionally, will influence the self-selection of potential employees. They will seek for such organizations actively and will be committed to if they identify with the organizational identity. Consequently, focusing on the environment may be a way to improve the neglected employee-dimension in the organizations and putting the employee into the focus of research may yield additional understanding about the transformation of potential to realized absorptive capacity.

The results highlight the importance of antecedents like corporate social responsibility, organizational identity, as well as university cooperation being beneficial concerning realized absorptive capacity. Still, there is the underlying assumption that the strategy concerning these antecedents has a fit concerning the organizational culture (Scholz, 1987). Many organizations, however, struggle with creating such a strategy and some are even utilizing the corporate social responsibility, organizational identity, and university cooperation for ulterior motives. There is occasionally the claim of greenwashing in corporate social responsibility (Delmas and Burbano, 2011), that the organizational identity is used for enforcing strategic change top-down (Ford et al., 2008), as well as the intent to exploit governmental resources at universities (Lesch and Peterson, 1989). This may lead to a lack of authenticity and fit perceived by the employees and could be harmful towards the realized absorptive capacity. Consequently, an inauthentic environment may hinder realized absorptive capacity. However, this relationship requires verification. Finally, focusing on the environment to foster the realized absorptive capacity may be an aspect in which the SMEs have a competitive advantage in comparison to large corporations. Large corporations struggle with creating an authentic strategic fit in their environment. There are various corporate social responsibility strategies, a different understanding of the organizational identity and, potentially, a variety of university cooperation. SMEs have a way to create an authentic strategy that fits with their core values and beliefs; furthermore, they can share this with their employees and the regional universities.

Despite this natural benefit for creating a beneficial environment for the realized absorptive capacity, SMEs, especially in Germany, shy away from utilizing this possibility. But, to stay at the top, SMEs do need to employ their authenticity publicly to find future employees that willingly share their knowledge. SMEs need to stop being “hidden champions” (Simon, 1996), so they can exploit their transformative power to create realized absorptive capacity based on their approach to corporate social responsibility, organizational identity, and university cooperation.

Appendix

Appendix 4 Measurement of dependent and independent variables

Question: Please indicate to what extent you agree with the following statements:
(1= strongly disagree; 5= strongly agree)

Corporate Social Responsibility (α= 0.822)

CSR to social and non-social stakeholders (α= 0.764)

1	Our company participates to the activities which aim to protect and improve the quality of the natural environment.
2	Our company makes investment to create a better life for the future generations.
3	Our company implements special programs to minimize its negative impact on the natural environment.
4	Our company targets a sustainable growth which considers to the future generations.
5	Our company supports the non-governmental organizations working in the problematic areas.
6	Our company contributes to the campaigns and projects that promote the well-being of the society.

CSR to employees (α= 0.718)

7	Our company encourages its employees to participate to the voluntarily activities.
8	Our company policies encourage the employees to develop their skills and careers.
9	The management of our company primarily concerns with employees' needs and wants.
10	Our company implements flexible policies to provide a good work and life balance for its employees.
11	The managerial decisions related with the employees are usually fair.
12	Our company supports employees who want to acquire additional education.

CSR to customers (α= 0.275)

13	Our company protects consumer rights beyond the legal requirements.
14	Our company provides full and accurate information about its products to its customers.
15	Customer satisfaction is highly important for our company.

CSR to government (α= 0.337)

16	Our company always pays its taxes on a regular and continuing basis.
17	Our company complies with the legal regulations completely and promptly.

Source: Turker, D. (2009a)

Organizational Identity (α= 0.703)

1	Our employees have a sense of pride in the goals of this company.
2	Our employees think that this company occupies a unique position in its market.
3	Our employees know the history of this company.
4	This company seems to have no sense of its history.
5	This company has well defined objectives.
6	When our employees talk about this company, they usually do so with great enthusiasm.

Source: Based on Cole, M. and Bruch, H. (2006) and Milliken, J. (1990)

Realized absorptive capacity (α= 0.611)

1	Our employees secure and record newly acquired knowledge for possible later usage.
2	Our employees hardly share practical experience with each other.
3	This company is constantly considering the consequences of changing market demand.
4	Management meets regularly to discuss the effects of market developments and new product developments.
5	This company quickly recognizes the usefulness of new external knowledge over existing knowledge.
6	This company rarely uses opportunities arising from new external knowledge.

Source: Based on Jansen, J. et al., (2005)

Appendix 5 Measurement of controls

level of institutionalization *(α= 0.503)*

Question: Please indicate to what extent you agree with the following statements:
(1= strongly disagree; 5= strongly agree)

1 This company has a strong hierarchical structure.
2 This company has bureaucratic structures with extensive formal regulations.
3 Employees are fully involved in decisions.
4 This company is characterized by high team orientation.
5 Workflows and decision-making processes are precisely defined.
6 The relationship between employees is characterized by internal rivalry and competition.
7 Most employees see the company as one big family.
8 There is a high performance orientation in this company.
9 In this company, the information of employees has a high priority.
10 Our company has a fixed assignment of tasks per job profile.

Source: SOEP–LEE employer survey (2012)

competitiveness *(α= 0.716)*

Question: Please assess the following aspects of your company compared to your main competitor:
(1= much worse; 5= much better)

1 The economic success is…
2 The company image…
3 The ability to innovate…
4 The job security…
5 The wage level…
6 The capital endowment…

Source: self-developed

7 Summary, implications and outlook

This chapter provides a conclusion of this dissertation. Beginning with a brief summary and discussion of the key findings, this chapter provides several theoretical and practical implications for researchers, university administrators, SMEs' managing directors and policy-makers. The dissertation concludes with a discussion of potential limitations and provides promising future research avenues.

7.1 Summary and discussion

This section summarises and discusses the primary findings of the dissertation. Table 29 provides an overview of the research questions and key findings addressed in the previous chapters.

Table 29 Research questions addressed in this dissertation

	Research questions per chapter	Analytical approach	Key findings
Chapter 2	**RQ 1:** *What drives academics to become entrepreneurs?*	systematic literature review (196 Articles published in 52 Journals)	1) Micro-level: intrinsic and extrinsic motivations; human and social capital; demographic and personality traits; psychological and cognitive factors; research type, quality and discipline, 2) Meso-level: university characteristics and research orientation; support mechanisms, 3) Macro-level: regional and national context
	RQ 2: *Which barriers must academics overcome during the venturing process?*		1) Micro-level: lack of entrepreneurial capabilities, knowledge and resources; fear of failure; attitude towards science, 2) Meso-level: lack of entrepreneurial culture and incubation services; bureaucracy; management style, 3) Macro-level: regional and national context
	RQ 3: *Which factors influence the success of ASOs?*		1) Micro-level: initial competence endowments; firm strategies, objectives and structures, 2) Meso-level: relation with universities; university capabilities, 3) Macro-level: regional openness; governmental policies; venture capital support

(**Table 29** continues on the next page)

Table 29 (continued)

Chapter 3	**RQ 4:** *How individual psychological factors affect the extent of entrepreneurial obstacles perceived?*	OLS estimation (N= 711 academic entrepreneurs from 73 German Universities)	The perception of entrepreneurial obstacles depends 1) positively on the degree of individual decision paralysis and the attitude towards science and 2) negatively on entrepreneurial self-efficacy and individual risk-taking propensity
Chapter 4	**RQ 5:** *How motivating factors affect the venturing progress of academic entrepreneurship?* **RQ 6:** *Which motivating factors play a more important role for academic entrepreneurship?*	Descriptive statistics, OSL and TOBIT estimation (N= 611 academic entrepreneurs from 73 German Universities)	Knowledge transfer motives matter most, followed by economic and lifestyle motivations. 1) The desire for self-realization and 2) knowledge application as well as 3) necessity motives affect the venture progress positively, whereas 4) the desire for the better utilization of professional knowledge and 5) financial income motives have a negative effect
Chapter 5	**RQ 7:** *How the interplay between scientist's, organizational (university) context and the collaboration between external stakeholders advance academic entrepreneurship*	OSL and TOBIT estimation (N= 862 academic entrepreneurs from 73 German Universities)	The following combinations of knowledge collaborations facilitates academic entrepreneurship: 1) Technology transfer offices enable collaboration with private industry; 2) patent agencies facilitate collaboration with other scientists and potential customers; 3) university incubators facilitate collaboration with capital investors and develop new business contacts; 4) support programs at universities facilitate collaboration with customers.
Chapter 6	**RQ 8:** *What enhances the absorptive capacity of small and medium-sized enterprises?*	OLS estimation (N= 251 German SMEs located in North Rhein Westphalia)	university to industry cooperation leads to a stronger manifestation of SMEs realized absorptive capacity

Chapter 2 selected, evaluated, summarised and synthesised 193 articles dealing with the drivers, barriers and success factors of ASOs. Regarding the research objectives and units of analysis, a majority of the reviewed articles focussed on exploring the drivers (42.01%) and success factors (45.56%) of ASOs. In contrast, only 13 articles (7.69%) addressed the barriers. With respect to level of analysis, most of the articles attempted to explore the drivers, barriers and the success factors on the micro-level (55.03%), followed by the meso- (20.12%), multi- (19.93%) and macro-levels (5.92%).

With regard to **RQ 1**, both distinct intrinsic and extrinsic motivations affect academics' entrepreneurial propensities (e.g. Lam, 2011; Fini et al., 2009). Another driver for academic entrepreneurship lies in the human and social capital of an academic (e.g. Clarysse et al., 2011a; D'Este et al., 2012; Krabel and Mueller, 2009; Karlsson and Wigren, 2012). Furthermore, psychological and cognitive factors can significantly affect academics' entrepreneurial propensity (e.g. Obschonka et al., 2010; Goethner et al., 2012). Universities with solid resource bases and good reputations significantly facilitate the generation and development of ASOs. In addition, university and department entrepreneurial atmospheres can encourage academics to engage in spin-off creation (e.g. Hayter, 2011; Huyghe and Knockaert, 2015). Moreover, the existence of well-established university support mechanisms can significantly facilitate the venturing process of ASOs (e.g. Landry et al., 2006; Caldera and Debande, 2010). Moreover, findings from prior studies indicate that a well-established regional entrepreneurial environment and specialised government funding programmes can drive academics to become entrepreneurs (e.g. Botelho and Almeida, 2010; Rasmussen and Sørheim, 2012; Knockaert et al., 2010).

In terms of **RQ 2**, prior studies indicate that the sustainable development of ASOs is constrained by market, financial, management and physical obstacles (Geenhuizen and Soetanto, 2009). Moreover, conflicting objectives, internal corporate governance issues and a lack of entrepreneurial competences amongst founding teams also impede the consistent development of ASOs (e.g. Vohora et al., 2004; Davey et al., 2016; Zhou et al., 2011). Furthermore, the risk and stress aversion of founders are also considered major barriers in the pre-founding phase (Maes et al., 2014; Hayter et al., 2017). A further major barrier for scientists in the early stage of the spin-off formation process is the academic system, considering the lack of appreciation for commercialisation activities amongst academia (O'Gorman et al., 2008; Lacetera, 2009).

In terms of external barriers, the emergence of entrepreneurial intentions, as well as the growth potential of ASOs, can be impeded when the parent organisation possess relatively weak entrepreneurial culture, infrastructure and support mechanisms (Botelho and Almeida, 2010). Specific regional and country contexts also determine the perception of barriers in the venturing process of ASOs (Davey et al., 2016). Finally, failing to attract EVC is considered one of the largest challenges faced by most ASOs (Knockaert et al., 2010; Zhou et al., 2011).

Regarding **RQ 3**, the sustainable success of ASOs is closely related to the endogenous factors and external conditions that they encounter. Sufficient human, social and technological knowledge resource bases are key predictors of success for ASOs (e.g. Geenhuizen and Soetanto, 2009; Clarysse et al., 2011b). The composition and characteristics of the founding team in terms of balanced demographic structure and diverse expertise can, on the one hand, lead to superior performance by ASOs (e.g. Knockaert et al., 2011; D'Este et al., 2012; Gimmon and Levie, 2010) and, on the other hand, increase the possibility of ASOs obtaining early-stage funding support (Huynh, 2016). Moreover, the firms' financing and collaboration strategies, as well as various performance objectives, are also vital for the sustainable success of ASOs (e.g. Geenhuizen and Soetanto, 2009; Rasmussen, 2011). With regard to external factors, the performance of an ASO can be influenced by ties with the parent organisation (Rasmussen, 2011; Fackler et al., 2016). Geographical proximity to research institutions and industrial districts can develop synergy and cluster effects that further enhance ASO innovativeness (Stephan, 2014; Soetanto and Jack, 2016). In addition, compared to regional government support programmes, the regional environment in which an individual starts a firm demonstrates more explanatory power on ASO success (e.g. Botelho and Almeida, 2010; Zhang, 2009, Knockaert et al., 2010; Chugh et al., 2011). Another important success factor is EVC support. Sufficient EVC support allows ASOs to reach economic milestones more efficiently (Knockaert et al., 2010). Moreover, ASOs with EVC supports demonstrate higher survival rates, compared to non-venture capital-backed spin-offs (Zhang, 2009; Bock et al., 2018).

Chapter 3 explored the psychological mechanisms behind the perception of entrepreneurial obstacles in the academic context (e.g. Kollmann et al., 2017; Hossinger et al., 2020). In this regard, four well-known behavioural scientific theories were applied in this study, namely the decision conflict theory from Janis and Mann (1977), the theory of planned behaviour from Ajzen (1991), the need for achievement theory from McClelland et al. (1953) and the

institutional theory from Meyer and Rowan (1977). The study was based on a two-wave dataset of 711 academic entrepreneurs from Germany in 2013 and 2016. With respect to **RQ 4**, the findings indicate that the extent of entrepreneurial obstacles perceived is significantly determined by four major psychological factors, namely decision paralysis, entrepreneurial self-efficacy, risk-taking propensity and attitude towards science. Whereas decision paralysis and attitude towards science are positively associated with the extent of obstacles perceived, self-efficacy and risk-taking propensity demonstrate negative relationships with the obstacles perceived. Firstly, it is worth noting the positive effect of decision paralysis. This likely occurs because scientists tend to make more rational and analytical decisions than other types of founders and constantly seek more optimal and safer solutions when planning their founding projects. However, such perfect conditions do not exist in reality, and scientists must continually reconsider their decisions or solutions, which in turn might lead to confusion and ultimately to a stronger perception of entrepreneurial obstacles. In terms of entrepreneurial self-efficacy, the results revealed that it not only predicts academics entrepreneurial intentions (Guerrero et al., 2008; Díaz-García and Jiménez-Moreno, 2010) but also essentially influences the perception of entrepreneurial obstacles. This may occur because scientists with high ESE found companies with an open mind and complete self-confidence. As a consequence, these scientists are also in a better position to overcome serious entrepreneurial obstacles and accelerate entrepreneurial progress. Thirdly, in line with previous studies, Chapter 3 provides evidence that entrepreneurial decision and risk are inextricably connected (Brindley, 2005; Caliendo et al., 2014). The risks associated with starting a venture are primarily skill related (Macko and Tyszka, 2009). This in turn may explain why scientists, particularly highly skilled one, perceive fewer entrepreneurial obstacles. The positive effect of attitude towards science may be explained by the arising ‘publish or perish’ culture in academia. Since a scientist’s career is almost exclusively measured by the quality and number of their publications (O'Gorman et al., 2008; Wright et al., 2009), a lack of appreciation for the commercialisation of research results exists (Bijedić et al., 2017). As such, scientists may concentrate more on publishing their research results rather than seeking potential commercialisation opportunities.

