

# Determinants of Academic Entrepreneurship

Dissertation

der Wirtschaftswissenschaftlichen Fakultät

der Universität Augsburg

zur Erlangung des akademischen Grades eines Doktors

der Wirtschaftswissenschaften

(Dr. rer. pol.)

vorgelegt von

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Tag der mündlichen Prüfung: 06.06.2016

## Danksagung

Die vorliegende Dissertation habe ich im Rahmen meiner Tätigkeit als wissenschaftliche Mitarbeiterin am Lehrstuhl für Unternehmensgründung und Unternehmensführung und am Servicezentrum Forschung und Technologietransfer der Universität Würzburg, als Doktorandin von Herrn Prof. Dr. Marcus Wagner, Lehrstuhl für Betriebswirtschaftslehre, Innovation und internationales Management der Universität Augsburg angefertigt. An dieser Stelle möchte ich mich bei allen Personen bedanken, die zum Gelingen dieser Dissertation beigetragen haben.

Marcus Wagner möchte ich danken, für seine beständige Unterstützung als Doktorvater meiner Dissertation. Ich danke ihm für die wertvollen Kommentare und Diskussionen zu meiner Arbeit und die Anleitung im wissenschaftlichen Umfeld. Als größtenteils externe Doktorandin ermöglichte es Herr Wagner mir den Austausch am Lehrstuhl und auf internationalen Konferenzen zu nutzen. Ich danke ihm für die angenehme Zusammenarbeit und freue mich auf weitere gemeinsame Projekte!

Susanne Warning möchte ich herzlich danken für die Bereitschaft meine Arbeit als Zweitgutachterin zu unterstützen. Daneben möchte ich mich bei allen bedanken, die mir während gemeinsamer Diskussionen, Seminare und Konferenzen hilfreiche Anregungen gaben, genannt seien hier vor allem Hüseyin Doluca und Erik Lehmann und bei den anonymen Gutachtern für wertvolle Kommentare und Hinweise. Herzlichen Dank auch an alle Teilnehmerinnen und Teilnehmer an den von mir durchgeführten Umfragen und Interviews.

Bei meinen Kolleginnen und Kollegen am Servicezentrum Forschung und Technologietransfer, Rosalinde Baunach, Elke Dobiasch, Angela Eszen, Tamara Fuchs, Alexander Heeg, Olena Schmitt und Ana Vodopivec möchte ich mich für die tolle Zusammenarbeit bedanken. Lukas Worschech möchte ich für seine Unterstützung während meiner

Promotionszeit danken und für die Möglichkeit diese Arbeit mit meiner beruflichen Tätigkeit in Einklang zu bringen. Weiterhin möchte ich mich bei allen Kollegen der Wirtschaftswissenschaftlichen Fakultät bedanken und vor allem bei Mustafa Coban und Sascha Friesike für ihren methodischen Input.

Persönlich bedanken möchte ich mich bei meinen Freunden, neben den oben genannten Kollegen sind dies, Andreas Fuchs, André Jäger, Armin Anzenbacher, Bahtunur Yavuz, Balthasar Höhn, Bettina Müller, Birgit Kirschner, Christine Scheid, Christoph Bühling, David Hirschfeld, Emilie Dusol, Esther Bopp, Florian Pfarr, Hannes Appold, Ines Brantsch, Isabell Dettmer, Jan Waßmann, Katja Zöhdel, Manuel Strohmenger, Marvin Beitzel, Mijde Bulut, Philipp Huber, Robert Lippmann, Sandra Kolb, Sandra Urban, Sebastian Vogt, Simone Fakler, Tanja Lee, Thomas Lücking, Tobias Fries und Wilfried Zidorn. Ganz besonderer Dank gilt Alexander Bär, Alexandra Schindele und Susanne Wachter. Danke für eine unvergessliche gemeinsame Zeit!

Widmen möchte ich diese Dissertation meiner Groß-Familie. Ich danke euch von ganzem Herzen dafür, dass ihr immer an mich glaubt und mich während der Promotionszeit unterstützt habt. Ohne euch wäre dieses Vorhaben nicht gelungen! Danke, dass ihr immer für mich da seid!

## Zusammenfassung (German Summary)

Diese Dissertation beschäftigt sich mit Faktoren, die unternehmerisches Verhalten und Gründungsintentionen von Akademikern beeinflussen. Dabei konzentriert sich diese Arbeit sowohl auf persönliche Eigenschaften von Gründern als auch auf Faktoren, die im Umfeld der individuellen Gründungspersönlichkeiten zu finden sind. Beide Ansätze zeigen einen bedeutenden Einfluss. Das Hauptargument dieser Arbeit besteht darin, dass im Rahmen der Entrepreneurship Forschung auf die Heterogenität von unternehmerischen Persönlichkeiten eingegangen werden muss und verschiedene Untergruppen berücksichtigt werden müssen, um Erkenntnisse über akademische Unternehmensgründungen zu gewinnen. Darüber hinaus ist es wichtig, die Faktoren der Person und des Umfeldes in ihrer gegenseitigen Wechselwirkung zu berücksichtigen. Um entscheidende Varianzen im Umfeld der Gründungspersonen erkennen zu können, erfolgen die Betrachtungen an einer Universität und es kommen sowohl qualitative als auch quantitative Methoden zum Einsatz.

Die Arbeit besteht aus drei Hauptkapiteln, die schwerpunktmäßig einzelne Untergruppen von unternehmerischen Akteuren betrachten. Zuvor werden in der Einleitung die Motivation der Arbeit und die methodische Vorgehensweise betrachtet. In Kapitel 2 werden Unternehmensgründungen aus dem Umfeld der Universität mit Unternehmensgründungen von Akademikern verglichen, die während der Gründung nicht mehr im universitären Umfeld eingebunden sind. Als Proxy für die universitätsnahe Ausgründung wird daher der Beschäftigungsstatus des Individuums direkt vor oder während des Zeitpunkts der Gründung genutzt. Ziel ist die Erkenntnis, ob diese zwei Typen von Unternehmenspersönlichkeiten sich bezüglich ihrer Ausprägungen im bekannten Fünf-Faktoren-Modell unterscheiden. Diese sind Verträglichkeit, Gewissenhaftigkeit, Extroversion, Emotionale Stabilität und Offenheit. Dabei wird das universitäre Umfeld als

externe Umgebung berücksichtigt und die Höhe des Wissens- und Technologietransfers aus der Universität gemessen. Es zeigt sich, dass universitätsnahe Gründungen einen höheren Wissenstransfer vorweisen. Darüber hinaus scheint zwischen der Höhe des Wissenstransfers und der Gründungspersönlichkeit ein substitutiver Zusammenhang vorhanden zu sein. Das heißt, Gründer aus dem universitären Umfeld weisen die für eine Gründung positiv gezeigten Persönlichkeitseigenschaften in einem geringeren Ausmaß auf, als die Vergleichsgruppe der akademischen Gründer außerhalb der Universität. Dies deutet darauf hin, dass universitäre Gründungspersönlichkeiten durch das universitäre Umfeld gefördert oder gehemmt werden können.

In Kapitel 3 wird die Heterogenität von Gründungsprojekten im Rahmen einer qualitativen Studie untersucht, mit dem Ziel Unterschiede und Möglichkeiten der Unterstützung zu identifizieren. Die Untersuchung konzentriert sich auf Gründungen aus den Lebens- und Naturwissenschaften, die durch ein staatliches Förderprogramm unterstützt werden. Dies garantiert eine tatsächliche Anbindung an universitäre Strukturen und daher auch die Nutzung von Ressourcen. Es werden vier Gruppen identifiziert, die sich bezüglich ihrer anfänglichen Merkmale des Ideengebers – einzeln oder im Team – und des verwendeten Wissens unterscheiden. Diese vier Gruppen werden als *sciencepreneur*, *professorialpreneur*, *postdoctorialpreneur* und *contextpreneur* benannt. Während der Entwicklung des Projektes unterscheiden sich die Gruppen bezüglich der Verwendung von Ressourcen und der Interaktionspunkte innerhalb der Universität. Das Kapitel schließt mit einer Handlungsempfehlung. Es wird gezeigt, dass auch innerhalb einer Universität eine einheitliche Förderstrategie für alle Gründungsprojekte nicht ausreichend scheint und bei knappen Ressourcen unterschiedliche Schwerpunkte gesetzt werden müssen.

Kapitel 4 untersucht Unterschiede in den Gründungsintentionen von Männern und Frauen mit Hochschulabschluss und inwiefern die Faktoren Risikoeinstellung und wahrgenommene Kreditverfügbarkeit diese Intentionen über das Geschlecht beeinflussen. Es zeigt sich, dass Frauen mit einer akademischen Ausbildung nicht im geringeren Maße Gründungsintentionen aufweisen als Männer. Darüber hinaus zeigen die Faktoren der Risikobereitschaft und wahrgenommenen Kreditverfügbarkeit einen signifikant unterschiedlichen Einfluss für Männer und Frauen. Während für Männer bisherige Ergebnisse bestätigt werden können, gehen für Frauen hohe Gründungsintentionen Hand in Hand mit einer negativ wahrgenommenen Kreditverfügbarkeit und einer geringeren Risikobereitschaft. Dies lässt den Schluss zu, dass bisherige Variablen nicht im Stande sind die Gründungsaktivitäten und -intentionen von Frauen im selben Maße zu erklären wie bei Männern. Ein Wandel zur Dienstleistungsgesellschaft und eine korrespondierende höhere Humankapitalausstattung von Frauen, könnten die hohen Gründungsintentionen erklären. Neben den untersuchten Faktoren müssen aber auch strukturelle Unterschiede, wie eine mögliche Diskriminierung durch Kreditgeber und spezifische Opportunitätskosten von Frauen stärker in künftige Untersuchungen eingebunden werden.

In Kapitel 5 werden die Ergebnisse zusammenfassend dargestellt und eine übergreifende Schlussbetrachtung vorgenommen. Im Anschluss erfolgt die Auseinandersetzung mit Empfehlungen für zukünftige Forschungsarbeiten.

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## List of Abbreviations

ATT	Average treatment effect on the treated
Ed/eds	Editor/editors
e.g.	For example
Et al.	Et alii (and others)
GO-Bio	Gründungsoffensive Biotechnologie
IP	Intellectual property
KAI	Kirton Adaption Inventory
OECD	Organization for Economic Cooperation and Development
SD	Standard deviation
TTO	Technology transfer office
US	United States
VIF	Variance inflation factor

## 1. Introduction

The first chapter outlines the general motivation of the dissertation. First, the main research setting will be introduced by a review of the existing literature and statements regarding research needs. The structure of the thesis will then be presented.

### 1.1.Motivation of research

*“...heterogeneity of spin-outs in terms of the environments in which they emerge, the skills of the entrepreneurs and the resources they require. This suggests that policy measures need to be more sophisticated than simple one-size fits all support.”*

*(Wright et al. 2004, p. 245).*

Entrepreneurship research is of interdisciplinary interest and draws from various fields, including sociology, psychology, political or economic sciences. Various theories, perspectives, and methods have thus been applied to understand the heterogeneous picture of entrepreneurial activities (Parker 2004). At first, the focus was on the entrepreneur and a function-orientated perspective to explain macroeconomic development. The entrepreneur was seen as the carrier of risk (Knight 1921), the coordinator of resources, an arbitrageur (Kirzner 1973), and an innovator (Schumpeter 1934). Entrepreneurial activities are currently viewed from two main perspectives: the supply side and the demand side. The supply side includes the characteristics and attitudes of individuals, and the demand side involves contextual conditions and the existence of entrepreneurial opportunities. In addition, recognizing opportunities seems to be highly connected to individuals (Shane 2003; Fueglistaller et al. 2004): that is, while some individuals are able to detect entrepreneurial opportunities, others are not. Therefore, to understand entrepreneurial activities, it is important to understand the entrepreneurial personality. While entrepreneurs might differ from non-entrepreneurs and will pursue

an entrepreneurial career no matter what, individual characteristics alone cannot explain entrepreneurial engagement. It thus seems necessary to consider individual characteristics in a surrounding that might inhibit or promote entrepreneurship. Factors such as age, gender, work experience, motivation, cognitive skills, and personality traits have been shown to explain entrepreneurial engagement (Caliendo and Kritikos 2012). Entrepreneurship researchers, however, have been calling for a more careful distinction between the different types of entrepreneurs (Gartner 1988; Sarasvathy 2004). Following this, the specific focus of this dissertation, therefore, is on the entrepreneurial activities of scientists and graduates from universities.

Recently, there has been much interest in the entrepreneurial activities of academics because universities are seen as knowledge creation centers (Godin and Gingras 2000) providing potential innovative solutions and ideas. This is clear in the fields of biotechnology and medicine, where scientific know-how and long development times are needed. Another well-known success story of academic entrepreneurship is the mp3, which was developed at a German research institution. The idea is that the promotion of academic entrepreneurship can positively influence economic development. Broad definitions of academic entrepreneurship take into account all areas of knowledge transfer, including consulting work, commissioned research, patenting or licensing, joint-research projects, and the establishment of new companies (Klofsten and Jones-Evans 2000; Wigren et al. 2007). Academics are expected to commercialize research results and use their skills and knowledge to create new ventures with a high growth potential. Indeed, nearly 60% of all companies founded in knowledge-intensive industries take place with the involvement of scientists (Egeln et al. 2002). The so-called university-based spin-offs are therefore one major way of transferring knowledge from university

to industry and are consequently important to economic development (Matkin 1990; Bozeman 2000; O'Shea et al. 2008) and thus of particular interest.

Several steps have been taken to increase the spin-off activities of scientists. In Germany, for example, with an amendment to the law regarding inventions made by employees of universities, the so-called "Hochschullehrerprivileg", which provided scientific researchers with the sole ownership of their inventions, was abolished. This was done to secure exploitation possibilities for universities. In addition, several government grants were introduced to promote the entrepreneurial activities of university members, e.g., the "EXIST" grants. These changes promoted the establishment of technology transfer offices (TTOs) at universities and increased the awareness of the commercialization of research results. However, although wide-ranging university management guidelines have been introduced and TTOs have been established to foster commercialization processes and support spin-off development, most universities have a limited number of spin-offs (Degroof and Roberts 2004; O'Shea et al. 2005; Mustar et al. 2008).

While research has almost exclusively focused on the *creation* of spin-offs, attention should also be given to the *development* of spin-offs (Mustar et al. 2006). To understand *why* spin-off numbers are limited, it is necessary to gather information regarding the complex process of university-based spin-off development. Two aspects in particular seem influential on the early development of spin-off projects: individual (team) characteristics and variations in the environment (the university). Approaches to explaining university-based spin-off activities should therefore include the dependencies between individuals and the entity in which they exist (Rasmussen 2011). Furthermore, universities should not be seen as single entities, and more specific factors, such as the influences of the department or the single research setting, should be considered (Mustar et

al. 2006; Wright et al. 2004; Rasmussen et al. 2014). This means that insights are needed on both the heterogeneity of spin-off projects and the interactions they have with the different elements of a university (Rasmussen 2011; Rasmussen et al. 2014; Wright et al. 2004). Questions regarding the development of university-based spin-offs might best be answered using qualitative research methods. Because qualitative research concentrates on the criteria of openness, and research designs provide applicatory insights for processes (Atteslander 2010). Furthermore, qualitative research designs are valuable in developing patterns and classifications.

Next to the entrepreneurial activities of scientists, the economic impact of companies created by university graduates should not be underestimated (Wright et al. 2007a). To capture the entrepreneurial potential of universities and to understand differences in the numbers of spin-off activities between universities, the activities of all university members must be assessed (Grimaldi et al. 2011). However, the entrepreneurial activities of graduates are not easy to capture because, for example, it is unclear how much university knowledge has been used to establish a company a few years after a graduate leaves university. Along with research interests in actual entrepreneurial behavior, the intention to establish a company has been studied because it is a good predictor of future behavior (Krueger et al. 2000). It seems reasonable to assume that engagement in entrepreneurship is a conscious process rather than an accident. A great number of empirical studies have therefore focused on the characteristics of nascent entrepreneurs, analyzing *why* some individuals plan to become entrepreneurs and others do not (Wagner, 2007). Strong differences have been found between female and male entrepreneurs regarding their interest in entrepreneurship and their actual entrepreneurial behavior (e.g., Kelley et al. 2012). In almost all OECD countries, the share of self-employed individuals in all employed individuals is much lower among women than among men (Fossen 2012).

Thus, to increase the overall entrepreneurial activity in Germany, which is lower compared with other European countries, the factors that influence entrepreneurial intentions and how they differ across gender need to be understood (Sternberg et al. 2012). It has been shown that various preceding factors on the intention to become self-employed differ between men and women (e.g., Bönnte and Piegeler 2013; Koellinger et al. 2013; Caliendo et al. 2014; Barnir et al. 2014), but research on differences across gender, for example, on the influence of risk-taking propensity, is underrepresented (Dawson and Henley 2015). Quantitative research allows for the interpretation of larger samples, makes results available for replication, and allows for the identification and estimation of even small effects (Schwaiger and Meyer 2011). Research designs work with the criteria of reliability, validity, a representative nature, and intersubjective comprehensibility. The basis of scientific quantitative research is the verification of theoretical considerations through possible similarities and generalizations. Therefore, along with making results available for comparison, quantitative research designs are a valuable method for understanding differences in the entrepreneurial behaviors and intentions of graduates.

To summarize, the heterogeneity of individuals as well as various sub-groups of entrepreneurs must be taken into consideration to understand entrepreneurial processes. Following the “made” view of an entrepreneur, personality characteristics are important, but their influences must be analyzed in the specific environment in which they occur, which might enhance or mitigate entrepreneurial intentions and activities. Research on the intentions of students to become self-employed is broadly available, e.g., entrepreneurship education studies. For example, in their model on the entrepreneurial intentions of students, Franke and Lüthje (2004) include several personal and contextual factors to demonstrate their influences on the intention to found a company. However,

in most cases, a time gap of several years might exist between leaving university and establishing a company. Therefore, knowledge on how universities influence the intentions of graduates to engage in entrepreneurship is still missing.

A two-dimensional approach to classifying spin-off projects was offered by Clarysse and Moray (2004). Academic spin-offs are classified by the status of the person involved and the nature of the knowledge transferred from the university to the venture. On the individual side, one can either include individuals in the venture creation process (Gartner 1988) or focus on the intention to engage in entrepreneurship (Krueger et al. 2000). The core technology or idea transferred from the parent organization can be classified by the use of knowledge, methods and technology, or research results (Pirnay et al. 2003; Müller 2010). Depending on this classification of the nature of knowledge, new companies can be identified as competence spin-offs or transfer spin-offs (Egeln et al. 2002). A summary of the above mentioned aspects of academic spin-off activities is shown in Figure 1.

**Figure 1: Two-dimensional approach to classifying academic entrepreneurship**

Intention to create a new company	Creation of a new company	Creation competence spin-off	Creation transfer spin-off	
↑ ↑		↑	↑	↑
Faculty member Student Graduate Staff member		Knowledge	Method / technology	Research results
↑ ↑		↑	↑	↑
Status of the person		Core technology or idea		

(Own illustration based on the work of Clarysse and Moray (2004), Roberts and Malone (1996), and Pirnay et al. (2003))

A summary of the current research highlights three areas of interest. First, spin-offs are an important method of technology transfer, but capturing all spin-off activities from universities is still a challenge (Grimaldi et al. 2011). In addition, a more careful distinc-

tion between the different types of entrepreneurs is necessary (Gartner 1985; 1988; Sarasvathy 2004). Additional insights into the economic potential of universities are an expected outcome of investigating the entrepreneurial activities of graduates. However, it is unclear how much university-based knowledge or technology has been used to establish a company. The dissertation addresses these issues by asking entrepreneurs with a university background how indispensable university-based knowledge, methods, and/or research results were for the foundation of their venture. This allows in an improved manner for the entrepreneurial activities of scientists and graduates from universities to be captured comprehensively. To examine the differences in personality traits and effects of the environment, both entrepreneurs working at a university before engaging in entrepreneurship and those who have not been employed by a university are compared.

Second, even though several activities have been found to enhance academic entrepreneurship, knowledge on how university-based spin-offs develop and how this can be supported is still missing. By understanding the university as a conglomeration of various factors that interact differently with different spin-off projects, it might be possible to provide a systematical categorization of spin-off activity. This means that a concentration on single entities is needed; both the individual projects and the university structures should be addressed in parallel (Rasmussen 2011). This dissertation concentrates on one university to provide a stable university-wide setting for each spin-off project. This provides an understanding of the extent to which university-based spin-off projects differ and allows for the interpretation of the differences in their interactions with the specific factors of the university.

Third, studies on the intentions of students have shown the importance of personality traits and environmental factors, but less is known about the intentions of graduates to

engage in entrepreneurship. Furthermore, the differences between women and men regarding engagement in entrepreneurial activities is still not fully understood. This dissertation concentrates on the specific sub-group of graduates to determine the differences in intentions to become self-employed across gender.

This dissertation therefore seeks to understand the entrepreneurial behaviors and intentions of academics. By taking into account the heterogeneity of entrepreneurs and/or entrepreneurial projects, it aims to provide a comprehensive picture of the entrepreneurial potential of university-based spin-offs. In addition, environmental factors and individual factors are considered in parallel and regarding their interactions. Analyses are made qualitatively and quantitatively, and they provide insights into the process of spin-off development and into different sub-groups of the academic population. Including both qualitative and quantitative research methods allows for an explanation of the causes of effects in individual cases as well as the estimated average effects of various independent variables (Mahoney and Goertz 2006). Quantitative and qualitative research methods have long been seen as two contrasting streams (Schrodt 2006). By now, it is widely accepted that a research's goal and needs should determine which method is applied. This dissertation shows that applying both research designs provides a more comprehensive picture of the possible entrepreneurial activities at universities.

## **1.2. Thesis structure and main research goals**

The remainder of this work is structured as follows and directly addresses the research needs discussed above. Three studies form the main part of this dissertation. The second chapter analyzes the differences between individuals establishing a company out of university employment and graduates who were not employed at a university before creating a start-up. These two sub-groups of entrepreneurs are distinguished from each other based on the dimensions of the Five Factor personality model and the predominant

nature of the knowledge upon which the ventures were built. A theoretical overview is followed by the derivation of five hypotheses—one for each dimension. Hypotheses are tested on a unique dataset from one university in Germany using logistic regression models. The presentation of the results is followed by a discussion of the managerial implications and future research needs. In Chapter 3, the focus is on the possible heterogeneity of spin-off projects from one university. The literature review is followed by the creation of two main research questions regarding why and how spin-off projects differ. For

spin-off projects from the natural and life sciences, an empirical analysis is done using a qualitative study design on data collected via interviews at a large German university. This is followed by a discussion of the results, which involve four inductively derived types of university spin-offs and their interaction points with different factors of relevance within one university. Managerial implications and further research areas conclude the third chapter. Chapter 4 analyzes how the intentions of graduates from one university differ between men and women by concentrating on individual and environmental characteristics. Hypotheses are derived from a literature review and are tested on a unique dataset from a university in Germany using ordered logistic regression and graphical analysis. The results, managerial implications, and future research areas are then presented. The final chapter summarizes the overall results of the dissertation and provides concluding thoughts on its contribution as well as future research areas in the broad context of academic entrepreneurship.

## 2. Crowding in or crowding out: The link between academic entrepreneurship and entrepreneurial traits

### Abstract

The entrepreneurship literature has identified several entrepreneurial traits as being important to become a successful entrepreneur. Using the Five Factor personality model we analyze differences between two types of entrepreneurs: Individuals founding an enterprise out of university employment and graduates who are not employed at the university before starting a company. To analyze potential differences in personality between these two groups we use a unique data set of former students from a large German university. We show that entrepreneurs out of the university context possess lower levels of openness to experience as well as higher levels of agreeableness. Also, we provide evidence for the importance of the predominant type of knowledge upon which academic ventures are built. The findings confirm that entrepreneurs out of the university context overly focus on the scientific aspects of their start-up idea and thus may pursue it in a potentially suboptimal manner, but that this can be mitigated by dedicated support measures and structures within the university, for which we also provide specific examples.<sup>1</sup>

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<sup>1</sup> This chapter has been published as an article. 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. The final publication is available at Springer via <http://dx.doi.org/doi:10.1007/s10961-014-9346-y>.

## 2.1. Introduction

During the last two decades the attention towards academic entrepreneurship and its importance for knowledge and technology transfer has increased and universities and other public research institutions are challenged to take on technology transfer and commercialization as an integral part of their activities (Etzkowitz et al. 2000). This is challenging due to the many possible ways of commercialization, which range from cooperation of researchers with an industrial company to the establishment of a new company by scientists. Next to the interest of policy and research in spin-off formation of scientists, the entrepreneurial activity of graduates (synonymous in the following also: alumni) and students is of particular relevance to understand the importance of knowledge and technology transferred from the university. However, it is difficult to estimate the amount of start-ups from graduates not only because they are established with a significantly longer time-lag (Müller 2010) but also because it is not necessarily clear if specific knowledge created and transferred from the university is used to start the venture or if the knowledge is gained through employment occupations. Nonetheless, the extent of graduates' spin-off activity should not be underestimated, given that evidence even suggests it may outnumber the spin-off activity of scientists by 20% (Wright et al. 2007a).

The literature indicates that academics commercialize research results and use skills and knowledge that lead to new ventures with a high growth potential. For example, companies founded by graduates from MIT produce revenues that would make them the 24th largest economy in the world (Bank Boston 1997). Furthermore, science has been an essential factor for the development of innovative products and processes (Mansfield 1998). All of this shows that the establishment of new companies is one important means of technology transfer in general. But still, we have only limited insight of what

drives academics to exploit the knowledge gained at the university in this entrepreneurial manner. To define spin-offs it is common to use a two-dimensional approach (Clarysse and Moray 2004). This two-dimensional approach classifies academic spin-offs by means of the status of the person involved and the nature of knowledge transferred from the university to the venture. Therefore, the persons involved can be distinguished by being a faculty member, staff member, or a former student who has left the university to found the company or started the company while still being affiliated with the university. And the nature of knowledge can be classified as a core technology or an idea that is transferred from the parent organization (Roberts and Malone 1996). Whilst it is therefore necessary to consider both, the person involved in the creation process and the nature of knowledge, it still remains to be clarified what else determines academic entrepreneurship or moderates these influences.

Regarding the individual side of academic entrepreneurship demographic factors such as gender or work experience, motivations, cognitive skills and personality traits are able to explain entrepreneurial activities (Caliendo and Kritikos 2012). Several studies assess the importance of demographic factors and motivations to become self-employed for the overall population and for scientists in the founding process (DeMartino and Barbato 2003; Wright et al. 2004; Rosa and Dawson 2006; Fritsch and Krabel 2012). In addition, the literature basically supports the role of personality traits in the explanation of any entrepreneurial activity (Caliendo et al. 2011) and differing personality traits were observed for entrepreneurs and for non-entrepreneurs (Rauch and Frese 2007; Zhao et al. 2010). But, researchers call for a more careful distinction between different types of entrepreneurs (Gartner 1988; Sarasvathy 2004). We account for this by addressing whether personality traits differ between entrepreneurs due to contextual

aspects, specifically in terms of being employed at the university or not and under consideration of the nature of knowledge from the university used to establish a business.

As mentioned, spin-offs are one important way to disseminate university knowledge, but taking spin-off activities fully into account is frequently a challenge (Grimaldi et al. 2011). We seek to address this issue in an improved manner by asking company founders with a university background how indispensable university-based knowledge, methods and/or research results were for the foundation of the venture. In doing so, we are able to account more comprehensively than before for entrepreneurial activities of scientists and graduates from the university (e.g., technology transfer offices often do not know about all of the above activities) and we can address how university knowledge is used to establish the business. In our analysis, we thus compare entrepreneurs working at the university before engaging in entrepreneurship and those who have not been employed at the university. We do so to examine differences in personality characteristics since choosing an academic career and fitting into the institutional surrounding of the university might go hand in hand with cultivating personality traits that are less suitable for pursuing an entrepreneurial activity. Therefore, it is important to understand if academics founding companies out of the university context differ from founders that are not employed at the university. Most importantly, we want to identify if trade-offs exist and whether the university setting crowds out personality traits that matter for the entrepreneurial engagement. To this end, we specifically analyze if the perceived extent of knowledge transferred from the university associates with less useful personality traits, e.g., because other factors are more important for the realization of a business idea in the university context. Alternatively, traits positively linked to entrepreneurship might be even more prevalent in the academic context because of a stronger need to counter the institutional limitations. Therefore, our main research question is to what degree

these competing interpretations hold. Our analysis contributes to the literature of technology transfer by providing deeper insights in the specific personalities of founders out of the university context and the interplay between the knowledge transferred from the university and the personality structure of the individual. Furthermore, we provide specific suggestions and guidelines for technology transfer offices in the support of spin-off processes.

The paper proceeds as follows. In the next section we review the literature and derive our hypotheses. Then we describe our data and the approach to the empirical analysis. Following this, we present results and sensitivity analyses. The paper concludes with a discussion of the findings, practice and policy implications, as well as limitations and further research needs.

## **2.2. Literature review and development of hypotheses**

For the literature review we will first summarize previous conceptions on academic entrepreneurship and present results on the importance of university spin-offs for technology transfer activities and therefore for economic development. After that, we concentrate on the role of personality characteristics for entrepreneurship. Research institutions, such as universities, are considered the center of knowledge creation (Godin and Gingras 2000). Consequently, a high potential for transformation into marketable products via licensing technologies or firm creation is expected (Mansfield and Lee 1996; Etzkowitz 2003). Whilst the degree of academic knowledge commercialization is still discussed, there is a growing understanding that universities should—next to their traditional tasks of research and teaching—engage in technology transfer (Etzkowitz et al. 2000). Moreover, latest results suggest that this engagement does not affect the principle of open science (Shibayama 2012). In recent years, research institutions and policy makers paid increasing attention to the entrepreneurial engagement of academics. One

part of the extant literature concentrates on the total knowledge which is transferred from the public research institution to industry and uses a broad definition of academic entrepreneurship, including areas of consulting, patenting or licensing, joint-research projects or commissioned research (Klofsten and Jones-Evans 2000; Wigren et al. 2007). Another stream of literature focuses on the individual engaged in the technology transfer process and on the extent to which different members of the research institutions, like graduates, scientists, staff members or students should be included in the definition of academic entrepreneurship (Pirnay et al. 2003).

Whilst the whole picture of technology transfer activities needs to be acknowledged to measure the total impact of universities for the economic system, one major way to transform knowledge from university to industry and consequently highly important for the economic development are university spin-offs (Matkin 1990; Bozeman 2000; O'Shea et al. 2008). Shane (2003) provides evidence that better educated people start firms with higher growth expectations. Similarly, academics are more likely to establish companies in highly innovative and knowledge-intensive industries like biotechnology, IT and other high-technology industries. The purpose of fostering spin-off activity within universities is therefore to ensure that scientific findings from universities and other research institutions are transferred directly into products and services and to increase the transition of academics into self-employment. But, it is important to differentiate between spin-offs founded by scientists and spin-offs founded by former students because they can vary remarkably in the usage of knowledge or research results from the university (Pirnay et al. 2003). Empirical evidence shows that spin-offs with high levels of knowledge transfer are established faster than those with lower levels of knowledge transfer and that these spin-offs are founded rather by university staff than by graduates who have never worked at a university (Müller 2010).

As a result, we find a manifold picture in the definition of academic entrepreneurship and through the different types of individuals engaged in the entrepreneurial process. For our research setting we concentrate on the particular way to transfer university knowledge by founding new companies through graduates of one university, either still connected to the university setting through employment or not. Because of the importance of the individual founder in the early status of the company and furthermore the crucial dependency of newly founded ventures on the decisions made by the entrepreneur (Van Gelderen et al. 2005), we address individual characteristics and concentrate on personality traits, which we will examine in the following chapter.

Regarding the role of personality characteristics, the literature proposes two common perceptions of entrepreneurs as being either “born” or “made”. The “born” view promotes the entrepreneur with typical personal characteristics, who will engage in the entrepreneurial process in any case. The “made” view also acknowledges the importance of personality traits but examines them in a larger context. This view requires us to understand the individual in a surrounding that might inhibit or promote entrepreneurship and is consistent with the idea of the “individual-opportunity-nexus” described by Shane (2003). Following this approach there is no “average entrepreneur” (Gartner 1985; 1988) and the engagement in entrepreneurship depends on various other factors besides the personality.

Still,—searching for the entrepreneurial personality—it has been shown that different personal determinants are important in the decision to become self-employed, like socio-demographic characteristics, cognitive skills, motivations or personality traits (Caliendo et al. 2011). As personality traits are quite stable over time (Roccas et al. 2002; Cobb-Clark and Schurer 2011), they seem to be good predictors to entrepreneurial behavior. The literature therefore examines various individual personality traits to

understand their importance in explaining entrepreneurial activities (Rauch and Frese 2007). A comprehensive approach to account for personality traits of an individual is given by the Five Factor model (Digman 1990). It is a framework that has captured the personality of individuals consistently across several studies, empirical contexts, and is used worldwide to explain personality characteristics of individuals (Costa and McCrae 1992). Besides other theories, e.g., the six personality types of Holland (1959), the Five Factor model is highly utile to explain self-selection in occupational choice settings and the engagement in entrepreneurship (Wooten et al. 1999; Furnham 2001). It is consequently necessary to capture the personality of the respondents to understand actual behavior. The five dimensions of the Five Factor model are conscientiousness, openness to experience, emotional stability, extraversion and agreeableness. In a meta-analytical review in 2006 Zhao and Seibert showed differences between managers and entrepreneurs for the Five Factor model. All together the dimensions of the Five Factor model explain 13% of the variance in entrepreneurial intention and 10% of the variance in entrepreneurial performance (Zhao et al. 2010). Additionally, Caliendo et al. (2011) showed that the explanatory power of the five dimensions is comparable to that of education, which is one of the most prominent determinants of entrepreneurship and approximately three times larger than that of parental self-employment. The empirically tested personality of entrepreneurs seems to have higher levels of openness to experience, extraversion, conscientiousness and emotional stability as well as lower levels of agreeableness (Zhao and Seibert 2006; Zhao et al. 2010; Caliendo et al. 2011). Combining these findings with results from vocational psychology and theories of person-environment fit, which concentrate on the choice, satisfaction and productivity of an individual for and in an occupation and the fit of the individual to the job within a specific surrounding, shows that individual personality traits can explain occupational

choice (Furnham 2001; Prottas 2011). Hence, we might expect different structures in personality for entrepreneurs and scientists. But what about a scientist who decides to engage in entrepreneurship? If differences between entrepreneurs are bigger than between entrepreneurs and non-entrepreneurs (Gartner 1985), one possible moderating effect might be the surrounding, in our case the university context and earlier career choices that fit personality. Universities can best be described as exhibiting a structure of professional bureaucracy. On the one hand, this means they exist in a complex but stable environment and the organizational structure one faces within the university surrounding is formalized. On the other hand, this surrounding also provides high autonomy to the specialists providing innovative ideas and quality services, in our case the researcher (Mintzberg 1992; Lunenburg 2012). Drawing upon these findings, we will develop hypotheses for each of the personality traits according to the Five Factor model on whether scientists who create companies out of the university context and graduates not employed at the academic institution shortly before or during the process of establishing their venture differ.

### **2.2.1. Conscientiousness**

Conscientiousness is the first dimension of the Five Factor model which we seek to understand in its different manifestation between the two types of entrepreneurs. It captures two aspects. On the one hand “need for achievement” and on the other hand “dependability and dutifulness” (Mount and Barrick 1995). Individuals with a higher need for achievement want to be in control of their actions, have problems to assimilate with structured organizations and might avoid these surroundings (Brandstatter 1997). In an early work McClelland (1961) expected individuals with a high need for achievement to engage in entrepreneurship and entrepreneurs are shown to have a higher achievement motivation than managers (Stewart and Roth 2004). Dutifulness contrary might be posi-

tive for an employed occupation and negatively linked to entrepreneurship (Rauch and Frese 2007). In science highly conscientious people have been promoted and selected due to their working attitude and fit to the research environment (Charlton 2009). Therefore, we expect founders out of the university context to possess even higher levels of conscientiousness.

*Hypothesis 1: Entrepreneurs out of the university context possess higher levels of conscientiousness than founders outside the university.*

### **2.2.2. Emotional stability**

Emotional stability is the reverse measurement of neuroticism and captures individuals who are self-confident, calm and relaxed. Emotional stable individuals go on when others might be stopped by burdens or self-doubt. Entrepreneurs are described as being optimistic and stable in the face of social pressure or stress. Therefore, those individuals that engage in entrepreneurship and face all obstacles to establish their company are expected to possess high levels of emotional stability (Zhao and Seibert 2006). We also assume scientists to be high in emotional stability as they are confronted with high pressure for excellent research and publication achievements as well as with heavy workloads. These thoughts accompany with the finding that emotional stability is a general predictor for overall work performance (Barrick et. al. 2001). Therefore, we do not expect a difference in personality concerning this dimension between the types of entrepreneurs.

*Hypothesis 2: Entrepreneurs out of the university context do not differ in the level of emotional stability from founders outside the university.*

### 2.2.3. Extraversion

Extraversion describes people who are assertive, energetic, active and enthusiastic (Costa and McCrae 1992). People who score high on extraversion seek excitement and stimulation, they are outgoing and friendly and like to socialize. Entrepreneurs are expected to have higher levels of extraversion compared to individuals not founding a company because they like to take the role of leadership and assess strong competencies in building networks. The probability to engage in entrepreneurship is proven to increase with higher levels of extraversion (Wooten et al. 1999). Extraverted individuals are highly influenced by external stimuli and their behavior is dependent on the presence of an external surrounding. Scientists on the other hand seem to be more introverted than individuals in other occupations (Feist 1998) and are used to work for themselves for long periods of time in order to fulfill their urge for insights. Therefore, we expect individuals that found out of university to have lower levels of extraversion.

*Hypothesis 3: Entrepreneurs out of the university context possess lower levels of extraversion than founders outside the university.*

### 2.2.4. Openness to experience

Openness to experience is a dimension capturing unconventionality and broad-mindedness. Individuals scoring high on this factor should be innovative and tend to seek new experiences. Openness to experience is correlated with intelligence, especially intelligence that relates to creativity (McCrae 1987). Entrepreneurs need to handle newly and unconventional surroundings and are expected to have higher levels of openness to experience. On the one hand, working at the university implies creativity in research. However creativity is shown to be positively related to the discovery of opportunities and does not seem as important in the exploitation of opportunities (Fraboni and Saltstone 1990). On the other hand, individuals that choose to stay in the university sur-

rounding might prefer reliable and stable structures within a slow changing work environment. Individuals working at the university most likely have long-term objectives and might not show a high desire to break out of their current setting to seek new experiences by exploring the more unconventional way of entrepreneurship. Hence, we expect entrepreneurs out of the university context to have lower levels of openness to experience.

*Hypothesis 4: Entrepreneurs out of the university context possess lower levels of openness to experience than founders outside the university.*

### **2.2.5. Agreeableness**

Individuals who score high on agreeableness are forgiving, trustful, reflecting and friendly. This dimension concentrates more on interpersonal relations and assesses the way of behaving with other people. High levels of agreeableness are seen as inhibiting one's ability to look out for own interests and to influence others for the own advantage because these individuals show concern for the needs of others. Contrary, this cooperation ability might help when bargaining with customers and business partners. Agreeableness is proven to be negatively related to the propability to engage in entrepreneurship (Fraboni and Saltstone 1990) and positively correlated with academic performance of students because it facilitates cooperation in learning processes (Poropat 2009). Furthermore, individuals high on agreeableness show interest in occupations like teaching as these involve frequent interaction with others (Barrick et al. 2003) and fit well in the academic surrounding where individuals that behave accordingly to established structures are promoted (Charlton 2009). This fit and the corresponding work content as well as the need to cooperate in research fields might go hand in hand with higher levels of agreeableness. We therefore expect entrepreneurs out of the university context to be more agreeable.

*Hypothesis 5: Entrepreneurs out of the university context possess higher levels of agreeableness than founders outside the university.*

Testing empirically the hypotheses derived above concerning whether academics out of the university context have the same personality traits as founders outside this context when they decide to start their venture is the focus of the remainder of this paper.

### **2.3. Data and method**

Our data was collected during an online survey from December 2009 until February 2010. The survey questionnaire was distributed by email to the alumni of a university, in Bavaria (Germany). It asked for an assessment of various aspects concerning personal characteristics and demographic variables used to explain entrepreneurial activity, as well as for information for the latter. Specifically, we surveyed the dimensions of the Five Factor model. All questions were asked in German and based on a theoretical overview.<sup>2</sup>

To avoid common method bias different response formats were used and the anonymity of the respondents was ensured. Furthermore, all scale items that have been used have been shown before to be good measurements of the various personality traits (Franke and Lüthje 2002; 2004; Lüthje and Franke 2003; Gosling et al. 2003; Block and Koellinger 2009). Concerning a possible response bias, the answers received might contain over-proportionally graduates that still have a strong connection to the university and therefore represent only a specific subgroup. However, we tested for differences in age between the respondents and did not find any significant difference between the first and the last ten percent of respondents, which provides evidence against such a response bias within the sample. Furthermore, if we expect any sampling bias we would assume a strengthening of our results as the differences between the types of founders

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<sup>2</sup> The full questionnaire is provided in the Appendix Table A1.

should be higher the less contact founders outside the university context have with the university and thus, the less influenced they are by the university setting. Similarly, we would expect any usage of university knowledge, to establish the company, to be even less.

As said, the focus of the empirical analysis is to understand if academics that decide to found a company or were at the time of the survey in the process of founding out of the university context differ in their personality traits to individuals that establish their company outside the university context. Our sample comprises 423 alumni of the university from various fields of study, corresponding to an overall response rate of 17.1%. Due to technical problems we had to remove 22 observations of the sample for which we had only incomplete data. Furthermore, missing values lead up to a sample size of 345 observations in total and a missing value percentage of 14%. By concentrating only on graduates that have engaged in entrepreneurship by establishing their own company we arrive at 65 observations.<sup>3</sup> The companies were established between 1954 and 2009. For these 55 years we possess in-depth data on the 65 establishments and their usage of university knowledge as well as broad information about the individuals engaged in the process. Based on data from the technology office of the University about the spin-off activity in the last twenty years (43 spin-offs known to the technology transfer office in the period from 1990 to 2009) and the time period we are observing we thus arrive at a response rate of 55.8% for our analysis which provides us with confidence that the results are representative.

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<sup>3</sup> Four of the founders already founded a company and are in the process of founding another company. For these, data will only be used for the first company founded.

### **Dependent variable**

The literature requests a valid and broad method to be able to include all spin-off activity from universities and other research institutions as many of the foundations go through the back door. Recent studies suggest that the influence of university knowledge on the economic system might be underestimated if it is simply measured through technology transfer activities known to the technology transfer offices of the specific university (Wright et al. 2007a; Grimaldi et al. 2011). Furthermore, academic entrepreneurship of graduates might transfer knowledge from the university and needs to be acknowledged. This means, only concentrating on spin-offs known to the technology transfer offices might not show a comprehensive picture. To address this, we collect primary data of graduates of the university that have established a company. We assume that establishments out of the university context take place in a short period (e.g., within one to two years) after leaving the university, which is consistent with results of Müller (2010) who finds that spin-offs with high-level technology transfer are established in very short periods after leaving the university and rather from university staff. Therefore, we use as our dependent variable a dummy variable assuming unity if a respondent is employed at the university from one year before or still is after the establishment of the new venture. For all other entrepreneurs the dummy takes on a zero value.

### **Independent variables**

The variables for the personality traits used in our study in terms of the measures for the Five Factor model (Ostendorf 1990) are taken from a short version that has been shown to be reliable (Gosling et al. 2003). For each of the dimensions extraversion, emotional stability, agreeableness, conscientiousness and openness to experience two items are measured, resulting in five indices (one for each dimension) entering our model.

## Control variables

Given we concentrated our survey on academics of one university, we already control in this way for a number of institutional effects. Control variables for these are consequently less relevant given the high homogeneity that characterizes our sample at the outset of the analysis. Arguments exist that cognitive skills influence entrepreneurial intentions and decisions of an individual (Hartog et al. 2010). In our sample, because the change to bachelor and master degrees at the University took place only during 2009, 95.4% of the individuals hold a diploma or a state examination. We thus face a highly homogenous group in terms of cognitive skills and did not include the degree as a control variable, but as described below we control for the field of study. Given all university founders are male, we also do not have to control for gender to account for differences in entrepreneurial activity in this respect.

Nevertheless, we include several control variables that may still affect our dependent variable. Our control variables are the nature of knowledge transferred from the research institution to the venture, risk taking propensity and the field of study of the individual.

Because academic entrepreneurship always has two aspects to account for, namely the person involved and the nature of knowledge transferred we control for the influence of university technology and knowledge on commercialization activities of founders. This is measured using three questions on how important research results, new scientific methods and techniques or specific academic skills acquired or generated at the university were for graduates in a 3-item scale from “not important at all” to “indispensable” (Egehn et al. 2002; Müller 2010). Founders were asked about their academic background and the role of technology and knowledge transfer for establishing their business. By classifying spin-offs according to the nature and extent of knowledge used

to establish the new venture four categories can be distinguished: Transfer spin-offs using scientific research results, competence spin-offs using specific skills gained at the universities, academic start-ups with transfer effects and academic start-ups without transfer effects. We define transfer spin-offs if scientific research results or new methods were indispensable, competence spin-offs if specific skills were indispensable, start-ups with transfer effects if research results or new methods were of high importance and start-ups without transfer effects if competences were of high importance but research results or new methods were not important at all (Egeln et al. 2002; Müller 2010). Given that research results represent the highest possible transfer of knowledge from the university to the venture we measure the influence of university knowledge on venture foundation using a variable for university knowledge transfer based on these four categories.

As a further control variable, risk taking propensity (Kihlstrom and Laffont 1979) is included since the literature suggests a high risk tolerance for entrepreneurs (Baron 2007). An entrepreneur—being faced with more unstructured and uncertain problems—seems to be forced to take on more risks and has to take on responsibility for all decisions (Stewart and Roth 2001; 2004). Hence, risk-taking propensity can have an important effect on the probability of entrepreneurship even besides the dimensions of the Five Factor model (Paunonen and Ashton 2001). Three items, each on a 5-point Likert scale ranging from “not likely at all” to “very likely”, which have been valid measurements in earlier research (Franke and Lüthje 2002; 2004; Lüthje and Franke 2003) have been used to construct an index.

The field of study explains differences in career choice intentions of students and influences entrepreneurial intentions (Sieger et al. 2011). A common classification consists of four categories. The first category combines students studying natural sciences

like mathematics, computer sciences, medicine or architecture. The second sums up fields of study related to economic sciences such as economics, management and business administration or corporate and business law. The third category includes social studies like cultural studies, linguistics, religion or pedagogy. In the fourth category other studies like arts or sport are frequently combined (Fueglistaller et al. 2009). Following this classification we can build three categories for our analysis (given that in the last category just introduced no responses were recorded): Respondents were either in the field of natural sciences, economic sciences or social sciences. A detailed definition of all variables and the questionnaire wording is provided in Table 1.

**Table 1: Variable descriptions and items in the questionnaire**

Variable name	Questionnaire wording and/or variable description
<b>Dependent Variable</b>	
<b>Founder</b>	Dummy variable taking value of 1 if the individual is employed at the university before, by the time or after the establishment of the venture (0 otherwise)
<b>Independent Variables</b>	
<b>Five Factor model</b>	<i>Scale: 1 ('does not apply to me at all') to 7 ('applies to me perfectly')</i> <i>I see myself as...</i>
Extraversion	Extraverted, enthusiastic
Extraversion	Reserved, quiet (reversed item)
Agreeableness	Critical, quarrelsome (reversed item)
Agreeableness	Sympathetic, warm
Conscientiousness	Dependable, self-disciplined
Conscientiousness	Disorganized, careless (reversed item)
Emotional stability	Anxious, easily upset (reversed item)
Emotional stability	Calm and emotionally stable
Openness to experience	Open to new experiences, complex
Openness to experience	Conventional, uncreative (reversed item)
<b>Control Variables</b>	
<b>Risk-taking propensity</b>	<i>Scale: 1 ('disagree completely') to 5 ('agree completely')</i>
New routes	When I travel I tend to use new routes
Try new things	I like to try new things (e.g., exotic food or going to new places...)
Risk	I have taken a risk in the last six months
<b>Field of study</b>	<i>Please tell us about your special field of study:</i>
Natural sciences	Reference group
Economic sciences	Dummy variable taking value of 1 if the individual studies in fields conducive to business (0 otherwise)
Social sciences	Dummy variable taking value of 1 if the individual studied social sciences (0 otherwise)
<b>Nature of knowledge</b>	<i>Scale: 1 ('not important at all') to 3 ('indispensable')</i> <i>How important were the following factors for the establishment of your company?</i>
Research results	New research results developed at the public research institution, e.g., the development of a new product or service.
Methods	New scientific methods which you have acquired during the time at the public research institution.
Competence	Specific skills, which you have acquired during the time at the public research institution.” Ordinal variable representing the extent of university knowledge used to establish a venture from no knowledge transfer to high technology transfer. Scale: 1 = start-up without transfer effects, 2 = start-up with transfer effects, 3 = competence spin-off, 4 = transfer spin-off

## 2.4. Results

On average the respondents that engaged in entrepreneurship are 42.5 years old (SD = 11.4, range 23-84 years) and by the time of founding their company entrepreneurs are on average 33.3 years old (SD = 8.3, range 18-63 years). Founders out of the university context were around 32.6 years old (SD = 5.4, range 24-41 years) when establishing their venture. Most of the respondents are male (76.9%) and all of the founders out of the university context are male. 31.7% of the entrepreneurs worked in academia after completing their studies, while this is self-evident for all entrepreneurs that founded out of the university context. Furthermore, all entrepreneurs out of the university context possess at least a PhD degree. Asking respondents about their field of study shows that 35.4% were studying natural sciences, 43.1% economic sciences and 21.5% social sciences. Amongst the individuals founding out of the university context the share of those from economic sciences with 25.0% is lower and that from natural sciences higher (62.5%), whereas only 12.5% are from the field of social studies. 67.2% of the respondents had experience with the industry of the foundation before starting their own company. Half of all ventures in the survey data are established in a team and individuals out of the university context build their company even more often within team structures (57.1%).

Testing differences in personality traits between individuals that engage in entrepreneurship and others that do not, we find higher levels in the dimension extraversion for entrepreneurs (see Table 2).<sup>4</sup>

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<sup>4</sup> Also, we estimated a logistic regression model with the dependent variable of being an entrepreneur or not. Results yield a positive significant influence of the dimension extraversion on the probability to engage in entrepreneurship. Furthermore, we find a significant positive influence of economics as the study field. Results of these additional estimations are available upon request from the authors.

**Table 2: Comparison between entrepreneurs and non-entrepreneurs<sup>a</sup>**

Variable	Full sample		Entrepreneur		Non-entrepreneur		Entrepreneur vs. non-entrepreneur
	Mean	SD	Mean	SD	Mean	SD	p-value of t-test
Extraversion	4.39	1.26	4.68	1.09	4.32	1.29	-2.073**
Agreeableness	4.14	0.88	4.09	0.63	4.15	0.93	0.448
Conscientiousness	5.48	1.12	5.62	1.01	5.45	1.14	-1.072
Emotional stability	4.86	1.29	4.91	1.20	4.85	1.32	-0.343
Openness to experience	5.27	1.06	5.42	0.95	5.23	1.08	-1.258
Risk-taking propensity	3.14	0.82	2.75	0.46	3.19	0.85	-1.449
Natural sciences	0.40	0.49	0.35	0.48	0.41	0.49	0.790
Economic sciences	0.30	0.46	0.43	0.50	0.27	0.46	-2.538**
Social sciences	0.30	0.46	0.22	0.41	0.32	0.47	1.680*

<sup>a</sup> n = 345; 65 entrepreneurs and 280 non-entrepreneurs. The last column shows the p-values for a two sided t-test on the equality of means of entrepreneurs and non-entrepreneurs.

\*\*\* p<0.01; \*\* p<0.05; \* p<0.1

In the following, we survey the argument of Gartner (1985) proposing that differences between entrepreneurs and non-entrepreneurs are smaller compared to differences in personality traits amongst entrepreneurs and that various factors make it difficult to determine the typical entrepreneur. We examine if the proximity to the university leads to differences between entrepreneurs. This is done by focusing on differences of individuals who found a company one year after leaving or while being employed at the university and individuals who are not employed at the university while establishing their company. We use employment status as a proxy for university closeness and expect scientists to found more innovative and university-related companies. The t-tests (see Table 3) show that personality traits have some influence on founding out of the university context or not being employed at the university prior to founding. In this univariate analysis we find lower levels of openness to experience for entrepreneurs out of the university context as well as lower levels of conscientiousness. As expected individuals that create their company out of the university context also relate their companies

to higher usage of knowledge transferred from the institution and are more often from the field of natural studies in comparison to the other graduates not employed at the university before starting a company.

**Table 3: Comparison between the types of entrepreneurs<sup>a</sup>**

Variable	Founder sample		University founders		Non-university founders		University vs. non-university
	Mean	SD	Mean	SD	Mean	SD	
Extraversion	4.68	1.09	4.13	0.83	4.75	1.10	p-value of t-test
Agreeableness	4.09	0.63	4.25	0.46	4.07	0.65	-0.753
Conscientiousness	5.61	1.01	5.00	1.31	5.70	0.94	1.875*
Emotional stability	4.91	1.20	4.50	1.20	4.96	1.20	1.031
Openness to experience	5.42	0.95	4.50	0.93	5.54	0.89	3.099***
Risk-taking propensity	3.12	0.82	2.75	0.46	3.18	0.85	1.384
Natural sciences	0.35	0.48	0.63	0.52	0.32	0.47	-1.726*
Economic sciences	0.43	0.50	0.25	0.46	0.46	0.50	1.096
Social sciences	0.22	0.41	0.13	0.35	0.23	0.42	0.656
Nature of knowledge	0.86	1.12	1.75	1.28	0.74	1.04	-2.500**

<sup>a</sup> n = 65; 8 entrepreneurs out of the university context (university founders) and 57 entrepreneurs not employed at the university while starting the company (non-university founders). The last column shows the p-values for a two sided t-test on the equality of means of founders out of the university context and founders outside the university.

\*\*\* p<0.01; \*\* p<0.05; \* p<0.1

Based on the significant differences of the proxy for university closeness (being employed at the university) and clarifying the importance of the extent of university knowledge in the univariate analysis we carry out our multivariate analysis employing a logistic regression model. Prior to this, we provide evidence that non-normality and multicollinearity are no issues as can be seen from Table 4 and Table 5 reporting descriptive statistics and correlations as well as variance inflation factors.

**Table 4: Descriptive statistics<sup>a</sup>**

	<b>Variable</b>	<b>Mean</b>	<b>Median</b>	<b>S.D.</b>	<b>Min.</b>	<b>Max.</b>
1	University founder	0.12	0.00	0.33	0.00	1.00
2	Extraversion	4.68	5.00	1.09	2.00	7.00
3	Agreeableness	4.09	4.00	0.63	2.00	6.00
4	Conscientiousness	5.62	6.00	1.01	3.00	7.00
5	Emotional stability	4.90	5.00	1.20	2.00	7.00
6	Openness to experience	5.42	6.00	0.95	3.00	7.00
7	Risk-taking propensity	3.12	3.00	0.82	1.00	5.00
8	Natural sciences	0.35	0.00	0.48	0.00	1.00
9	Economic sciences	0.43	0.00	0.50	0.00	1.00
10	Social sciences	0.22	0.00	0.41	0.00	1.00
11	Nature of knowledge	0.86	0.00	1.12	0.00	3.00

<sup>a</sup> n = 65.

**Table 5: Correlations and variance inflation factors<sup>a</sup>**

Variable	1	2	3	4	5	6	7	8	9	10	11	VIF
1 University founder	1.00											
2 Extraversion	-0.19	1.00										1.33
3 Agreeableness	0.09	0.25 **	1.00									1.25
4 Conscientiousness	-0.23 *	0.17	0.01	1.00								1.19
5 Emotional stability	-0.13	-0.08	0.22 *	0.22 *	1.00							1.24
6 Openness to experience	-0.36 ***	0.34 ***	-0.09	0.28 **	-0.05	1.00						1.44
7 Risk-taking propensity	-0.17	0.25 **	0.13	-0.04	-0.15	0.23 *	1.00					1.26
8 Natural sciences	0.21 *	-0.17	-0.16	-0.07	0.06	-0.19	-0.03	1.00				(reference)
9 Economic sciences	-0.14	0.12	0.12	-0.01	-0.01	-0.02	0.06	-0.64 ***	1.00			1.39
10 Social sciences	-0.08	0.05	0.04	0.09	-0.05	0.25 **	-0.03	-0.39 ***	-0.46 ***	1.00		1.45
11 Nature of knowledge	0.30	-0.09	-0.11	0.09	-0.14	0.07	-0.24 *	0.18	-0.17	-0.01	1.00	1.19

<sup>a</sup> n = 65

\*\*\* p<0.01; \*\* p<0.05; \* p<0.1

Table 6 provides the estimation results for three logistic regression models with robust standard errors. The first model provides results for the estimation on founding out of the university context by including only control variables. We find a positive significant influence of the extent of knowledge on the probability to found out of the university context. This means, founders out of the university context transfer significantly more knowledge developed at the university. The second model includes our explanatory variables of the Five Factor model. We find lower levels in the dimension of conscientiousness for individuals founding out of the university context and therefore we are not able to confirm hypothesis H1. However we are able to show that individuals founding out of the university context possess lower levels of openness to experience and thus confirm hypothesis H4. Another central result is that the level of agreeableness is higher for entrepreneurs out of the university context, which confirms hypothesis H5. We also find support for hypothesis H2 stating that founders out of the university context and founders outside the university do not differ in terms of emotional stability. However, with our results we are not able to confirm hypothesis H3 that individuals out of the university context possess lower levels of extraversion.