Chapter 4 addresses the role of individual founding motives for academic entrepreneurship and explains the discrepancy between the propensity to start a business and its final implementation (Kollmann et al., 2017; Fritsch and Krabel, 2012; Mueller, 2010). More precisely, Chapter 4 investigated which founding motives are more important for academic entrepreneurship and how these motives affect the venturing progress of academic entrepreneurship. The study was based on two cross-sectional surveys collected in 2013 and 2016 at 73 German universities. Six-hundred and eleven scientists from various research disciplines and positions were included in the final sample. The findings demonstrate that academics are driven by a diverse set of motivations to engage in entrepreneurial activities. Regarding **RQ 5**, the descriptive results reveal that the most important motivating factor is self-realisation, followed by knowledge and skill exploitation and the need to apply one's own research idea. Furthermore, economic motives, such as monetary and necessity motives, are the second most important reasons for academics to start a company. Finally, work–life balance as a founding motive is relatively less important for academic entrepreneurship. With regard to **RQ 6**, the multivariate results show that both transfer and economic motives decisively affect the venturing progress of academic entrepreneurship. In line with the proposed hypothesis, the findings indicate that self-realisation, the need for application and necessity motives positively affect the venturing progress. In contrast, the need for better exploitation of professional knowledge impedes the venturing progress of academic entrepreneurship. Transfer motives may matter most due to the role identity of academics. Compared to other types of founders, academic entrepreneurs are driven by a strong inner realisation, as well as a 'need for utilisation' (Morales-Gualdrón et al., 2009; Berggren, 2017; Iorio et al., 2017). Role identity may closely relate to the negative effect of 'knowledge and skill utilisation'. Scientists may consider entrepreneurship as a platform to further advance their research. Thus, scientists invest their knowledge and skills in their research rather than in commercialisation activities. In line with prior research, the results reveal that compared to non-monetary incentives, the influence of monetary factors amongst academic entrepreneurs is very limited (Hayter, 2011; Lam, 2011), which indicates that financial rewards could be considered more as a form of collateral compensation (Morales-Gualdrón et al., 2009; Goethner et al., 2012). In addition, in line with Kirkwood (2009), the results highlight that necessity founders make more venturing progress. This may occur because scientists with unlimited or part-time working contracts must constantly extend or search for new income opportunities. In terms of work–life balance, no significant effect could be found.

This may occur because work–life balance at universities is comparatively well pronounced. Scientists have relatively flexible working schedules and therefore are able to manage their own time. Thus, the issue of work–life balance might be less important for scientists.

Chapter 5 addresses a call to bridge the micro, organisational and macro divide in university knowledge transfer. Building on endogenous economic growth and the knowledge spill-over of entrepreneurship theory, Chapter 5 investigated how the interplay between scientist's individual characteristics, organisational structures and external stakeholders could facilitate start-up activities. The study was based on two cross-sectional surveys collected in 2013 and 2016 at 73 German universities. The statements of 826 scientists from various research disciplines and positions comprised the final sample for the multivariate analysis. In terms of **RQ 7**, empirical evidence supports the co-occurrence of different conduits to knowledge commercialisation activities in German universities. The multivariate results indicate that the following combinations of organisational structures and external stakeholders facilitate start-up activities amongst scientists: TTOs compliment collaboration with private industry; patent agencies complement collaboration with other scientists and potential customers; university incubators complement collaboration with capital investors and building new business contacts; and support programmes at universities complement collaboration with customers. Aldridge and Audretsch (2010) found that 30% of highly productive scientists choose a 'back-door route' to commercialise their research results. In line with this finding, Chapter 5 revealed that TTOs do not facilitate academic entrepreneurship by serving as mediators to capital investors. Scientists may not need to liaise with TTOs if they have an invention and investors with the capital to bring the product directly to market. In contrast, TTOs are more likely to serve as mediators to private industry. This may occur because private firms often approach university TTOs or knowledge transfer units (Guerrero et al., 2015) due to R&D and technology cost reduction. Thus, the role of TTOs lies in bridging the micro–macro divide (Aldridge and Audretsch, 2011). Moreover, the results indicate that patent agencies can facilitate academic entrepreneurship by acting as a conduit to other academic communities and scientists. Collaborating with other scientists can increase the quality of knowledge creation but may also pose a risk of freeriding (Wright et al., 2008b). Thus, inventions should be protected via patenting or other legal forms of IP. In this manner, scientists can exploit their inventions further. Surprisingly, no link between university incubators and scientist's contacts with potential customers and professional associations could be found.

This may be attributed to the special characteristics of professional associations, which may serve as incubators of ideas, networks and access to potential investors. Moreover, they provide technical and mentorship, consultancy and IP protection to their members. As a result, scientists' entrepreneurial ideas may be commercialised within professional associations or in corporate incubators.

Chapter 6 focussed on the knowledge transfer between universities and the private economy and highlighted the role of university cooperation for SMEs' absorptive capacity. Based on a sample of 256 SMEs, this study showed that university cooperation can enhance SMEs' ability to recognise the value of new information, assimilate it and apply it to commercial ends. With regard to **RQ 8**, the results revealed that university cooperation leads to a stronger manifestation of realised absorptive capacity. This aligns with previous studies suggesting that university cooperation positively affects a firm's innovativeness (Cassiman and Veugelers, 2006). The stronger manifestation or realised absorptive capacity through university cooperation may be attributed to the following reasons: firstly, university-to-industry cooperation enhances a company's awareness of new research and technological opportunities (Gibbons and Johnston, 1974; Salter and Martin, 2001; Bishop et al., 2011), which in turn contributes to the development of explorative learning capabilities. Secondly, university cooperation positively affects a company's capacity to exploit new or existing knowledge to create product and/or process innovation (Bishop et al., 2011). Thirdly, university-to-industry cooperation enhances a company's problem-solving, as well as analytical, capabilities (Bishop et al., 2011; Salter and Martin, 2001). Fourthly, knowledge transfer is bidirectional; it can be achieved from university to organisation but also the other way around.

7.2 Implications for Theory

From a theoretical perspective, this dissertation sheds light on the phenomenon of why academic entrepreneurs cease, postpone or actually implement their founding plans. The findings contribute to the literature on academic entrepreneurship in multiple ways.

Firstly, this dissertation provides deeper insights into academic entrepreneurship from a behavioural science perspective. Prior studies have argued that entrepreneurship depends to a great extent upon the individuals' involvements and commitments (Lee et al. 2011 and Shane et al. 2012), which suggests that entrepreneurship is a purposive behaviour propelled by intentions (Hayter 2015a). Based on a contextualised research approach (Welter 2011), this dissertation improves the understanding of the founding behaviour of academics by providing empirical evidence that academic entrepreneurship is determined less by entrepreneurial and/or university-specific factors and more by the individual psychological factors of the founders. In this regard, tendencies towards paralysis, ESE and individual risk-taking propensity are particularly crucial.

Secondly, beyond previous studies, the results reveal that the entrepreneurial self-efficacy not only predicts academics' intentions to start their own businesses (Guerrero et al. 2008; Díaz-García and Jiménez-Moreno) but also essentially influences the perception of entrepreneurial obstacles. Therefore, this dissertation contributes to the theory of planned behaviour and suggests that entrepreneurs with strong self-efficacy can overcome even the most difficult obstacles through persistent efforts (Bandura 1977).

Thirdly, this dissertation introduces a new and interesting construct to entrepreneurship research which has been systematically overlooked, namely, decision paralysis. By combining both vigilance and procrastination, a new holistic construct can be implemented to explain the inability to make decisions or to act (Luce, 1998; Janis and Mann, 1977; Mann et al., 1998). In contrast to previous research, this study focusses not only on the aspect of choice procrastination or avoidance in entrepreneurship but also on the degree of vigilance with which an entrepreneur attempts to make decisions. Thus, decision paralysis provides a new perspective on entrepreneurial decision-making and represents a new starting point for further research on the founding behaviour of entrepreneurs.

Moreover, this dissertation enhances existing knowledge on the role of founders' individual risk-taking propensities. Prior studies indicate that individual risk-taking and entrepreneurial success are inextricably connected (e.g. Brindley, 2005; Caliendo et al., 2014; Haeussler and

Colyvas, 2011; Hoye and Pries, 2009; Singh Sandhu et al., 2011). Building upon these findings, this dissertation shows that individual risk-taking propensity is not only positively related to entrepreneurial success but also reduces the extent of obstacles perceived. The results obtained may have implications for understanding the situations in which entrepreneurs tend to take or avoid risks when facing obstacles.

One further implication is closely related to the aforementioned psychological factors and concerns the gender-specific effect, which has often been negatively attested in the entrepreneurial research literature (e.g. Díaz-García and Jiménez-Moreno, 2010; Abreu and Grinevich, 2013; Alonso-Galicia et al., 2015; Iorio et al., 2017). This study provides further insight regarding this issue. The empirical results suggest that female scientists perceive obstacles associated with the venturing progress much more strongly than their male colleagues, which confirms the findings of Bijedić et al. (2017). However, this dissertation reveals that the gender effect diminishes as soon as psychological factors have been considered. This suggests that academic entrepreneurship is influenced less by gender variables and more by the individual characters and attitudes of founders. Thus, the results of this work contribute to the literature on female entrepreneurship and gender studies.

Furthermore, this dissertation further explains the high discrepancy between the propensity to found a company and its implementation in the academic context (Fritsch and Krabel, 2012; Mueller, 2010). Prior research suggests that the key to overcoming the intention–action gap may lie in a person's individual motivation for various purposes. (Van Gelderen et al., 2015). In addition, this dissertation provides empirical evidence and shows that the intention–action gap in academic entrepreneurship can be bridged by encouraging and enhancing those motives that are positively related to academic entrepreneurship. In this regard, self-realisation, the need for application and necessity motives are particularly critical. This finding contributes to the literature related to push and pull theory and suggests that scholars should focus more on this interesting group of founders.

Knowledge transfer through ASOs has drawn numerous scholars' attention (O'Shea et al., 2004; Mustar et al., 2006; Rothaermel et al., 2007; Djokovic and Souitaris, 2008; Miranda et al., 2017a). However, very little is known about the conduit of university knowledge transfer or its channels, financing or external partners. This dissertation expands the research agenda on the role of the individual, organisational and ecosystem contexts for academic entrepreneurship (Agarwal and Shah, 2014) by providing a theoretical model which brings together scientists' characteristics, organisational mechanisms and external stakeholders in

supporting academic entrepreneurship. The results suggest that the extent to which organisational structures can serve as direct antecedents to contacts with external stakeholders interested in the results of academic research. Thus, this dissertation enhances the understanding of how various types of external stakeholders, along with scientists and universities, can shape an individual's decision to engage in entrepreneurial activities.

7.3 Implications for Practice

From a practical perspective, this dissertation provides university administrators and policymakers who are interested in fostering academic entrepreneurship with the help necessary to more effectively implement their support programmes. Since academic entrepreneurship is determined to a great extent by the individual involvements, commitments and intentions of the founders, differentiated and customised policies and support programmes are required to meet the diverse needs of the different types of ASOs.

Firstly, university administrators and their technology transfer programmes should specifically target academics who exhibit strong entrepreneurial orientations. Fostering academics' entrepreneurial mindsets and enhancing their internal entrepreneurial potential can significantly increase their inclinations towards entrepreneurship. Introducing coaching programmes is an effective manner to achieve this goal. Thus, not only can the entrepreneurial skills of academics be strengthened through education and training programmes, but their 'entrepreneurial drive' can also be fostered (Walter and Block, 2016; Raposo et al., 2008).

Moreover, support programmes aiming merely at commercialisation activities should be offered. Such programmes should concentrate more on helping scientists search for suitable cooperation with business partners, conducting market analyses or addressing exploitation rights. In this manner, scientists themselves can focus more on prototype development instead of struggling for the commercial exploitation of these products or services. In this way, more effective resource allocation could be achieved, which might reduce the negative effects of 'skill utilisation' and lead to more venturing progress.

Furthermore, enhancing the mediator role of support programmes between academic entrepreneurs and VCs could further increase the number of university start-ups. University administrators and their technology transfer programmes should focus on establishing and expanding VC networks, which would be extremely helpful for academic entrepreneurs in

many ways; firstly, by providing platforms where ASOs can proactively signal their capabilities and objectives to potential investors, the information asymmetry problem (Köhn, 2018) can be reduced. Secondly, academic entrepreneurs can benefit from the networks and experience of their VC partners. Thirdly, by providing sufficient financial resources, EVC would facilitate ASOs to reach economic milestones more efficiently. Finally, existing fears and arising uncertainties could be decreased by providing professional advice and compensating for potential knowledge shortages.

In addition to providing tailored support programmes and VC networks, various entrepreneurship-related events, such as lectures from successful academic entrepreneurs, workshops and seminars, should be regularly introduced. Such events would not only impart new knowledge to academics but also provide them with valuable opportunities to extend their networks.

Another way for university administrators to facilitate academic entrepreneurship is to create more industry collaboration opportunities, particularly for scientists in technology-oriented disciplines, and maintain these relationships over the long term. Universities aiming at increasing entrepreneurial involvement should also encourage academics to participate in both informal and formal commercialisation activities.

To further increase the number of university start-ups, a stronger entrepreneurial culture should be bred within universities. Fostering favourable department and university environments aimed towards entrepreneurship can be achieved by appointing department leaders who are strong role models. For academics who are more sensitive to the influence of their peers, university administrators should increase the awareness of role models amongst their subordinates. In addition to fostering an entrepreneurial department atmosphere, university administrators and academics should reconsider their promotion systems. With the arising ‘publish or perish’ culture in academia, academics’ promotion and tenure assessments remain primarily based upon scientific productivity and quality such as publications.

Such an orientation constrains the entrepreneurship involvement of academics. Hence, to encourage academics to participate in commercialisation activities, university administrators should reconsider existing promotion policies, and knowledge transfer should also be considered an indicator, alongside the research and teaching missions at universities.

Finally, scientists must allocate most of their time for teaching or searching for financial funding. Due to the increasing number of students and lecture assignments, as well as the need for acquiring third-party fundings, most scientists do not have enough time for further advancing their founding projects. Therefore, internal university policies based on diverse individual objectives and motives, such as leaves of absence, discharge in teaching and additional financial support, can effectively stimulate academics' entrepreneurial propensities and facilitate them in starting their own businesses.

In terms of policymakers, they should reconsider the processes and conditions for applying funding programmes. The processes should be simplified, and the restrictions should be eased, so that the spectrum of eligible start-up projects can be expanded. This would, on the one hand, relieve scientists of heavy financial burdens and push their start-up projects forward. On the other hand, the number of university start-ups could also be sustainably increased. In addition, to facilitate ASO creation, government and university policymakers should consider reducing transaction costs, such as simplifying bureaucratic administrative procedures, breaking down organisational hierarchies and providing tax incentives.

Furthermore, in the German context, policymakers should reshape the law on employee inventions (Paragraphs 40–42 of *Gesetz über Arbeitnehmererfindungen*). Since the abolition of the professor's privilege in Germany in 2002, the property rights on an invention are transferred from the scientist to the organisation (Bartenbach and Volz, 2019). This makes it extremely difficult for scientists to commercialise their inventions or research. Therefore, policymakers should redesign the law on employee inventions and eventually reintroduce the professor's privilege. By doing so, scientists could profit more from their own creations, which in turn might increase their inclination to exploit their inventions for commercial ends.