As we expect some graduates to engage in entrepreneurship more often than others as traditionally in the fields of medicine or law, we also provide a third model, which includes a medical dummy (since only one lawyer is in the sample). The results, shown in column three of Table 6, remain unchanged. Even more, we find no further explanatory power of the medical dummy. For the second and third model we also find the expected positive association of the nature of knowledge on the probability of being a founder out of the university context. Furthermore, we find that founders out of the university context possess lower levels of risk taking than founders outside the university. We did not find any significant difference between the two groups of founders concern-

ing the field of study. We also estimated predicted probabilities and provide the results and the number of correctly identified entrepreneurs in

Table 7, finding 60 of 65 cases being correctly specified, which strongly supports our model. Thus sample size seems not an issue in the analysis.

**Table 6: Determinants of starting a business out of the university context<sup>a</sup>**

	Model 1		Model 2		Model 3	
<b>Independent variables</b>						
Extraversion			0.24	(0.53)		0.21 (0.57)
Agreeableness			1.87	(1.01)	*	2.12 (1.14) *
Conscientiousness			-1.12	(0.64)	*	-1.32 (0.73) *
Emotional stability			-0.52	(0.65)		-0.56 (0.65)
Openess to experience			-2.38	(0.82)	***	-2.42 (0.79) ***
<b>Control Variables</b>						
Risk-taking propensity	-0.50	(0.39)	-1.57	(0.90)	*	-1.67 (0.96) *
Economic sciences	-0.90	(0.95)	-0.89	(1.70)		-1.43 (1.74)
Social sciences	-1.28	(1.22)	-2.13	(2.00)		-2.73 (2.25)
Nature of knowledge	0.62	(0.35)	1.96	(0.67)	***	2.05 (0.65) ***
Medical degree						-0.74 (1.58)
Observations	65		65		65	
Log likelihood	-20.30***		-11.33***		-11.30**	
Pseudo R <sup>2</sup> (Chi <sup>2</sup> )	0.16		0.53		0.54	

<sup>a</sup> n = 65; Coefficient estimates for the logistic regression model. Heteroskedasticity-robust standard errors in parentheses; Reference group is the study field of natural sciences.  
\*\*\* p<0.01; \*\* p<0.05; \* p<0.1

**Table 7: Analysis of predicted probabilities<sup>a</sup>**

		Founders out of the university context	
		1	0
Predicted probabilities	1	4	2
	0	3	56

<sup>a</sup> n = 65; 60 cases correctly specified (corresponding to 92.3%)

Our sample comprises 65 entrepreneurs from which eight are situated in the university context. Therefore, we conduct a further, more detailed analysis using Nearest Neighbor Matching method as the selection into one or the other group of founders may not be at random and could depend on unobserved factors relating to the individual. A way to reduce a potential selection bias by such confounding factors is the use of propensity score matching. In reality we can only observe effects of personality traits in the case that an individual is either employed at the university before founding the venture or not. This means, that we can not measure the effect of personality traits for the case that a founder out of the university would not have been employed at the university before. Based on non-parametric estimates, the Nearest Neighbor Matching method in propensity score matching will evaluate differences in the dimensions of the Five Factor model by comparing founders out of the university context to founders outside the university who are as similar as possible (Caliendo and Kopeinig 2008; Harder et al. 2010).<sup>5</sup> As there are five dimensions of the Five Factor model we estimate five comparison models. To estimate the propensity score we use demographic variables such as field of study, gender and the age when the individual started the company (Rubinstein 2005) as well as the nature of knowledge transferred from the university to establish the company. The propensity score satisfies the balancing property. Compared to the results of the logistic regression, matching only nearest neighbors shows a slightly different picture, as can be seen in Table 8. While the results for agreeableness and openness to experience are significant, the effect of the dimension conscientiousness between the types of entrepreneurs is not significant, suggesting that its relevance might be more circumstantial or sensitive to distributional aspects. However, together the univariate

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<sup>5</sup> We also use Kernel Matching method and receive qualitatively the same results. Kernel Matching uses all observations of the control group and weights the distance between the propensity scores inversely whereas Nearest Neighbor Matching searches the nearest observation of each treated unit in a forward and backward exploration. For both methods we excluded observations outside the common support region. Results of the Kernel Matching method are available upon request.

analyses based on propensity score and the t-tests pick up exactly those significant effects found in the multivariate regression and thus this sensitivity test confirms the results of the hypotheses testing.

**Table 8: Propensity score estimations based on Nearest Neighbor Matching method<sup>a</sup>**

Variable	University founders		Non-university founders		University vs. non-university
	Mean	SD	Mean	SD	p-value of ATT
Extraversion	4.13	0.83	5.00	1.34	-0.875 (0.648)
Agreeableness	4.25	0.46	3.25	0.91	1.000 (0.407)**
Conscientiousness	5.00	1.31	6.00	1.10	-1.000 (0.706)
Emotional stability	4.50	1.20	4.63	0.53	-0.125 (0.598)
Openness to experience	4.50	0.93	5.63	0.76	-1.125 (0.344)***

<sup>a</sup> n = 65; 8 entrepreneurs out of the university context (university founders) with matched entrepreneurs not employed at the university while starting the company (non-university founders); Nearest Neighbor Matching method (random draw version); ATT (average treatment effect on the treated) is the average gain from the treatment for those who were actually treated (inside the university surrounding); Bootstrapped standard errors are presented in parentheses (N=500); p-values are calculated based on critical values;

\*\*\* p<0.01; \*\* p<0.05; \* p<0.1

To ensure that our findings are actually reflecting the theoretical considerations on which our hypotheses are based we provide further affirmation that the dimensions of the Five Factor model explain differences between entrepreneurs in more detail than differences in self-selection processes of the graduates, e.g., in their decision to work at the university or in the private sector. Regression results on the dependent variable of working at the university or not after finishing the studies in the whole sample of university graduates show a weaker predictive power compared to the results when distinguishing between different types of entrepreneurs. Graduates that decide to stay at the university after finishing their studies are less open to experience and less often from the field of economic and social sciences. Furthermore, and as discussed above, estima-

tions on the engagement in entrepreneurship show once more only one dimension of the Five Factor Model, namely extraversion, to be significant and also a lower explanatory power. Based on the findings we can show that the dimensions of the Five Factor Model have thus higher predictive power and seem to be better suited to distinguish between entrepreneurs out of the university context and entrepreneurs in general than between entrepreneurs and non-entrepreneurs as well as between university employment or not after graduation. This supports our theoretically developed hypotheses and provides additional evidence that university entrepreneurs are different.

## **2.5. Conclusion and discussion of research findings**

Our paper set out to clarify the association of personality traits with entrepreneurial activity out of the university context compared to entrepreneurs outside the university context. We relate our research specifically to the dimensions of the Five Factor model and its importance in explaining person-environment fit. We find that the dimensions of openness to experience, agreeableness and to some extent conscientiousness differ amongst the types of entrepreneurs and as expected we also do not find any difference for the dimension of emotional stability. However, we find no difference between the types of entrepreneurs for the dimension extraversion. One reason for this might be that a scientist who engages in entrepreneurship possesses a level of this dimension higher than other scientists, but similar to any other founder outside this context. For example, in an academic environment prior work experience with private firms and personal experience with industry cooperation lead to a positive attitude towards switching to entrepreneurship (Fritsch and Krabel 2012), which might be facilitated through higher levels of extraversion (Roberts 1991). Our finding of lower levels of openness to experience shows that individuals out of the university context are less likely than the typical entrepreneur to enter uncertain situations. A researcher is familiar with uncertainty con-

cerning the process of research, but future career plans are foreseeable and even so they are sometimes not secure, they are certain in terms of temporal progression. As well, we find that individuals starting their business out of the university context possess higher levels of agreeableness. This is likely because scientists need to work together in research activities and play nondiscriminatory as reputation is of high importance and cooperation partners are well-known.

Previous research results suggest a valuable influence of the personality on the probability to engage in entrepreneurship. An entrepreneur is expected to possess higher levels of conscientiousness, extraversion, emotional stability and openness to experience as well as lower levels of agreeableness (Zhao and Seibert 2006; Zhao et al. 2010; Caliendo et al. 2011). Analyzing scientists founding out of the university context suggests that this does not hold for all kind of entrepreneurs, supporting the argument of Gartner (1985) on the variation within the group of entrepreneurs. Additionally, our findings indicate that entrepreneurs out of the university context possess lower levels of risk-taking propensity than founders outside the university. It is plausible that a scientist who decides to establish a spin-off is strongly convinced about the business idea and values the potential outcome of the process highly promising. This means, scientists will build ventures based on scientific findings even without being high risk-takers. This finding also speaks to the discussion about the broad and narrow approach of the Five Factor model and supports the opinion that risk-taking propensity is an important personality trait besides the dimensions of the Five Factor model (Paunonen and Ashton 2001; Caliendo et al. 2011). As expected, the influence of the nature of knowledge is significantly positive related to the probability to found out of the university context, suggesting a substitutive relationship with personality traits, which will be discussed below.

In summary, our study provides evidence for differences between founders from different contexts, specifically for those emerging inside versus outside the university. Our results support that entrepreneurs as a group are not homogeneous, suggesting also that personality is important, but mediated by interaction with organizational or societal factors (Cromie 2000). Scientists that found out of the university context possess lower levels of openness to experience and might be inhibited easily through barriers in the early founding stages. Therefore, in terms of practice and policy implications our results suggest to offer supporting structures for founders out of the university context and evenly important, to communicate this support in an adequate and frequent way to increase the probability of scientists to engage in entrepreneurship (Goethner et al. 2012). One possible way to decrease structural obstacles and increase the technology transfer activity of scientists could be provided by the offer of economic incentives. Another approach of high importance is to consider and handle the conflict a scientist faces between promotion policies and the engagement in technology transfer activities. While promotion is mostly based on publications and research quality, engaging in patenting and the creation of companies is hardly of value in this respect (Renault 2006).

Given the differences we identified, it is also possible that academic institutions crowd out personality traits that have been shown relevant for pursuing entrepreneurial activities, which is indicated by the substitutive link of knowledge and personality traits identified above. This could be mitigated by supporting team forming, since founders out of the university context possess higher levels of agreeableness and therefore might fit better in a team. Given that team start-ups have better success perspectives than single individual foundations, especially in the context of high-tech and knowledge intensive industries (Müller 2006), dedicated structures to help entrepreneurs out of the university context to find adequate team members to establish a company could be particu-

larly effective and might even turn this personality trait into a strength for both, the founding process and the start-up success. Furthermore, technology transfer offices could support spin-off processes by connecting graduates with entrepreneurial experience and founders out of the university context to get the best of both, personality traits conducive for entrepreneurship and high knowledge transfer in the context of teams. More generally, identifying areas where university entrepreneurship differs from ventures outside academia helps to identify targeted measures to improve the skill set of academic founders out of the university. For example, these could be educated about the expected effects of the different traits of the Five Factor model. Hence, their attention could be directed towards assessing their own levels of openness to experience, agreeableness or conscientiousness. Also, dedicated coachings or exercises could be offered to them (for example by technology transfer offices in the overall process of supporting their spin-off activity) to systematically reflect their performance in the above or other relevant dimensions. This could also imply offering suitable psychological diagnostic tools as part of university-internal support schemes. In summary, our results contribute to better providing guidance to any technology transfer office supporting scientists in their spin-off process and to better address the specific needs of founders out of the university context, for example by means of the detailed suggestions above.

## **2.6. Limitations and further research areas**

Our study has some limitations that also point to future research needs. Firstly, we cannot control well for cross-causality, as personality traits and the foundation of a company were recorded with the same questionnaire. Building up a successful company might have been the reason why individuals develop specific entrepreneurial traits. However personality traits have been shown to be stable over time (Roccas et al. 2002) and experiencing adverse life events that are economically meaningful seems to be gen-

erally unrelated with changes in personality, suggesting that the dimensions of the Five Factor model can be seen as a stable input to the analysis (Cobb-Clark and Schurer 2011).

Secondly, using further personality characteristics matched closer to the tasks of the entrepreneurial activity might yield even stronger evidence of differences between the various types of academic entrepreneurs. For example, Rauch and Frese (2007) found strong correlations between the personality traits generalized self-efficacy, proactive personality, innovativeness and achievement motives, and entrepreneurial behavior. Therefore, they highlighted the importance to connect personality traits to the tasks an entrepreneur really has to fulfill. These tasks may even differ across the foundation process and traits which were helpful to start a company may become hindering in the process of growing the business. Further analysis could thus use sub-elements of the dimensions of the Five Factor model to clarify if any differentiation between possible divergent influences provides additional insights. This could specifically be of use concerning the dimension conscientiousness. Future research should investigate the two sub-elements of this dimension “need for achievement” and “dependability and dutifulness” to assess potential differences between types of entrepreneurs.

### **3. Different breeds, different needs: How university spin-offs differ in composition and interaction – a qualitative approach**

#### **Abstract**

During their early development, academic spin-off projects are embedded in the context of research institutions. However, knowledge is still lacking on whether the influence of university structures on spin-off projects or the immanent factors of these projects vary across research disciplines or university departments. To enhance our understanding of the development of spin-off projects, it is necessary to identify strategies focusing on the specific characteristics of spin-off projects within a single research institution. In our study, we address the interactions of spin-off projects and several factors within one university. Data on spin-off projects from 2007 to 2013 were collected via interviews at a large German university. In addition, secondary data from all the spin-off projects were analyzed. We inductively derive four types of spin-off projects that interact differently with the university, and by concentrating on the specific needs of each type, we are able to provide a framework on how to identify spin-off groups and implement target-oriented support mechanisms.

### 3.1. Introduction

The evolution of the entrepreneurial university and its aim of uniting research, teaching, and technology transfer is of interest in entrepreneurship research. The entrepreneurial university takes its own strategic position in the (regional) surrounding and establishes optimized processes to foster entrepreneurship and technology transfer (Etzkowitz 2008). New firms exploiting university knowledge are one important method of technology transfer, and they influence economic activity in general (Di Gregorio and Shane 2003; Etzkowitz 2008). In addition, possible knowledge spillovers from universities can influence the locational choices of young and new firms and can therefore enhance regional development (Audretsch et al. 2005; Audretsch et al. 2004). To foster entrepreneurial activities at research institutions and to overcome the knowledge filter—known as a gap between investments in new knowledge creation and their commercialization (Audretsch et al. 2006; Acs et al. 2010)—legal regulations have been introduced, and the importance of university-based spin-off projects is publicly stimulated. For example, in 2002, the law for inventions made by employees of universities in Germany (“Arbeitnehmererfindungsgesetz”) changed significantly (§§ 42, 43 ArbNErfG). The so-called “Hochschullehrerprivileg,” which ensured all scientific researchers the sole ownership of their inventions, was abolished. This step should ensure the commercial exploitation of university-based knowledge and inventions to provide valuable solutions for major problems in society. The overall changes promoted both the establishment of TTOs at universities and an increasing awareness of the commercialization of research results.

The European Commission stated that compared with the valuable output that researchers in Europe produce, the exploitation of new inventions and research results remains low (European Commission 2007). Most OECD countries, except the US, have

a maximum of a dozen spin-offs a year (Degroof and Roberts 2004), and even in the US, only some universities, such as MIT or Stanford, are known for their large numbers of spin-offs. Although the Bayh-Dole Act—a legal regulation to foster the commercialization of university-based knowledge—was introduced in the US almost twenty years before the law in Germany changed, most American universities still have only limited numbers of spin-off formations (O’Shea et al. 2005; Mustar et al. 2008). This means that most universities in the US may face similar problems to those in Europe. Thus, we require answers on how university spin-offs evolve and how support mechanisms should be structured. In the recent literature, stage-gate models were used to describe the evolution of spin-off projects within the university context (Vohora et al. 2004; Degroof and Roberts 2004; Vanaelst et al. 2006; Clarysse and Moray 2004; Ndonzuau et al. 2002). These models are valuable in understanding spin-off formation and performance, but they cannot provide sufficient answers alone. Approaches that include interdependencies between individuals and the entity they are facing—in this case the university surrounding—are needed to gather insight into the complex process of spin-off formation (Rasmussen 2011). Furthermore, it is important to address these key issues in parallel and thereby provide a systematical categorization of spin-off activity. The importance of the overall university structure and university management’s strategic choices to support spin-off activities, especially in the early phases of the spin-off process, has been demonstrated in a variety of studies; this was called the “institutional perspective” by Mustar et al. (2006). However, we still lack knowledge regarding the influence of specific factors within universities and the heterogeneity of spin-off projects and therefore need to conduct research on the level of departments and research centers (Rasmussen et al. 2014; Wright et al. 2004). Here, we analyze the differences between spin-off projects and their associated needs and interactions within one univer-

sity. Data was collected at a large German university via interviews with an expert in the advisory network and members of spin-off projects from 2007 to 2013. Furthermore, intensive talks were held with representatives of the university, and we analyzed the secondary data from all spin-off projects.

The paper proceeds as follows. In the next chapter, in the literature review, we will show how individual or team characteristics and the university influence the development of spin-off projects. We then describe the research setting and the approach of the empirical analysis. After that, the results are presented, and we conclude the paper with a discussion on the findings, practice and policy implications, and limitations and further research needs.

## **3.2. Literature review**

Stage-gate models assume that spin-off projects develop within universities through defined steps or stages. These models are valuable in understanding spin-off formation and performance (e.g., Vanaelst et al. 2006). There is no congruent opinion on how the stages are named, how long they persist, or when a project moves from one stage to the next. However, if a critical juncture (the step from one stage to the next) cannot be taken for a prolonged period, the project will fail (Vohora et al. 2004). In the beginning, spin-off projects are embedded in the university context and highly require resources provided by the university. Furthermore, as the decisions that are made in the early phases significantly influence the development perspectives in the later phases (Degroof and Roberts 2004), it is necessary to determine what can be done in the early stages to secure the development and improve the success of spin-off projects. In this context, stage-gate models have some weaknesses, as summarized by Rasmussen (2011): they do not explain *why* projects develop, and they do not include human aspects in the spin-off formation process. While O'Shea et al. (2008) define six streams in the entrepre-

neurship literature that help to explain spin-off activities in universities, two aspects seem influential on early development: individual (team) characteristics and variations in the environment (the university). In the following, we will provide an overview of the existing research results on both aspects.

The importance of human capital in academic spin-off processes has been discussed broadly in the literature. The focus lies in individuals' personal characteristics, such as demographic factors (e.g., academic background, career development, age, gender), experiences (in research or cooperation), motivational factors (push and pull factors), cognitive skills, and personality traits (Fritsch and Krabel 2012; Caliendo and Kritikos 2012). The importance of personal characteristics for entrepreneurship has been demonstrated in various studies (Wright et al. 2004; Rosa and Dawson 2006; Caliendo et al. 2011; Fritsch and Krabel 2012). However, personality traits seem to be linked in a substitutive way to the nature of knowledge transferred from universities (Kolb and Wagner 2015). There has also been a focus on the career choices of scientists, including their willingness to engage in entrepreneurship, and on the possibly conflicting goals of academic and commercial activities (Fritsch and Krabel 2012; O'Shea et al. 2008). Teleological theory concentrates solely on the individual in the entrepreneurial process and assumes rational behavior. This means every action is guided by a purpose or a final goal. Therefore, the entire spin-off formation process can be described as involving the ongoing formulation, implementation, evaluation, and modification of self-set goals (see Rasmussen [2011] for an adaption to the entrepreneurship context). The various key individuals in the process of spin-off development are the researcher or inventor, the academic or surrogate entrepreneur (Franklin et al. 2001; Lockett et al. 2003), and the privileged witnesses (Vanaelst et al. 2006). In addition, with regard to human capital aspects, team composition and team processes provide insights into academic entrepre-

neurship (Wright et al. 2007b; Vanaelst et al. 2006; Clarysse and Moray 2004; Ucbasaran et al. 2003), and the social capital of the individuals is important in the entrepreneurial setting for establishing networks and attracting the resources necessary for the spin-off (Shane and Stuart 2002).

The overall importance of the university setting in the initiation and development of spin-offs has also received considerable attention. In a seminal work, Mustar et al. (2006) categorize the heterogeneity of research-based spin-offs by reviewing the existing literature; they find a resource-based perspective, a business model perspective, and an institutional perspective of analysis, and they then developed two major areas of interest: the creation and the development of research-based spin-offs within universities. An important element for both areas are TTOs. TTOs are established to foster university–industry linkages and to support researchers and other members of the university in the entrepreneurial process. The task of TTOs varies slightly, but the principle aim of any TTO is to evaluate inventions and manage and enhance the value of intellectual property rights (Roberts and Malone 1996). They also provide access to other support structures important for the commercialization of university knowledge and the development of spin-offs. However, TTOs have been criticized as being inflexible and conservative. In interviews with entrepreneurs and scientists, Siegel et al. (2003) found that the skills of TTO staff regarding marketing and negotiation tasks are seen as unsatisfactory. Furthermore, because they use the same mechanism for each spin-off project, TTOs seem to speed up complex projects while decelerating less complex projects (Vanaelst et al. 2006). While the characteristics of a TTO, such as the division of labor in tasks, can explain performance differences, which are measured by the number of invention disclosures (Hülsbeck et al. 2013), and though TTOs have received a lot of attention (e. g. O’Shea et al. 2008), they are not the only factor influencing entrepre-

neurial activities within a university. Departmental level and colleagues (Rasmussen et al. 2014; Stuart and Ding 2006), cultural setting and group norms (Bercovitz and Feldman 2008; Wright et al. 2004), the nature and importance of knowledge transferred from the parent organization (Kolb and Wagner 2015; Pirnay et al. 2003), and the parent organization's strategic choices regarding spin-off support (Clarysse et al. 2005; Di Gregorio and Shane 2003) have also been shown to influence spin-off creation and development. Furthermore, academic institutions need to be aware of the influence that perceived support has on the interest of their academics to engage in spin-off activities. George et al. (2005) show that the more university factors—measured as department norms and the activities of TTOs—for entrepreneurship were perceived as being supportive, the more likely a single scientist was to be open to participating in entrepreneurial activities. Similarly, the entrepreneurial behavior of professors is influenced by social relationships and the surrounding in which the professor is embedded (Kenney and Goe 2004). Previous transitions of scientists to entrepreneurs increase the likelihood that other scientists working in the same department will engage in entrepreneurial spin-off processes (Stuart and Ding 2006). Even if the university in general promotes the entrepreneurial activity of scientists, projects could be restrained by missing resources or existing barriers within single departments or other mechanisms (Rasmussen et al. 2014). Therefore, it is valuable to shed light on specific factors within one university to see whether they have the same importance for each spin-off project from that university.

Dialectical theory explains the development process by assuming conflicts between opposing entities and the method of finding a balance in power between these entities (Van de Ven and Poole 1995). In the context of universities and the process of spin-off formation, we therefore have the entities of the individual entrepreneur or the entrepre-

neurial team opposite the specific factors of the university. It is thus important to understand the interdependability of spin-off projects' characteristics and the specific factors of the university. To enhance our understanding of support mechanisms for spin-offs, it might be necessary to develop strategies that are tailored to different types of spin-offs in the context of a single research institution (Mustar et al. 2006; Wright et al. 2004).

Our research questions are as follows:

1. To what extent and for which reasons do university-based spin-off projects differ?
2. How do spin-off projects interact with different factors of the university surrounding, and if there is not a one-size-fits-all solution, how should tailored structures look to best support spin-off projects?

### **3.3. Research setting**

With the 2002 amendment to the law regarding inventions made by employees of universities in Germany, universities can attain the rights to inventions made by their scientific employees. In addition, government grants have been introduced to foster the entrepreneurial activities of scientists, such as the EXIST grant (introduced in 1999), the state-supported program GO-Bio (introduced in 2005), and programs to improve university structures to provide entrepreneurship support (introduced in 1998). The changes in legal regulations stimulated the establishment of TTOs at universities and lead to an increasing awareness of commercialization and transparency in the support of spin-off projects in Germany. The university that provided the research setting for our study is a so-called "Volluniversität" that consists of ten different faculties, ranging from the natural to the social sciences, excluding an engineering faculty. After the acquisition of a government grant to develop support structures for entrepreneurial activities, the univer-

sity provides a solid surrounding since 2007. Since then, all spin-off projects generally experience the same university-wide structures, and we are thus able to determine the differences occurring at the departmental level or from informal methods of university support. Following Clarysse et al. (2005), we can categorize the university as being between the low selective mode and the supportive mode over the whole time frame of our analysis, where office space (incubator premises), infrastructure, a permanent staff at the TTO to support spin-off activities, and a (regional) support network are available. The university chosen therefore provides a good research setting to answer questions regarding how spin-off projects differ and whether this influences their interaction with the university.

### **3.4. Data and research design**

All spin-off projects included in this paper took part in a government incentive program to foster spin-off projects that use university knowledge. This validates that the projects have moved from a single research orientation towards a focus on own business possibilities to establish a company and/or prove the market potential and validity of the business idea. Furthermore, we concentrated on projects from the field of natural or life sciences to focus on spin-off projects that have a strong link to the university due to the higher requirements of university-based technical resources. In the final dataset, we included only projects occurring since 2007 to ensure a homogenous background with regard to the availability of government support programs and a stable overall university structure.<sup>6</sup> This led to a possible sample size of 22 spin-off projects from the university supported by a government grant and from the field of natural and life sciences.

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<sup>6</sup> For our analysis, we first identified spin-offs and spin-off projects in the period from 2004 (due to the changes in the legal regulations and the fact that several transitional regulations existed for a year after 2002, for example, universities were still able to provide all rights to the inventor) to 2013. We then decided to exclude projects occurring before 2007 to guarantee a similar university setting. Only one spin-off project and one legal establishment from the field of natural and life sciences from 2004 to 2006 had to be excluded. This also provides evidence for the decision to start our analysis in 2007.

Seven of these spin-off projects were legally independent capital companies, five spin-off projects were not legally established and ten spin-off projects no longer engaged in business development. Including projects that failed throughout the process makes our dataset more representative. We summarized information regarding all the spin-off projects using secondary data available on the project homepages and from the participants, who were asked to provide background information. Primary data was collected through interviews with project team members and an expert in the field of spin-off support in the region, as well as by intensive talks with representatives of the university support system. The sample strategy used is therefore a pre-test definition of the projects we want to include. We thoroughly re-checked our sample throughout the data collection period by asking the interviewees and the experts whether they knew of other projects (Flick 2002; Vanaelst et al 2006). Our sample is thus representative because we did not find any projects not included in the first place and because our approach concentrates on spin-offs from natural and life sciences that use a government grant. We decided to use qualitative research because it is a valuable method for understanding processes and developing patterns and classifications. Using a comparative case study design, we can therefore derive answers from emergent findings (Eisenhardt and Graebner 2007).

Possible interviewees were contacted via email and, if necessary, called a few days after the email was sent. If the individual agreed to participate in the interview, we sent another email with further information and a questionnaire for them to fill out before the interview. The questionnaire included questions on several demographic factors and previous work experience. The interviews took place in the offices of the interviewees or in a separate conference room at the university, and the interviewee was ensured anonymity. Anonymity was necessary to obtain access to documents and reliable information from the interviewees. All interviews were held using an open approach (the

interviewee was able to answer questions freely) and a semi-structured interview form. This means that we used a guideline that we adapted in sequence or wording, depending on the interview partner.<sup>7</sup> The guideline consisted predominantly of open questions focusing on the development of the project and the influences of the university. Because we were open to any new thoughts or unknown areas that the interviewee presented, we used the guideline flexibly to adjust other aspects of the interview. Some closed questions were used during the interview to gather information on the team members' entrepreneurial skills and experiences and the nature of the knowledge used for the spin-off project (see Table 9).

**Table 9: Closed questions in the guideline**

Question wording	Description
Did you or anyone in the initial team have experience in one of the following aspects?	<i>Scale: 1 ('no experience') to 5 ('long years of experience')</i> Experience with the establishment of a company; experience in the target market (the industry in which the company should be established); management experience; experience regarding budget responsibility and financial planning; experience regarding marketing and sales; experience in the management of research projects
How important were the following factors for the establishment of your company?	<i>Scale: 1 ('not important at all') to 3 ('indispensable')</i> Specific skills that you acquired during time at the public research institution; new scientific methods that you acquired during time at the public research institution; new research results developed at the public research institution, e.g., the development of a new product or service
Please tell us the degree to which changes occurred in the following areas	<i>Scale: 1 ('no changes') to 5 ('very strong changes')</i> Technological solution or the technical approach; fundamental product or service concept; target market/target group; marketing, market entry strategy, or sales strategy; team composition

The decision to use a guideline allowed us to make concrete statements regarding the process we wanted to understand (Stigler and Reicher 2005) and enabled us to focus on

<sup>7</sup> For example, we used the same questions for the interview with the expert in the advisory network, but the questions were more generally formulated. A selected interview guideline as used for spin-off projects that established a company is provided in Table A2 in the Appendix.

the research questions (Kuckartz et al. 2008). The guideline also allowed for comparability over interviews (Aufenanger 1991) and it was first used in a pretest to identify missing information or discontinuity in the structure of the questions. Furthermore, several questions were discussed with spin-off projects in the surrounding of the TTO to eliminate any weaknesses in wording or possible double meanings. Experts from the advisory network and from the university support structures were also consulted on specific issues and for their opinions on the spin-off projects. If necessary, the interviewees were contacted for follow-up questions and validation of interpretation. During the process, the mentor of the spin-off projects was contacted for answers on the research background. All interviews were recorded and later transcribed, and conducted by the same researcher to guarantee the necessary background knowledge.<sup>8</sup> The questions were focused on the interactions between the spin-off project and specific factors of the university during project development. The questions covered aspects about initial team formation and development, critical junctures and resources, the decision to go forward with an idea, the decision to establish a company (if done), the influences of the chair, the attitudes of colleagues, the attitude and behavior of the mentor, and other influences within the university. Further information was gathered on other influences in the surrounding of the university and on the development of the relationship between the project and the university, the project's expectations towards the university, and any changes in the project's development path. In addition, questions were asked regarding the project's financial and funding requirements. In parallel, we analyzed the regulations and surrounding factors of the university and included secondary data, such as the business plans of the entrepreneurial projects or the presentations of the teams. Infor-

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<sup>8</sup> Detailed information on the transcription process is available in Table A3 in the Appendix.

mation regarding the spin-off projects was collected both before and throughout the research process.

We conducted our analysis using a qualitative content analysis that was mostly based on the work of Mayring (2010). Qualitative content analysis is well established and enables a theory-based assessment while still being able to adjust to the data collected. Due to its systematic approach and clear regulations, qualitative content analysis allows for intersubjective confirmability (Mayring 2010). The analysis was conducted in MaxQDA11,<sup>9</sup> and the coding of information from the interviews into categories was done based on the research questions. We tested the codes on two or four interviews to prove their applicability (Kuckartz et al. 2008).

Data analysis and further data collection was done in parallel and recursively (Eisenhardt 1989). This allowed us to structure our information based on the specific topics which we were interested in. The next step was a first paraphrasing of the content of the categories; we used the abstraction level of a single interview to select important issues and to clear doubled paraphrases. A second reduction process on a higher abstraction level was done after re-checking the categories in the original sample and by combining the information across interviews. This was possible due to the application of a guideline. After restructuring and summarizing the information in the data, we evaluated the findings based on former research results and theoretical assumptions (Mayring 2010; Stigler and Reicher 2005; Meuser and Nagel 1991). Throughout all steps, we made content aspects more important than arguments based on the research procedure (Mayring 2010; Bähring et al. 2008). This allowed us to be open to new findings in the data (Meuser and Nagel 1991).<sup>10</sup>

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<sup>9</sup> MaxQDA is a program developed by Kuckartz at the FU Berlin in the early 90s to support qualitative data analysis of communication content.

<sup>10</sup> The code system and the full model of analysis are provided in Tables A4 and A5 in the Appendix.

We provide an assessment of the research design based on the findings of Gibbert et al. (2008) regarding quality criteria for qualitative research. The internal validity of the study design is ensured by deriving our research questions from the literature and taking into account both earlier research results in the field and several theoretical streams. Construct validity is ensured through the use of different data sets, including secondary data and interview data. Furthermore, we worked transparently in the collection of data and the analysis process. Due to the nested approach and the sample selection (i.e., in the first step, we included all spin-off projects and thoroughly deleted projects not suitable to our research aim), we can also guarantee external validity. Reliability can be provided by thoroughly processing and storing all data collected during the process, such as reports on the cases, interview transcripts, and secondary data.<sup>11</sup>

### **3.5. Results**

After contacting project members from the pre-selected spin-off projects, we were able to include 11 projects in our analysis. The projects are labelled A to K. Due to the secondary data, the distribution of the final sample in comparison to the full sample,<sup>12</sup> the interview with the expert in the advisory network, and the interactions with members of the support network, we can confidently provide a representative sample of spin-off activities supported by government grants.

#### **3.5.1. Different groups of spin-off projects**

We found that spin-off projects differ significantly in two initial points, which we will present first. Differences are found regarding the initial providers of the (business) ideas and their scientific background and in the nature of the knowledge—technology or competences—used to start the spin-off process. In the next step, we show commonali-

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<sup>11</sup> Protocols and the anonymized database are available upon request from the authors.

<sup>12</sup> Four projects are legally established companies, one project will soon legally establish a company and six spin-off projects no longer engage in business development. Therefore, we were able to include projects from all developmental stages.

ties and differences in the way that spin-off projects interact with university structures. We inductively identified four different groups of spin-off projects using government grants to develop their ideas: *sciencepreneur*, *professorialpreneur*, *postdoctorialpreneur*, and *contextpreneur*. We are able to show more commonalities for spin-off projects within one group compared to projects in other groups. We will first provide information on the different groups and the spin-off projects within each specific group with regard to their initial differences. For detailed information on the sample, we provide an overview of the spin-off projects in Table 10.

**Table 10: Sample overview**

Characteristics of the groups	Sciencepreneur			Professorialpreneur				Postdoctorialpreneur		Contextpreneur	
	B	C	J	E	G	H	K	D	F	A	I
<b>Field of technology</b>	Medical science	Medical science	Medical sciences	Medical science	Veterinary science	Medical sciences	Medical sciences / Biology	Pharmaceutical Chemistry	Pharmaceuticals	Geography	Physics / Engineering
<b>Business model</b>	Product development	Drug development / Product	Drug development / Product	Medical diagnosis / Service	Product development	Medical diagnosis / Service	Product development	Product development	Medical diagnosis / Service	Product development / Software	Product development
<b>Source of initial idea</b>	Basic university research	Basic university research	Basic university research	Basic university research	Basic university research	Basic university research	Basic university research	Basic university research	Basic university research	Competences acquired	Competences acquired
<b>Initial provider of the idea (time of project start)</b>	1 professor + 1 postdoc (+1 postdoc)	1 professor + 1 postdoc	1 professor (+1 postdoc)	1 professor	1 professor	1 professor	1 professor + 1 phd	1 postdoc	1 postdoc	2 phd + 1 alumni	2 alumni
<b>University-owned intellectual property</b>	Yes	Yes	Yes	No	No	No	No	Yes	Yes	No	No

### Sciencepreneur

The first group is called *sciencepreneur*; in this group, projects develop after many years of preceding research. The projects have a high innovative potential but are in the early phases, where much research still has to be done. The initial team comprises several experienced researchers in the domain who want to engage in entrepreneurship but do not plan to leave the university context. The group includes projects **B**, **C**, and **J**.

### Professorialpreneur

In the second group, a professor is the initial idea provider. Many years of research precede the project, but most of the basic scientific work is done. The professor provides the initial input for the spin-off project and starts to build a team. The initial idea provider continues to concentrate on the scientific career and wants to engage in entrepreneurship in parallel. The group includes projects **E**, **G**, **H**, and **K**.

### Postdoctorialpreneur

For the third group, opportunity recognition was possible due to several years of preceding research and the unique know-how of the researcher who started the project. The researcher is in a postdoctoral position at the university and as the initial idea provider begins to acquire further team members. The researchers are in a phase where they plan to engage in entrepreneurship but scientific career progress is also a possibility. The group consists of projects **D** and **F**.

### Contextpreneur

The fourth group identified is the *contextpreneur*. The initial idea providers are several graduates who have known each other for some time and who have worked together on idea development. The idea is based on the competences and know-how gained at the university. These individuals do not want a scientific career besides their entrepreneurial activity. The group includes projects **A** and **I**.

A summary of the findings on the initial setting with regard to the idea provider(s) and their scientific background is provided in Figure 2.

**Figure 2: Categorization of spin-off groups with regard to the initial idea provider(s) and their scientific background**

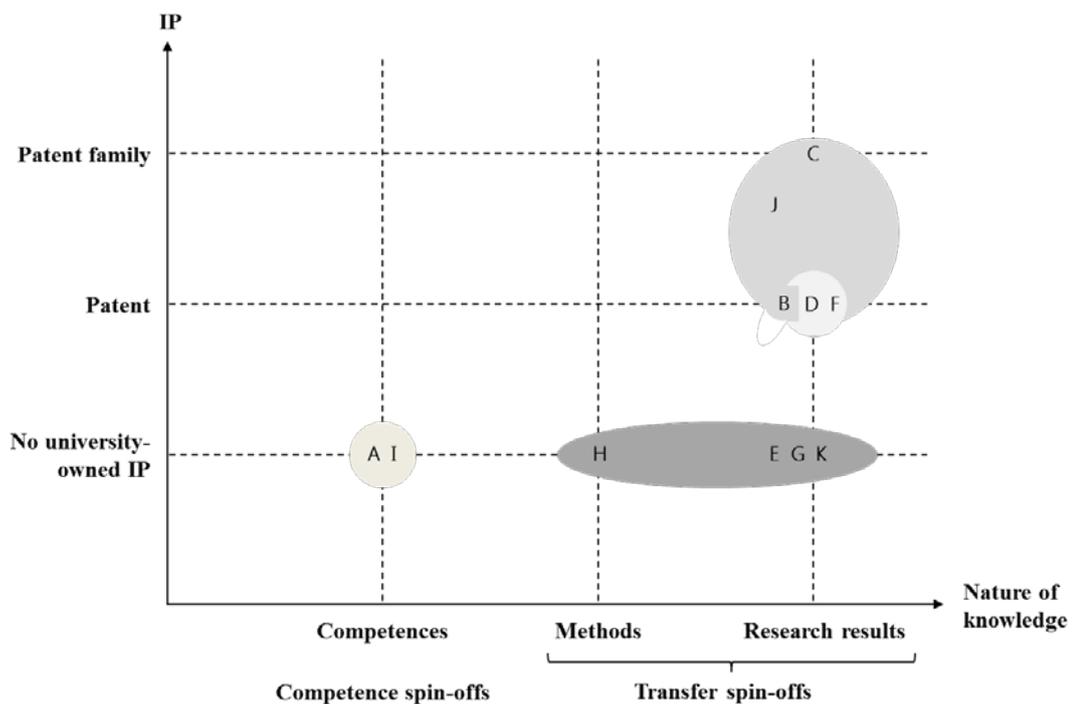
<b>Long scientific experience</b>	<b>Professorialpreneur</b>	<b>Sciencepreneur</b>
	<ul style="list-style-type: none"> <li>- Scientific career intentions</li> <li>- Most research work done</li> <li>- No university-based IP</li> <li>- Cases: E, G, K, H</li> </ul>	<ul style="list-style-type: none"> <li>- Scientific career intentions</li> <li>- More research work needed</li> <li>- University-based IP</li> <li>- Cases: B, C, J</li> </ul>
<b>Short scientific experience</b>	<b>Postdoctorialpreneur</b>	<b>Contextpreneur</b>
	<ul style="list-style-type: none"> <li>- Unclear scientific career intentions</li> <li>- Most research work done</li> <li>- University-based IP</li> <li>- Cases: D, F</li> </ul>	<ul style="list-style-type: none"> <li>- No scientific career intentions</li> <li>- Idea development</li> <li>- No university-based IP</li> <li>- Cases: A, I</li> </ul>
	<b>Single key individual</b>	<b>Several key individuals</b>

(Own illustration)

In addition, we collected detailed information on the know-how and technology used to start the spin-off project. The nature of knowledge was measured in two ways. First, we asked the interviewees about their use of university knowledge. Based on their answers, the spin-off projects were classified as transfer spin-offs if either research results or methods were seen as indispensable, or they were classified as competence spin-offs if the same held for competencies acquired at the university (Egeln et al. 2002; Müller 2010). Second, secondary data showing the assignment of intellectual property (IP) from the university to the spin-off projects were used and combined with the self-

reported answers of the team members. For the groups *sciencepreneur*, *professorialpreneur*, and *postdoctorialpreneur*, research results and methods are highly important, which classifies them as transfer spin-off projects. But while projects in the groups *sciencepreneur* and *postdoctorialpreneur* are based on patentable ideas, the projects in the group *professorialpreneur* are not based on university-based intellectual property rights. Projects from the group *contextpreneur* use algorithms and know-how and are not secured by university intellectual property rights. They depend on the skills and competences that the initial idea providers have gained at the university, and they can be classified as competence spin-offs (see Figure 3).

**Figure 3: Categorization of spin-off groups with regard to the nature of knowledge and university-owned intellectual property (IP)**



(Own illustration: Projects A and I comprise the *contextpreneur* group; projects E, G, H, and K are in the *professorialpreneur* group; projects B, C, and J are in the *sciencepreneur* group; and projects D and F are in the *postdoctorialpreneur* group.)

### 3.5.2. Interaction points between the different groups and the university

During their development in the university setting, spin-off project members need to work on a business model and must acquire capabilities and knowledge of entrepreneurial processes. Furthermore, they need to acquire the resources necessary for the business model, such as seed funding, further team members, and key customers. These tasks are the same for each project in each group. In the next step, based on the different groups, we will show how spin-off projects interact with specific points of the university to fulfill these tasks. We found four interaction points with varying levels of importance for the specific groups:<sup>13</sup> To acquire a government grant, the projects need the official support of a so-called “mentor,” who must be a chair holder or full professor; this is the first interaction point. The second interaction point is the “chair surrounding,” which includes the direct surrounding of the project team. The third is the “university surrounding,” which includes every interaction outside the own chair setting or institute, and the fourth is the “TTO,” which includes interactions with the technology transfer office. In the following, we will provide information on the interaction points for each group.

#### Sciencepreneur

Spin-off projects in this group receive mostly scientific-content-based input from the **mentor**. According to a member of team B: “...*open conversations with the chair holder, who has advice on the product or on steps to watch out for, were very beneficial.*” The projects are not supported proactively but experience a fertile ground in their direct surrounding. For example, for all projects in this group, the mentor already had experience with spin-off processes or knew someone who had already engaged in entrepreneurship. Furthermore, the chair holder guaranteed the projects the freedom to operate,

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<sup>13</sup> We also took into account other possible interaction points with the university, e.g., the influence of colleagues, but did not find significant differences. In all groups, the attitudes of colleagues were similar, ranging from neutral to interested, but they were always stated as not directly influencing project development.

as pointed out by a member of project C: *“The chair holder was not highly involved but guaranteed the freedom to work...”* This was also mentioned by a team member of project B: *“no one advised the team to move toward a spin-off project, but the chair holder provided indirect support through flexibility in time and space to work on the development of the project.”*

The spin-off projects are comparable to other research projects running at a department. The most critical aspect for this group of spin-off projects are human resources, for the scientific development, available within the **chair surrounding** or working group. This includes the employment of university staff with money from the government grant and the know-how from other chair members, as well as the possibility of having regular PhD students working on the project or students writing their final theses in the field. This was mentioned by members from all projects and can be summarized by a member of project C: *“...in the evening, we could sit together and talk [...] the working group was comfortably financed due to the government grant.”* The employment status of the scientists involved does not change, and all members stay employees of the university. Furthermore, the chair and the spin-off projects work together in joint research projects and can both profit from mutual work progress, as summarized by a member of project B: *“...interplay makes it possible to proceed in research projects that would not have been done otherwise, enables the employment of researchers, and fosters the motivation of the team members to spend more working hours on the project, which ends up in more publications for the university.”* All projects are able to use the resources and infrastructure of the chair. Equally used and highly important in this group are other resources from the wider **university surrounding**, such as the premises in which pre-clinical studies can be conducted. Their usage either lowered costs or shortened the time between tests and obtaining results.

Furthermore, the projects in this group interact with the **TTO**, mainly the patent department of the TTO. Clarity on the patent situation is seen as crucial by all spin-off projects in this group. Communicating early and consistently with the patent department of the university enables quick patent strategy development, as discussed by a member of project C: *“The department for IP-protection was involved early [...], conversations and discussions about possible patent strategies took place in advance.”* Other activities of the TTO which were mentioned—though not considered as equally important—are the support given for grant applications and consultancy on business-related tasks.

### **Professorialpreneur**

As the professor is the initial idea provider in this group, the influence of the **mentor** is highly important at the beginning of the project. Furthermore, the acquisition of the team members necessary to obtain the government grant and to work on the project is actively done by the professor, and the first team members are found within the chair. The know-how necessary to develop the business model belongs to the mentor and is therefore needed to develop the project, as stated by a team member of project E: *“It would not have worked without the professor.”* This was echoed by a member of project G: *“The most important resource was the professor, with his previous experience.”* The reputations of both the professor and his/her contacts are essential for the development of spin-off projects in this group as they work as a signaling effect on the quality of the idea and provide the first cooperation partners. This is summarized by a member of project H: *“The professor had a good reputation and plenty of publications using the method, which underpins the project scientifically. [...] it was good that I published myself, but it would have worked solely with the scientific reputation of the professor.”* This was also stated by a member of project E: *“Contact with the actual customers of the spin-off project was already available.”*

For the projects, the availability of premises, resources, and infrastructure in the **chair surrounding** is mostly due to the government grant. Furthermore, the know-how available from the chair—besides that of the mentor—is indispensable. The teams work on the business model, starting with understanding the processes established from their research and developing these toward commercialization. In doing so, some colleagues helped them with their knowledge about special applications or with specific problems. During the development, the project members in this group do not use other resources from the wider **university surrounding**.

All spin-off projects in this group use support from the **TTO** to write grant applications. Furthermore, the consultants support the development of the business plan, direct consideration toward economic aspects, and help with the acquisition of further team members (at other university institutes). This was stated by all interviewees, including, for example, a member of project G: “*[the consultants were] good resources for the economic part, [they] answered questions quickly and [were] aim oriented.*” Practically, this means that the team and the consultants meet on a regular basis—once a month—to discuss the project development and think about further steps. However, this support is sometimes seen as insufficient and more (external) coaching and detailed support is necessary, as summarized by the leading professor of project K: “*The team would have needed professional support from the beginning [...] The problem was that the team spent one year learning about things an expert could have done in maybe two weeks [...] If it is in the interest of the university to foster entrepreneurship, then the support of the projects should be high and intense.*”

## Postdoctorialpreneur

For the third group, the necessary knowledge about the scientific aspects of the projects belongs to the postdoc and is therefore available in the operational team of the spin-off projects. This also means that the influence of the **mentor** is more or less neutral, with a specific scientifically based motivation to support the projects. The mentor of all projects is the chair holder, and project development is also seen as a possibility for keeping the know-how of the postdoc available. The chair holder is not actively involved in the process but also does not impede it. This is clear because the postdoc—in his/her position as an “insider” already knowing the university context very well—works independently and acquires the necessary resources through his/her own network, including the acquisition of further project members.

Due to the government grant, resources and infrastructure are available in the **chair surrounding**. Furthermore, the interplay between the chair and the spin-off projects is important. Without know-how in the research area, project development would not be possible, as pointed out by a member of project F: *“[There was] a general interest in the development of spin-off projects from the research activities done by the chair as this is good for the references.”* This also leads to the acquisition of other cooperation projects between the spin-off project and outside institutions through the existing contacts of the chair. Furthermore, the existing network and contacts of the postdoc are used within the wider **university setting**. This means that other scientists for example executed measurements for the projects simply because they knew the postdoc, or as stated by a member of project D: *“The project cooperated with another department due to personal contacts as they were also potential customers.”*

The projects in this group also use the support available at the **TTO** to write grant applications. *“The application would not have been possible without this support,”* stat-

ed a member of project D. After the successful acquisition of a grant, the TTO supports the projects in the development of a business model. Members saw the advice given by the TTO as good, but again, it was sometimes seen as insufficient. The TTO also helps in finding adequate team members. The acquisition of team members is done within the whole university, mostly for members with business competences, as other members are available in the postdoc's network. Team work is a difficult area for these projects, as stated by a team member of project F: *"The team members did not understand what the other part was doing. It is not enough to have one member for the economic part and one for the scientific work. The competences need to merge."* Aside from support with business aspects, the projects also get support from the TTO regarding the possibility of patenting the results on which the idea is based. This support is seen as helpful, and patents are filed until the end of the grant period.

### **Contextpreneur**

For the fourth group, the initial input of professors regarding opportunity recognition was naturally missing. The **mentor** influences the project in a positive manner by giving free time to the team members and providing the necessary know-how and resources. But this support is more or less neutral with regard to the actual development of the spin-off project, as pointed out by a member of project I: *"The professor was a big supporter and open-minded [and] cooperative but did not influence the project's contents."* Furthermore, the mentor provides his/her own network and contacts to the teams. This seems to be valuable as long as it is both scientifically based and related to the business development of a spin-off project. Support regarding administrative issues arising due to the grant is also very important for the development of the projects. The projects experience the grant setting within the university structure as bureaucratic and time consuming, even if the mentor and his/her assistance at the chair provide good

support. As a team member from project I stated: *“Bureaucratic issues are a juncture [...] problems originate from different time scales of a spin-off in comparison to the public sector.”*

Teams move to an incubation center after the start of the grant and are therefore naturally less involved in other processes in the **chair surrounding**. As the required resources are available and it is possible to pay costs using grant money, this does not result in any scarcity for the projects and this changes the situation from the beginning on. The interplay between the chair and the spin-off project occurs in initial cooperation projects or by exchanging know-how on special measurements and instruments. The relationship between the chair and the projects is loose but stable throughout the whole spin-off development. This was stated by a member of the project A: *“[...] the relationship is stable, meaning the spin-off is independent and working with the chair on several projects.”* This means that the spin-off projects are independent partners, and they work on joint projects that are acquired together. This is seen as a benefit for both sides. The spin-off projects in this group did not have other interactions with the wider **university surrounding**.

The second interaction point for this group is with the members of the **TTO**. At the TTO, the team members receive support in writing grant applications, and after acquiring a grant, they obtain support in developing a suitable business model. Again, this support is seen as important, but sometimes the projects experience it as insufficient. Problems arise early in understanding the market. Team members from both projects in this group stated that it was difficult *“[...]to develop products that are required by the mass customer”* and that the *“[...] team had to learn a lot about the market.”* Furthermore, as stated by a member of project I: *“It is difficult to establish a company out of*

*the university, also from the mindset one gets there [...]. A founder out of the university needs to have a lot of good support regarding business issues.”*

### **3.6. Conclusion**

We set out to clarify how and to what extent spin-off projects within one university differ. Furthermore, we wanted to understand the differences in the interactions of spin-off projects with specific factors of the university. We inductively derived four groups that differ in their initial usage of university know-how and the initial providers of the ideas: namely, *sciencepreneur*, *professorialpreneur*, *postdoctorialpreneur*, and *contextpreneur*. In addition, the interactions between the spin-off projects and a specific point of the university context are different and of varying importance depending on the group under which the project can be summarized. To provide better support, these differences should be considered. A summary of our findings is presented in Table 11.

**Table 11: Summary of the findings based on the interaction points (bold letters indicate high importance)**

<b>GROUP AND CATEGORY</b>	<b>SCIENCE-PRENEUR</b>	<b>PROFESSORIAL-PRENEUR</b>	<b>POSTDOCTORIAL-PRENEUR</b>	<b>CONTEXT-PRENEUR</b>
<b>MENTOR</b>	Content-based input; scientists experienced in the development of spin-offs; guaranteed freedom to operate	Scientific know-how provider; reputation and contacts are indispensable (signaling effect); acquisition of team members	Research interest; not actively involved	Supporter; support regarding bureaucratic issues; network and contacts are provided
<b>CHAIR SUR-ROUNDING</b>	Human resources available; joint research projects; usage of premises, equipment, and infrastructure	Know-how available; acquisition of first team members; usage of premises and equipment	Human resources and know-how available; contacts with cooperation partners; usage of premises and equipment	Cooperation projects; little content-related input
<b>UNIVERSITY SUR-ROUNDING</b>	University-wide usage of premises, infrastructure, and know-how		Cooperation projects with other departments; Acquisition of other team members	
<b>TTO</b>	Strategy development, IP protection, and negotiation; grant application and business model development	Business model development; coaching; acquisition of team members; grant application	Grant application, business model development, and coaching; acquisition of team members; team work; patent application	Grant application; business model development; coaching

### 3.7. Discussion and policy implications

For the *sciencepreneur* group, the most crucial points of contact with university structures seem to be the IP regularities and agreements, as well as the resources of the chair. Furthermore, access to premises, even outside the single chair or working group, is necessary. We found that spin-off projects in this group develop in an open-minded surrounding with regard to entrepreneurial processes. The influence of an open-minded surrounding on spin-off processes, the (perceived) local norms, and the previous transition of scientists to entrepreneurs have been shown to be important (Rasmussen et al. 2014; Stuart and Ding 2006). The success of spin-off projects in the *sciencepreneur* group might therefore be enhanced by becoming aware of the single gate-keepers who provide resources for entrepreneurial projects and by identifying the departments that provide a fertile ground due to past experience with spin-off processes or other forms of commercialization. In addition, clarity regarding IP regularities and early contact between the IP department of the TTO and the spin-off project seem to be of great importance.

For the spin-off projects in the *professorialpreneur* and *postdoctorialpreneur* groups, the transition from research to industry must happen in a relatively short-time frame. But for this transition to occur, the teams depend on “project-external” input. While scientific know-how is mostly dependent on the professor in the *professorialpreneur* group, for both groups, economic know-how is mostly subject to support from TTO staff. However, as mentors of *professorialpreneur* projects do not join the teams, and the TTO staff can only provide coaching to some degree, this dependency is a challenge for project development. Rasmussen and Borch (2010) have identified several problems that scientists experience in decoupling from the academic environment. They showed that spin-off projects situated at higher hierarchical levels are considered more positive.

This indicates that activities from higher hierarchical levels or by university management to legitimize spin-off projects might have a signaling effect and therefore ease their development. The initial idea provider of the *professorialpreneur* and *postdoctorialpreneur* groups, more than for the *sciencepreneur* and *contextpreneur* groups, has to adapt to two roles: being an entrepreneur and being a scientist. The importance of scientists identifying with the role of an entrepreneur has been shown by Vanaelst et al. (2006). If the initial idea provider focuses more on career prospects in academia, such as receiving a (new) professorship, spin-off projects are thus hindered by the lack of technical know-how. To better support the projects of these groups, two approaches might help. The first approach is enhancing a positive attitude in the direct surrounding regarding spin-off projects to help balance academic and commercial interests (Fritsch and Krabel 2012; Rasmussen and Borch 2010). A proactive statement of support for spin-offs from higher hierarchical levels and a clear and explicit strategy for the establishment and development of spin-offs from university management could help with this (Locket et al. 2003). The second approach is to strengthen the links between TTOs and team members—from coaching to actually working with the team on certain business aspects. This could result in a mutual “learning by doing” of the team and the TTO staff. Matching teams with an external expert from the specific industry in which the business idea takes place could also provide them with the necessary business knowledge. For the *postdoctorialpreneur* group, support from TTOs with regard to team acquisition and development is of importance. Enhancing TTO staff competencies with regard to team functioning and team mediation might be necessary.<sup>14</sup> Conversely, this approach requires many resources and a minimum number of employees. This goes hand in hand with the finding that German TTOs fulfil seven different tasks when sup-

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<sup>14</sup> We included team aspects in our data analysis because they are relevant in the development of a spin-off project (Vanaelst et al. 2006). We find that teams that have problems with each other never develop.

porting spin-off projects and that a lack of labor division seems to lower their performance (Hülsbeck et al. 2013). For the *professorialpreneur* group, it might be possible to find an additional scientific mentor—perhaps in the working group of the official mentor—who works with the project team on the technical development of the idea. However, this additional work load has to be connected with a proper incentive system, such as a reduction in teaching responsibilities. As the initial idea provider for the *postdoctorialpreneur* group is the postdoc, it seems that progress depends on the social and scientific networks that the postdoc has already gained and how well he/she is able to use them.

Spin-off projects in the *contextpreneur* group develop more “outside” the university context, and their predominant connection to the university is due to the grants and to some degree to the know-how of the chair. It seems that a support scheme where only the TTO and the mentor are included already provides a good structural setting. Regarding support from the mentor, it is important that administrative issues are handled non-bureaucratically. Furthermore, as most of these projects’ challenges arise on the market-side, early contact with industry partners and potential mentors who are business experts in the specific industry could foster development. A network established by the TTO could provide these contacts. In addition, support for administrative issues eases the spin-off project development in this group.