7.4 Limitations and future research avenues

This dissertation is not without limitations. Firstly, the research design of Chapters 3–5 is based on a self-reported survey in which academics participated voluntarily, so a potential selection bias could consequently exist. Moreover, the dataset is only from one country (Germany). Although the results primarily align with those of previous studies from European countries and the US, whether or to what extent these results are also generalisable to other countries with different cultural and regulatory backgrounds remains unclear. The results should be tested across various institutional and cultural environments (e.g. other regions in Europe) and between developing and developed countries. As such, future research should pay more attention to multi-national comparisons, particularly of the less researched but rapidly developing continents, such as Asia (Fisch et al., 2016). Considering the variety of regional and national cultures and traditions, academics with different backgrounds may be motivated to engage in entrepreneurial activities for various reasons.

Another limitation of this dissertation springs from the cross-sectional character of the underlying dataset. Each participant was surveyed in two single years (2013 and 2016). Therefore, no conclusions can be drawn regarding founding behaviour and founding steps between these years. It is consequently difficult to strictly determine the causal relationship over the years surveyed. Hence, future research should adopt a more dynamic perspective to analyse the venturing process of ASOs. Researchers should primarily consider longitudinal analysis in the future, since academic entrepreneurship is complex, long-term and dynamic and involves influencing factors from multiple dimensions (Rasmussen, 2011; Miranda et al., 2017b); academics' human and social capital, involvement, commitment, intentions and capabilities may evolve over time during the venturing process. Hence, longitudinal analysis can be adopted to track how the evolution of academics' profiles affects the venturing process.

With regard to the interplay between the micro-, meso- and macro-levels, researchers should adopt a more integrated perspective so that an optimal combination can be identified (Nolzen, 2018) to facilitate academic entrepreneurship. For many scientists, efforts to facilitate collaboration between universities and external knowledge collaborators have been limited, which has not aided start-up development (Audretsch, 2014). As such, future studies should focus on identifying channels (TTO, patent agency, support programme, incubator) to facilitate start-up activities, in collaboration with private industrial funding, capital investment, customers, business partners and academic and professional communities.

Moreover, future research should also examine new conduits of knowledge transfer, using longitudinal data, as well as university and patent office data. For example, researchers could focus on investigating start-up development activities at universities by clustering them into three groups: 1) exploration or exploitation oriented, 2) home or foreign market oriented and 3) self-employment or enterprise oriented. They can then test the multi-level model of micro-university-macro characteristics which affect each of the outcomes.

In addition to focussing on channels to facilitate start-up activities, future studies should also further investigate the obstacles that impede ASO development. The question of why many academic entrepreneurs cease or postpone pursuing their business ideas has not been answered convincingly by previous research (Hossinger et al., 2020). Although studies on entrepreneurial barriers have occurred (Vohora et al., 2004; Parker and Belghitar, 2006; Van Gelderen et al., 2011), the understanding of the driving forces behind these barriers remains in its infancy. Thus, future research should pay more attention to exploring the antecedents of entrepreneurial obstacles. In this regard, it is worth noting that some obstacles and associated needs occur during more than one specific phase (Mueller-Wieland et al., 2019). Thus, future research should determine how entrepreneurial obstacles affect the venturing process of ASOs at different stages and how these barriers can be overcome or lifted. A deeper understanding of the barriers associated with the venturing process of ASOs would offer university administrators and policymakers a more comprehensive overview for developing improved support mechanisms and programmes to facilitate the commercialisation activities of scientists (Hueske and Guenther, 2015).

In terms of psychological factors, many previous studies have employed Ajzen's (1991) theory of planned behaviour to explain the entrepreneurial behaviour of academics. Further studies should consider whether other psychological characteristics, such as habits or preferences, are more suitable for explaining academics' entrepreneurial behaviour. In this respect, the construct of decision paralysis provides an interesting and new perspective to explain why many academic entrepreneurs cease or postpone pursuing their start-up plans. Hence, the potential causes and consequences deserve further analysis. Future research could examine the extent to which decision paralysis varies between different types of founders. In addition, if decision paralysis persists, subsequent studies should also focus on how it affects entrepreneurial venture at later stages and the transfer speed of ASOs. This might improve the understanding of why most ASOs have been launched at least four years after the founder has left the university (Mueller, 2010).

With respect to the motivating factors of academics, further research is also needed, in particular regarding how to enhance motivating factors that are positively related to academic entrepreneurship and how to reduce those negatively related to academic entrepreneurship. Moreover, the following issues deserve further study as well: to what extent various motivating factors vary between different types of founders and how the effects of these motives could be moderated or mediated by the types of research, faculties and the types of founders, or their positions within the university. Furthermore, it remains unclear how these motivating factors vary in different phases during the venturing progress. Future research should therefore pay more attention to potential phase-specific motivating factors.

Regarding ASO performance, future research should consider expanding the selection scope of performance indicators and include those that better align with the peculiar characteristics of ASOs to evaluate the benefits of different ASO types.

Finally, it is worth noting the relationship between scientific output and entrepreneurial engagement. Prior studies emphasise the complementary relationship between these two activities. However, exactly how and to what extent academics and universities benefit from technology transfer activity deserves further investigation.

References

Abramo, G., D'Angelo, C. A., Ferretti, M., Parmentola, A. (2012). An individual-level assessment of the relationship between spin-off activities and research performance in universities. RD Management, 42(3), 225-242.

Abreu, M., Demirel, P., Grinevich, V., Karataş-Özkan, M. (2016). Entrepreneurial practices in research-intensive and teaching-led universities. Small Business Economics, 47(3), 695–717.

Abreu, M., Grinevich, V. (2013). The nature of academic entrepreneurship in the UK: Widening the focus on entrepreneurial activities. Research Policy, 42(2), 408-422.

Abreu, M., Grinevich, V. (2017). Gender patterns in academic entrepreneurship. The Journal of Technology Transfer, 42(4), 763-794.

Acs, Z., Audretsch, D., Lehmann, E. (2013). The knowledge spillover theory of entrepreneurship. Small Business Economics, 41(4), 757–774.

Agarwal, R., Shah, S. (2014). Knowledge sources of entrepreneurship: firm formation by academic, user and employee innovators. Research Policy, 43(7), 1109-1133.

Agrawal, A. (2006). Engaging the inventor: Exploring licensing strategies for university inventions and the role of latent knowledge. Strategic Management Journal, 27(1), 63–79.

Agrawal, A. K. (2001). University to industry knowledge transfer: Literature review and unanswered questions. International Journal of Management Reviews, 3(4), 285–302.

Aguinis, H. (2011). Organizational responsibility: Doing good and doing well. In S. Zedeck (Ed.), APA handbook of industrial and organizational psychology (Vol. 3): 855-879. Washington, DC: American Psychological Association.

Aidis, R., Estrin, S., Mickiewicz, T. (2008). Institutions and entrepreneurship development in Russia: A comparative perspective. Journal of Business Venturing, 23(6), 656–672.

Ajzen, I. (1991). The theory of planned behavior. Organizational behavior and human decision processes, 50(2), 179-211.

Albert, S., Whetten, D. A. (1985). Organizational identity. In Cummings, L. L., Staw, B. M. (Eds.), Research in organizational behavior. vol. 7 (263–295). Greenwich, CT: JAI Press.

Aldridge, T., Audretsch, D. B. (2010). Does Policy Influence The Commercialization Route? Evidence from National Institutes of Health Funded Scientists. Research Policy 39(5), 583-588.

Aldridge, T., Audretsch, D. B. (2011). The Bayh-Dole Act and scientist entrepreneurship. Research Policy, 40(8), 1058–1067.

Algieri, B., Aquino, A., Succurro, M. (2013). Technology transfer offices and academic spin-off creation: the case of Italy. The Journal of Technology Transfer, 38(4), 382-400.

Alonso-Galicia, P. E., Fernández-Pérez, V., Rodríguez-Ariza, L., Fuentes-Fuentes, M. D. (2015). Entrepreneurial cognitions in academia: exploring gender differences. Journal of Managerial Psychology, 30(6), 630-644.

Alsos, G. A., Hytti, U., Ljunggren, E. (2011). Stakeholder theory approach to technology incubators. International Journal of Entrepreneurial Behaviour and Research 17(6), 607–625.

Anderson, C. J. (2003). The psychology of doing nothing: Forms of decision avoidance result from reason and emotion. Psychological Bulletin, 129(1), 139–167.

Antonioli, D., Nicolli, F., Ramaciotti, L., Rizzo, U. (2016). The Effect of Intrinsic and Extrinsic Motivations on Academics' Entrepreneurial Intention. Administrative Sciences, 6(4), 1-18.

Arenius, P., Minniti, M. (2005). Perceptual variables and nascent entrepreneurship. Small Business Economics, 24(3), 233–247.

Arvanitis, S., Kubli, U., Woerter, M. (2008). University-industry knowledge and technology transfer in Switzerland: what university scientists think about co-operation with private enterprises. Research Policy, 37(10), 1865-1883.

Ashforth, B., Mael, F. (1996). Organizational Identity and Strategy as a Context for the Individual. Advances in Strategic Management, 13(1), 19–64.

Assink, M. (2006). Inhibitors of disruptive innovation capability: a conceptual model. European Journal of Innovation Management, 9(2), 215-233.

Audretsch, D. B. (2014). From the entrepreneurial university to the university for the entrepreneurial society. The Journal of Technology Transfer, 39(3), 313-321.

Audretsch, D. B., Belitski, M. (2013a). Creativity spillover of entrepreneurship theory: evidence from european cities. in: bernhard, i. (eds) innovation, high-growth entrepreneurship and regional development. University West, 145-157.

Audretsch, D. B., Belitski, M. (2013b). The missing pillar: the creativity theory of knowledge spillover entrepreneurship. Small Business Economics 41(4), 819-836.

Audretsch, D. B., Belitski, M. (2017). Entrepreneurial ecosystems in cities: establishing the framework conditions. The Journal of Technology Transfer, 42(5), 1030–1051.

Audretsch, D. B., Belitski, M., Desai, S. (2019). National business regulations and city entrepreneurship in Europe: A multilevel nested analysis. Entrepreneurship Theory and Practice, (forthcoming).

Audretsch, D. B., Keilbach, M. (2005). Entrepreneurship capital and regional growth. The Annals of Regional Science, 39(3), 457–469.

Autio, E., Sapienza, H.J., Almeida, J.G. (2000). Effects of Age at Entry, Knowledge Intensity, and Imitability on International Growth. Academy of Management Journal, 43(5), 909-924

Avnimelech, G., Feldman, M. P. (2015). The stickiness of university spin-offs: a study of formal and informal spin-offs and their location from 124 US academic institutions. International Journal of Technology Management, 68(1/2), 122-149.

Ayoub, M. R., Gottschalk, S., Mueller, B. (2017). Impact of public seed-funding on academic spin-offs. The Journal of Technology Transfer, 42(5), 1100-1124.

Backes-Gellner, U., Werner, A. (2007). Entrepreneurial Signaling via Education: A Success Factor in Innovative Start-Ups. Small Business Economics 29(1-2), 173-190

Baldini, N. (2009). Implementing Bayh–Dole-like laws: faculty problems and their impact on university patenting activity. Research Policy, 38 (2009), 1217-1224

Balven, R., Fenters, V., Siegel, D., Waldman, D. (2017). Academic Entrepreneurship: The roles of organizational justice, championing, education, work-Life balance, identity, and motivation. The Academy of Management Perspectives, 32(1).

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review, 84(2), 191–215.

Bandura, A. (1982). Self-Efficacy Mechanism in Human Agency. American Psychologist, 37(2), 122-177.

Bandura, A. (1989). Human Agency in Social Cognitive Theory. American Psychologist, 44(9), S. 1175-1184.

Bandura, A. (1990). Perceived self-efficacy in the exercise of personal agency. Journal of Applied Sport Psychology, 2(2), 128–163.

Bandura, A. (1997). Self-efficacy: The exercise of control. New York, NY, US: W H Freeman/Times Books/ Henry Holt & Co.

Barba-Sánchez, V., Atienza-Sahuquillo, C. (2012). Entrepreneurial behavior: Impact of motivation factors on decision to create a new venture. Investigaciones Europeas de Dirección y Economía de La Empresa, 18(2), 132-138.

Barba-Sánchez, V., Atienza-Sahuquillo, C. (2018). Entrepreneurial intention among engineering students: the role of entrepreneurship education. European Research on Management and Business Economics, 24(1), 53-61.

Barney, J. (1991). Firm resources and sustained competitive advantage. Journal of management, 17(1), 99-120.

Bartel, C. A. (2001). Social comparisons in boundary-spanning work: effects of community outreach on members organizational identity and identification. Administrative Science Quarterly, 46(3), 379-413.

Bartenbach, K., Volz, F. E. (2019). Arbeitnehmererfindergesetz: Kommentar zum Gesetz über Arbeitnehmererfindungen, 6th Edition,

Bekkers, R., Bodas Freitas, I. M. (2008): Analysing knowledge transfer channels between universities and industry: To what degree do sectors also matter. Research Policy, 37(10), 1837-1853.

Belitski, M. Desai, S. (2015). Creativity, entrepreneurship and economic development: city-level evidence on creativity spillover of entrepreneurship, Journal of Technology Transfer. 41(6). 1354–1376.

Belitski, M., Kalyuzhnova, Y., Azhgaliyeva, D. (2018). The role of alliances in leveraging national local content policies for firm competitiveness. International Journal of Strategic Business Alliance. 6 (1/2), 69-85.

Ben-Hafaïedh, C., Micozzi, A., Pattitoni, P. (2018). Academic spin-offs' entrepreneurial teams and performance: a subgroups approach. The Journal of Technology Transfer, 43(3), 714-733.

Benz, M. (2009). Entrepreneurship as a non-profit-seeking activity. International Entrepreneurship and Management Journal, 5(1), 23–44.

Berbegal-Mirabent, J., Ribeiro-Soriano, D. E., García, J. L. (2015). Can a magic recipe foster university spin-off creation? Journal of Business Research, 68(11), 2272-2278.

Bercovitz, J., Feldman, M. (2006). Entrepreneurial universities and technology transfer: a conceptual framework for understanding knowledge-based economic development. Journal of Technology Transfer 31 (1), 175–188.

Bercovitz, J., Feldman, M. (2007). Fishing upstream: Firm innovation strategy and university research alliances. Research Policy, 36(7), 930-948.

Bercovitz, J., Feldman, M. (2008). Academic Entrepreneurs: organizational Change at the Individual Level. OrganizationScience, 19(1), 69-89.

Bercovitz, J., Feldman, M., Feller, I., Burton, R. (2001). Organizational structure as a determinant of academic patent and licensing behavior: An exploratory study of Duke, Johns Hopkins, and Pennsylvania State Universities. The Journal of Technology Transfer 26(1), 21–35.

Berelson, B., Steiner, G. A. (1964). Human behavior: An inventory of scientific findings. Oxford, England: Harcourt, Brace & World.

Berggren, E. (2017). Researchers as enablers of commercialization at an entrepreneurial university. Journal of Management Development, 36(2), 217-232.

Bhardwaj, P., Chatterjee, P., Demir, K. D., Turut, O. (2018). When and how is corporate social responsibility profitable? Journal of Business Research, 84(1), 206-219.

Bhayani, A. (2015). Building entrepreneurial universities in a specific culture-barriers and opportunities: the case of universities in the United Arab Emirates. International Journal of Nonprofit and Voluntary Sector Marketing, 20(4), 312-330.