A framework of the managerial implications depending on the relative importance for each group is provided in Table 12.

**Table 12: Differences in the importance of support structures with regard to the specific interactions between the groups and the university setting (framework)**

Managerial advice for specific support	SP	ProfP	PdP	CP
Provide clarity on IP regularities and early contact with the IP department of the TTO	X			
Identify single gate-keepers and departments with spin-off experiences or provide contact to these	X			
Guarantee university-wide usage of premises and resources	X			
Find a scientific co-mentor to work with the team		X		
Present a proactive statement from higher hierarchical levels/university management to legitimize spin-off activity		X	X	
Strengthen the links between the TTO and the team members for mutual “learning by doing”		X	X	
Be active in mediation of team processes			X	
Match business experts from the specific industry		X	X	X
Assure early contacts with industry partners provided by an existing industry network of the TTO				X
Provide support regarding administrative issues due to the grant				X

SP = sciencepreneur; ProfP = professorialpreneur; PdP = postdoctorialpreneur; CP = contextpreneur

Knowing the crucial interaction points between universities and spin-off projects is the first step to better understanding the potential differences between success and failure in the development of university spin-offs. As resources for spin-off development in universities are often scarce, we need clear and objective measures of if, how, and when to support such projects. In the beginning, while projects are still within the university setting, these criteria are mostly qualitative and should be considered in their interdependence. This goes hand in hand with the findings regarding stage gate systems in the industrial context (Cooper 1990). It is important to consider the individuality of each spin-off project. However, our findings provide the first conclusions on different groups

and their specific interaction points. Therefore, we are able to provide a pattern that serves as a starting point for further validation in other university settings.

### **3.8. Limitations and further research areas**

We investigated how spin-off projects differ in their development through interactions with different university structures within one university. Using only one setting to understand specific interrelations is seen as fruitful (Yin 1994). Furthermore, Eisenhardt (1989) suggests that analytical generalization in a cross-case analysis is valuable when using four to ten case studies. This provides confidence in our sample size and our findings. However, further research can benefit from an analysis of the specific contexts of university-wide strategies and settings (Degroof and Roberts 2004) in relation to the specific groups of spin-off projects.<sup>15</sup> Furthermore, as performance also depends on the characteristics of TTOs (Hülsbeck et al. 2013), it is important to shed light on the differences between the spin-off project groups and their interactions with the TTOs of different universities. Although our data collection was done over several months in a retrospective view, the statements of the interviewees might suffer from later-on judgments (Pettigrew 1990). We are confident that we can still provide solid answers to the research questions due to the secondary data available and our thorough rechecking of statements with the interviewees and the expert from the advisory network. In addition, data collection and analysis were completed by carefully building on the concepts of validity and reliability for qualitative research designs, as explained earlier (Gibbert et al. 2008).

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<sup>15</sup> In their model of spin-off policies, based on the work of Roberts and Malone (1996), Degroof and Roberts summarize four archetypes that they evaluate on the level of selectivity and the level of support from academic institutions. First, they found an absence of any proactive spin-off policy. Second, they categorized a minimalistic support and low selectivity of the projects. Third, there might be intermediate support activity and middle selectivity in choosing which project to support (or not). Fourth, they provide evidence for high support for the spin-off projects selected, but selectivity is strong. They assume that spin-off policies should be aligned with the surrounding, in which the university exists. In weak entrepreneurial surroundings, regarding culture or infrastructure, a policy of high support and high selectivity seems to work but requires a great deal of resources. In regions with a highly developed entrepreneurial culture, a low support and low selectivity policy can be adapted (Degroof and Roberts 2004).

The specific needs of the different spin-off projects identified in our research might explain why some universities are more capable of developing spin-offs than others. In addition, this approach might also justify the need for further qualitative research to understand the differences in the number of spin-off projects from universities in the US.

## 4. Intentions of graduates to become self-employed: Differences across gender

### Abstract

The focus of this paper is on who is becoming an entrepreneur and how differences in entrepreneurial intentions vary across gender. Hypotheses were derived from a literature review and tested on an individual dataset consisting of alumni from a large German university. Using an ordered logistic regression analysis, we contribute to the understanding of how risk-taking propensity and the perceived environment influence the intention of female and male academics to start their own business. Interestingly, we find that women with an academic background are highly inclined to engage in entrepreneurship. In addition, the factors “risk-taking propensity” and “perceived environment” significantly influence the intentions of academics to become self-employed, but they do so differently for men and women. We are able to confirm previous findings regarding these factors for men but not for women. To increase the entrepreneurial activity of women, it seems important to take into account women-specific opportunity costs and human capital assets.

## 4.1. Introduction

It is unclear *why* some individuals plan to become entrepreneurs and others do not. In this regard, intention can act as an important predictor of future behavior and includes the motivation for and effort a person will put forth to carry out a specific behavior (Krueger et al. 2000). Thus, the intention to become self-employed is a fundamental element in explaining future entrepreneurial behavior. Additionally, it has been shown that the intention to become self-employed increases over time after leaving university (Golla et al. 2006; Müller 2010; Fueglistaller et al. 2009).

Universities are seen as important knowledge creation centers, and they influence economic development through technology transfer (Etzkowitz 2003; Godin and Gingras 2000). Therefore, politicians and researchers have recently given much attention to the creation of new ventures by university members and students. To fully identify the entrepreneurial potential of universities, we need to assess the activities of all parties involved, including students, graduates or employees, and scientists (Grimaldi et al. 2011). The specific importance of graduate entrepreneurship in this regard can easily be shown by the revenues produced by companies founded by graduates from, for example, MIT, making them the 24th largest economy in the world (Bank Boston 1997). Furthermore, the entrepreneurial activity of graduates might outnumber the spin-off activities of scientists by 20% (Wright et al. 2007a). Asking graduates about their intentions will improve our understanding of academic entrepreneurship and provide a more comprehensive picture of the entrepreneurial impact of universities.

Globally, women are less active in establishing their own companies than men (Miniti et al. 2005). In Germany, data from the Global Entrepreneurship Monitor shows that

the total early-stage entrepreneurial activity (TEA)<sup>16</sup> of men is almost double that of women. The actual entrepreneurial activity of men and women therefore differs significantly, not only in Germany but in nearly every economy worldwide (Kelley et al. 2012). How to increase the overall entrepreneurial activity in Germany, which is currently perceived as low, is of interest for politicians and researchers. To do so, we need to understand what determines entrepreneurial interest in general and specifically whether there are differences in such interest across gender (Sternberg et al. 2012). It has been shown that the preceding factors of the intention to become self-employed differ between men and women (e.g., Bönnte and Piegeler 2013; Koellinger et al. 2013; Caliendo et al. 2014; Barnir et al. 2014). We will therefore include specific preceding factors—namely, risk-taking propensity and the perceived credit availability—to understand their influence on the decisions of graduates from one university to become self-employed, and we will explain how these influences differ between men and women. We include other demographic variables that have been shown to be important in explaining entrepreneurial behavior. To our knowledge, we are the first to combine the individual characteristic of risk-taking propensity with factors of the perceived environment, in particular, perceived credit availability, with regard to their importance for graduates' intentions to become self-employed across gender.

Based on a unique dataset of former students from a large German university (n = 227), we find significant evidence that risk-taking propensity and the perceived availability of credit influence the intentions of academics to engage in entrepreneurship but with different importance for men and women. Lower levels of risk-taking propensity and a less positive perceived credit availability go together with higher entrepreneurial intentions of women. Furthermore, women with an academic background do not have

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<sup>16</sup> The percentage of individuals who have legally established a company in the last three years or who are currently in the process of establishing a company.

lower intentions to become self-employed compared to men. These findings support the existing evidence showing that academic entrepreneurship is a highly heterogeneous field in which we need to consider several personal and contextual aspects for various sub-groups (Gartner 1985; Mustar et al. 2006; Kolb and Wagner 2015).

The paper proceeds as follows. In the next section, we explain the theoretical background of research on entrepreneurial intentions and derive our hypotheses. We then describe our data and the methodology applied in the empirical analysis. Following this, we present the descriptive results and the results of the ordered logistic regression models and the graphical analysis. The paper concludes with a discussion of the findings, further research areas, and policy implications.

## **4.2. Literature review and development of hypotheses**

The intention to start and manage one's own business is widely recognized as the first critical step in the process of becoming an entrepreneur (e.g., Krueger et al. 2000). Indeed, the decision to engage in entrepreneurship does not happen by accident and is often the result of a conscious action plan. To understand the differences in entrepreneurial intentions and their predictors, we need to include individuals with high entrepreneurial intentions as well as individuals that do not plan to engage in entrepreneurship (Krueger et al. 2000). We want to understand the entrepreneurial intentions of graduates from a university and how these are influenced by personal and environmental factors. In addition, we want to show the differences in the influence of these factors based on gender. In the following, we will provide a summary of the existing literature, concentrating on gender as a basic source of potential differences in the intention to become self-employed. Furthermore, we include the preceding constructs of interest: risk-taking propensity and perceived credit availability. Based on the findings, we derive our hypotheses.

#### 4.2.1. Entrepreneurial intentions and gender differences

Two important models used to gain insights into entrepreneurial intentions are the theory of planned behavior (Ajzen 1991) and the theory of entrepreneurial event (Shapero and Sokol 1982). In the recent literature, it has been shown that several factors besides the antecedents of intention, which are included in the aforementioned theories, are valuable for understanding the entrepreneurial intentions of individuals, not only as preceding impact factors but also with a direct influence on intention. As a result, we should include human or social capital factors in our analysis (Hindle et al. 2009). Individual characteristics that have been proven to be important in the entrepreneurial setting are divided into socio-demographic factors, such as age or education, and personality characteristics, including risk-taking propensity or the dimensions of the Five Factor model (e.g., Caliendo and Kritikos 2012; Caliendo et al. 2011; Rauch and Frese 2007; Wright et al. 2004). Regarding entrepreneurial intentions, risk-taking propensity is seen as an important personality trait (Paunonen and Ashton 2001; Caliendo et al. 2011). Personality traits are often used to explain individuals' behavior because they are stable over time (Roccas et al. 2002; Cobb-Clark and Schurer 2011).

Following a socio-psychological perspective, the creation of companies varies due to the characteristics of individuals and due to variations in the environment (O'Shea et al. 2008). The model of entrepreneurial decision applied by Franke and Lüthje (2002; 2004; Lüthje and Franke 2003) includes several personality traits and contextual factors, and it greatly explains the antecedents of students' intentions to become self-employed. In fact, most of the studies on the predictors of entrepreneurial intention focus on students. This is generally due to good data availability and because students are a quite homogeneous group with regard to environmental influences and life challenges. However, in many cases, a time gap of several years exists between leaving university and

establishing a company. This might illustrate the need to have some “training time” before engaging in entrepreneurship (Müller 2010), or it may be because the individual is unsatisfied with the working conditions in a dependent occupation (push theory of entrepreneurship) (e.g., Lee et al. 2011). This is why we concentrate on the intentions of graduates.

In general, entrepreneurial activities in Germany are seen as relatively low compared with other European countries. For academics in Germany, job opportunities have been advantageous. Together with the high fear of failure—a fear which is often to be observed in German culture—this might explain the low entrepreneurial intentions of Germans (Sternberg et al. 2012). In addition, it has been shown that women experience an even higher fear of failure than men, which might explain why women do not choose to start their own business (Wagner 2007; Koellinger et al. 2013). In fact, in Europe, women show only limited interest in entrepreneurship, and men have higher intention rates than women (Kelley et al. 2012). In addition, in almost all OECD countries, the share of self-employed in the employed population is much lower among women than men (Fossen 2012). Although there have been many activities supporting women entrepreneurship, as well as much research on the topic, the question of *why* this gap exists remains. Recently, it has been stated that research on gender issues, entrepreneurial intentions, and risk-taking propensity has been underrepresented (Dawson and Henley 2015), and there is specific potential for economic growth by strengthening the engagement of women in entrepreneurial activities (Sternberg et al. 2012).

The probability of a person becoming self-employed increases with his/her level of education (Fritsch et al. 2012). In addition, self-employed women are better educated than men (Cowling and Taylor 2001). Caliendo et al. (2014) found that a lower educational level of women explains the gender differences in entrepreneurial entry rates, and

they expect the share of women entrepreneurship to increase because more women now graduate from university. As the share of female graduates from German universities has steadily increased since the 1950s (Federal Statistical Office 2013), we expect to find interesting insights by concentrating on university graduates and investigating the differences between women and men in entrepreneurial intentions. In summary, companies created by individuals with higher formal qualifications seem to differ from the total entrepreneurial output. In line with previous research (e.g., Wagner 2007; Kelley et al. 2012; Koellinger et al. 2013), we expect men with a university degree to have higher intentions than women with a university degree.

Hypothesis 1: Women with university degrees have lower intentions to become self-employed than men with university degrees.

#### **4.2.2. Risk-taking propensity**

In addition, it is of interest to identify the potential differences between men and women in the specific sub-group of graduates with regard to risk-taking propensity and the perceived environment, which we will do in the following.

Risk-taking propensity has received considerable research interest and has been shown to have a significant influence on entrepreneurial intentions. However, the results have been divergent in the context of entrepreneurship research. On the one hand, entrepreneurs were expected to have a high risk tolerance (Baron 2007), and more specifically, entrepreneurs were found to have a higher risk-taking propensity than managers (Zhao et al. 2006). In addition, a high willingness to take risks is positively associated with entrepreneurial intentions (Zhao et al. 2010). Entrepreneurs seem to take more risks than others because they face more unstructured and uncertain problems and have to bear the ultimate responsibility for all decisions made (Stewart and Roth 2001; 2004). Conversely, Miner and Raju (2004) found that entrepreneurs are even more risk

avoidant. In a recent analysis, entrepreneurs were found to have a medium level of risk-taking propensity, and that they can handle risks but do not seek them (Willebrands et al. 2012). It has also been shown that women who become self-employed are more risk-tolerant than those who do not act entrepreneurially (Caliendo et al. 2014). Wagner (2007) showed that there exists a specific difference in risk aversion between women and men in Germany. In general, women are more risk avoidant than men (e.g., Caliendo et al. 2009; Croson and Gneezy 2009; Dawson and Henley 2015), but Fossen (2012) found that women's higher risk aversion only explains their low entry rates into entrepreneurship to a small degree. He stated that discrimination by customers or creditors might be more relevant in explaining why women engage in entrepreneurship less often than men. Conversely, Caliendo et al. (2014) found that women's higher risk aversion can explain a large part of their decreased willingness to engage in entrepreneurship. Carsrud et al. (2009) suggested that for women in "a man's world" to have entrepreneurial intentions, they seem to require even more social or human capital than men. We thus expect the level of risk-taking propensity to significantly influence the intention to become self-employed, Similar to Carsrud et al. (2009), we also expect that women require even higher levels of risk-taking propensity compared to men because of possible discriminatory conditions.

Hypothesis 2a: A higher level of risk-taking propensity has a positive influence on the intention to become self-employed.

Hypothesis 2b: A higher level of risk-taking propensity has an additional positive effect on women's intention to become self-employed.

#### 4.2.3. (Perceived) environmental factors

Environmental or external factors also influence the entrepreneurial activity within one country or region (O'Shea et al. 2008). In general, we can find a heterogeneous picture of the environmental reality in Germany. Berlin is known as being a good place for start-up activities, and it provides a fertile ground for financial and governmental support, as well as for network-related factors such as conferences, festivals, and summits. Similar environmental settings can be found in big cities such as Munich or Hamburg (Start-up Barometer 2014).

The way individuals perceive their surroundings influences their intentions to engage in entrepreneurship. The existing environmental support mechanisms or structures are interpreted differently by individuals and thus influence their perceptions (Fini et al. 2012) and their intentions to engage in entrepreneurship. For example, it has been shown that the extent to which students perceive labor regulations as negative influences their decision to become self-employed. Nevertheless, the perceptions of regulations differ from the actual regulations for start-ups. Specific regulations, such as those in the employment area, are seen as more negative than they actually are, which can hinder entrepreneurial engagement (Moog and Backes-Gellner 2005). In addition, a stable environment fosters entrepreneurial processes when being positively interpreted by individuals as it might increase their conviction to succeed in entrepreneurial activities (Fini et al. 2012). Effective legal systems have been shown to lead to lower financial obstacles for companies and therefore enhance intentions to become self-employed (Beck et al. 2005). Empirical evidence shows that women tend to overestimate barriers, difficulties, and bureaucratic efforts to establish a company. This means that similar barriers are not recognized by men and therefore do not negatively influence their entrepreneurial intentions (Grilo and Irigoyen 2006; Verheul et al. 2012). A crucial factor

of the environment for entrepreneurs is the availability of sufficient financial assets (e.g., Hill et al. 2006). Women's companies are established with less financial capital and grow on lower investments compared to men (Coleman and Robb 2009). Furthermore, women tend to use less credit financing in the process of establishing a company, and if they do, such financing is lower (Treichel and Scott 2006). One explanation is that women experience creditor discrimination (Fossen 2012) and therefore face an even more negative financial environment than men; it is also possible that women tend to avoid financial risks and therefore take on fewer investments (Roper and Scott 2009; Kay and Arndt 2006).

One finding of the Start-up Barometer (2014) in Germany is that start-up companies expect big advancements to enhance entrepreneurial activities by providing better access to loans and by reducing bureaucracy. As the perceived environment significantly influences the probability of becoming self-employed, better perceived credit availability should go hand in hand with higher intentions to engage in entrepreneurship. Discrimination by creditors in lending money to women—both in women being less likely to get a bank loan and in higher interest rates if a loan is granted (Muravyev et al. 2009)—could result in women perceiving a less positive surrounding, and higher perceived support regarding credit availability could be more necessary for women compared to men because of women's aforementioned overestimation of barriers. Therefore, we expect that a better perceived environment has an additional effect for woman.

Hypothesis 3a: A better perceived environment regarding credit availability has a positive influence on the intention to become self-employed.

Hypothesis 3b: A better perceived environment regarding credit availability has an additional positive effect on women's intention to become self-employed.

### 4.3. Research setting

Entrepreneurial universities are assumed to provide their members with the knowledge and mindset needed to identify opportunities, and they can significantly influence the likelihood of graduates engaging in entrepreneurship (Krabel 2013). The increasing effort of universities to foster entrepreneurship and improve support structures for entrepreneurial activities has been captured in a German-wide ranking. The overall result of the university studied in this work notably improved over the last 15 years, but also the total points achieved by all universities increased significantly (Schmude et al. 2011; Schmude and Heumann 2007), which shows a higher awareness about this topic at all universities. At the university studied in this paper, the first university-wide alumni coordination started in 2009, which might lead to a younger sample of graduates in the alumni network compared to all graduates. The university is a so-called “Volluniversität” that consists of ten different faculties ranging from the natural to the social sciences, excluding an engineering faculty, and it belongs to the U15-community. This community includes a strong focus on basic scientific research as one of its aims. In addition, the university in our research setting focuses on interdisciplinary projects and international-oriented research and teaching. In summary, technology transfer has gained more interest in the last years but still sits outside the original tasks of research and teaching.

### 4.4. Data and method

To gather information on aspects concerning individual characteristics and contextual factors, we conducted an online survey in late 2009 and early 2010. The survey was sent to members of the university’s alumni network.<sup>17</sup> The focus of the questions was on the factors that influence entrepreneurial activities. Based on a theoretical overview,

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<sup>17</sup> Basis of this sample is the same data set as used and explained in Chapter 2 in detail. The full questionnaire is provided in the Appendix Table A1.

we used risk-taking propensity and factors of the perceived environment—in particular, perceived credit availability—in the attempt to explain entrepreneurial behavior. The 2204 members (as of December 2009) of the network were asked to participate in the survey by email, leading to a response rate of 17.1%. All questions were asked in German.

Common method bias is an issue that often occurs in self-assessment surveys and through the use of only one survey instrument. We used considerably different response formats, and anonymity was ensured to all respondents. Furthermore, only items that have already been shown to be good measurements were used (Franke and Lüthje 2002; 2004; Lüthje and Franke 2003; Caliendo et al. 2014; Bönnte and Piegeler 2013). With regard to a possible non-response bias by self-selection of the respondents, we would expect to have graduates in the sample that might have a higher interest in entrepreneurship. As we are interested in what drives the intentions of individuals to engage in entrepreneurship, a slightly larger proportion of individuals with high intentions to become self-employed is beneficial. Nevertheless, we carefully investigate the differences between individuals with high and low intentions to become self-employed to account for this percentage shift in our sample.

The focus of the empirical analysis is on the factors that influence the intentions of graduates from the university to engage in entrepreneurship in the foreseeable future. As our dependent variable is ordinal, we use ordered logistic regression to estimate our results (Long and Freese 2014).

### **Dependent variable**

The intention to become self-employed in the foreseeable future is measured using one item on a 5-point Likert scale (Franke and Lüthje 2002; 2004; Lüthje and Franke 2003). Measuring intentions with one item has been successfully done in several entre-

preneurship studies (e.g., Krueger et al. 2000). Individuals older than 59 years were excluded from the sample because the dependent variable measures entrepreneurial intentions in the next five years (Caliendo et al. 2014).

### **Risk-taking propensity and perceived environment**

The personality trait of risk-taking propensity is measured using one item on a 5-point Likert scale asking if someone is generally willing to take risks (Caliendo et al. 2014; Bönnte and Piegeler 2013). This general measurement for the level of risk-taking propensity, independent from any situational context, is already empirically validated (Dohmen et al. 2011; Mullins and Forlani 2005), and it has been applied in studies on nascent entrepreneurship (e. g. Caliendo et al. 2009).

To measure the influence of the perceived environment, we included one item on the perceived ease of acquiring a bank loan. The item is measured on a 5-point Likert scale, ranging from “disagree completely” to “agree completely.” Furthermore, environmental influence is measured using all items shown to be reliable by Franke and Lüthje (2002; 2004) and Lüthje and Franke (2003). The index includes the items credit availability; the perception of state laws, rules, and regulations; and the perceived ease of coming up with an idea. This index enters our regression model in a robustness check.

Both independent variables are not only of interest regarding their direct influence, but we also include the interaction effects of gender and the perceived credit availability as well as of gender and risk-taking propensity.

### **Control variables**

For our analysis, we include other control variables that have been shown to be important, such as age, role models, field of study, attitudes toward entrepreneurship, human capital aspects, and an innovation measure to capture the creativity levels of the respondents.

Their field of study influences the interest of students with regard to engaging in entrepreneurship. Graduates from the field of natural sciences establish companies in highly innovative and dynamic industries with a higher propensity than other graduates and thus significantly increase economic growth and the employment rate (Roberts 1991). However, it has been shown that students from an economic-related study field are more interested in establishing their own company. The differences in intentions do seem to diminish a few years after graduation (Golla et al. 2006; Fueglistaller et al. 2009), and students showing a moderate interest in entrepreneurial activities increase their interest during the years after graduation. Empirical studies found evidence that job expectations also change over time. Directly after graduation, most students prefer an employed occupation. After five years, these figures change and show a significant increase in the interest to become self-employed (Golla et al. 2006; Fueglistaller et al. 2009). We will therefore include field of study as one factor in understanding the intentions of academics to engage in entrepreneurship. The variable we use consists of three categories: One category combines graduates from economically oriented fields, including management, business administration, and law. The second category comprises academics who studied natural sciences, such as mathematics, computer sciences, medicine, and architecture, and the third category includes graduates in social studies and other studies, such as the arts or sports.

In addition, one's attitude toward something acts as an important predictor of behavior (Ajzen 1991). Attitudes towards entrepreneurship have been shown to influence intentions to become self-employed. The more individuals value an entrepreneurial career path, the stronger their intention will be to become an entrepreneur (Krueger et al. 2000). Attitudes towards entrepreneurship are measured using four items on a 5-point Likert scale and enter our model in one index.

Role models in the direct surrounding or who are known to an individual are important in the decision to become self-employed (Morales-Gualdrón and Roig 2005; De Clercq and Arenius 2006). For example, parental self-employment is crucial in explaining entrepreneurial activities (Fairlie and Robb 2007; Davidsson und Honig 2003). Furthermore, role models show a high and positive influence on academic entrepreneurship (Krabel and Mueller 2009), and a positive relation between entrepreneurial engagement and knowing an entrepreneur has been found for women (Arenius und Kovalainen 2006). We include a dummy variable taking the value one if at least one parent is self-employed and zero otherwise.

By attending an entrepreneurship course, individuals are able to change their attitudes regarding entrepreneurship and gain knowledge on both the process of establishing a company, and their own capabilities (von Graevenitz et al. 2010). Entrepreneurship courses have been shown to directly increase the entrepreneurial intentions of students. Furthermore, Franke and Lüthje (2004) highlight that American students from MIT show higher intentions to engage in entrepreneurship than do students from Vienna, which may be due to the lack of entrepreneurship education in most European countries. We include a dummy variable taking the value one if the individual has attended at least one entrepreneurship course and zero otherwise.

Age is included as a continuous variable. For most economies, a bell-shaped distribution is found for engagement in entrepreneurship, with the highest rates of engagement occurring between 25 and 34 years of age and the second highest rates between 35 and 44. Almost half of all entrepreneurs are in these two age categories (Xavier et al. 2012).

To measure an individual's originality and comfort with new ideas, we use the originality factor from the Kirton Adaption Inventory (KAI) index (Kirton 1976; 2003; Bagozzi and Foxall 1995). The index used in the regression model is built with five items

measured on a 5-point Likert scale. KAI has been used in the entrepreneurship context to measure innovativeness, and high levels of originality have been found to have a positive influence on the intention to engage in entrepreneurship (Marcati et al. 2008; Kuckertz and Wagner 2010). Detailed definitions of all the variables and the wording of the questionnaire are provided in Table 13.

**Table 13: Variable descriptions and items in the questionnaire**

Variable name	Questionnaire wording and/or variable description
<b>Dependent variable</b>	
<b>Intention to become self-employed</b>	<i>Scale: 1 ('disagree completely') to 5 ('agree completely')</i> I intend to become self-employed in the next five years
<b>Independent variables</b>	
<b>Risk-taking propensity</b>	<i>Scale: 1 ('disagree completely') to 5 ('agree completely')</i> In general, I am willing to take risks
<b>Perceived environment</b>	<i>Scale: 1 ('disagree completely') to 5 ('agree completely')</i>
Credit availability	Banks do not readily give credit to startup companies (inverse)
<i>Government</i>	<i>State laws (rules and regulations) are adverse to running a company (inverse)</i>
<i>Idea</i>	<i>It is difficult to come up with an idea that has not yet been realized (inverse)</i>
<b>Control variables</b>	
<b>Field of study</b>	<i>Please tell us about your special field of study:</i>
Natural sciences	Reference group
Economic sciences	Dummy variable taking the value of 1 if the individual studied in fields conducive to business (0 otherwise)
Social sciences	Dummy variable taking the value of 1 if the individual studied social sciences (0 otherwise)
<b>Propensity to innovate</b>	<i>Scale: 1 ('disagree completely') to 5 ('agree completely')</i> <i>Would you describe yourself as someone who...</i> 1. Has fresh perspectives on old problems 2. Copes with several new ideas and problems at the same time 3. Is stimulating 4. Has original ideas 5. Proliferates ideas
<b>Attitude towards entrepreneurship</b>	<i>Scale: 1 ('disagree completely') to 5 ('agree completely')</i> 1. I'd rather be my own boss than have a secure job 2. You can only make big money if you are self-employed 3. I'd rather found a new company than be the manager of an existing one 4. A fixed salary and working hours are important for me (inverse)
<b>Role model</b>	Dummy variable taking the value of 1 if the individual's parents are or have been self-employed (0 otherwise)
<b>Entrepreneurship course</b>	Dummy variable taking the value of 1 if the individual has attended at least one entrepreneurship course (0 otherwise)
<b>Age</b>	Continuous variable

## 4.5. Results

Our final sample consists of 227 individuals having different intentions to become self-employed in the next five years. A comparison of the intentions depending on gender is shown in Table 14. All in all, around 9 % of the participants have very high intentions to become self-employed.

**Table 14: Distribution of the dependent variable**

Intention to become self-employed in the next five years	Women total (%)	Men total (%)	Total (%)
Disagree completely	31	43	39
Rather disagree	30	17	21
Neutral	23	20	21
Rather agree	8	11	10
Agree completely	8	9	9
In %	33	67	100

<sup>a</sup> n = 227; 74 women and 153 men.

The descriptive statistics, correlations, and variance inflation factors are provided in Table 15 and Table 16.