Bijedić, T., Chlosta, S., Hossinger, S., Kasdorf, A., Schneck, S., Schröder, C., Werner, A. (2017): Gründungserfolg von Wissenschaftlern an deutschen Hochschulen, IfM Bonn: IfM-Materialien Nr. 257, Bonn.

Bishop, K., D'Este, P., Neeley, A. (2011). Gaining from interactions with universities: multiple methods for nurturing absorptive capacity. Research Policy, 40(1), 30-40.

Blasi, S., Caporin, M., Fontini, F. (2018). A Multidimensional Analysis of the Relationship between Corporate Social Responsibility and Firms' Economic Performance. Ecological Economics, 147(1), 218-229.

Block, J. H., Brockmann, H., Klandt, H., Kohn, K. (2008): Start-up Barriers in Germany: A Review of the Empirical Literature, MPRA Paper No. 9538, München.

Block, J. H., Fisch, C. O., Van Praag, M. (2017). The Schumpeterian entrepreneur: a review of the empirical evidence on the antecedents, behaviour and consequences of innovative entrepreneurship. Industry and Innovation, 24(1), 61-95.

Block, J. H., Sandner, P. (2009). Necessity and Opportunity Entrepreneurs and Their Duration in Self-employment: Evidence from German Micro Data. Journal of Industry, Competition and Trade, 9(2), 117–137.

Block, J. H., Wagner, M. (2010). Necessity and opportunity entrepreneurs in Germany: Characteristics and earnings differentials. Schmalenbach Business Review, 62(2), 154–174.

Block, J. H., Wagner, M. (2014). The Effect of Family Ownership on Different Dimensions of Corporate Social Responsibility: Evidence from Large US Firms. Business Strategy and the Environment, 23(7), 475–492.

Bock, C., Huber, A., Jarchow, S. (2018). Growth factors of research-based spin-offs and the role of venture capital investing. The Journal of Technology Transfer, 43(5), 1375-1409.

Bonaccorsi, A., Colombo, M. G., Guerini, M., Rossi-Lamastra, C. (2014). The impact of local and external university knowledge on the creation of knowledge-intensive firms: evidence from the Italian case. Small Business Economics, 43(2), 261-287.

Borges, C., Filion, L. J. (2013). Spin-off Process and the Development of Academic Entrepreneur's Social Capital. Journal of Technology Management & Innovation, 8(1), 21-34.

Botelho, A. J., Almeida, M. (2010). Overcoming institutional shortcomings for academic spin-off policies in Brazil. International Journal of Technology Management & Sustainable Development, 9(3), 175-193.

Bower, J. L., Christensen, C. M. (1995). Disruptive technologies: catching the wave. Harvard Business Review

Bozeman, B., Rimes, H., Youtie, J. (2015). The evolving state-of-the-art in technology transfer research: Revisiting the contingent effectiveness model. Research Policy 44(1), 34–49.

Bradley, S. R., Hayter, C., Link, A. N. (2013). Models and methods of university technology transfer. Foundations and Trends in Entrepreneurship. 9(6), 571–650.

Brammer, S., Millington, A., Rayton, B. (2007). The contribution of corporate social responsibility to organizational commitment. The International Journal of Human Resource Management, 18(10), 1701-1719.

Braunerhjelm, P., Acs, Z. J., Audretsch, D. B., Carlsson, B. (2010). The missing link: Knowledge diffusion and entrepreneurship in endogenous growth. Small Business Economics, 34(2), 105–125.

Brettel, M., Mauer, R., Walter, T. (2013). High-profile employees at universities and their intentions of commercializing research results. Journal of Business Economics, 83(4), 357-382.

Brindley, C. (2005). Barriers to women achieving their entrepreneurial potential: Women and risk. International Journal of Entrepreneurial Behavior & Research, 11(2), 144–161.

Brockhaus, R. H. (1980). Risk taking propensity of entrepreneurs. Academy of Management Journal, 23(3), 509–520.

Busenitz, L. W., Gomez, C., Spencer, J. W. (2000). Country institutional profiles: unlocking entrepreneurial phenomena. Academy of Management Journal 43(5), 994–1003.

Calcagnini, G., Favaretto, I., Giombini, G., Perugini, F., Rombaldoni, R. (2016). The role of universities in the location of innovative start-ups. The Journal of Technology Transfer, 41(4), 670-693.

Caldera, A., Debande, O. (2010). Performance of Spanish universities in technology transfer: an empirical analysis. Research Policy, 39(9), 1160-1173.

Caliendo, M., Fossen, F., Kritikos, A. S. (2014). Personality characteristics and the decisions to become and stay self-employed. Small Business Economics, 42(4), 787–814.

Carayol, N., Matt, M. (2004). Does research organization influence academic production? Laboratory level evidence from large European university. Research Policy 33(8), 1081-1102.

Cassiman, B., Veugelers, R. (2002). RD Cooperation and Spillovers: Some Empirical Evidence from Belgium. American Economic Review, 92(4), 1169–1184.

Cassiman, B., Veugelers, R. (2006). In search of complementarity in innovation strategy: Internal RD and external knowledge acquisition. Management science, 52(1), 68-82.

Chesbrough, H. W. (2006). Open innovation: the new imperative for creating and profiting from technology. Harvard Business Press.

Cho, J. H., Sohn, S. Y. (2017). Competing risk model for predicting stabilization period of university spin-off ventures. International Entrepreneurship and Management Journal, 13(3), 777-796.

Christensen, C. M., Raynor, M. E., McDonald, R. (2015). What is disruptive innovation? Harvard Business Review, 93(12), 44-53.

Chugh, H., Nicolaou, N., Barnes, S. (2011). How does VC feedback affect start-ups? Venture Capital, 13(3), 243-265.

Ciuchta, M. P., Gong, Y., Miner, A. S., Letwin, C., Sadler, A. (2016). Imprinting and the progeny of university spin-offs. The Journal of Technology Transfer, 41(5), 1113-1134.

Civera, A., Meoli, M., Vismara, S. (2019). Do academic spinoffs internationalize? The Journal of Technology Transfer 44(2), 381–403.

Clarysse, B., Moray, N. (2004). A process study of entrepreneurial team formation: the case of a research-based spin-off. Journal of Business Venturing, 19(1), 55-79.

Clarysse, B., Tartari, V., Salter, A. (2011a). The impact of entrepreneurial capacity, experience and organizational support on academic entrepreneurship. Research Policy, 40(8), 1084-1093.

Clarysse, B., Wright, M., Bruneel, J., Mahajan, A. (2014). Creating value in ecosystems: Crossing the chasm between knowledge and business ecosystems. Research Policy, 43(7), 1164–1176.

Clarysse, B., Wright, M., Lockett, A., Mustar, P., Knockaert, M. (2007). Academic spinoffs, formal technology transfer and capital raising. Industrial and Corporate Change 16(4), 609–640.

Clarysse, B., Wright, M., Velde, E. V. (2011b). Entrepreneurial Origin, Technological Knowledge, and the Growth of Spin-Off Companies. Journal of Management Studies, 48(6), 1420-1442.

Cohen, W. M., Levinthal, D. A. (1990). Absorptive capacity: A new perspective of learning and innovation. Administrative Science Quarterly, 35(1), 128–152.

Cole, M. S., Bruch, H. (2006). Organizational identity strength, identification, and commitment and their relationships to turnover intention: does organizational hierarchy matter? Journal of Organizational Behavior, 27(5), 585–605.

Collier, J., Esteban, R. (2007). Corporate social responsibility and employee commitment. Business ethics: A European review, 16(1), 19-33.

Colombo, M. G., Piva, E. (2012). Firms' genetic characteristics and competence-enlarging strategies: a comparison between academic and non-academic high-tech start-ups. Research Policy, 41(1), 79-92.

Conceição, O., Faria, A. P., Fontes, M. (2017). Regional variation of academic spinoffs formation. The Journal of Technology Transfer, 42(3), 654-675.

Constant, A., Zimmermann, K. F. (2006). The Making of Entrepreneurs in Germany: Are Native Men and Immigrants Alike? Small Business Economics, 26(3), 279–300.

Corsi, C., Prencipe, A. (2015). Measuring the Performance of Academic Spin-Offs. Analysis of the Optimal Methods Predicting Ventures Development. International Journal of Humanities and Social Science, 5(4), 174-192.

Criaco, G., Minola, T., Migliorini, P., Serarols-Tarrés, C. (2014). "To have and have not": founders' human capital and university start-up survival. The Journal of Technology Transfer, 39(4), 567-593.

Crossan, M.M., Lane, H.W., White, R.E. (1999). An organizational learning framework: from intuition to institution. Academy of Management Review, 24(3), 522–537.

Cunningham, J. A., Link, A. N. (2015). Fostering university industry RD collaborations in European Union countries. International Entrepreneurship and Management Journal 11(4), 849–860.

Czarnitzki, D., Glänzel, W., Hussinger, K. (2009). Heterogeneity of patenting activity and its implications for scientific research. Research Policy, 38(1), 26–34.

Czarnitzki, D., Rammer, C., Toole, A. A. (2014). University spin-offs and the "performance premium". Small Business Economics, 43(2), 309-326.

Davey, T., Rossano, S., Sijde, P. v. (2016). Does context matter in academic entrepreneurship? The role of barriers and drivers in the regional and national context. The Journal of Technology Transfer, 41(6), 1457-1482.

Davis, K. (1973). The case for and against business assumption of social responsibilities. Academy of Management journal, 16(2), 312-322.

De Cleyn, S. H., Braet, J., Klofsten, M. (2015). How human capital interacts with the early development of academic spin-offs. International Entrepreneurship and Management Journal, 11(3), 599-621.

Delmas, M. A., Burbano, V. C. (2011). The drivers of greenwashing. California Management Review, 54(1), 64-87.

D'Este, P., Llopis, O., Rentocchini, F., Yegros, A. (2019). The relationship between interdisciplinarity and distinct modes of university-industry interaction. Research Policy, 103799. doi:10.1016/j.respol.2019.05.008

D'Este, P., Mahdi, S., Neely, A., Rentocchini, F. (2012). Inventors and entrepreneurs in academia: What types of skills and experience matter? Technovation, 32(5), 293–303.

D'Este, P., Perkmann, M. (2011). Why do academics engage with industry? The entrepreneurial university and individual motivations. The Journal of Technology Transfer, 36(3), 316–339.

Dhar, R. (1996). The effect of decision strategy on deciding to defer choice. Journal of Behavioral Decision Making, 9(4), 245–281.

Diánez-González, J. P., Camelo-Ordaz, C. (2016). How management team composition affects academic spin-offs' entrepreneurial orientation: the mediating role of conflict. The Journal of Technology Transfer, 41(3), 530-557.

Diánez-González, J. P., Camelo-Ordaz, C. (2017). The influence of the structure of social networks on academic spin-offs' entrepreneurial orientation. Industrial Marketing Management, forthcoming.

Díaz-García, M. C., Jiménez-Moreno, J. (2010). Entrepreneurial intention: the role of gender. International Entrepreneurship and Management Journal, 6(3), 261-283.

Di Gregorio, D., Shane, S. (2003). Why some universities generate more start-ups than others? Research Policy 32(2), 209-227.

Ding, W. W., Murray, F., Stuart, T. E. (2006). Gender Differences in Patenting in the Academic Life Sciences. Science, 313(5787), 665–667.

Djokovic, D., Souitaris, V. (2008). Spinouts from academic institutions: a literature review with suggestions for further research. The Journal of Technology Transfer, 33(3), 225-247.

Doluca, H., Wagner, M., Block, J. (2018). Sustainability and environmental behaviour in family firms: a longitudinal analysis of environment-related activities, innovation and performance. Business Strategy and the Environment, 27(1), 152–172.

Donavan, D. T., Brown, T. J., Mowen, J. C. (2004). Internal benefits of service-worker customer orientation: job satisfaction, commitment, and organizational citizenship behaviors. Journal of Marketing, 68(1), 128-146.

Douglas, E. J. (2013). Reconstructing entrepreneurial intentions to identify predisposition for growth. Journal of Business Venturing, 28(5), 633-651.

Druilhe, C., Garnsey, E. (2004). Do Academic Spin-Outs Differ and does it Matter? The Journal of Technology Transfer, 29(3-4), 269-285.

Du, S., Bhattacharya, C. B., Sen, S. (2007). Reaping relational rewards from corporate social responsibility: the role of competitive positioning. International Journal of Research in Marketing, 24(3), 224 – 241.

Du, S., Bhattacharya, C. B., Sen, S. (2011). Corporate social responsibility and competitive advantage: overcoming the trust barrier. Management Science, 57(9), 1528 – 1545.

Easterby-Smith, M., Lyles, M. A., & Tsang, E. W. K. (2008). Inter-Organizational Knowledge Transfer: Current Themes and Future Prospects. Journal of Management Studies, 45(4), 677–690.

Ebersberger, B., Pirhofer, C. (2011). Gender, management education and the willingness for academic entrepreneurship. Applied Economics Letters, 18(9), 841–844.

Edwards, M. R. (2005). Organizational identification: A conceptual and operational review. International journal of management reviews, 7(4), 207-230.

Erikson, T., Knockaert, M., Foo, M. D. (2015). Enterprising scientists: The shaping role of norms, experience and scientific productivity. Technological Forecasting and Social Change, 99, 211–221.

Escribá-Carda, N., Balbastre-Benavent, F., Canet-Giner, T. M. (2017). Employees' perceptions of high-performance work systems and innovative behaviour: The role of exploratory learning. European Management Journal, 35(2), 273-281.

Etzkowitz, H. (2002). Incubation of incubators: Innovation as a triple helix of university-industry-government networks. Science and Public Policy 29(2), 115–128.

Etzkowitz, H. (2003). Research groups as 'quasi-firms': The invention of the entrepreneurial university. Research policy, 32(1), 109–121.

Etzkowitz, H., Webster, A., Gebhardt, C., Terra, B. R. C. (2000). The future of the university and the university of the future: Evolution of ivory tower to entrepreneurial paradigm. Research Policy 29(2), 313–330.

Fackler, D., Schnabel, C., Schmucker, A. (2016). Spinoffs in Germany: characteristics, survival, and the role of their parents. Small Business Economics, 46(1), 93-114.

Feola, R., Vesci, M., Botti, A., Parente, R. (2019). The Determinants of Entrepreneurial Intention of Young Researchers: combining the Theory of Planned Behavior with the Triple Helix Model. Journal of Small Business Management, forthcoming.

Fernández-Alles, M., Camelo-Ordaz, C., Franco-Leal, N. (2015). Key resources and actors for the evolution of academic spin-offs. The Journal of Technology Transfer, 40(6), 976-1002.

Fernández-Pérez, V., Alonso-Galicia, P. E., Fuentes-Fuentes, M., Rodriguez-Ariza, L. (2014). Business social networks and academics' entrepreneurial intentions. Industrial Management & Data Systems, 114(2), 292-320.

Fernández-Pérez, V., Alonso-Galicia, P. E., Rodríquez-Ariza, L., Fuentes-Fuentes, M. (2015). Professional and personal social networks: a bridge to entrepreneurship for academics? European Management Journal, 33(1), 37-47.

Ferrari, J. R. (1991). Self-handicapping by procrastinators: Protecting self-esteem, social-esteem, or both? Journal of Research in Personality, 25(3), 245–261.

Ferretti, M., Ferri, S., Fiorentino, R., Parmentola, A., Sapio, A. (2018a). Neither absent nor too present: the effects of the engagement of parent universities on the performance of academic spin-offs. Small Business Economics, 52(1), 153-173.

Ferretti, M., Ferri, S., Fiorentino, R., Parmentola, A., Sapio, A. (2018b). What drives the growth of academic spin-offs? Matching academics, universities, and non-research organizations. International Entrepreneurship and Management Journal, 1-27.

Ferri, S., Fiorentino, R., Parmentola, A., Sapio, A. (2018). Patenting or not? The dilemma of academic spin-off founders. Business Process Management Journal, 25(1), 84-103.

Fini, R., Fu, K., Mathisen, M., Rasmussen, E., Wright, M. (2017). Institutional determinants of university spin-off quantity and quality: a longitudinal, multilevel, cross-country study. Small Business Economics, 48(2), 361-391.

Fini, R., Grimaldi, R., Santoni, S., Sobrero, M. (2011). Complements or substitutes? The role of universities and local context in supporting the creation of academic spin-offs. Research Policy, 40(8), 1113-1127.

Fini, R., Grimaldi, R., Sobrero, M. (2009). Factors fostering academics to start up new ventures: an assessment of Italian founders' incentives. The Journal of Technology Transfer, 34(4), 380-402.

Fini, R., Lacetera, N., Shane, S. (2016). Academic entrepreneurship. The Palgrave Encyclopedia of Strategic Management, 1-4.

Fini, R., Toschi, L. (2016). Academic logic and corporate entrepreneurial intentions: a study of the interaction between cognitive and institutional factors in new firms. International Small Business Journal, 34(5), 637-659.

Fiol, C. M. (1991). Managing culture as a competitive resource: an identity-based view of sustainable competitive advantage. Journal of Management, 17(1), 191–211.

Fisch, C., Block, J., Sandner, P. (2016). Chinese university patents: quantity, quality, and the role of subsidy programs. Journal of Technology Transfer, 40(2), 318-345.

Fischer, B. B., Schaeffer, P. R., Vonortas, N. S., Queiroz, S. (2017). Quality comes first: university-industry collaboration as a source of academic entrepreneurship in a developing country. The Journal of Technology Transfer, 43(2), 263–284.

Flatten, T. C., Greve, G. I., Brettel, M. (2011). Absorptive Capacity and Firm Performance in SMEs: The Mediating Influence of Strategic Alliances. European Management Review, 8(3), 137–152.

Fleming, L., Waguespack, D. M. (2007). Brokerage, boundary spanning, and leadership in open innovation communities. Organization science, 18(2), 165-180.

Florida, R. L., Kenney, M. (1988). Venture Ccapital, high technology and regional development. Regional Studies 22(1), 33-48.

Foo, M.-D., Knockaert, M., Chan, E. T., Erikson, T. (2016). The Individual Environment Nexus: impact of Promotion Focus and the Environment on Academic Scientists' Entrepreneurial Intentions. IEEE Transactions on Engineering Management, 63(2), 213-222.

Ford, J. D., Ford, L. W., D'Amelio, A. (2008). Resistance to change: the rest of the story. Academy of Management Review, 33(2), 362-377.

Fosfuri, A., Helmers, C., Roux, C. (2012). Are Joint Patents Collusive? Evidence from the US and Europe (October 19, 2012). TILEC Discussion Paper No. 2012-035; U. of St. Gallen Law & Economics Working Paper No. 2013-15.

Freitas, J. S., Gonçalves, C. A., Cheng, L. C., Muniz, R. M. (2013). Structuration aspects in academic spin-off emergence: a roadmap-based analysis. Technological Forecasting and Social Change, 80(6), 1162-1178.

Fritsch, M., Krabel, S. (2012). Ready to leave the ivory tower? Academic scientists' appeal to work in the private sector. The Journal of Technology Transfer, 37(3), 271-296.

Garengo, P., Biazzo, S., Bitici, U.S. (2005). Performance measurement systems in SMEs: a review for a research agenda, International Journal of Management Reviews, 7(1), 25-47.

Geenhuizen, M. v., Soetanto, D. P. (2009). Academic spin-offs at different ages: a case study in search of key obstacles to growth. Technovation, 29(10), 671-681.

Geenhuizen, M. v., Soetanto, D. P. (2013). Benefitting from Learning Networks in "Open Innovation": spin-off Firms in Contrasting City Regions. European Planning Studies, 21(5), 666-682.

George, G., Zahra, S. A., Wood, D. R. (2002). The effects of business-university alliances on innovative performance: a study of publicly traded biotechnology companies. Journal of Business Venturing 17, 577–609.

Geuna, A., Nesta, L. (2006). University patenting and its effects on academic research: The emerging European evidence. Research Policy, 35, 790–807.

Ghio, N., Guerini, M., Rossi-Lamastra, C. (2016). University knowledge and the creation of innovative start-ups: an analysis of the Italian case. Small Business Economics, 47(2), 293-311.

Gibbons, M., Johnston, R. (1974). The roles of science in technological innovation. Research Policy 3, 220–242.

Gibson, C. B., Birkinshaw, J. (2004). The antecedents, consequences, and mediating role of organizational ambidexterity. Academy of management Journal, 47(2), 209-226.

Gimmon, E., Levie, J. (2010). Founder's human capital, external investment, and the survival of new high-technology ventures. Research Policy, 39(9), 1214-1226.

Gioia, D. (1998). From individual to organizational identity. In D. Whetten P. Godfrey (Eds.), Identity in organizations: Building theory through conversations (pp. 17–31). Thousand Oaks, CA: Sage.

Gioia, D. A., Schultz, M., Corley, K. G. (2000). Organizational identity, image, and adaptive instability. Academy of management Review, 25(1), 63-81.

Gist, M. E., Mitchell, T. R. (1992). Self-Efficacy: A Theoretical Analysis of Its Determinants and Malleability. The Academy of Management Review, 17(2), 183–211.

Gittelman, M., Kogut, B. (2003). Does good science lead to valuable knowledge? Biotechnology firms and the evolutionary logic of citation patterns. Management Science 49(4), 366–382.

Glavas, A., Godwin, L. N. (2012): Is the perception of "goodness" good enough? exploring the relationship between perceived corporate social responsibility and employee organizational identification. Journal of Business Ethic, 114(1), S. 15-27.

Goel, R. K., Göktepe-Hultén, D. (2013). Nascent entrepreneurship and inventive activity: a somewhat new perspective. The Journal of Technology Transfer, 38(4), 471-485.

Goethner, M., Obschonka, M., Silbereisen, R. K., Cantner, U. (2012). Scientists' transition to academic entrepreneurship: economic and psychological determinants. Journal of Economic Psychology, 33(3), 628-641.

Göktepe-Hulten, D., Mahagaonkar, P. (2009). Inventing and patenting activities of scientists: In the expectation of money or reputation? The Journal of Technology Transfer, 35(4), 401–423.

Gollwitzer, P.M. (1999). Implementation intentions—Strong effects of simple plans. American Psychologist, 54(7), 493–503

Gómez Gras, J. M., Galiana Lapera, D. R., Mira Solves, I., Verdu Jover, A. J., Sancho Azuar, J. (2008). An empirical approach to the organizational determinants of spin-off creation in european universities. International Entrepreneurship and Management Journal 4(2), 187-198.

Grandi, A., Grimaldi, R. (2005). Academics' organizational characteristics and the generation of successful business ideas. Journal of Business Venturing, 20(6), 821– 845.

Greene, W. H. (2003). Econometric Analysis. 5th Edition, Prentice Hall, Upper Saddle River.

Grilo, I., Thurik, R. (2008). Determinants of entrepreneurial engagement levels in Europe and the US. Industrial and Corporate Change, 17(6), 1113–1145.

Grimaldi, R., Kenney, M., Siegel, D. S., Wright, M. (2011). 30 Years after Bayh-Dole: Reassessing academic entrepreneurship. Research Policy 40(8), 1045-1057.

Grimm, H. M., Jaenicke, J. (2012). What drives patenting and commerzialisation activity at East German universities? The role of new public policy, institutional environment and individual prior knowledge. The Journal of Technology Transfer, 37(4), 454-477.

Grimpe, C., Fier, H. (2010). Informal university technology transfer: a comparison between the United States and Germany. The Journal of Technology Transfer 35(6), 637-650.

Guerrero, M., Cunningham, J. A., Urbano, D. (2015). Economic impact of entrepreneurial universities' activities: an exploratory study of the United Kingdom. Research Policy, 44(3), 748-764.

Guerrero, M., Rialp, J., Urbano, D. (2008). The impact of desirability and feasibility on entrepreneurial intentions: a structural equation model. International Entrepreneurship and Management Journal, 4(1), 35-50.

Guerrero, M., Urbano, D. (2012). The development of an entrepreneurial university. The Journal of Technology Transfer 37(1), 43–74.

Guerrero, M., Urbano, D. (2014). Academics' start-up intentions and knowledge filters: An individual perspective of the knowledge spillover theory of entrepreneurship. Small Business Economics 43(1), 57–74.

Guerrero, M., Urbano, D., Fayolle, A. (2016). Entrepreneurial activity and regional competitiveness: Evidence from European entrepreneurial universities. The Journal of Technology Transfer 41(1), 105–131.

Gulbranson, C. A., Audretsch, D. B. (2008). Proof of concept centers: accelerating the commercialization of university innovation. The Journal of Technology Transfer 33(3), 249{258.

Guttentag, D. (2015). Airbnb: disruptive innovation and the rise of an informal tourism accommodation sector. Current issues in Tourism, 18(12), 1192-1217.

Haeussler, C., Colyvas, J. A. (2011). Breaking the Ivory Tower: academic Entrepreneurship in the Life Sciences in UK and Germany. Research Policy, 40(1), 41-54.

Hague, D., Oakley, K. (2000). Spin-offs and Start-ups in UK Universities. Available at: http://eprints.gla.ac.uk/174799/

Hanna, M. D., Rocky Newman, W., Johnson, P. (2000). Linking operational and environmental improvement through employee involvement. International Journal of Operations & Production Management, 20(2), 148-165.

Harrington, S. J., Guimaraes, T. (2005). Corporate culture, absorptive capacity and IT success. Information and Organization, 15(1), 39-63.

Haslam, S. A., Eggins, R. A.,Reynolds, K. J. (2003): The ASPIRe model: actualizing social and personal identity resources to enhance organizational outcomes. Journal of Occupational and Organizational Psychology, 76(1), S. 83-131.

Hayter, C. S. (2011). In search of the profit-maximizing actor: motivations and definitions of success from nascent academic entrepreneurs. The Journal of Technology Transfer, 36(3), 340-352.

Hayter, C. S. (2013). Harnessing University Entrepreneurship for Economic Growth: factors of Success among University Spin-offs. Economic Development Quarterly, 27(1), 18-28.

Hayter, C. S. (2015a). Public or private entrepreneurship? Revisiting motivations and definitions of success among academic entrepreneurs. The Journal of Technology Transfer, 40(6), 1003-1015.

Hayter, C. S. (2015b). Social Networks and the Success of University Spin-offs: toward an Agenda for Regional Growth. Economic Development Quarterly, 29(1), 3-13.

Hayter, C. S. (2016). Constraining entrepreneurial development: a knowledge-based view of social networks among academic entrepreneurs. Research Policy, 45(2), 475-490.

Hayter, C. S., Lubynsky, R., Maroulis, S. (2017). Who is the academic entrepreneur? The role of graduate students in the development of university spinoffs. The Journal of Technology Transfer, 42(6), 1237–1254.

Heaton, S., Siegel, D. S., Teece, D. J. (2019). Universities and innovation ecosystems: A dynamic capabilities perspective. Industrial and Corporate Change 28(4), 921–939.

Heblich, S., Slavtchev, V. (2014). Parent universities and the location of academic startups. Small Business Economics, 42(1), 1-15.

Heinzl, J., Kor, A. L., Orange, G., Kaufmann, H. R. (2013). Technology transfer model for Austrian higher education institutions. The Journal of Technology Transfer 38(5), 607–640.

Hellmann, T. (2007). The role of patents for bridging the science to market gap. Journal of Economic Behavior & Organization 63(4), 624–647.

Helm, R., Mauroner, O., Pöhlmann, K. (2016). Towards a better understanding of performance measurements: the case of research-based spin-offs. Review of Managerial Science, 12(1), 135-166.

Helmers, C., Rogers, M. (2015). The impact of university research on corporate patenting: evidence from UK universities. The Journal of Technology Transfer 40(1), 1-24.

Higgins, E. T. (1987). Self-discrepancy: a theory relating self and affect. Psychological Review, 94(3), 319-340.

Holmes, S., Smart, P. (2009). Exploring open innovation practice in firm-nonprofit engagements: a corporate social responsibility perspective. Rd Management, 39(4), 394-409.

Horta, H., Meoli, M., Vismara, S. (2016). Skilled unemployment and the creation of academic spin-offs: A recession-push hypothesis. The Journal of Technology Transfer, 41(4), 798–817.

Hossinger, S. M., Chen, X., Werner, A. (2020). Drivers, barriers and success factors of academic spin-offs: A systematic literature review. Management Review Quarterly, 70(1), 97–134.

Hoye, K., Pries, F. (2009). 'Repeat commercializers,' the 'habitual entrepreneurs' of university–industry technology transfer. Technovation, 29(10), 682-689.

Huber, F., Köcher, S., Vogel, J., Meyer, F. (2012). Dazing Diversity: Investigating the Determinants and Consequences of Decision Paralysis. Psychology & Marketing, 29(6), 467–478.

Hueske, A.-K., Guenther, E. (2015). What hampers innovation? External stakeholders, the organization, groups and individuals: a systematic review of empirical barrier research. Management Review Quarterly, 65(2), 113–148.

Hülsbeck, M. (2010). Hochschullehrerprivileg und Technologietransfer. In M. Hülsbeck (Hrsg.), Wissenstransfer deutscher Universitäten: Eine empirische Analyse von Universitätspatenten (S. 23–49).

Hundley, G. (2001). Why and when are the self-employed more satisfied with their work? Industrial Relations: A Journal of Economy and Society, 40(2), 293–316.

Huszár, S., Prónay, S., Buzás, N. (2016). Examining the differences between the motivations of traditional and entrepreneurial scientists. Journal of Innovation and Entrepreneurship, 5(1), 25.

Huyghe, A., Knockaert, M. (2015). The influence of organizational culture and climate on entrepreneurial intentions among research scientists. The Journal of Technology Transfer, 40(1), 138-160.

Huyghe, A., Knockaert, M., Obschonka, M. (2016a). Unraveling the "passion orchestra" in academia. Journal of Business Venturing, 31(3), 344-364.

Huyghe, A., Knockaert, M., Piva, E., Wright, M. (2016b). Are researchers deliberately bypassing the technology transfer office? An analysis of TTO awareness. Small Business Economics, 47(3), 589-607.

Huyghe, A., Knockaert, M., Wright, M., Piva, E. (2014). Technology transfer offices as boundary spanners in the pre-spin-off process: The case of a hybrid model. Small Business Economics 43(2), 289–307.

Huyghe, A., Souitaris, V., Knockaert, M. (2015). Academic Entrepreneurship: a Multilevel Study of Individual, Subunit and Organization Effects. Academy of Management Proceedings, 2015(1), 456-472.

Huynh, T. (2016). Early-stage fundraising of university spin-offs: a study through demand-site perspectives. Venture Capital, 18(4), 345-367.

Huynh, T., Patton, D., Arias-Aranda, D., Molina-Fernández, L. M. (2017). University spin-off's performance: capabilities and networks of founding teams at creation phase. Journal of Business Research, 78, 10-22.