**Table 15: Descriptive statistics<sup>a</sup>**

	<b>Variable</b>	<b>Mean</b>	<b>Median</b>	<b>S.D.</b>	<b>Min.</b>	<b>Max.</b>
1	Intention to become self-employed	2.29	2	1.31	1	5
2	Gender	0.33	0	0.47	0	1
3	Credit availability	2.41	2	0.86	1	5
4	Risk-taking propensity	2.90	3	1.03	1	5
5	Age	36.59	35	9.08	23	59
6	Natural sciences	0.34	0	0.47	0	1
7	Economic sciences	0.33	0	0.47	0	1
8	Social sciences	0.33	0	0.47	0	1
9	Role model	0.29	0	0.45	0	1
10	Attitude towards entrepreneurship	2.41	2	0.84	1	5
11	Propensity to innovate	3.49	4	0.75	1	5
12	Entrepreneurship course	0.22	0	0.41	0	1

<sup>a</sup> n = 227.

**Table 16: Correlations and variance inflation factors<sup>a</sup>**

Variable	1	2	3	4	5	6	7	8	9	10	11	12	VIF
1 Intention self-employed	1.00												
2 Gender	0.02	1.00											1.24
3 Credit availability	-0.01	0.16 **	1.00										1.10
4 Risk-taking propensity	0.38 ***	-0.11	-0.06	1.00									1.49
5 Age	-0.11 *	-0.25 ***	-0.22 ***	0.03	1.00								1.13
6 Natural sciences	-0.02	-0.22 ***	-0.06	-0.02	0.12 *	1.00							(reference)
7 Economic sciences	0.14 **	-0.13 *	-0.12 *	0.06	-0.02	-0.50 ***	1.00						1.43
8 Social sciences	-0.12 *	0.35 ***	0.18 ***	-0.03	-0.10	-0.50 ***	-0.49 ***	1.00					1.55
9 Role model	0.19 ***	-0.02	-0.05	0.08	-0.04	0.06	0.01	-0.07	1.00				1.04
10 Att. entrepreneurship	0.53 ***	-0.19 ***	-0.08	0.53 ***	0.12 *	-0.03	0.12 *	-0.09	0.09	1.00			1.56
11 Propensity to innovate	0.38 ***	-0.01	-0.01	0.35 ***	0.01	0.10	-0.20 ***	0.09	0.15 **	0.30 ***	1.00		1.28
12 Entrepreneurship course	0.24 ***	-0.09	-0.13 *	0.09	0.05	0.12 *	0.06	-0.19 ***	0.07	0.23 ***	0.14**	1.00	1.11

<sup>a</sup> n = 227; \*\*\* p<0.01; \*\* p<0.05; \* p<0.1

A univariate analysis shows no significant difference in the intention to become self-employed between women and men. All the women in our sample (regardless of their level of intentions to become self-employed) perceive credit availability as being significantly more supportive than men do. For the whole sample, we find no significant difference in risk-taking propensity between men and women.

Regarding our control variables, the women in our sample are on average 33.4 years old, and men are on average 38.1 years old. This means that the women are significantly younger than the men. In Germany, most individuals establish a company between the ages of 25 and 44. The oldest (55-64) and youngest groups (18-24) make up only a small proportion of company founders, while all other age groups engage in entrepreneurship quite homogeneously (Xavier et al. 2012). Therefore, we can expect that the difference in age between women and men will not drive our findings. We find that men more often chose natural sciences or business-related studies, and women are more often from the field of social studies. In addition, we find no significant difference in parental self-employment, the creativity measure, or having attended an entrepreneurship course across gender. However, we find that men have a significantly better attitude towards entrepreneurship than do women. The results of the univariate analysis on the differences between men and women are shown in Table 17.

**Table 17: Comparison between men and women<sup>a</sup>**

Variable	Full sample		Women		Men		Women vs. men
	Mean	SD	Mean	SD	Mean	SD	p-value
Intention to become self-employed	2.29	1.31	2.32	1.23	2.27	1.35	-0.2677
Credit availability	2.41	0.86	2.61	0.79	2.31	0.88	-2.4309**
Risk-taking propensity	2.90	1.05	2.74	1.05	2.98	1.02	1.6248
Age	36.59	9.08	33.39	7.52	38.14	9.39	3.7975***
Natural sciences	0.34	0.47	0.19	0.39	0.41	0.49	3.3888***
Economic sciences	0.33	0.47	0.24	0.43	0.37	0.49	1.9492*
Social sciences	0.33	0.47	0.57	0.50	0.22	0.41	-5.6168***
Role model	0.29	0.45	0.27	0.45	0.29	0.46	0.3710
Attitude towards entrepreneurship	2.41	0.83	2.19	0.77	2.52	0.85	2.8530***
Propensity to innovate	3.49	0.75	3.49	0.78	3.49	0.74	0.0349
Entrepreneurship course	0.22	0.41	0.16	0.37	0.24	0.43	1.3672

<sup>a</sup> n = 227; 74 women and 153 men. The last column shows the p-values for a two sided t-test on the equality of means of women and men. \*\*\* p<0.01; \*\* p<0.05; \* p<0.1

Furthermore, we find that credit availability is seen as highly negative by all individuals, independent from high or low intentions to establish a company. This confirms the earlier results of a survey conducted among young German companies in 2014, showing that the environmental factors for startups are seen as insufficient (Start-up Barometer 2014). In addition, the univariate analysis shows that individuals with high intentions to become self-employed and individuals with low intentions differ significantly in their risk-taking propensity.<sup>18</sup>

<sup>18</sup> Results of the univariate analysis are provided in the Appendix Table A6.

#### 4.5.1. Regression results

Table 18 provides the results of the ordered logistic regression models<sup>19</sup> and allows for the interpretation of our hypotheses.<sup>20</sup> Women with a university degree have higher intentions to become self-employed in all models. Therefore, we cannot confirm Hypothesis 1. Without interaction terms, we do not find a significant influence of risk-taking propensity or credit availability. Including the interaction terms between gender and the perceived credit availability and gender and risk-taking propensity shows a slightly different picture. Risk-taking propensity positively influences the intention to become self-employed, thus confirming Hypothesis 2a. We find no significant direct influence of perceived credit availability on the intention to become self-employed. Therefore, we cannot confirm Hypothesis 3a. Nevertheless, we find an additional significant effect for the interaction terms of gender and the preceding factors. With the same level of risk-taking propensity, women are less willing to engage in entrepreneurship compared to men. In addition, with the same perception of credit availability, women have lower intentions to become self-employed compared with men. Furthermore, on the intention to become self-employed, we find a significant negative influence of age and a positive influence of the attitude towards entrepreneurship and our measurement for creativity, as well as a slightly significant influence of having attended an entrepreneurship course. Field of study and parental self-employment show no significant effects. Including industry variables does not change the results, and only the health sector has a slightly significant influence on the intention to become self-employed.

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<sup>19</sup> The regression model allows for more than two manifestations in the (ordered) dependent variable and is therefore an extension of logit or probit models. It is suitable regarding our dependent variable on a Likert scale, which is ordered from no agreement to high agreement with the statement. We also performed one regression including only the control variables. The results are stable in both direction and significance.

<sup>20</sup> Variables used for the interaction terms are mean centered, which is recommended by Aiken and West (1991) to reduce collinearity problems. The variance inflation factors and the finding that the results for all other variables included in the regression with and without interaction terms are almost identical make us confident that multicollinearity is not an issue.

**Table 18: Determinants on the intention to become self-employed<sup>a</sup>**

	Model 1			Model 2			Model 3			Model 4			Model 5		
Gender	0.73	(0.30)	**	0.74	(0.30)	**	0.82	(0.31)	***	0.82	(0.31)	***	0.68	(0.32)	**
Credit availability	-0.01	(0.16)		0.01	(0.16)		0.30	(0.18)		0.31	(0.19)		0.27	(0.20)	
Risk-taking	0.17	(0.15)		0.40	(0.18)	**	0.22	(0.15)		0.44	(0.18)	**	0.52	(0.19)	***
Gender x credit							-1.09	(0.35)	***	-1.03	(0.34)	***	-1.00	(0.35)	***
Gender x risk				-0.63	(0.27)	**				-0.59	(0.27)	**	-0.64	(0.28)	**
Age	-0.05	(0.02)	***	-0.05	(0.02)	***	-0.05	(0.02)	***	-0.05	(0.02)	***	-0.06	(0.02)	***
Economics	0.35	(0.32)		0.38	(0.32)		0.29	(0.32)		0.32	(0.33)		0.37	(0.40)	
Social sciences	-0.49	(0.35)		-0.49	(0.35)		-0.48	(0.35)		-0.48	(0.35)		-0.60	(0.45)	
Role model	0.42	(0.29)		0.38	(0.29)		0.38	(0.29)		0.35	(0.29)		0.25	(0.30)	
Attitude entr.ship	1.26	(0.21)	***	1.27	(0.21)	***	1.27	(0.21)	***	1.28	(0.21)	***	1.33	(0.23)	***
Prop. to innovate	0.75	(0.20)	***	0.80	(0.21)	***	0.71	(0.21)	***	0.75	(0.21)	***	0.77	(0.22)	***
Entr.ship course	0.56	(0.31)	*	0.55	(0.31)	*	0.55	(0.31)	*	0.55	(0.31)	*	0.54	(0.32)	*
Industry variables	NO			NO			NO			NO			YES		
Observations	227			227			227			227			227		
Log likelihood	-274.36***			-271.61***			-269.33***			-266.91***			-260.49***		
Pseudo R <sup>2</sup> (Chi <sup>2</sup> )	0.18			0.19			0.19			0.20			0.22		

<sup>a</sup> n = 227; coefficient estimates for the ordered logistic regression model. Standard errors are shown in parentheses. The reference group is the study field of natural sciences. Note that gender is coded 1 for women. Model 1 presents the regression results for the control variables only. Models 2 and 3 include each interaction term separately, while the full model of analysis is shown in Model 4. Model 5 includes the industry variables.

\*\*\* p<0.01; \*\* p<0.05; \* p<0.1

However, an interpretation of the interaction terms in ordered logistic regressions should not be done only from the coefficients of the regression model (Ai and Norton 2003; Cameron and Trivedi 2009). This is because the effects of the independent variables might differ for each observation. Furthermore, for logistic regressions, different signs are possible for different covariate values, and therefore, the coefficient sign does not have to be the sign of the interaction effect over all categories (Norton et al. 2004). One way of interpreting the results is by graphical analysis (Mitchell 2012; Greene 2010) and by understanding the predicted probabilities and marginal effects for each category.<sup>21</sup> Therefore, we analyze the influence of our independent variables for each category of the intention to become self-employed. We summarized our categories into three groups for the graphical analysis.<sup>22</sup> The first new category combines a negative intention to become self-employed, the second includes individuals with a neutral intention, and the third combines individuals with a positive intention. The graphical findings for perceived credit availability and risk-taking propensity for the three categories across gender are presented in Figure 4. The graphical analysis shows the expected results for men. With better perceived credit availability, the predicted probabilities in the categories of positive and neutral intentions to become self-employed increase, and they decrease in the category of negative intentions. In addition, with higher levels of risk-taking propensity, the predicted probabilities in the categories of neutral and negative intentions decrease, and they increase in the category of positive intentions. Interestingly, for women, the predicted probabilities decrease with better perceived credit availability in the positive and neutral category, and they increase in the category of negative

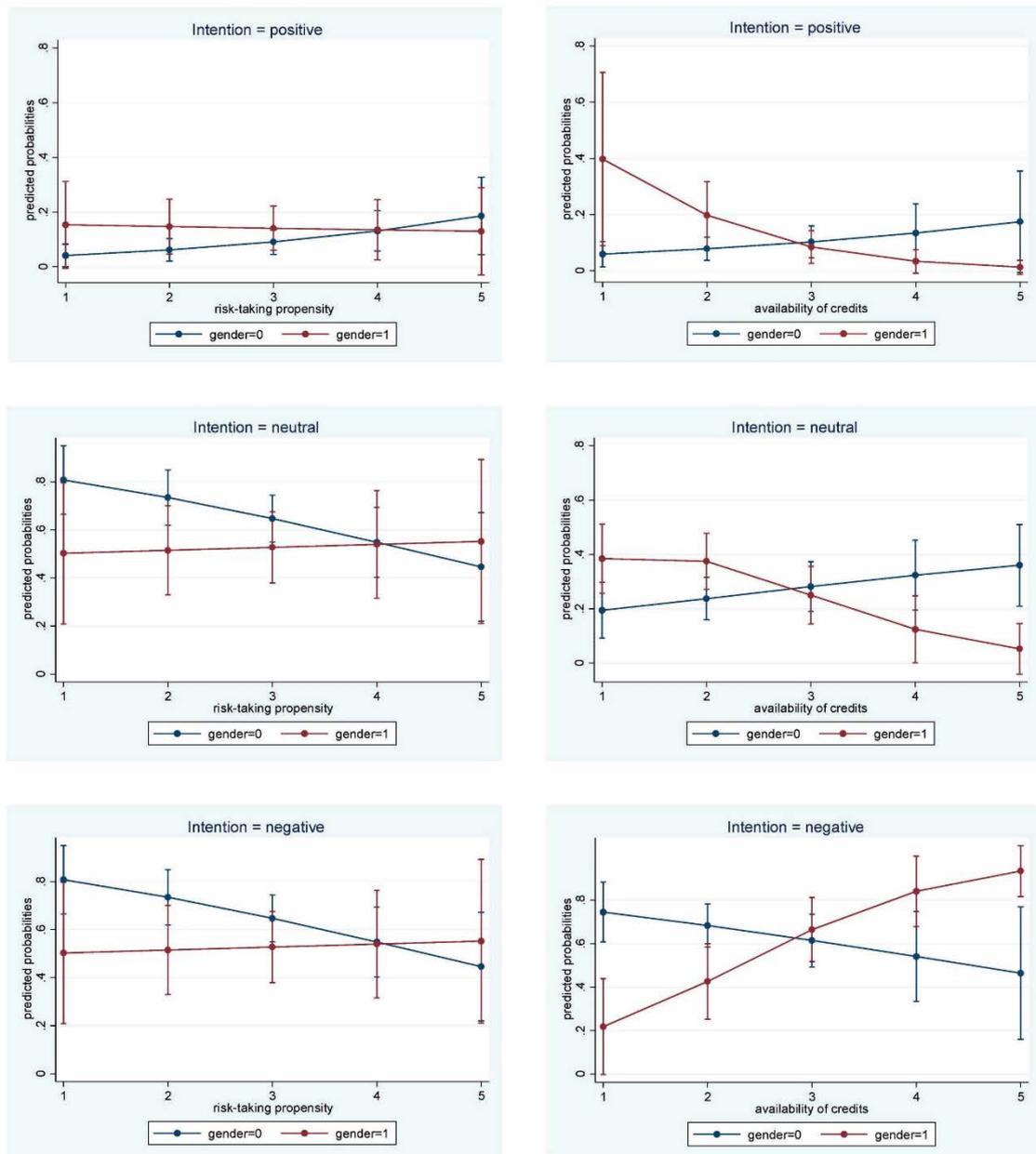
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<sup>21</sup> For the graphical analysis and for the average marginal effects, mean centering of the variables was redone.

<sup>22</sup> Graphical analysis of the dependent variable measured on the 5-point-Likert scale shows similar influences for the categories *disagree completely* and *rather disagree* and the same results for *agree completely* and *rather agree*. This is why we combined them into *positive* and *negative* intentions to establish a company.

intentions. Furthermore, the predicted probabilities of women in all categories change only slightly with the level of risk-taking propensity.

**Figure 4: Influences of the preceding factors divided by the categories of the intention to become self-employed<sup>a</sup>**



<sup>a</sup> n = 227; the left column shows the effects of the preceding factor risk-taking propensity, and the right column shows the effects of the perceived credit availability; the category of positive intentions includes 31 men and 12 women, neutral intentions are shown by 31 men and 17 women, and the category of negative intentions includes 91 men and 45 women.

To analyze whether the differences across gender are significant, we estimate the average marginal effects for each category of the dependent variable. The results are shown in Table 19 for risk-taking propensity and in Table 20 for perceived credit availability.

**Table 19: Average marginal effects for risk-taking propensity<sup>a</sup>**

	Disagree completely		Rather disagree		Neutral		Rather agree		Agree completely	
Women	0.02 (0.04)		0.01 (0.01)		-0.01 (0.01)		-0.01 (0.01)		-0.01 (0.01)	
Men	-0.07 (0.03)	**	0.01 (0.01)		0.02 (0.01)	**	0.02 (0.01)	**	0.03 (0.01)	**
Chi2	4.96	**	0.60		4.07	**	4.02	**	4.43	**

<sup>a</sup> n = 227; average marginal effects are shown for each category of the dependent variable. Standard errors are shown in parentheses. Individuals were asked whether they agree with the statement: “I intend to become self-employed in the next five years.” The last row shows the significant results of the Chi-squared test: \*\*\* p<0.01; \*\* p<0.05; \* p<0.1

**Table 20: Average marginal effects for the perceived credit availability<sup>a</sup>**

	Disagree completely		Rather disagree		Neutral		Rather agree		Agree completely	
Women	0.12 (0.04)	***	0.01 (0.01)		-0.05 (0.02)	**	-0.04 (0.02)	**	-0.04 (0.02)	**
Men	-0.05 (0.03)		0.01 (0.01)		0.01 (0.01)		0.01 (0.01)		0.02 (0.01)	*
Chi2	10.21	***	0.01		7.99	***	7.04	***	8.82	***

<sup>a</sup> n = 227; average marginal effects are shown for each category of the dependent variable. Standard errors are shown in parentheses. Individuals were asked whether they agree with the statement: “I intend to become self-employed in the next five years.” The last row shows the significant results of the Chi-squared test: \*\*\* p<0.01; \*\* p<0.05; \* p<0.1

The results of the regression models provide evidence that when the interaction term is included, a higher risk-taking propensity has a significantly positive influence on the intention to become self-employed. For women, a graphical analysis for each category of the dependent variable shows that the predicted probabilities change only slightly with the level of risk-taking propensity. In addition, an analysis of the average marginal

effects for each category of the dependent variable shows no significant influence of risk-taking propensity for women. This means that an infinitesimal increase in the level of risk-taking propensity does not lead to a change in the intentions of women to become self-employed. However, for men, we find that an infinitesimal increase in risk-taking propensity has a significant positive influence in the groups with high or neutral intentions and a significant negative effect in the group with no intention to become self-employed. The influence of risk-taking propensity on the intentions of women and men is therefore significantly different.

The regression results for the whole sample show no significant influence of perceived credit availability on the intention to become self-employed. For women, a graphical analysis has shown that the probability for good perceived credit availability is low when having high intentions. The average marginal effect on each category of the dependent variable shows that the influence of perceived credit availability is mostly significant for women but never for men. An infinitesimal increase in perceived credit availability has a significant negative influence in the group with high or neutral intentions and a significant positive effect in the group with no intention to become self-employed. This shows that the influence of perceived credit availability is significantly different for men and women.

In summary, we cannot confirm Hypotheses 2b or 3b with our findings. Higher levels of risk-taking propensity show no positive effect on the intentions of women to become self-employed, and a higher perceived credit availability has no additional positive effect. It might be possible that women perceive credit availability as good as long as they do not plan to engage in entrepreneurship. As soon as they start to work on an idea to establish a business, they might face, for example, discrimination from creditors and therefore update their perceptions of the environment. Furthermore, risk-taking

propensity does not seem to have the same explanatory power for the intentions of women compared to men. The influences of risk-taking propensity and perceived credit availability differ significantly between women and men. Our results might indicate that women tend to choose less risky and less credit-intensive fields in which to establish a company.<sup>23</sup>

#### 4.5.2. Robustness checks

Ordered logistic regression models assume that the relationship between each pair of outcomes is the same. This is known as the proportional odds assumption or the parallel regression assumption. We used a likelihood ratio test (Long and Freese 2014) to determine whether this parallel assumption has been violated. The test is significant at the 10% level. Therefore, we also conducted a stereotype logistic regression. All regression results are stable, which allows for interpretation of our results. Furthermore, we used a generalized ordered logit model to allow our independent variables to be flexible on each category. We find that the proportional odds assumption has not been violated for our explanatory variables.<sup>24</sup> We ran a regression including actual employment status because it has been argued that a situation of interest should be studied before the actual behavior has taken place (Noel 2002). Being self-employed is measured with a dummy variable taking the value one if the individual is self-employed at the time of the survey and zero otherwise. The actual status of being self-employed and the intention to become self-employed are significantly correlated ( $r=0.35$ ;  $p < 0.01$ ). We find that being self-employed has a significant and positive influence on the intention to become self-employed. The influences of our independent variables and the corresponding interaction terms stay the same. Furthermore, including an interaction term between being

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<sup>23</sup> Note that risk-taking propensity and perceived credit availability are not significantly correlated in the whole sample ( $r = -0.06$ ;  $p = 0.34$ ). The same holds true for each group investigated separately; women ( $r = 0.03$ ;  $p = 0.83$ ) or men ( $r = -0.08$ ;  $p = 0.32$ ).

<sup>24</sup> This is the case for the original model and for the model in the Appendix Table A7 of our dependent variable on a 3-point Likert scale.

from the field of social studies and gender shows that being female and being from the field of social studies has an additional significant positive effect on the intention to become self-employed, while social studies in general have a significant negative effect. The direct influence of gender becomes insignificant, and the direct effect of the perceived credit availability becomes slightly significant. Obviously, the tendency of women to study social sciences goes hand in hand with a high potential for any employed occupation in a service-based economy (which will be discussed later) and consequently for self-employment. However, the other results of our independent variables and the corresponding interaction terms stay the same. Therefore, we are able to show that our results are not only driven by self-selection into specific study fields as a proxy for industry-related human capital, but they also provide evidence for differences in perceived credit availability and risk-taking propensity across gender.<sup>25</sup>

Including all the items of the perceived environment from Franke and Lüthje (2002; 2004; Lüthje and Franke 2003) in one index in the regression provides the same findings, which is shown in Table 21. The interaction terms with gender are significant, and risk-taking propensity has a significant positive influence on the intention to become self-employed. The direct effect of the perceived environment is insignificant. This might indicate that for academics, the environment is not the most decisive influence after leaving university.

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<sup>25</sup> Regression results of all robustness checks are provided in the Appendix Table A8.

**Table 21: Robustness check: Perceived environment**

	Model 7			Model 8		
Gender	0.75	(0.31)	**	0.76	(0.31)	**
Perc. environment (index)	-0.04	(0.20)		0.25	(0.24)	
Risk-taking	0.11	(0.15)		0.34	(0.19)	*
Gender x perc. environment				-0.96	(0.43)	**
Gender x risk				-0.54	(0.27)	**
Age	-0.04	(0.02)	**	-0.04	(0.02)	***
Economics	0.33	(0.33)		0.36	(0.33)	
Social sciences	-0.29	(0.35)		-0.31	(0.35)	
Role model	0.39	(0.30)		0.36	(0.30)	
Attitude entr.ship	1.27	(0.22)	***	1.28	(0.22)	***
Prop. to innovate	0.72	(0.21)	***	0.75	(0.21)	***
Entr.ship course	0.61	(0.31)	*	0.61	(0.32)	*
Observations	212			212		
Log likelihood	-261.32***			-256.27***		
Pseudo R <sup>2</sup> (Chi <sup>2</sup> )	0.17			0.18		

<sup>a</sup> Coefficient estimates for the ordered logistic regression model. Standard errors are shown in parentheses; the reference group is the study field of natural sciences. Note that gender is coded 1 for women. \*\*\* p<0.01; \*\* p<0.05; \* p<0.1

## 4.6. Conclusion and discussion

We wanted to understand how the preceding factors of risk-taking propensity and perceived credit availability, or more generally, the perceived environment, influence the intention to become self-employed for graduates of one university. In this specific setting, we concentrated on the differences between gender to take into account specific sub-groups (Gartner 1985; Mustar et al. 2006; Kolb and Wagner 2015). We based our setting on the findings of Franke and Lüthje (2002; 2004; Lüthje and Franke 2003) regarding the entrepreneurial potential of students and their intentions to become self-employed. By focusing on whether personality traits or environmental factors are the relevant predictors of entrepreneurial behavior, their results show that both streams explain the probability of students' intentions to found a company. Because the entrepreneurial intentions of academics increase a few years after leaving university, we wanted

to understand whether these preceding factors have the same value for graduates. We find that women with an university degree have similar intentions to engage in entrepreneurship as men. For women, a higher academic qualification is indeed assumed to increase entrepreneurial engagement (Caliendo et al. 2014). Recent data on German entrepreneurial activities also show that women with a university degree overproportionally engage in entrepreneurial activities (KfW-Gründungsmonitor 2015). Regarding the still existing wage gap between men and women in dependent occupations, which might result from employer discrimination (Fossen 2012), women with a university degree may decide to engage in entrepreneurship to receive an adequate return on their human capital investments. In addition, entrepreneurial activities are assumed to provide more flexibility in time and more independency regarding work content. This could encourage women to engage in entrepreneurship as they still seem to be more restrained by family obstacles and childcare than are men. Assuming that some self-employment occupations can be combined with childcare, and to handle restrained time frames, it might be possible that women choose self-employment as a way to balance work and family issues (Raknerud and Rønsen 2014).

Men still dominate in capital and knowledge-based manufacturing and service sectors, and women entrepreneurs are mostly found in the consumer industry (Kelley et al. 2012). The trend toward a service-based economy increases the importance of entrepreneurial activities in this sector. In 2012, the performance of the so-called creative industry was higher than that of the chemical and energy industry. Furthermore, companies in the creative industry provide innovative solutions for societal challenges, including concepts such as crowdfunding or coworking spaces (Bundesministerium für Wirtschaft und Energie 2012). The creative industry is generally a field in which women are educated. Recognizing highly promising business opportunities in this field could lead to

women's high intentions to engage in entrepreneurship. This means that the change to a service-based economy might also foster this finding. Indeed, opportunity motivation generally dominates the decisions of women in developed economies to engage in entrepreneurship (Kelley et al. 2012). What was previously a limitation to growth perspectives and company establishment by women might now become an advantage.

The expected positive influence of higher levels of risk-taking propensity on the intention to become self-employed is significant for the whole sample, but the findings are driven by the influences of risk-taking propensity for men. For women, infinitesimal increases in the level of risk-taking propensity for each category of the dependent variable have no significant effect. A test for differences between women and men is significant. This might indicate that risk-taking propensity has a higher explanatory value for the entrepreneurial intentions of men than for women. Women seem to choose entrepreneurship for reasons other than their level of risk-taking propensity. Therefore, our results somewhat support the finding of Fossen (2012) that lower levels of risk-taking propensity do not fully explain women's lower entry rates into entrepreneurship. The entrepreneurial intentions of women might be driven by higher needs for flexibility in combining work and family issues. Flexibility has been shown to be an important motivational factor for the engagement of women in entrepreneurship (De Martino et al. 2003). In addition, Caliendo et al. (2014) have shown that the influence of personality characteristics, such as the dimensions of the Five Factor model, is small and different from expectations. Regarding their levels in the dimensions, women should be even more inclined to engage in entrepreneurship than men (Caliendo et al. 2014). This finding suggests that personality traits might not be as suitable for explaining the entrepreneurial behavior of women as they are for men.

We find no significant influence of credit availability for the whole sample of academics. The low overall entrepreneurial activity in Germany compared with other developed countries (Sternberg et al. 2012) might be partly due to the negatively perceived environment in general. Only around 10% of the graduates perceive credit availability as good (and only 3% view the perceived overall environment as good). This confirms the results of a survey conducted among young companies in Germany in 2014, which perceive the environment as highly negative (Start-up Barometer 2014). Comparing these results with the findings of Franke and Lüthje (2002; 2004; Lüthje and Franke 2003), the influence of the perceived environment does not show the same explanatory power for graduates as it does for students. For women, the perceived surrounding with regard to credit availability has a significant influence, while this is not true for men. The influence of the perception of credit availability is significantly different for women and men, indicating that men might be less influenced by their environment. We expected women to perceive the environment as being even better if they plan to engage in entrepreneurial activities, but the predicted probabilities to have high intentions to become self-employed decrease with a better perceived credit availability. On the one hand, it might be possible that women update their perception when working on a business model because they are confronted with discrimination by creditors (Fossen 2012). For example, financing restrictions are mentioned more often by women that exit entrepreneurship than they are by men (Kelley et al. 2012). Women tend to experience the idea of entrepreneurship as more interesting than do men, but they seem to lack a positive attitude regarding their own capabilities and competences to start a company (Kelley et al. 2010; Raknerud and Rønsen 2014). However, the confidence of women in their abilities seems to go hand in hand with entrepreneurial intentions (Wilson et al. 2004). Having a university degree and some years of work experience might

increase women's perceptions of their own qualifications. Generally, self-efficacy can be increased by training (Eden and Aviram 1993), and it has been shown that, for example, entrepreneurship education can play a more crucial role for women than for men as it increases self-efficacy (Wilson et al. 2007). If we understand an academic degree as a way to gain confidence in one's own abilities, women with a university degree might be aware of the hindering structures in the environment, but still feel inclined to engage in entrepreneurship. In addition, discrimination by employers (Fossen 2012) might enhance this decision.