Iorio, R., Labory, S., Rentocchini, F. (2017). The importance of pro-social behaviour for the breadth and depth of knowledge transfer activities: an analysis of Italian academic scientists. Research Policy, 46(2), 497-509.

Ireland, R. D., Hitt, M.A., Sirmon, D. G. (2003). A model of strategic entrepreneurship: the construct and its dimensions. Journal of Management 29(6), 963–989.

Jain, S., George, G., Maltarich, M. (2009). Academics or entrepreneurs? Investigating role identity modification of university scientists involved in commercialization activity. Research Policy, 38(6), 922-935.

Janis, I. L., Mann, L. (1977). Decision making: A psychological analysis of conflict, choice, and commitment. New York, NY, US: Free Press.

Jansen, J. J. P., Van Den Bosch, F. A. J., Volberda, H. W. (2005). Managing Potential and Realized Absorptive Capacity: How do Organizational Antecedents Matter? Academy of Management Journal, 48(6), 999–1015.

Jansen, J. J. P., Van Den Bosch, F. A. J., Volberda, H. W. (2006). Exploratory innovation, exploitative innovation, and performance: effects of organizational antecedents and environmental moderators. Management Science, 52(11), 1661 – 1674.

Johnson, M., Monsen, E. W., MacKenzie, N. G. (2017). Follow the Leader or the Pack? Regulatory Focus and Academic Entrepreneurial Intentions: regulatory focus theory and academic entrepreneurship. Journal of Product Innovation Management, 34(2), 181-200.

Jung, H., Kim, B.-K. (2017). Determinant factors of university spin-off: the case of Korea. The Journal of Technology Transfer, 43(6), 1631-1646.

Karlsson, T., Wigren, C. (2012). Start-ups among university employees: the influence of legitimacy, human capital and social capital. The Journal of Technology Transfer, 37(3), 297-312.

Kenney, M., Patton, D. (2009). Reconsidering the Bayh–Dole act and the current university invention ownership model. Research Policy, 38 (2009), 1407-1422.

Kenney, M., Patton, D. (2011). Does inventor ownership encourage university research-derived entrepreneurship? A six university comparison. Research Policy, 40(8), 1100-1112.

Kervyn, N., Fiske, S. T., Malone, C. (2012). Brands as intentional agents framework: how perceived intentions and ability can map brand perception. Journal of Consumer Psychology, 22(2), 166 – 176.

Kilger, C., Bartenbach, K. (2002). New rules for German professors. Science 298(8), 1173–1175.

Kirby, D. A., Guerrero, M., Urbano, D. (2011). Making universities more entrepreneurial: development of a model. Canadian Journal of Administrative Sciences 28(3), 302–316.

Kirkwood, J. (2009). Motivational factors in a push-pull theory of entrepreneurship. Gender in Management: An International Journal, 24(5), 346–364.

Klein, J., Dawar, N. (2004). Corporate social responsibility and consumers' attributions and brand evaluations in a product – harm crisis. International Journal of Research in Marketing, 21(3), 203 – 217.

Knockaert, M., Clarysse, B., Wright, M. (2010). The extent and nature of heterogeneity of venture capital selection behaviour in new technology-based firms. RD Management, 40(4), 357-371.

Knockaert, M., Foo, M. D., Erikson, T., Cools, E. (2015). Growth intentions among research scientists: a cognitive style perspective. Technovation, 38, 64-74.

Knockaert, M., Ucbasaran, D., Wright, M., Clarysse, B. (2011). The Relationship between Knowledge Transfer, Top Management Team Composition, and Performance: the Case of Science-Based Entrepreneurial Firms. Entrepreneurship Theory & Practice, 35(4), 777-803.

Köhn, A. (2018). The determinants of startup valuation in the venture capital context: a systematic review and avenues for future research. Management Review Quarterly, 68(1), 3–36.

Kolb, C., Wagner, M. (2015). Crowding in or crowding out: the link between academic entrepreneurship and entrepreneurial traits. The Journal of Technology Transfer, 40(3), 387-408.

Kollmann, T., Stöckmann, C., Kensbock, J. M. (2017). Fear of failure as a mediator of the relationship between obstacles and nascent entrepreneurial activity—an experimental approach. Journal of Business Venturing, 32(3), 280–301.

Kolympiris, C., Klein, P. G. (2017). The effects of academic incubators on university innovation. Strategic Entrepreneurship Journal 11(2), 145-170.

Korosteleva, J., Belitski, M. (2017). Entrepreneurial dynamics and higher education institutions in the post-communist world. Regional Studies 51(3), 439-453.

Kostopoulos, K., Papalexandris, A., Papachroni, M., Ioannou, G. (2011). Absorptive capacity, innovation, and financial performance. Journal of Business Research, 64(12), 1335–1343.

Krabel, S., Mueller, P. (2009). What drives scientists to start their own company? An empirical investigation of Max Planck Society scientists. Research Policy, 38(6), 947-956.

Kroll, H., Liefner, I. (2008). Spin-off enterprises as a means of technology commercialisation in a transforming economy—Evidence from three universities in China. Technovation, 28(5), 298-313.

Kruss, G., Visser, M. (2017). Putting university–industry interaction into perspective: a differentiated view from inside South African universities. The Journal of Technology Transfer, 42(4), 884–908.

Kuratko, D. F., Hornsby, J. S., Covin, J. G. (2014). Diagnosing a firm's internal environment for corporate entrepreneurship. Business Horizons 57(1), 37–47.

Lacetera, N. (2009). Academic entrepreneurship. Managerial and Decision Economics, 30(7), 443-464.

Lam, A. (2011). What motivates academic scientists to engage in research commercialization: 'Gold', 'ribbon' or 'puzzle'? Research Policy, 40(10), 1354–1368.

Landry, R., Amara, N., Rherrad, I. (2006). Why are some university researchers more likely to create spin-offs than others? Evidence from Canadian universities. Research Policy, 35(10), 1599-1615.

Landry, R., Amara, N., Saïhi, M. (2007). Patenting and spin-off creation by Canadian researchers in engineering and life sciences. The Journal of Technology Transfer, 32(3), 217-249.

Lane, P. J., Koka, B. R., Pathak, S. (2006). The Reification of Absorptive Capacity: A Critical Review and Rejuvenation of the Construct. The Academy of Management Review, 31(4), 833–863. JSTOR.

Lane, P. J., Lubatkin, M. (1998). Relative absorptive capacity and interorganizational learning. Strategic Management Journal, 19(5), 461–477.

Leal-Rodríguez, A. L., Roldán, J. L., Ariza-Montes, J. A., Leal-Millán, A. (2014). From potential absorptive capacity to innovation outcomes in project teams: The conditional mediating role of the realized absorptive capacity in a relational learning context. International Journal of Project Management, 32(6), 894–907.

Lee, E. M., Park, S.-Y., Lee, H. J. (2013): Employee perception of CSR activities: its antecedents and consequences. Journal of Business Research, 66(10), S. 1716-1724.

Lee, L., Wong, P. K., Foo, M. D., Leung, A. (2011). Entrepreneurial intentions: The influence of organizational and individual factors. Journal of Business Venturing, 26(1), 124-136.

Lee, Y., Shin, J., Park, Y. (2012). The changing pattern of SME's innovativeness through business model globalization. Technological Forecasting and Social Change, 79(5), 832-842.

Lee, Y. S. (1996).Technology transfer and the research university: A search for the boundaries of university-industry collaboration. Research Policy 25(6), 843–863.

Lesch, W. C., Peterson, L. H. (1989). The Management of Discovery: exploiting the fruits of university research. Journal of Professional Services Marketing, 5(1), 71-86.

Leuthesser, L. Kohli, C. (1997). Corporate identity: The role of mission statements. Business Horizons, 40(3), 59–66.

Lévesque, M., Minniti, M. (2006). The effect of aging on entrepreneurial behavior. Journal of Business Venturing, 21(2), 177–194.

Liao, J., Welsch, H., Stoica, M. (2003). Organizational Absorptive Capacity and Responsiveness: An Empirical Investigation of Growth–Oriented SMEs. Entrepreneurship Theory and Practice, 28(1), 63–86.

Libaers, D., Wang, T. (2012). Foreign-born academic scientists: entrepreneurial academics or academic entrepreneurs? RD Management, 42(3), 254–272.

Liñán, F. (2008). Skill and value perceptions: how do they affect entrepreneurial intentions? International Entrepreneurship and Management Journal, 4(3), 257-272.

Link, A. N., Paton, D., Siegel, D. S. (2005). An econometric analysis of trends in research joint venture activity. Managerial and Decision Economics, 26(2), 149-158.

Link, A. N., Rees, J. (1990). Firm size, university based research, and the returns to RD. Small Business Economics, 2(1), 25–31.

Link, A. N., Scott, J. T. (2005). Universities as partners in US research joint ventures. Research Policy 34(3), 385-393.

Link, A. N., Scott, J. T. (2019). The economic benefits of technology transfer from US federal laboratories. The Journal of Technology Transfer, (forthcoming).

Link, A. N., Siegel, D. S. (2005). University-based technology initiatives: quantitative and qualitative evidence. Research Policy 34(3), 253–257.

Link, A. N., Siegel, D. S., Bozeman, B. (2007). An empirical analysis of the propensity of academics to engage in informal university technology transfer. Industrial and Corporate Change 16 (4), 641–655.

Link, A. N., Siegel, D. S., Wright, M. (2015). The Chicago handbook of university technology transfer and academic entrepreneurship. University of Chicago Press.

Lisboa, A., Skarmeas, D., Lages, C. (2011). Innovative capabilities: their drivers and effects on current and future performance. Journal of Business Research, 64(11), 1157-1161.

Litan, R. E., Mitchell, L. (2010). Breakthrough ideas for 2010. A faster path from lab to market. Harvard Business Review, 88(1-2), 52.

Litan, R. E., Reedy, E. J., Mitchell, L. (2007). Commercializing university innovations: A better way. AEI-Brookings Joint Center for Regulatory Studies.

Lockett, A., Wright, M. (2005). Resources, capabilities, risk capital and the creation of university spin-out Companies. Research Policy, 34(7), 1043-1057.

Lockett, A., Wright, M., Franklin, S. (2003). Technology transfer and universities' spinout strategies. Small Business Economics, 20(2), 185-200.

Luce, M. F. (1998). Choosing to Avoid: Coping with Negatively Emotion-Laden Consumer Decisions. Journal of Consumer Research, 24(4), 409–433.

Luce, M. F., Payne, J. W., Bettman, J. R. (2000). Coping with Unfavorable Attribute Values in Choice. Organizational Behavior and Human Decision Processes, 81(2), 274–299.

Lukeš, M., Longo, M. C., Zouhar, J. (2019). Do business incubators really enhance entrepreneurial growth? Evidence from a large sample of innovative Italian start-ups. Technovation, forthcoming.

Luo, X., Du, S. (2015): Exploring the relationship between corporate social responsibility and firm innovation, in: Marketing Letters, 26(4), 703-714.

Macko, A., Tyszka, T. (2009). Entrepreneurship and Risk Taking. Applied Psychology, 58(3), 469–487.

Mael, F. A., Ashforth, B. E. (1995): Loyal from day one: biodata, organizational identification, and turnover among newcomers. Personnel Psychology, 48(2), 309-333.

Maes, J., Leroy, H., Sels, L. (2014). Gender differences in entrepreneurial intentions: A TPB multi-group analysis at factor and indicator level. European Management Journal, 32(5), 784-794.

Mann, L., Burnett, P., Radford, M., Ford, S. (1998). The Melbourne decision making questionnaire: an instrument for measuring patterns for coping with decisional conflict. Journal of Behavioral Decision Making, 10(1), 1–19.

Mansfield, E. (1991). Academic research and industrial innovation. Research Policy, 20(1), 1–12.

Mansfield, E., Lee, J. Y. (1996). The modern university: Contributor to industrial innovation and recipient of industrial RD support. Research Policy 25(7), 1047–1058.

Marion, T. J., Dunlap, D. R., Friar, J. H. (2012). The university entrepreneur: a census and survey of attributes and outcomes. RD Management, 42(5), 401–419.

Markman, G., Gianiodis, P., Phan, P., Balkin, D. (2005). Innovation speed: Transferring university technology to market. Research Policy 34(7), 1058-1075.

Markman, G. D., Gianiodis, P. T., Phan, P. H. (2009). Supply-side innovation and technology commercialization. Journal of Management Studies 46(4), 625-649.

Mathieu, C., St-Jean, É. (2013). Entrepreneurial personality: the role of narcissism. Personality and Individual Differences, 55(5), 527-531.

Matusik, S. F., Heeley, M. B. (2005). Absorptive capacity in the software industry: identifying dimensions that affect knowledge and knowledge creation activities. Journal of Management, 31(4), 549-572.

McAdam, M., Miller, K., McAdam, R. (2016). Situated regional university incubation: A multi-level stakeholder perspective. Technovation, 50–51, 69–78.

McClelland, D. C., Atkinson, J. W., Clark, R. A., Lowell, E. L. (1953). The achievement motive. New York: Appleton-Century-Crofts.

McEvily, B., Zaheer, A. (1999). Bridging ties: A source of firm heterogeneity in competitive capabilities. Strategic Management Journal, 20(12), 1133–1156.

McShane, L., Cunningham, P. (2012). To thine own self be true? employees' judgments of the authenticity of their organization's corporate social responsibility program. Journal of Business Ethics, 108(1), 81-100.

Meek, W. R., Wood, M. S. (2016). Navigating a Sea of Change: identity Misalignment and Adaptation in Academic Entrepreneurship. Entrepreneurship Theory and Practice, 40(5), 1093-1120.

Meoli, M., Paleari, S., Vismara, S. (2017). The governance of universities and the establishment of academic spin-offs. Small Business Economics, 52(2), 485-504.

Meoli, M., Vismara, S. (2016). University support and the creation of technology and non-technology academic spin-offs. Small Business Economics, 47(2), 345-362.

Meyer, J. W., Rowan, B. (1977). Institutionalized Organizations: Formal Structure as Myth and Ceremony. American Journal of Sociology, 83(2), 340–363.

Meyer, M. (2003). Academic patents as an indicator of useful research? A new approach to measure academic inventiveness. Research Evaluation 12(1), 17-27.

Mian, S. (1996). Assessing value-added contributions of university technology business incubators to tenant firms. Research Policy 25 (3), 325-335

Miller, K., McAdam, M., McAdam, R. (2014). The changing university business model: a stakeholder perspective. RD Management 44(3), 265-287.

Milliken, F. J. (1990). Perceiving and interpreting environmental change: an examination of college administrators' interpretation of changing demographics. Academy of Management Journal, 33(1), 42–63.

Min, J. W., Vonortas, N. S., Kim, Y. (2019). Commercialization of transferred public technologies. Technological Forecasting and Social Change 138(3), 10-20.

Minbaeva, D., Pedersen, T., Björkman, I., Fey, C. F., Park, H. J. (2003). MNC knowledge transfer, subsidiary absorptive capacity, and HRM. Journal of International Business Studies, 34(6), 586–599.

Miranda, F. J., Chamorro, A., Rubio, S. (2017a). Re-thinking university spin-off: a critical literature review and a research agenda. The Journal of Technology Transfer, 43(4), 1007–1038.

Miranda, F. J., Chamorro-Mera, A., Rubio, S. (2017b). Academic entrepreneurship in Spanish universities: an analysis of the determinants of entrepreneurial intention. European Research on Management and Business Economics, 23(2), 113-122.

Moog, P., Werner, A., Houweling, S., Backes-Gellner, U. (2015). The impact of skills, working time allocation and peer effects on the entrepreneurial intentions of scientists. The Journal of Technology Transfer, 40(3), 493-511.

Morales-Gualdrón, S. T., Gutiérrez-Gracia, A., Roig Dobón, S. (2009). The entrepreneurial motivation in academia: a multidimensional construct. International Entrepreneurship and Management Journal, 5(3), 301-317.

Morsing, M., Perrini, F. (2009). CSR in SMEs: do SMEs matter for the CSR agenda? Business Ethics: A European Review, 18(1), 1-6.

Mosey, S., Wright, M. (2007). From human capital to social capital: A longitudinal study of technology-based academic entrepreneurs. Entrepreneurship theory and practice, 31(6), 909–935.

Mueller, C., Westhead, P., Wright, M. (2012). Formal venture capital acquisition: can entrepreneurs compensate for the spatial proximity benefits of South East England and 'star'golden-triangle universities? Environment and Planning A, 44(2), 281–296.

Mueller, K. (2010). Academic spin-off's transfer speed – Anayzing the time from leaving university to venture. Research Policy, 39(2), 189–199.

Mueller-Wieland, R., Muschner, A., Schraudner, M. (2019). Academic entrepreneurship: Phase-specific constraints and needs. Journal of Enterprising Communities: People and Places in the Global Economy, 13(3), 353–371.

Munari, F., Sobrero, M., Toschi, L. (2018). The university as a venture capitalist? Gap funding instruments for technology transfer. Technological Forecasting and Social Change, 127, 70-84.

Muscio, A. (2010). What drives the university use of technology transfer offices? Evidence from Italy. The Journal of Technology Transfer 35(2), 181–202.

Muscio, A., Quaglione, D., Ramaciotti, L. (2016). The effects of university rules on spinoff creation: the case of academia in Italy. Research Policy, 45(7), 1386-1396.

Mustar, P., Renault, M., Colombo, M. G., Piva, E., Fontes, M., Lockett, A., Wright, M., Clarysse, B., Moray, N. (2006). Conceptualizing the heterogeneity of research-based spin-offs: A multidimensional taxonomy. Research Policy 35(2), 289-308.

Nag, R., Corley, K. G., Gioia, D. A. (2007). The intersection of organizational identity, knowledge, and practice: attempting strategic change via knowledge grafting. Academy of Management Journal, 50(4), 821–847.

Nelson, A. J. (2014). From the ivory tower to the startup garage: organizational context and commercialization processes. Research Policy, 43(7), 1144-1156.

Neves, M., Franco, M. (2016). Academic spin-off creation: barriers and how to overcome them. RD Management, 48(5), 505-518.

Newman, A., Miao, Q., Hofman, P. S., Zhu, C. J. (2016). The impact of socially responsible human resource management on employees' organizational citizenship behaviour: the mediating role of organizational identification. The International Journal of Human Resource Management, 27(4), 440-455.

Nicolaou, N., Birley, S. (2003a). Academic networks in a trichotomous categorisation of university spinouts. Journal of Business Venturing, 18(3), 333-359

Nicolaou, N., Birley, S. (2003b). Social Networks in Organizational Emergence: the University Spinout Phenomenon. Management Science, 49(12), 1702-1725.

Nicolaou, N., Souitaris, V. (2016). Can Perceived Support for Entrepreneurship Keep Great Faculty in the Face of Spinouts? Journal of Product Innovation Management, 33(3), 298-319.

Nielsen, K. (2015). Human capital and new venture performance: the industry choice and performance of academic entrepreneurs. The Journal of Technology Transfer, 40(3), 453-474.

Nolzen, N. (2018). The concept of psychological capital: a comprehensive review. Management Review Quarterly, 68(3), 237–277.

Obschonka, M., Goethner, M., Silbereisen, R. K., Cantner, U. (2012). Social identity and the transition to entrepreneurship: the role of group identification with workplace peers. Journal of Vocational Behavior, 80(1), 137-147.

Obschonka, M., Silbereisen, R., Cantner, U., Goethner, M. (2015). Entrepreneurial Self-Identity: predictors and Effects within the Theory of Planned Behavior Framework. Journal of Business Psychology, 30(4), 773-794.

Obschonka, M., Silbereisen, R. K., Schmitt-Rodermund, E. (2010). Entrepreneurial intention as developmental outcome. Journal of Vocational Behavior, 77(1), 63-72.

O'Gorman, C., Byrne, O., Pandya, D. (2008). How scientists commercialise new knowledge via entrepreneurship. The Journal of Technology Transfer, 33(1), 23–43.

O'Kane, C., Mangematin, V., Geoghegan, W., Fitzgerald, C. (2015). University technology transfer offices: The search for identity to build legitimacy. Research Policy 44(2), 421-437.

O'Neil, E. B., Newsome, R. N., Li, I. H. N., Thavabalasingam, S., Ito, R., Lee, A. C. H. (2015). Examining the Role of the Human Hippocampus in Approach-Avoidance Decision Making Using a Novel Conflict Paradigm and Multivariate Functional Magnetic Resonance Imaging. Journal of Neuroscience, 35(45), 15039–15049.

Ortín-Ángel, P., Vendrell-Herrero, F. (2010). Why do university spin-offs attract more venture capitalists? Venture Capital, 12(4), 285-306.

O'Shea, R., Allen, T., O'Gorman, C., Roche, F. (2004). Universities and Technology Transfer: a Review of Academic Entrepreneurship Literature. Irish Journal of Management, 25(2), 11-29.

O'Shea, R. P., Allen, T. J., Chevalier, A., Roche, F. (2005). Entrepreneurial orientation, technology transfer and spinoff performance of U.S. universities. Research Policy, 34(7), 994-1009.

O'Shea, R. P., Allen, T. J., Morse, K. P., O'Gorman, C., Roche, F. (2007). Delineating the anatomy of an entrepreneurial university: the Massachusetts Institute of Technology experience. RD Management, 37(1), 1-16.

O'Shea, R. P., Chugh, H., Allen, T. J. (2008). Determinants and consequences of university spinoff activity: a conceptual framework. The Journal of Technology Transfer, 33(6), 653–666.

Parker, S. C., Belghitar, Y. (2006). What Happens to Nascent Entrepreneurs? An Econometric Analysis of the PSED. Small Business Economics, 27(1), 81–101.

Patel, P. C., Terjesen, S., Li, D. (2012). Enhancing effects of manufacturing flexibility through operational absorptive capacity and operational ambidexterity. Journal of Operations Management, 30(3), 201–220.

Patzelt, H., Shepherd, D. A. (2009). Strategic Entrepreneurship at Universities: academic Entrepreneurs' Assessment of Policy Programs. Entrepreneurship Theory and Practice, 33(1), 319–340.

Perkmann, M., King, Z., Pavelin, S. (2011). Engaging excellence? Effects of faculty quality on university engagement with industry. Research Policy, 40(4), 539-552.

Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Brostrom, A., D'Este, P., Krabel, S. (2013). Academic engagement and commercialisation: A review of the literature on university– industry relations. Research Policy 42(2), 423–442.

Phan, P. H., Siegel, D. S. (2006). The effectiveness of university technology transfer. Foundations and Trends in Entrepreneurship 2(2), 77-144.

Piperopoulos, P., Dimov, D. (2015). Burst Bubbles or Build Steam? Entrepreneurship Education, Entrepreneurial Self-Efficacy, and Entrepreneurial Intentions. Journal of Small Business Management, 53(4), 970-985.

Porter, M. E., Kramer, M. R. (2011). Creating shared value. Harvard Business Review, 89(1/2), 62 – 77.

Powers, J. B., McDougall, P. P. (2005). University start-up formation and technology licensing with firms that go public: a resource-based view of academic entrepreneurship. Journal of Business Venturing, 20(3), 291-311.

Prencipe, A. (2016). Board Composition and Innovation in University Spin-offs. Evidence from the Italian Context. Journal of Technology Management & Innovation, 11(3), 33-39.

Prodan, I., Drnovsek, M. (2010) Conceptualizing academic-entrepreneurial intentions: an empirical test. Technovation, 30(5–6), 332–347.

Ramaciotti, L., Rizzo, U. (2015). The determinants of academic spin-off creation by Italian universities. RD Management, 45(5), 501-514.

Ramos-Vielba, I., Sánchez-Barrioluengo, M., Woolley, R. (2016). Scientific research groups' cooperation with firms and government agencies: Motivations and barriers. The Journal of Technology Transfer, 41(3), 558–585.

Rao, B., Mulloth, B. (2017). The Role of Universities in Encouraging Growth of Technology-Based New Ventures. International Journal of Innovation and Technology Management, 14(4), 1750014.

Raposo, M. L., Ferreira, J. J., Paço, A. M., Rodrigues, R. J. (2008). Propensity to firm creation: empirical research using structural equations. International Entrepreneurship and Management Journal, 4(4), 485-504.

Rasmussen, E. (2008). Government instruments to support the commercialization of university research: lessons from Canada. Technovation, 28(8), 506-517.

Rasmussen, E. (2011). Understanding academic entrepreneurship: exploring the emergence of university spin-off ventures using process theories. International Small Business Journal, 29(5), 448-471.

Rasmussen, E., Borch, O. J. (2010). University capabilities in facilitating entrepreneurship: a longitudinal study of spin-off ventures at mid-range universities. Research Policy, 39(5), 602-612.

Rasmussen, E., Gulbrandsen, M. (2012). Government Support Programmes to Promote Academic Entrepreneurship: a Principal–Agent Perspective. European Planning Studies, 20(4), 527-546.

Rasmussen, E., Mosey, S., Wright, M. (2011). The Evolution of Entrepreneurial Competencies: A Longitudinal Study of University Spin-Off Venture Emergence: The Evolution of Entrepreneurial Competencies. Journal of Management Studies, 48(6), 1314–1345.

Rasmussen, E., Mosey, S., Wright, M. (2014). The influence of university departments on the evolution of entrepreneurial competencies in spin-off ventures. Research Policy, 43(1), 92-106.

Rasmussen, E., Mosey, S., Wright, M. (2015). The transformation of network ties to develop entrepreneurial competencies for university spin-offs. Entrepreneurship Regional Development, 27(7/8), 430–457.

Rasmussen, E., Sørheim, R. (2012). How governments seek to bridge the financing gap for university spin-offs: proof-of-concept, pre-seed, and seed funding. Technology Analysis Strategic Management, 24(7), 663-678.

Ravasi, D., Schultz, M. (2006). Responding to organizational identity threats: Exploring the role of organizational culture. Academy of Management Journal, 49(3), 433–458.

Redelmeier, D. A., Shafir, E. (1995). Medical decision making in situations that offer multiple alternatives. JAMA: Journal of the American Medical Association, 273(4), 302–305.

Riviezzo, A., Santos, S. C., Liñán, F., Napolitano, M. R., Fusco, F. (2018). European universities seeking entrepreneurial paths: the moderating effect of contextual variables on the entrepreneurial orientation-performance relationship. Technological Forecasting and Social Change, 141, 232-248.

Rizzo, U. (2014). Why do scientists create academic spin-offs? The influence of the context. The Journal of Technology Transfer, 40(2), 198–226.

Roberts, E. B. (1991). The technological base of the new enterprise. Research Policy, 20(4), 283-298.

Rodríguez-Gulías, M., Fernández-López, S., Rodeiro-Pazos, D. (2016). Growth determinants in entrepreneurship: a longitudinal study of Spanish technology-based university spin-offs. Journal of International Entrepreneurship, 14(3), 323-344.

Rodríguez-Gulías, M. J., Rodeiro-Pazos, D., Fernández-López, S. (2017). The effect of university and regional knowledge spillovers on firms' performance: an analysis of the Spanish USOs. International Entrepreneurship and Management Journal, 13(1), 191-209.

Rodríguez-Gulías, M. J., Rodeiro-Pazos, D., Fernández-López, S., Corsi, C., Prencipe, A. (2018). The role of venture capitalist to enhance the growth of Spanish and Italian university spin-offs. International Entrepreneurship and Management Journal, 14(4), 1111-1130.

Roininen, S., Ylinenpää, H. (2009). Schumpeterian versus Kirznerian entrepreneurship: a comparison of academic and non-academic new venturing. Journal of Small Business and Enterprise Development, 16(3), 504-520.

Romer, P. M. (1986). Increasing returns and long-run growth. Journal of Political Economy 94(5), 1002–1037.

Rothaermel, F. T., Agung, S. D., Jiang, L. (2007). University entrepreneurship: a taxonomy of the literature. Industrial and Corporate Change, 16(4), 691-791.

Rothaermel, F. T., Thursby, M. (2005). University-incubator firm knowledge flows: assessing their impact on incubator firm performance. Research Policy 34(3), 305–320.

Rugman, A. M., Verbeke, A. (2001). Subsidiary-specific advantages in multinational enterprises. Strategic Management Journal, 22(3), 237-250.

Rupp, D. E., Shao, R., Thornton, M. A., Skarlicki, D. P. (2013). Applicants' and employees' reactions to corporate social responsibility: The moderating effects of first-party justice perceptions and moral identity. Personnel Psychology, 66(4), 895-933.

Salter, A. J., Martin, B. R. (2001). The economic benefits of publicly funded basic research: A critical review. Research Policy, 30(3), 509–532.

Samila, S., Sorenson, O. (2010). Venture capital as a catalyst to commercialization. Research Policy, 39(10), 1348–1360.

Santini, C. (2017). Ecopreneurship and Ecopreneurs: Limits, Trends and Characteristics. Sustainability, 9(4), 492.

Sauermann, H., Stephan, P. (2013). Conflicting Logics? A Multidimensional View of Industrial and Academic Science. Organization Science, 24(3), 889–909.

Schmitz, A., Urbano, D., Dandolini, G. A., de Souza, J. A., Guerrero, M. (2017). Innovation and entrepreneurship in the academic setting: a systematic literature review. International Entrepreneurship and Management Journal 13(2), 369-395.

Scholten, V., Omta, O., Kemp, R., Elfring, T. (2015). Bridging ties and the role of research and start-up experience on the early growth of Dutch academic spin-offs. Technovation, 45-46, 40-51.

Scholz, C. (1987). Corporate culture and strategy: The problem of strategic fit. Long Range Planning, 20(4), 78-87.

Semadeni, M., Cannella, A. A. (2011). Examining the performance effects of post spin-off links to parent firms: should the apron strings be cut? Strategic Management Journal, 32(10), 1083-1098.

Sen, S., Bhattacharya, C. B., Korschun, D. (2006). The role of corporate social responsibility in strengthening multiple stakeholder relationships: a field experiment. Journal of the Academy of Marketing Science, 34(2), 158 – 166.

Shah, S. K., Pahnke, E. C. (2014). Parting the ivory curtain: understanding how universities support a diverse set of startups. The Journal of Technology Transfer, 39(5), 780-792.

Shane, S. (2004). Academic entrepreneurship: university spinoffs and wealth creation. Cheltenham, UK: E. Elgar.

Shane, S. (2004a). Academic entrepreneurship: University spinoffs and wealth creation. Northampton: Edward Elgar Publishing.

Shane, S. (2004b). Encouraging university entrepreneurship? The effect of the Bayh-Dole Act on university patenting in the United States. Journal of Business Venturing, 19(1), 127–151.

Shane, S., Delmar, F. (2004). Planning for the market: business planning before marketing and the continuation of organizing efforts. Journal of Business Venturing 19(6), 767–785.