The opportunity costs for women in Germany seem to be very high as they have a higher probability of experiencing family obstacles. This might increase their entrepreneurial intentions more than personal or environmental factors do. In Germany, typical entrepreneurial characteristics are still associated with masculine attributes. Risk-taking propensity is such a characteristic, and it explains men's entrepreneurial engagement to a greater extent than it does for women. This might lead to low identification of women with the possibility of entrepreneurship. As women entrepreneurship cannot easily be explained by what we know thus far about personal factors, broader networks and contacts to other female entrepreneurs might have a positive impact on the entrepreneurial intentions of women. For example, men are more likely to know an entrepreneur than are women (Kelley et al. 2012). Preexisting support offers seem to be unsuccessful in reaching potential female entrepreneurs. As women may be less confident in their ability to start a company (Kelley et al. 2010), programs should make women aware of their qualifications to help them overcome (perceived) obstacles. In addition, women tend to underestimate the importance of broad networks and thus tend to use smaller and more personal networks (Kelley et al. 2010). Therefore, university alumni networks could

arrange workshops and seminars on entrepreneurial competencies with particular attention paid to female role models.

Knowing that the ratio from interest in starting a company to actual behavior is similar for men and women (Kelley et al. 2012), understanding what drives the intentions of women can thus significantly enhance women entrepreneurship. This includes the interdependencies of women-specific opportunity costs and levels of risk-taking propensity. This seems of special interest as we were able to show that higher educated women are not less interested in engaging in entrepreneurship.

#### **4.7. Limitations and further research area**

Our study has some limitations that point toward future research needs. First, we cannot control well for cross-causality as information on risk-taking propensity, credit availability, and intentions to become self-employed were collected with the same questionnaire. Furthermore, all answers are self-reported. However, because of the precautions taken—different response formats and securing the anonymity of the respondents—we are confident that common method bias and biases due to socially desirable responses are unlikely.

For our analysis, we concentrated on graduates of one university. The university in our context is known for its scientific orientation, which has changed slightly in the recent years toward a greater focus on research application and technology transfer. For future research, it might be of interest to determine whether there are differences regarding an university's influence over the years on its graduates. It seems that work experience significantly influences future self-employment choices, while there does not seem to be a significant influence of grades (Krabel 2013). We found that graduates who left the university more than five years prior perceive the environment as significantly more negative. It might be of interest to understand how much this perception can be influ-

enced by university structures over the short and long term. Further studies could also include differentiated work experience (human capital approach) or industry information to account for the ability to perform entrepreneurially. It might be interesting to evaluate whether the trend toward a service-based economy and the entrepreneurial intentions of women are related and how this influences entrepreneurial behavior in general.

We have shown that the preceding factors of risk-taking propensity and perceived credit availability differently influence men and women's intentions to become self-employed, and for women with an academic degree, the effect of risk-taking propensity is not significant. In addition, women might have different social preferences than men, which could lead to higher variability in their behavior (Croson and Gneezy 2009). In future research, insights can be gained by taking into account the possible interdependencies of risk-taking propensity and women-specific opportunity costs.

## 5. General summary and future research areas

This chapter provides an overview of the empirical results of the dissertation and explains how this contributes to existing research.

The importance of academic entrepreneurship for economic development has been widely accepted, and universities are called to include technology transfer as a third stream of their activities (Etzkowitz et al. 2000). A common two-dimensional approach to classifying academic entrepreneurship has been provided by Clarysse and Moray (2004), and the questions are whether to include all members of a university (students, scientists, graduates) and to what extent knowledge from the university has been used to establish a company. The aim of this dissertation is to provide insights into the mechanisms of technology transfer through the means of academic spin-offs. This dissertation investigates several aspects of academic entrepreneurship, focusing on scientists and graduates as their impact on economic development is assumed to be important for economic development but is not yet fully understood (Grimaldi et al. 2011; Mansfield 1998). The studies of this dissertation contribute to the principle aim of this thesis, which is to take into account the heterogeneity of entrepreneurial activities by concentrating on specific sub-groups and a parallel consideration of individual and environmental factors. In addition, altogether, the results provide a consistent and more complete picture of the entrepreneurial potential of universities. The analyses are concentrated on one university in Germany to eliminate more general variations in the environment and to focus on the detailed characteristics of the individual entrepreneur or spin-off project. With regard to individual characteristics, the focus is on gender and personality traits, including the dimensions of the Five Factor model and risk taking propensity.

The analyses are done both qualitatively and quantitatively, and they provide insights into the spin-off development process and the different sub-groups of the academic population.

### **5.1. Overall results, conclusion, and managerial implications**

Chapter 2 concentrates on the differences between founders from different contexts. Specifically, university members establishing a company while being employed at the university or directly after leaving the university and founders that had already left the university before engaging in entrepreneurship; that is, entrepreneurs emerging inside versus outside the university. Because of its importance in person–environment fit, the influence of the dimensions of the Five Factor model are investigated. The main result is that personality traits assumed to increase the probability of engaging in entrepreneurship are less present among scientists. Besides the dimensions of the Five Factor model, risk-taking propensity differs significantly between the two types of entrepreneurs. This finding contributes to the discussion on the broad and narrow approach of the Five Factor model and shows that risk-taking propensity is an important additional personality trait. The findings support the argument of Gartner (1985) that entrepreneurs are not a homogeneous group and that entrepreneurs might differ more from each other than do entrepreneurs from non-entrepreneurs. In addition, a higher usage of university-based knowledge was found to have a positive influence on the probability of establishing a company out of the university context. This finding suggests a substitutive relationship between the nature of knowledge and personality traits. In terms of practice and policy implications, this means that the support structures of universities can enhance scientific entrepreneurial activities, but they need to be communicated frequently.

The university setting should not be seen as one entity, and the heterogeneity of spin-offs needs to be addressed (Rasmussen et al. 2014; Wright et al. 2004), which is the

focus of Chapter 3. Using a qualitative study design, Chapter 3 contributes to the understanding of the differences between spin-off projects and their interactions with specific factors of one university. Four different types of spin-offs are inductively derived that differ in their initial setting regarding the idea provider(s) and their scientific background. The differences are confirmed when including the nature of the knowledge transferred from the university. In addition, the four groups—*sciencepreneur*, *professorialpreneur*, *postdoctorialpreneur* and *contextpreneur*—interact differently with specific points of the university. Four interaction points are identified: (1) the role and influence of the mentor of the spin-off project, (2) the direct influence of the chair surrounding, (3) the role of university-wide structures, and (4) interactions with the TTO. To enhance support activities for university-based spin-off projects, these specific differences need to be taken into consideration. A framework of the most important aspects for each group is provided in the managerial implications of Chapter 3. Depending on whether resources of support are scarce—as they are for most German universities—what to do first depends on the specific group under which a spin-off project can be summarized.

A first step in understanding academic entrepreneurship is made by concentrating on the intentions of academics to engage in entrepreneurship. The influence of the preceding factors (i.e., the perceived environment and personality traits such as risk-taking propensity) has been shown to influence students' intentions to engage in entrepreneurship (Franke and Lüthje 2004). Less is known about their influence on the intention of university graduates to engage in entrepreneurship. This topic is addressed in Chapter 4. One specific focus of this chapter is on differences across gender, as specific gender-related differences are still not fully understood. The study contributes to the existing research by outlining the specific influence of the factors credit availability and risk-

taking propensity in parallel. Women with a university degree are found to be highly interested in entrepreneurial activities. This finding may depend on the trend toward a service-based economy and the corresponding human capital of women. In addition, risk-taking propensity and perceived credit availability influence entrepreneurial intentions of women and men differently. This influence was also different from what was expected. Higher levels of risk-taking propensity increase entrepreneurial intentions of men, but for women, high entrepreneurial intentions go together with a more negative perception of credit availability and are not influenced by the levels of risk-taking propensity. This might indicate that women with high entrepreneurial intentions update their perception of the environment due to creditor and customer discrimination. Conversely, women might decide to engage in entrepreneurial activities for reasons other than what we know about the influence of risk-taking propensity. Following Dawson and Henley (2015), these results also show that the entrepreneurial activities of women are an under-researched area, and this thesis provides evidence that significant differences exist between women and men regarding the influences of preceding factors on entrepreneurial intention.

## **5.2. Concluding thoughts on the contribution and implications for future research**

Each study of this dissertation contributes to the existing research on academic entrepreneurship by focusing on clearly defined sub-groups. While the contribution of each study has been shown in the previous section, this section concludes with some summarizing thoughts on the overall contribution of the dissertation.

Three aspects are detected as important for timely research on academic entrepreneurship and underlie the agenda of this dissertation. First, it is important to capture the full picture of the entrepreneurial activities that result from university knowledge (Gri-

maldi 2011). This includes the activities of graduates, which have been underrepresented and are addressed in this dissertation. Second, there is no one single type of entrepreneur, and they differ due to several factors depending on their personality or various aspects of their environment. A more careful distinction between the different types of entrepreneurs and entrepreneurial projects has long been demanded (Gartner 1988; Sarasvathy 2004, Wright et al. 2004). Third, it is important to understand the interdependencies between the environment and the individual project and thus the single entrepreneur (Rasmussen 2011). This means that environmental and individual characteristics should be studied at the same time, which requires a focus on one university (Rasmussen et al. 2014; Wright et al. 2004). These topics have been taken into account in all three studies of this dissertation, which all therefore provide insights into the different sub-groups of entrepreneurs and entrepreneurial projects in their relation to the environment. This dissertation supports the statement that entrepreneurs are not a homogeneous group, and it can be suggested that personality traits are important for entrepreneurial behavior but need to be seen in their relation with other factors, such as the nature of knowledge, environmental factors, or the structural influences of universities.

This opens up the first of three fruitful areas for further research. Krabel (2013) has shown that the entrepreneurial orientation of universities can increase the probability of their graduates engaging in entrepreneurship. Analyses such as those in this dissertation should therefore be conducted for other universities from different cultural backgrounds and with different entrepreneurial orientations and support structures. Additionally, based on the previous work of Roberts and Malone (1996), Degroof and Roberts (2004) summarize four archetypes that they evaluate based on academic institutions' level of selectivity and level of support. It is thus necessary to investigate how possible differences in specific university-wide strategies or TTO characteristics (Hülsbeck et al.

2013) influence the spin-off activity of scientists or increase the entrepreneurial activities of graduates. In summary, a combination of studies on single entities could lead to a framework on the best practices for different types of universities and how to support the spin-off development of various sub-groups.

Second, a first critical step in any entrepreneurial process is opportunity recognition (Kirzner 1973). Shane and Venkataraman (2000) found that the ability to detect an opportunity might be influenced by the characteristics of the opportunity and by the individual. In addition, the prior knowledge and cognitive abilities of an individual influence his/her ability to identify an opportunity (Shane 2000). Research is limited on the extent to which entrepreneurial opportunities in the academic setting are detected by academic entrepreneurs themselves or with the support of TTOs and surrogate entrepreneurs. If scientists are not the ones to detect such opportunities, this could be due to a lack of information and may also result from different mindsets or from an initial interest in research and not in the commercialization of existing knowledge (Lockett et al. 2003). This suggests that mechanisms supporting the detection of opportunities might result in additional spin-off projects. This dissertation shows that it is important to consider the existing heterogeneity of spin-off projects, and it finds evidence of different motivations of the entrepreneurs regarding career prospects. D'Este and Perkmann (2011) found that scientists' motivations to engage in technology transfer, including all areas from contract research to spin-off formation, are highly different. For future research, it might be of interest to determine whether tailored support mechanisms are needed to increase opportunity recognition processes and how this relates to the motivations of single scientists to engage in entrepreneurship.

Third, long-term measurements of graduate and student entrepreneurship are needed. Longitudinal analysis could provide findings on how entrepreneurial activities and in-

tentions are influenced by general and specific university structures in the long run. While a decreasing influence can be expected over time, it is of interest to determine which factors endure over time. Insights into this issue are restricted by the availability of data on graduates. Therefore, an analysis like the one done in this thesis is a first critical step to understanding the entrepreneurial activities of graduates.

In summary, this dissertation is able to show the importance of concentrating on a single university and specific sub-groups to account for the complexity of academic entrepreneurship and the heterogeneity of entrepreneurs and entrepreneurial projects. In future research, common patterns and categories should be developed by combining studies on single entities.

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## 6. Appendix

Table A1: Online questionnaire

<b>Alumni-Survey Wuerzburg</b>	
<b>A) Erststudium und Einstellungen zu Unternehmertum</b>	
<b>1: Wann haben Sie ihr Erststudium abgeschlossen?</b>	
Bitte schreiben Sie Ihre Antwort hier	<input type="text"/>
<b>2: Welchen Abschluss haben Sie im Erststudium erworben?</b>	
Bitte <b>nur eine Antwort</b> aus folgenden Möglichkeiten wählen	
<input type="checkbox"/> Diplom	
<input type="checkbox"/> Magister	
<input type="checkbox"/> Staatsexamen	
<input type="checkbox"/> Bachelor	
<input type="checkbox"/> Sonstiger	
[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Sonstiger' war bei der Frage '2 ']	
<b>2.1: Bezeichnung des Abschlusses?</b>	
Bitte schreiben Sie Ihre Antwort hier	<input type="text"/>
<b>3: In welchem Bereich haben Sie Ihr Erststudium studiert?</b>	
Bitte <b>nur eine Antwort</b> aus folgenden Möglichkeiten wählen	
<input type="checkbox"/> Informatik/Mathematik	
<input type="checkbox"/> Natur-/Ingenieurwissenschaften	
<input type="checkbox"/> Wirtschaftswissenschaften	
<input type="checkbox"/> Medizin (Human-/Tier-)	
<input type="checkbox"/> Sonstiges	
<b>4: Welches Fach haben Sie im Erststudium studiert?</b>	
Bitte <b>alle</b> auswählen, die zutreffen	
<input type="checkbox"/> Ägyptologie, Archäologie, Altorientalistik	
<input type="checkbox"/> Berufliches Lehramt oder ähnliches	
<input type="checkbox"/> Betriebswirtschaftslehre, Business Management	
<input type="checkbox"/> Bildungswissenschaft, Pädagogik	
<input type="checkbox"/> Biologie, Biomedizin	
<input type="checkbox"/> Chemie, Biochemie, Lebensmittelchemie	
<input type="checkbox"/> Ethik, Religionslehre, Theologie, Ethnologie	
<input type="checkbox"/> Europäisches Recht, Rechtswissenschaften, Jura	
<input type="checkbox"/> Experimentelle Medizin, Medizin, Zahnmedizin	
<input type="checkbox"/> Geographie, Kulturgeographie	
<input type="checkbox"/> Geschichte	
<input type="checkbox"/> Informatik, Wirtschaftsinformatik, Luft- und Raumfahrtinformatik, Technische Informatik	
<input type="checkbox"/> Kulturwissenschaft, Musikwissenschaft	
<input type="checkbox"/> Mathematik, Wirtschaftsmathematik, Computational Mathematics	
<input type="checkbox"/> MBA Business Integration	
<input type="checkbox"/> Medienkommunikation, Medienphilologie, Digital Humanities	
<input type="checkbox"/> Pharmazie	
<input type="checkbox"/> Philosophie, Soziologie, Politikwissenschaft	
<input type="checkbox"/> Physik, Nanostrukturtechnik, Mathematische Physik	
<input type="checkbox"/> Psychologie	
<input type="checkbox"/> Space Science and Technology, Space Mathematics	
<input type="checkbox"/> Sportwissenschaft	
<input type="checkbox"/> Sprachwissenschaften	
<input type="checkbox"/> Technologie der Funktionswerkstoffe	
<input type="checkbox"/> Volkswirtschaftslehre, Economics	
<input type="checkbox"/> Wirtschaftswissenschaft	
<input type="checkbox"/> Sonstiges	
<b>5: Haben Sie promoviert?</b>	
Bitte <b>nur eine Antwort</b> aus folgenden Möglichkeiten wählen	
<input type="checkbox"/> Ja	
<input type="checkbox"/> Nein	
[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' war bei der Frage '5 ']	
<b>5.1: In welchem Jahr?</b>	
Bitte schreiben Sie Ihre Antwort hier	<input type="text"/>
<b>6: Haben Sie mehr als ein Hochschulstudium abgeschlossen?</b>	

Bitte **nur eine Antwort** aus folgenden Möglichkeiten wählen

- Ja
- Nein

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' war bei der Frage '6 ']

**6.1: Bitten nennen Sie uns kurz den Bereich und das Fach Ihres weiteren Studiums.**

Bitte schreiben Sie Ihre Antwort hier

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' war bei der Frage '6 ']

**6.2: Wann haben Sie dieses Studium abgeschlossen?**

Bitte schreiben Sie Ihre Antwort hier

**7: In welcher Branche sind Sie momentan tätig?**

Bitte **alle** auswählen, die zutreffen

- Ingenieurwesen, Architektur, Bauwesen
- Beratung, Recht, Training
- Sprachdienstleistungen (z.B. Übersetzung, Lektorat, Journalismus)
- IT/Telekommunikation (inkl. Programmierung)
- Handel, Einzelhandel
- Produzierendes Gewerbe
- Medizin, Gesundheit, Fitness, Schönheit
- Marketing, Werbung, Medien, Grafik & Design, Event-Management, Kunst
- Kaufmännische Dienstleistungen
- Gastronomie, Hotel
- Vertrieb (z.B. Finanzvertrieb, Makler)
- Service (z.B. Reparatur, Reinigung, Transport, Haushalt, Garten)
- Erziehung, Unterricht
- Handwerk
- Sonstiges

**8: Waren Sie an einer Hochschule und/oder einer sonstigen Forschungseinrichtung beschäftigt?**

Bitte **nur eine Antwort** aus folgenden Möglichkeiten wählen

- Ja
- Nein

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' war bei der Frage '8 ']

**8.1: Wenn ja, bis wann?**

Bitte schreiben Sie Ihre Antwort hier

**9: Wir möchten etwas über Ihre unternehmerische Eigenschaften allgemein lernen. Inwiefern stimmen Sie den folgenden Aussagen zu?**

Bitte wählen Sie die zutreffende Antwort aus

	Stimme voll zu	Stimme eher zu	Neutral	Stimme eher nicht zu	Stimme überhaupt nicht zu
In den letzten 6 Monaten habe ich mich einer riskanten Situation ausgesetzt	<input type="checkbox"/>				
Wenn ich reise, dann wähle ich eher Routen, die ich kenne	<input type="checkbox"/>				
Ich möchte immer wieder etwas Neues ausprobieren (z.B. exotische Gerichte, fremde Länder, ...)	<input type="checkbox"/>				
Es fällt mir nicht schwer, mit Menschen, die ich nicht kenne ein Gespräch zu beginnen.	<input type="checkbox"/>				
Ich beabsichtige, mich in den nächsten fünf Jahren selbstständig zu machen	<input type="checkbox"/>				
Ich denke oft: "So ist es eben, und da gibt es nichts, was man daran ändern könnte."	<input type="checkbox"/>				
Wenn die Dinge gut für mich laufen, so denke ich, dies sei größtenteils Glück.	<input type="checkbox"/>				
Ein festes Gehalt und geregelte Arbeitszeiten sind für mich wichtig.	<input type="checkbox"/>				
Mir ist es wichtiger, mein eigener Chef zu sein, als eine besonders sichere Stelle zu haben.	<input type="checkbox"/>				
Richtig gut verdienen kann man auf Dauer nur, wenn man als Selbstständiger arbeitet.	<input type="checkbox"/>				
Eine Unternehmensgründung reizt mich mehr als die Leitung eines bereits bestehenden Betriebs.	<input type="checkbox"/>				
Existenzgründer haben ein positives Image in der Bevölkerung.	<input type="checkbox"/>				
Es gibt genügend qualifizierte Beratungs- und Serviceangebote für Existenzgründer.	<input type="checkbox"/>				
Die Atmosphäre an der Universität Würzburg inspiriert zur Entwicklung einer Geschäftsidee.	<input type="checkbox"/>				
Als Gründer ist es schwierig, Kredite von Banken zu erhalten.	<input type="checkbox"/>				

Die staatlichen Reglementierungen (Gesetze, Genehmigungsverfahren, Verordnungen etc.) sind unternehmerfeindlich.	<input type="checkbox"/>				
Es ist schwer, eine Geschäftsidee zu finden, die nicht bereits realisiert wurde.	<input type="checkbox"/>				
Das Lehrangebot der Universität Würzburg bietet eine gute Gründungsausbildung	<input type="checkbox"/>				
Mir ist der Gedanke unangenehm, anders zu sein als andere.	<input type="checkbox"/>				
Wenn ich von etwas überzeugt bin, dann vertrete ich auch eine unbequeme Meinung.	<input type="checkbox"/>				
Bei beruflichen Entscheidungen bin ich risikobereit.	<input type="checkbox"/>				
Im allgemeinen bin ich ein risikobereiter Mensch und versuche Risiken einzugehen.	<input type="checkbox"/>				

**10: Wie bewerten Sie folgende Aussagen?**

Bitte wählen Sie die zutreffende Antwort aus

	Stimme voll zu	Stimme eher zu	Neutral	Stimme eher nicht zu	Stimme überhaupt nicht zu
Ich glaube, dass Umweltprobleme zu den größten Herausforderungen in unserer Gesellschaft gehören	<input type="checkbox"/>				
Ich bin der Meinung, dass Unternehmer und Unternehmen eine breitere gesellschaftliche Verantwortung übernehmen müssen	<input type="checkbox"/>				
Deutsche Unternehmen sollten im Bereich Umweltschutz eine internationale Vorreiterrolle einnehmen	<input type="checkbox"/>				
Firmen, die als umweltfreundlich gelten, haben es leichter qualifizierte Mitarbeiter zu rekrutieren und zu halten	<input type="checkbox"/>				
Die Umweltleistungen eines Unternehmens werden in Zukunft zunehmend von Finanzinstituten berücksichtigt (z.B. in der Kreditvergabe oder bei Aktienempfehlungen)	<input type="checkbox"/>				
Corporate Social Responsibility sollte in den Firmengrundsätzen jedes Unternehmens verankert sein	<input type="checkbox"/>				

**11: Haben Sie vor Ihrem Erststudium eine Ausbildung gemacht?**

Bitte nur eine Antwort aus folgenden Möglichkeiten wählen

- Ja
- Nein

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' war bei der Frage '11']

**11.1: Inwieweit stand dieser berufliche Abschluss in einem fachlichen Zusammenhang mit Ihrem Studium?**

Bitte nur eine Antwort aus folgenden Möglichkeiten wählen

- gar nicht
- wenig
- mittelmäßig
- überwiegend
- völlig

**12: Wie viele Praktika / studienbezogene Nebenjobs haben Sie während Ihres Erststudiums gemacht? (auch mehrere bei einem Arbeitgeber)**

Bitte schreiben Sie Ihre Antwort hier

**13: Haben Sie sich im Rahmen Ihres Studiums im Ausland aufgehalten?**

Bitte alle auswählen, die zutreffen

- ja, für ein Auslandsstudium
- ja, für ein Praktikum
- ja, für einen Sprachkurs
- nein

**14: Waren/Sind Ihre Eltern selbstständig?**

Bitte nur eine Antwort aus folgenden Möglichkeiten wählen

- Ja
- Nein

**15: Arbeiten Sie aktuell als Selbstständiger?**

Bitte nur eine Antwort aus folgenden Möglichkeiten wählen

- Ja
- Nein

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' war bei der Frage '15']

**15.1: Bitte beschreiben Sie kurz, was Sie als Selbstständiger tun (Tätigkeit, Branche).**

Bitte schreiben Sie Ihre Antwort hier

**16: Würden Sie sich selbst sehen als jemand, der...**

Bitte wählen Sie die zutreffende Antwort aus

... sich	... fügt	... detailgenaues	... bedacht	... niemals	... neue	... gründlich	... vielen	... Ideen	... belebend	... originelle	... mit allen	... Details	... neue Ideen	... methodisch	... der	... gut in	... sich
und	Arbeiten	im	ohne	die	Blickwinkel	ist	gleichzeitig	wirkt	hat	sorgfältig	hervorbringt	systematisch	System"				
anpasst	gerne mag	Umgang	nötige	auf	alte												

	mit Autorität agiert	Befugnis handelt	Probleme eröffnet	befassen kann	befasst	ist	einfügt
Stimme voll zu	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Stimme eher zu	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Neutral Stimme eher nicht zu	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Stimme überhaupt nicht zu	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

## B) Unternehmertum

**1: Haben Sie schon mal an Kursen zur Unterstützung einer Unternehmensgründung teilgenommen (z.B. Kurs zu Geschäftsplanerstellung)?**

Bitte nur eine Antwort aus folgenden Möglichkeiten wählen

- Ja  
 Nein

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' war bei der Frage '1']

**1.1: An wie vielen Kursen dieser Art haben Sie teilgenommen?**

Bitte schreiben Sie Ihre Antwort hier

**2: Wie würden Sie folgende Aussage bewerten?**

Bitte wählen Sie die zutreffende Antwort aus

Das Gründungsklima an der Universität Würzburg ist...  sehr gut  ziemlich gut  eher gut  eher schlecht  ziemlich schlecht  sehr schlecht

**3: Haben Sie während Ihres Studiums über eine Gründung nachgedacht?**

Bitte nur eine Antwort aus folgenden Möglichkeiten wählen

- Ja  
 Nein

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' war bei der Frage '3']

**4: Haben Sie während Ihrer Promotion über eine Unternehmensgründung nachgedacht?**

Bitte nur eine Antwort aus folgenden Möglichkeiten wählen

- Ja  
 Nein

**5: Haben Sie bereits ein Unternehmen gegründet oder sind Sie im Begriff ein Unternehmen zu gründen?**

Bitte wählen Sie die zutreffende Antwort aus

	Ja	Nein
Ich habe bereits ein Unternehmen gegründet.	<input type="checkbox"/>	<input type="checkbox"/>
Ich bin im Begriff ein Unternehmen zu gründen.	<input type="checkbox"/>	<input type="checkbox"/>
Ich habe nicht vor ein Unternehmen zu gründen.	<input type="checkbox"/>	<input type="checkbox"/>

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' oder 'Ich habe bereits ein Unternehmen gegründet.' war bei der Frage '5']

**5.1: Haben Sie bereits mehrere Unternehmen gegründet und wenn ja, wieviele?**

Bitte schreiben Sie Ihre Antwort hier

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' oder 'Ich habe bereits ein Unternehmen gegründet.' war bei der Frage '5']

**5.1.1: Wann haben Sie ihr (erstes) Unternehmen gegründet?**

Bitte schreiben Sie Ihre Antwort hier

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' oder 'Ich habe bereits ein Unternehmen gegründet.' war bei der Frage '5']

**5.1.2: In welcher Branche fand diese Gründung statt?**

Bitte schreiben Sie Ihre Antwort hier

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' oder 'Ich habe bereits ein Unternehmen gegründet.' war bei der Frage '5']

**5.2: Erfolgte die Gründung im Team?**

Bitte nur eine Antwort aus folgenden Möglichkeiten wählen

- Ja  
 Nein

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' war bei der Frage '5.2']

**5.2.1: Aus wievielen Mitgliedern bestand das Team?**

Bitte nur eine Antwort aus folgenden Möglichkeiten wählen

- 2
- 3
- 4
- 5
- Mehr als 5

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' oder 'Ich habe bereits ein Unternehmen gegründet.' war bei der Frage '5 ']

**5.2.2: Hatten Sie (bzw. ein Teammitglied) Erfahrung in der Branche, in der die Gründung stattfand?**

Bitte nur eine Antwort aus folgenden Möglichkeiten wählen

- Ja
- Nein

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' oder 'Ich habe bereits ein Unternehmen gegründet.' war bei der Frage '5 ']

**5.3: Wie wichtig waren folgende Faktoren für die Gründung Ihres Unternehmens?**

Bitte wählen Sie die zutreffende Antwort aus

	unwichtig	von großer Bedeutung	von geringer bis keiner Bedeutung
Besondere Fähigkeiten, die Sie im Zuge Ihrer Tätigkeit an der wissenschaftlichen Einrichtung erworben haben.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Neue wissenschaftliche Methoden oder Techniken, die Sie im Zuge Ihrer Tätigkeit an der wissenschaftlichen Einrichtung erworben haben.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ergebnisse der Forschungstätigkeit an einer wissenschaftlichen Einrichtung, z.B. die Entwicklung eines neuen Produkts oder einer neuen Dienstleistung.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' oder 'Ich habe bereits ein Unternehmen gegründet.' war bei der Frage '5 ']

**5.4: Alles in allem, würden Sie sagen Sie haben Ihr Unternehmen gegründet...**

Bitte nur eine Antwort aus folgenden Möglichkeiten wählen

- um eine konkrete Gelegenheit zu nutzen.
- weil sich keine bessere Erwerbsalternative bot, also aus der Notwendigkeit heraus.
- aus der Notwendigkeit heraus und weil sich gerade eine gute Gelegenheit bot.