Shane, S., Locke, E. A., Collins, C. J. (2012). Entrepreneurial motivation. Human Resource Management Review, 13(2), 257-279.

Shane, S. A. (2000). Prior knowledge and the discovery of entrepreneurial opportunities. Organization Science 11 (4), 448–469.

Sheeran, P. (2002). Intention—Behavior Relations: A Conceptual and Empirical Review. European Review of Social Psychology, 12(1), 1–36.

Shinnar, R. S., Hsu, D. K., Powell, B. C. (2014). Self-efficacy, entrepreneurial intentions, and gender: assessing the impact of entrepreneurship education longitudinally. International Journal of Management Education, 12(3), 561-570.

Shu, C., Liu, C., Gao, S., Shanley, M. (2014). The knowledge spillover theory of entrepreneurship in alliances. Entrepreneurship Theory and Practice, 38(4), 913–940.

Siegel, D., Wessner, C. (2012). Universities and the success of entrepreneurial ventures: Evidence from the small business innovation research program. Journal of Technology Transfer 37(4), 404–415.

Siegel, D. S., Waldman, D. (2019). Organizational and Psychological Issues in the Commercialization of Research at Universities and Federal Labs. les Nouvelles-Journal of the Licensing Executives Society, 54(2).

Siegel, D. S., Waldman, D. A., Atwater, L., Link, A. N. (2004). Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: qualitative evidence from the commercialization of university technologies. Journal of Engineering and Technology Management, 21 (1–2), 115-142.

Siegel, D. S., Waldman, D. A., Atwater, L. E., Link, A. N. (2003). Commercial knowledge transfers from universities to firms: Improving the effectiveness of university–industry collaboration. The Journal of High Technology Management Research, 14(1), 111–133.

Siegel, D. S., Wright, M. (2015). Academic entrepreneurship: time for a rethink? British Journal of Management 26(4), 582-595.

Siegel, D. S., Wright, M., Lockett, A. (2007). The rise of the entrepreneurial activities at universities: Organizational and societal implications. Industrial And Corporate Change 16(4), 489-504.

Simon, H. (1996). You don't have to be German to be a "hidden champion". Business Strategy Review, 7(2), 1-13.

Singh, R. K., Garg, S. K., Deshmukh, S. G. (2008). Strategy development by SMEs for competitiveness: a review. benchmarking: an international journal, 15(5), 525-547.

Singh Sandhu, M., Fahmi Sidique, S., Riaz, S. (2011). Entrepreneurship barriers and entrepreneurial inclination among Malaysian postgraduate students. International Journal of Entrepreneurial Behavior & Research, 17(4), 428-449.

Sitkin, S. B., Weingart, L. R. (1995). Determinants of Risky Decision-Making Behavior: A Test of the Mediating Role of Risk Perceptions and Propensity. The Academy of Management Journal, 38(6), 1573–1592.

Skudiene, V., Auruskevience, V. (2012): The contribution of corporate social responsibility to internal employee motivation, in: Baltic Journal of Management, 7(1), S.49-67.

Slater, S. F., Mohr, J. J. (2006). Successful development and commercialization of technological innovation: Insights based on strategy type. Journal of Product Innovation Management, 23(1), 26–33.

Slavtchev, V., Göktepe-Hultén, D. (2016). Support for public research spin-offs by the parent organizations and the speed of commercialization. The Journal of Technology Transfer, 41(6), 1507-1525.

Smidts, A., Pruyn, A. T. H., Van Riel, C. B. (2001). The impact of employee communication and perceived external prestige on organizational identification. Academy of Management journal, 44(5), 1051-1062.

Smilor, R., Gibson, D., Dietrich, G. (1990). University spin-out companies: technology start-ups from UT-Austin. Journal of Business Venturing, 5(1), 63-76.

Smith, K. G., Collins, C. J., Clark, K. D. (2005): Existing knowledge, knowledge creation capability, and the rate of new product introduction in high-technology firms, in: Academy of Management Journal, 48(2), 346-357.

Soetanto, D., Geenhuizen, M. v. (2015). Getting the right balance: university networks' influence on spin-offs' attraction of funding for innovation. Technovation, 36-37, 26-38.

Soetanto, D., Geenhuizen, M. v. (2019). Life after incubation: The impact of entrepreneurial universities on the long-term performance of their spin-offs. Technological Forecasting and Social Change, forthcoming.

Soetanto, D., Jack, S. (2016). The impact of university-based incubation support on the innovation strategy of academic spin-offs. Technovation, 50/51, 25-40.

Soetanto, D. P., Geenhuizen, M.v. (2009). Social Networks and Competitive Growth of University Spin-Off Firms: a Tale of Two Contrasting Cities. Tijdschrift Voor Economische En Sociale Geografie, 100(2), 198–209.

Steffensen, M., Rogers, E. M., Speakman, K. (2000). Spin-offs from research centers at a research university. Journal of Business Venturing, 15(1), 93-111.

Stephan, A. (2014). Are public research spin-offs more innovative? Small Business Economics, 43(2), 353-368.

Sternberg, R. (2014). Success factors of university-spin-offs: regional government support programs versus regional environment. Technovation, 34(3), 137-148.

Stringer, R. (2000). How to manage radical innovation. California management review, 42(4), 70-88.

Stuart, T. E., Ding, W. W. (2006). When Do Scientists Become Entrepreneurs? The Social Structural Antecedents of Commercial Activity in the Academic Life Sciences. American Journal of Sociology, 112(1), 97-144.

Sun, P. Y. T., Anderson, M. H. (2010). An examination of the relationship between absorptive capacity and organizational learning, and a proposed integration. International Journal of Management Reviews, 12(2), 130–150.

Surroca, J., Tribo, J. A., Waddock, S. (2010). Corporate responsibility and financial performance: the role of intangible resources. Strategic Management Journal, 31(5), 463 – 490.

Thomas, A., Passaro, R., Scandurra, G. (2014). The Perception of the Contextual Factors as Predictor of Entrepreneurial Intent: evidences from an Empirical Survey. Journal of Enterprising Culture, 22(4), 375-400.

Thursby, J., Kemp, S. (2002). Growth and productive efficiency of university intellectual property licensing. Research Policy 31(1), 109–124.

Toole, A. A., Czarnitzki, D. (2009). Exploring the Relationship between Scientist Human Capital and Firm Performance: the Case of Biomedical Academic Entrepreneurs in the SBIR Program. Management Science, 55(1), 101–114.

Tranfield, D., Denyer, D., Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. British Journal of Management, 14(3), 207-222.

Trantopoulos, K., von Krogh, G., Wallin, M. W., Woerter, M. (2017): External knowledge and information technology: implications for process innovation performance. MIS Quarterly, 41(1), S. 287-300.

Treibich, T., Konrad, K., Truffer, B. (2013). A dynamic view on interactions between academic spin-offs and their parent organizations. Technovation, 33(12), 450-462.

Tsai, W. (2001). Knowledge transfer in intra-organizational networks: effects of network position and absorptive capacity on business unit innovation and performance. Academy of Management Journal, 44(5) 996-1004

Turker, D. (2009a). Measuring corporate social responsibility: a scale development study. Journal of Business Ethics, 85(4), 411–427.

Turker, D. (2009b). How corporate social responsibility influences organizational commitment. Journal of Business Ethics, 89(2), 189.

Turker, D., Selcuk, S. S. (2009). Which factors affect entrepreneurial intention of university students? Journal of European Industrial Training, 33(2), 142–159.

Tushman, M. L. (1977). Special boundary roles in the innovation process. Administrative science quarterly, 22(4), 587-605.

Tversky, A., Shafir, E. (1992). Choice under Conflict: The Dynamics of Deferred Decision. Psychological Science, 3(6), 358–361.

Ucbasaran, D., Westhead, P., Wright, M. (2008). Opportunity Identification and Pursuit: does an Entrepreneur's Human Capital Matter? Small Business Economics, 30(2), 153-173.

Urban, B., Chantson, J. (2019). Academic entrepreneurship in South Africa: testing for entrepreneurial intentions. The Journal of Technology Transfer, forthcoming.

Urbano, D., Guerrero, M. (2013). Entrepreneurial universities: Socio-economic impacts of academic entrepreneurship in a European region. Economic Development Quarterly 27(1), 40–55.

Uzzi, B., Lancaster, R. (2003). Relational embeddedness and learning: the case of bank loan managers and their clients. Management Science, 49(4), 383-399.

Van Dick, R. (2001). Identification in organizational contexts: linking theory and research from social and organizational psychology. International Journal of Management Reviews, 3(4), 265-283.

Van Gelderen, M., Kautonen, T., Fink, M. (2015). From entrepreneurial intentions to actions: Self-control and action-related doubt, fear, and aversion. Journal of Business Venturing, 30(5), 655–673.

Van Gelderen, M., Thurik, R., Patel, P. (2011). Encountered Problems and Outcome Status in Nascent Entrepreneurship. Journal of Small Business Management, 49(1), 71–91.

Van Looy, B., Landoni, P., Callaert, J., van Pottelsberghe, B., Sapsalis, E., Debackere, K. (2011). Entrepreneurial effectiveness of European universities: an empirical assessment of antecedents and trade-offs. Research Policy, 40(4), 553-564.

Van Riel, C.B.M., Balmer, J.M.T. (1997). Corporate identity: the concept, its measurement and management. European Journal of Marketing, 31(5/6), 340–355.

Veugelers, R. (1997). Internal RD expenditures and external technology sourcing. Research Policy 26(3), 303–315.

Veugelers, R., Cassiman, B. (2005). RD Corporation between firms and universities. some empirical evidence from belgian manufacturing. International Journal of Industrial Organization, 23(5-6), 355-379.

Vincett, P. S. (2010). The economic impacts of academic spin-off companies, and their implications for public policy. Research Policy, 39(6), 736–747.

Visintin, F., Pittino, D. (2014). Founding team composition and early performance of university-based spin-off companies. Technovation, 34(1), 31-43.

Vohora, A., Wright, M., Lockett, A. (2004). Critical junctures in the development of university high-tech spinout companies. Research Policy, 33(1), 147-175.

von Stamm, B. (2004). Collaboration with other firms and customers: Innovation's secret weapon. Strategy & Leadership 32(3), 16–20.

Walter, A., Parboteeah, K. P., Riesenhuber, F., Hoegl, M. (2011). Championship Behaviors and Innovations Success: an Empirical Investigation of University Spin-Offs. Journal of Product Innovation Management, 28(4), 586-598.

Walter, S. G., Block, J. H. (2016). Outcomes of entrepreneurship education: An institutional perspective. Journal of Business Venturing 31(2), 216–233.

Walter, S. G., Parboteeah, K. P., Walter, A. (2013). University Departments and Self-Employment Intentions of Business Students: a Cross-Level Analysis. Entrepreneurship Theory and Practice, 37(2), 175-200.

Weick, K. E. (1995). Sensemaking in organizations. Thousand Oaks, CA: Sage.

Welter, F. (2011). Contextualizing Entrepreneurship – Conceptual Challenges and Ways Forward. Entrepreneurship Theory and Practice, 35(1), 165–184.

Wennberg, K., Wiklund, J., Wright, M. (2011). The effectiveness of university knowledge spillovers: performance differences between university spinoffs and corporate spinoffs. Research Policy, 40(8), 1128-1143.

Werner, A. (2011). Abbruch und Aufschub von Gründungsvorhaben: Eine empirische Analyse mit den Daten des Gründerpa-nels des IfM Bonn, IfM Bonn: IfM-Materialien Nr. 209, Bonn.

West, J., Salter, A., Vanhaverbeke, W., Chesbrough, H. (2014). Open innovation: the next decade. Research Policy 43(5), 805–811.

Whetten, D., Felin, T., King, B.G. (2009). Theory-borrowing in organizational studies: issues and future directions. Journal of Management, 35(3), 537–563.

Whetten, D. A., Mackey, A. (2002). A Social Actor Conception of Organizational Identity and Its Implications for the Study of Organizational Reputation. Business & Society, 41(4), 393–414.

Wilson, F., Kickul, J., Marlino, D. (2007). Gender, Entrepreneurial Self-Efficacy, and Entrepreneurial Career Intentions: Implications for Entrepreneurship Education. Entrepreneurship Theory and Practice, 31(3), 387–406.

Wood, M. S. (2009). Does One Size Fit All? The Multiple Organizational Forms Leading to Successful Academic Entrepreneurship. Entrepreneurship Theory and Practice, 33(4), 929–947.

Wooldridge, J. (2002). Econometric analysis of cross section and panel data. MIT Press.

Wright, M., Clarysse, B., Lockett, A., Binks, M. (2006). Venture capital and university spin-outs. Research Policy 35(4), 481-501.

Wright, M., Clarysse, B., Lockett, A., Knockaert, M. (2008b). Mid-range universities' linkages with industry: Knowledge types and the role of intermediaries. Research policy 37(8), 1205-1223.

Wright, M., Clarysse, B., Mustar, P., Lockett, A. (2008a). Academic entrepreneurship in Europe. UK Edward Elgar, Cheltenham.

Wright, M., Piva, E., Mosey, S., Lockett, A. (2009). Academic entrepreneurship and business schools. The Journal of Technology Transfer, 34(6), 560–587.

Wright, M., Vohora, A., Lockett, A. (2003). The formation of high-tech university spinouts: the role of joint ventures and venture capital investors. The Journal of Technology Transfer 29 (3–4), 287-310.

Zahra, S. A., George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. Academy of management review, 27(2), 185–203.

Zahra, S. A., Van de Velde, E., Larrañeta, B. (2007). Knowledge conversion capability and the performance of corporate and university spin-offs. Industrial & Corporate Change, 16(4), 569–608.

Zapkau, F. B., Schwens, C., Steinmetz, H., Kabst, R. (2015). Disentangling the effect of prior entrepreneurial exposure on entrepreneurial intention. Journal of Business Research, 68(3), 639-653.

Zellweger, T., Eddleston, K., Kellermanns, F. (2010). Exploring the concept of familiness: introducing family firm identity. Journal of Family Business Strategy, 1(1), 54–63.

Zellweger, T., Sieger, P., Halter, F. (2011). Should I stay or should I go? Career choice intentions of students with family business background. Journal of Business Venturing, 26(5), 521–536.

Zellweger, T. M., Nason, R. S., Nordqvist, M., Brush, C. G. (2013). Why do family firms strive for nonfinancial goals? an organizational identity perspective. Entrepreneurship Theory and Practice, 37(2), 229–248.

Zhang, J. (2009). The performance of university spin-offs: an exploratory analysis using venture capital data. The Journal of Technology Transfer, 34(3), 255-285.

Zhou, Y., Xu, G., Su, J., Minshall, T. (2011). Barriers to entrepreneurial growth: an empirical study on university spin-offs in China. Journal of Science and Technology Policy in China, 2(3), 277-294.

Zimmerman, B. J., Bandura, A., Martinez-Pons, M. (1992). Self-Motivation for Academic Attainment: The Role of Self-Efficacy Beliefs and Personal Goal Setting. American Educational Research Journal, 29(3), 663–676.

Zollo, L., Laudano, M. C., Ciappei, C., Zampi, V. (2017). Factors affecting universities' ability to foster students' entrepreneurial behaviour: an empirical investigation. Journal of Management Development, 36(2), 268-285.

Zucker, L. G., Darby, M. R., Armstrong, J. S. (2002). Commercializing knowledge: University science, knowledge capture, and firm performance in biotechnology. Management Science 48(1), 138–153.