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' oder 'Ich habe bereits ein Unternehmen gegründet.' war bei der Frage '5 ']

**5.5: Welche Motive standen hinter Ihrer Unternehmensgründung?**

Bitte wählen Sie die zutreffende Antwort aus

	sehr wichtig	wichtig	eher wichtig	eher unwichtig	unwichtig	völlig unwichtig
Den Wunsch eine selbst entwickelte Technologie umzusetzen.	<input type="checkbox"/>					
Den Wunsch nach finanziellem Erfolg.	<input type="checkbox"/>					
Ihr Verlangen nach Unabhängigkeit.	<input type="checkbox"/>					
Die Möglichkeit Arbeit und Familie flexibel zu vereinen.	<input type="checkbox"/>					

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' oder 'Ich habe bereits ein Unternehmen gegründet.' war bei der Frage '5 ']

**6: In welcher Branche findet diese Gründung statt?**

Bitte schreiben Sie Ihre Antwort hier

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' oder 'Ich habe bereits ein Unternehmen gegründet.' war bei der Frage '5 ']

**6.1: Erfolgt die Gründung im Team?**

Bitte nur eine Antwort aus folgenden Möglichkeiten wählen

- Ja
- Nein

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' war bei der Frage '6.1 ']

**6.1.1: Aus wievielen Mitgliedern besteht das Team?**

Bitte nur eine Antwort aus folgenden Möglichkeiten wählen

- 2
- 3
- 4
- 5
- Mehr als 5

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' oder 'Ich habe bereits ein Unternehmen gegründet.' war bei der Frage '5 ']

**6.2.: Haben Sie (bzw. ein Teammitglied) Erfahrung in der Branche, in der die Gründung stattfindet?**

Bitte nur eine Antwort aus folgenden Möglichkeiten wählen

- Ja
- Nein

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' oder 'Ich habe bereits ein Unternehmen gegründet.' war bei der Frage '5 ']

**6.3: Wie wichtig sind folgende Faktoren für die Umsetzung Ihrer Geschäftsidee?**

Bitte wählen Sie die zutreffende Antwort aus

	sehr wichtig	wichtig	eher wichtig	eher unwichtig	unwichtig	völlig unwichtig
Besondere Fähigkeiten, die Sie im Zuge Ihrer Tätigkeit an der wissenschaftlichen Einrichtung erworben haben.	<input type="checkbox"/>					

Neue wissenschaftliche Methoden oder Techniken, die Sie im Zuge Ihrer Tätigkeit an der wissenschaftlichen Einrichtung erworben haben.	<input type="checkbox"/>					
Ergebnisse der Forschungstätigkeit an einer wissenschaftlichen Einrichtung, z.B. die Entwicklung eines neuen Produkts oder einer neuen Dienstleistung.	<input type="checkbox"/>					
Der Wunsch eine selbst entwickelte Technologie umzusetzen.	<input type="checkbox"/>					
Der Wunsch nach finanziellem Erfolg.	<input type="checkbox"/>					
Ihr Verlangen nach Unabhängigkeit.	<input type="checkbox"/>					
Die Möglichkeit Arbeit und Familie flexibel zu vereinen.	<input type="checkbox"/>					

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' oder 'Ich habe bereits ein Unternehmen gegründet.' war bei der Frage '5']

**6.4: Alles in allem, würden Sie sagen Sie gründen Ihr Unternehmen...**

Bitte **nur eine Antwort** aus folgenden Möglichkeiten wählen  
um eine konkrete Gelegenheit zu nutzen.

- weil sich keine bessere Erwerbsalternative bietet, also aus der Notwendigkeit heraus.
- aus der Notwendigkeit heraus und weil sich gerade eine gute Gelegenheit bietet.

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' oder 'Ich habe bereits ein Unternehmen gegründet.' war bei der Frage '5']

**6.5: Welche Motive stehen hinter Ihrer Unternehmensgründung?**

Bitte wählen Sie die zutreffende Antwort aus

	sehr wichtig	wichtig	eher wichtig	eher unwichtig	unwichtig	völlig unwichtig
Den Wunsch eine selbst entwickelte Technologie umzusetzen.	<input type="checkbox"/>					
Den Wunsch nach finanziellem Erfolg.	<input type="checkbox"/>					
Ihr Verlangen nach Unabhängigkeit.	<input type="checkbox"/>					
Die Möglichkeit Arbeit und Familie flexibel zu vereinen.	<input type="checkbox"/>					

**C) MBA**

**\* 1: Absolvieren Sie ein MBA-Aufbaustudium?**

Bitte **nur eine Antwort** aus folgenden Möglichkeiten wählen

- Ja
- Nein

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' war bei der Frage '1']

**1.1: Fand das Aufbaustudium...**

Bitte **nur eine Antwort** aus folgenden Möglichkeiten wählen

- ...direkt nach Abschluss Ihres Erststudiums statt?
- ...nach einigen Jahren beruflicher Tätigkeit statt?

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' war bei der Frage '1']

**1.2: Wann haben Sie Ihr MBA-Aufbaustudium (aufbauend auf Ihrem Erststudium) abgeschlossen?**

Bitte schreiben Sie Ihre Antwort hier

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' war bei der Frage '1']

**1.3: An welcher Hochschule absolvierten Sie Ihr MBA-Aufbaustudium?**

Bitte schreiben Sie Ihre Antwort hier

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Nein' war bei der Frage '1']

**2: Planen Sie ein MBA-Aufbaustudium...**

Bitte wählen Sie die zutreffende Antwort aus

	Mit Sicherheit	Wahrscheinlich	Auf keinen Fall
...zu absolvieren?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**D) Motivation**

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Ja' war bei der Frage '1']

**1: Wie wichtig waren die folgenden Gründe für Ihre Entscheidung für ein MBA-Aufbaustudium?**

Bitte wählen Sie die zutreffende Antwort aus

	sehr wichtig	wichtig	eher wichtig	eher unwichtig	unwichtig	völlig unwichtig
Verbesserung der Chancen auf dem Arbeitsmarkt	<input type="checkbox"/>					
Höheres Gehalt nach Abschluss des MBA	<input type="checkbox"/>					
Höhere Position im Unternehmen erreichbar	<input type="checkbox"/>					
Erlernen bzw. Verbessern des unternehmerischen Denkens	<input type="checkbox"/>					
Zusätzlicher akademischer Abschluss	<input type="checkbox"/>					
Interesse an den Inhalten des MBA-Studiums	<input type="checkbox"/>					
Schlechte Arbeitsmarktlage / Überbrückung von Arbeitslosigkeit	<input type="checkbox"/>					
"Soft Skills" / Entwicklung der Persönlichkeit	<input type="checkbox"/>					
Kontakte für das spätere Berufsleben knüpfen	<input type="checkbox"/>					
Praxisvertiefung durch Fallstudien	<input type="checkbox"/>					
Qualifikation in neuem Fachgebiet	<input type="checkbox"/>					

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Nein' war bei der Frage '1']

**O1: Wie wichtig sind die folgenden Gründe für Ihre Entscheidung für ein MBA-Aufbaustudium allgemein, soweit ein solches Aufbaustudium grundsätzlich für Sie in Frage kommt? (Sollten Sie grundsätzlich kein derartiges Aufbaustudium planen, so gehen Sie bitte direkt zu Abschnitt E)**

Bitte wählen Sie die zutreffende Antwort aus

	sehr wichtig	wichtig	eher wichtig	eher unwichtig	unwichtig	völlig unwichtig
Verbesserung der Chancen auf dem Arbeitsmarkt	<input type="checkbox"/>					
Höheres Gehalt nach Abschluss des MBA	<input type="checkbox"/>					
Höhere Position im Unternehmen erreichbar	<input type="checkbox"/>					
Erlernen bzw. Verbessern des unternehmerischen Denkens	<input type="checkbox"/>					
Zusätzlicher akademischer Abschluss	<input type="checkbox"/>					
Interesse an den Inhalten des MBA-Studiums	<input type="checkbox"/>					
Schlechte Arbeitsmarktlage / Überbrückung von Arbeitslosigkeit	<input type="checkbox"/>					
"Soft Skills" / Entwicklung der Persönlichkeit	<input type="checkbox"/>					
Kontakte für das spätere Berufsleben knüpfen	<input type="checkbox"/>					
Praxisvertiefung durch Fallstudien	<input type="checkbox"/>					
Qualifikation in neuem Fachgebiet	<input type="checkbox"/>					

### E) Sozio-demographische Charakteristika

**1: Bitte geben Sie an, inwieweit die jeweils aufgeführten Persönlichkeitseigenschaften auf Sie zutreffen. Sie sollten bewerten, wie das Paar der Eigenschaften auf Sie zutrifft, selbst wenn eine Eigenschaft stärker zutrifft, als die andere. Ich betrachte mich eher als...**

Bitte wählen Sie die zutreffende Antwort aus

	Trifft überhaupt nicht zu	Neutral	Trifft voll zu
extrovertiert, begeisterungsfähig	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
kritisch, streitbar	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
gewissenhaft, selbstdiszipliniert	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
nervös, leicht erregbar	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
offen für neue Erfahrungen, aufgeschlossen	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
reserviert, zurückhaltend	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
sympathisch, umgänglich	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
unorganisiert, unachtsam	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
entspannt, emotional stabil	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
konventionell, unkreativ	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**2: Wie alt sind Sie?**

Bitte schreiben Sie Ihre Antwort hier

**3: Sie sind:**

Bitte **nur eine Antwort** aus folgenden Möglichkeiten wählen

- Weiblich  
 Männlich

### F) Alumni-Netzwerk

**1: Welche Informationen erwarten Sie auf der Alumni-Website (mehrere Antworten möglich)?**

Bitte **alle** auswählen, die zutreffen

- Neueste Informationen aus dem Alumni-Netzwerk oder aus der Universität  
 Informationen über Veranstaltungen  
 Alumni-Galerie mit Alumni-Porträts  
 Videosequenzen mit dem Lebensalltag verschiedener Alumni in verschiedenen Ländern  
 Bilder  
 Chat-Möglichkeiten, Diskussionsforen, Twitter  
 Informationen zu Absolventenfeiern  
 Andere

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Andere' war bei der Frage '1']

**1.1: Bitte beschreiben Sie kurz welche Informationen sie erwarten?**

Bitte schreiben Sie Ihre Antwort hier

**2: Welche Angebote des Alumni-Büros interessieren Sie?**

Bitte **alle** auswählen, die zutreffen

- Organisation von "Homecomings", Veranstaltungen, Alumni-Sommerfest  
 Organisation von Alumni-Stammtischen  
 Lebenslange Email-Adresse  
 Organisation von Alumni-Exkursionen  
 Alumni-DVD  
 Organisation von Weiterbildungsangeboten  
 Andere

[Bitte beantworten Sie diese Frage nur, falls ihre Antwort 'Andere' war bei der Frage '2']

**2.1: Bitte beschreiben Sie kurz welche Angebote Sie interessieren würden.**

Bitte schreiben Sie Ihre Antwort hier

**G) Verlosung**

Bitte beachten Sie, dass diese Frage getrennt von allen anderen Antworten behandelt wird und damit Ihre Anonymität weiterhin gewahrt bleibt.

**1: Vielen Dank für Ihre Teilnahme. Falls Sie an der Verlosung unserer attraktiven Buchpreise teilnehmen möchten, geben Sie hier bitte Ihre E-Mailadresse an: (Ihre Adresse wird nur für Zwecke der Verlosung verwendet und separat von Ihren Antworten gespeichert. Ihre Anonymität bleibt dadurch gewahrt).**

Bitte schreiben Sie Ihre Antwort hier

**Übermittlung Ihres ausgefüllten Fragebogens:**

Vielen Dank für die Beantwortung des Fragebogens. Bitte faxen Sie den ausgefüllten Fragebogen an .

**Table A2: Exemplary guideline**

<p><b>I. Einleitung</b></p> <p>Guten Tag Herr/Frau,</p> <p>zunächst einmal vielen herzlichen Dank, dass Sie sich bereit erklärt haben, an diesem Interview teilzunehmen. Ich möchte noch einmal betonen, dass mir Ihre Erfahrungen und Ihre Meinung zum Thema „Gründen aus der Universität“ wichtig sind.</p> <p>Bevor wir anfangen, möchte ich mich kurz vorstellen. Ich bin Cornelia Kolb und bin Gründungsberaterin am SFT der JMU. Ich promoviere am Lehrstuhl für Unternehmensgründung und Unternehmensführung von Herrn Prof. Dr. Marcus Wagner.</p> <p>In unserem Forschungsprojekt untersuchen wir, wie universitäre Strukturen Gründungsvorhaben beeinflussen und welchen Weg eine Gründung aus der Wissenschaft geht. Das Interview ist dabei in 5 verschiedene Bereiche gegliedert: Zuerst werden wir auf die Gründungsentwicklung eingehen – darauf liegt auch der Schwerpunkt unseres Interviews. Danach werde ich Sie kurz zu der Finanzierungsstruktur Ihres Gründungsprojektes befragen und anschließend möchte ich gerne mehr zu Ihrer Person und Ihrem Werdegang erfahren. Auch die weitere Entwicklung und die gegenwärtige Situation werden wir thematisieren.</p> <p>Wenn Sie einverstanden sind, würde ich das Gespräch gerne auf einem Tonband aufzeichnen, so dass wir später nicht nur auf unser Gedächtnis angewiesen sind. Mit den gewonnenen Daten werde ich natürlich gemäß den Datenschutzbestimmungen vorgehen und keinerlei personenbezogene Daten weitergeben oder veröffentlichen. Außerdem werden sämtliche Angaben, aus denen Rückschlüsse auf Ihre Person gezogen werden können, bereits bei der Transkription des Interviews anonymisiert.</p> <p>Damit ich im Gesprächsverlauf nichts vergesse, habe ich diesen Interviewleitfaden mitgebracht. Er dient als strukturierendes Element für die Befragung, allerdings ist es gut möglich, dass wir an bestimmten Punkten abweichen, um Aspekte, die besonders interessant sind, genauer zu betrachten. Falls Sie mit einer Frage nichts anfangen können oder diese für Ihren Fall nicht richtig gestellt erscheint, teilen Sie mir dies bitte einfach mit. Vielen Dank!</p>
--

<b>II. Gründungsentwicklung</b>					
(1) Bitte erzählen Sie uns zu Beginn was Sie in Ihrem Unternehmen tun und wo Sie heute mit Ihrem Unternehmen stehen / vom Stand Ihres Projektes zum jetzigen Zeitpunkt.					
<i>Gerne möchte ich nun auf die Anfangszeit der Geschäftsidee zurückkehren und daher frage ich Sie im Folgenden ein paar Fragen, die sich vor allem auf die erste Zeit Ihres Projektes vor der Gründung beziehen.</i>					
(2) Sind/waren Sie der Ideengeber?					
a. Bitte erzählen Sie, wie es zu der Idee kam.					
<u>Falls nein zusätzlich:</u>					
b. Bitte erzählen Sie, wie Sie in das Projekt gekommen sind. (Falls noch nicht beantwortet: Wie lange bestand das Projekt damals schon?)					
(3) Wann und wie fiel die Entscheidung die Idee weiter zu verfolgen? (Falls nicht beantwortet: In Form einer Gründung? Waren diese beiden Entscheidungen identisch?)					
(4) Wie viel Zeit verging zwischen der ersten Idee und der Erkenntnis, dass eine marktwirtschaftliche Nutzung möglich ist?					
(5) Im Falle einer Teamgründung: Bitte erzählen Sie wie Ihr Team konkret in dieser Anfangsphase aufgebaut war und wie die Kompetenzen verteilt waren?					
<u>Falls Befragter Ideengeber:</u> Wie kam das Team zu Stande? (Falls noch nicht beantwortet: Wie wurden weitere Gründungsmitglieder gefunden? Wie viele Teammitglieder hatte das Vorhaben zu Beginn? Welche Kompetenzen hatten die Teammitglieder? Woher kannten Sie sich? Waren/sind Sie alle an der Universität beschäftigt?)					
(6) Hatten Sie oder eines der Teammitglieder relevante Erfahrungen in den folgenden Aspekten? (5er-Skala von 1 = gar keine Erfahrung bis 5 = langjährige Erfahrung)					
	Gar keine Erfahrung				Langjährige Erfahrung
Erfahrungen mit einer Unternehmensgründung					

Erfahrungen in der Zielbranche (Branche in der gegründet wurde)					
Erfahrungen im Unternehmensmanagement					
Erfahrungen im Hinblick auf Budgetverantwortung und Finanzplanung					
Erfahrungen im Hinblick auf Marketing und Vertrieb?					
Erfahrungen in der Leitung von Forschungsprojekten?					
<i>Ich würde nun gerne etwas mehr über das Umfeld des Projektes in der frühen Phase erfahren.</i>					
(7) Hatte Ihr direktes Umfeld - sowohl privat als auch beruflich - Einfluss auf das unternehmerische Vorhaben?					
(8) Können Sie konkret beschreiben in welcher Form? (Erwartungen: Einfluss von persönlichen Kontakten; Einfluss Lehrstuhl, Universität, Institut)					
(9) <i>Falls noch nicht genannt:</i> Nahm auch Ihr Lehrstuhl Einfluss auf Ihr Vorhaben und wenn ja, wie? (Falls nicht beantwortet: Hatte der Lehrstuhl Drittmittelprojekte? Kooperationen mit Unternehmen? Wie waren die direkten Kollegen/Lehrstuhlinhaber dem Gründungsprojekt gegenüber eingestellt? Nutzung Infrastruktur?)					
(10) Abgesehen vom Lehrstuhl, können Sie uns auch von wesentlichen Einflüssen auf Ihre Unternehmung innerhalb der übrigen Universität (Instituts-Gesamtuniversitäts-Ebene) berichten? <i>Falls ja:</i> War diese Art der Einflussnahme / Unterstützung förderlich / hinderlich: Bitte führen Sie aus.					
(11) Erfolgten aus Ihrem Lehrstuhl oder Ihrem Institut noch weitere Gründungen vor oder nach Ihrem Vorhaben? <i>Falls ja:</i> (Inwiefern) standen diese Gründungen in einem Zusammenhang mit Ihrem eigenen Projekt?					

(12) Was sagen Sie: Was waren die wichtigsten Ressourcen in dieser Phase Ihres Projektes?			
(13) Aus Ihrer Erfahrung: Was waren die größten Hindernisse in dieser Phase der Gründung?			
(14) Welche weiteren Schritte haben Sie konkret unternommen, um das Projekt voranzutreiben?			
(15) Wann haben Sie Ihr Unternehmen gegründet und mit wem?			
(16) <i>Falls noch nicht beantwortet:</i> Basiert Ihr Unternehmen also auf einer Produkt- oder Dienstleistungsidee?			
(17) Wie weit war die Produkt- oder Dienstleistungsidee entwickelt zum Zeitpunkt der Gründung?			
Vage Idee			
Konkrete Idee, aber noch marktfern			
Funktions- oder Labormuster			
Prototyp			
Markt- oder serienreif			
(18) Wie viel Zeit verging zwischen der ersten Idee und der Gründung?			
(19) Wie wichtig waren folgende Faktoren für die Umsetzung Ihrer Geschäftsidee?			
	Von geringer bis keiner Bedeutung	Vor großer Bedeutung	Unverzichtbar
Besondere Fähigkeiten, die Sie im Zuge Ihrer Tätigkeit an der wissenschaftlichen Einrichtung erworben haben			
Neue wissenschaftliche Methoden oder Techniken, die Sie im Zuge Ihrer Tätigkeit an der wissenschaftlichen Einrichtung erworben haben			
Ergebnisse der (eigenen) Forschungstätigkeit an einer wissenschaftlichen Einrichtung, z. B. die Entwicklung eines neuen Produkts oder einer neuen Dienstleistung			

(20)Wie ging es nach der formalen Gründung weiter? Bitte erzählen Sie doch einmal.					
(21)Kam es im Verlauf der Gründungsvorbereitung oder nach der Gründung zu größeren Veränderungen? (Falls nicht genannt: Kam es zu Änderungen in der Teamzusammenstellung?)					
(22) Bitte nennen Sie mir die die Ausprägung der jeweiligen Änderungen in den folgenden Bereichen:					
Art der Änderung	Gar keine Änderung				Sehr deutliche Änderung
Bei dem technologischen Lösungsweg oder der technischen Vorgehensweise					
Beim grundsätzlichen Produkt- oder DL-Konzept					
Beim Zielmarkt, bei der Zielgruppe					
Bei Marketing-, Markteintritts- oder Vertriebsstrategie					
In der Teamzusammensetzung					
(23)Hatten Ihrer Einschätzung nach eine oder mehrere dieser Änderungen einen ausschlaggebenden Einfluss auf die Entwicklung Ihres Unternehmens? Bitte erzählen Sie.					
<i>Ich möchte nun gerne noch mal auf die Verbindung zu Universität eingehen.</i>					
(24)Bestanden weiterhin konkrete Verbindungen zwischen der Universität und der Gründung? (Lehrstuhl / Institut / Universität) (Erwartungen: Gab es Unterstützung? Wenn ja, was wurde gemacht, zur Verfügung gestellt? Wenn nein, wieso nicht?) <i>Falls ja:</i> Sie haben erwähnt es gab diese Verbindungen. Hätten Sie außerdem etwas von Ihrer Universität oder Ihrem Lehrstuhl erwartet? <i>Falls nein:</i> Hätten Sie etwas von Ihrer Universität oder Ihrem Lehrstuhl erwartet?					
(25)Wenn Sie abschließen ein Statement nehmen müssten, wie würden Sie sagen hat sich das Verhältnis zwischen der Gründung und der Universität / dem Lehrstuhl im Laufe der Zeit entwickelt?					
(26)Was waren die wichtigsten Ressourcen in der Phase nach der Gründung?					

(27) Aus Ihrer Erfahrung: Was waren die größten Hindernisse in dieser Phase?	
<i>Ich würde Ihnen nun gerne ein paar Fragen zu der Finanzierung Ihres Unternehmens / Projektes stellen.</i>	
<b>III. Finanzierung</b>	
(28) Wie wurde ihr Unternehmen finanziert? (Erwartungen: Öffentliche Förderzuschüsse und –kredite; Eigenmittel der Gründer; Bankkredite; Beteiligungen Dritter (BA, VC etc.); Finanzierung aus laufenden Einnahmen; Sonstige Finanzierungsquellen)	
(29) Bitte erzählen Sie uns wie es zu den Finanzierungen kam. Konnten Sie Ihren Finanzierungsbedarf termingerecht decken? (Falls nicht genannt: Wie wurde dies erreicht? Wer hat dabei unterstützt? Welche Unterstützung wäre zusätzlich benötigt worden? Was führte dazu, dass das Kapital nicht akquiriert werden konnte?)	
(30) Wie hoch war in etwa der gesamte Kapitalbedarf für die Gründung?	
Bis 10.000 €	
Über 10.000 € bis 25.000 €	
Über 25.000 € bis 100.000 €	
Über 100.000 € bis 500.000 €	
500.000 € bis unter 1.000.000 €	
Über 1.000.000 €	
Noch offen	
(31) Ab wann machten Sie Umsätze? Wie viel Zeit ist zwischen dem ersten Umsatz (aus dem GM) und der Gründung vergangen?	
(32) Ab wann machten Sie Gewinne? Wie viel Zeit ist zwischen den ersten Gewinnen (aus dem GM) und der Unternehmensgründung vergangen?	
(33) Wie viele Mitarbeiter haben Sie zur Zeit?	
<b>IV. Persönliche Einstellung</b>	
(34) Bitte erzählen Sie, was das Gründungsvorhaben für Sie persönlich bedeutet (hat)? (War / ist es ein persönlicher Erfolg für Sie?)	
(35) Hatten Sie bereits vor der berichteten Gründung einmal eine verwertbare Idee oder Interesse an der Umsetzung einer Idee im unternehmerischen Sinne? Bitte erzählen Sie.	

(Falls nicht genannt: Stand diese Idee in irgendeinem Zusammenhang mit der dann erfolgten Gründung? Gab es mehrere Ideen? Warum wurden diese nicht umgesetzt?)					
(36)Wie wichtig ist Ihrer Einschätzung nach der Universität Würzburg die Förderung von Unternehmensgründungen?					
sehr unwichtig					sehr wichtig
<b>IV. Zukünftige Entwicklung</b>					
<i>Die nächsten Fragen beziehen sich auf die zukünftige Entwicklung und wir möchten Sie bitten diese nur kurz zu beantworten.</i>					
(37)Wie geht es bei Ihnen weiter (beruflich und privat)? Bitte erzählen Sie kurz.					
(38)Wo sehen Sie Ihr Unternehmen in 5 Jahren?					
(39)Möchten Sie gerne abschließend noch allgemein etwas zum Thema Gründen aus der Universität / Spin-offs sagen?					
VIELEN DANK für Ihre Zeit und Ihre Meinung/Einschätzung!					

### **Table A3: Rules of transcription**

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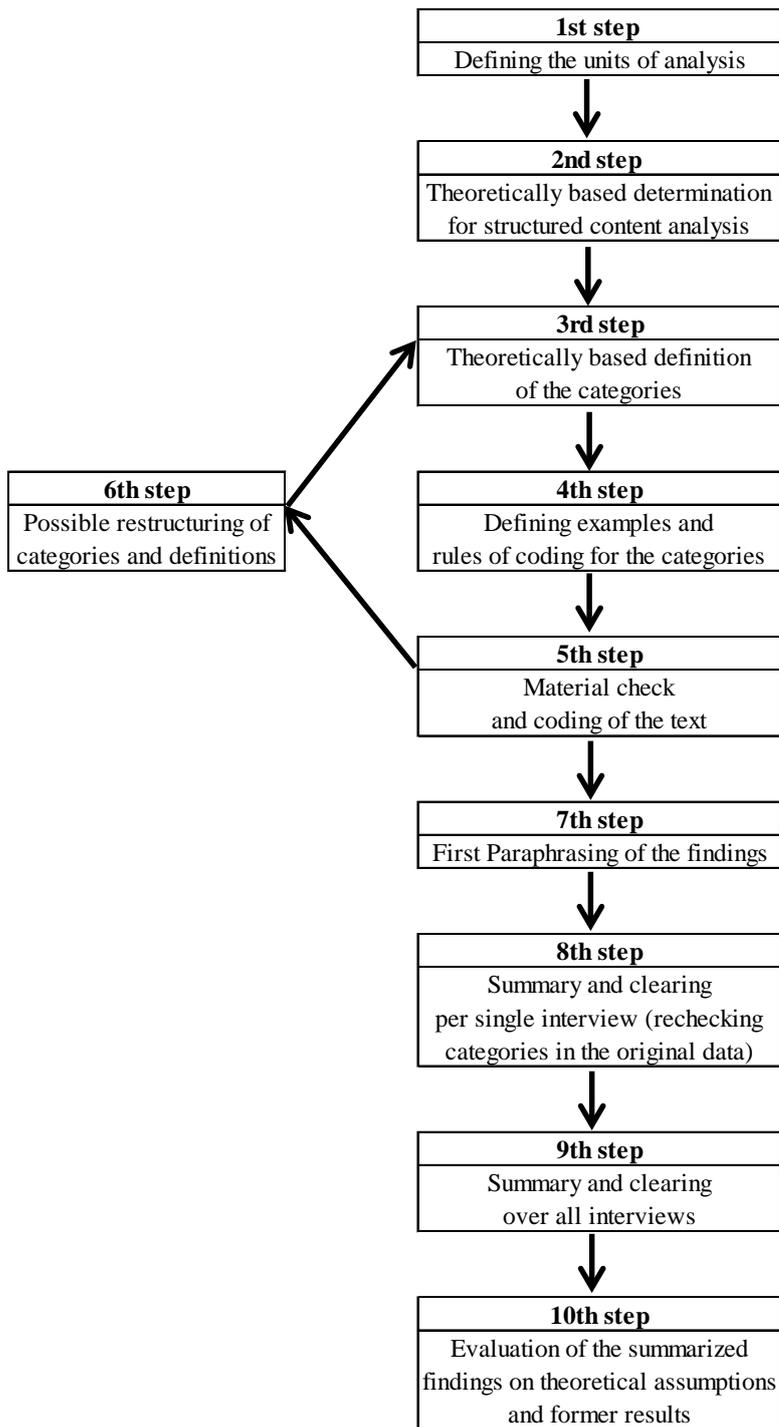
Transcription of wording (not summarized); spoken language was transferred to standard German
All information on personal data was anonymized
The interviewer is labelled “I” and the interviewee is labelled with “B” and the consecutive number (for example, B3)
Noticeably long breaks are tagged with (...)
Terminated words or phrases without meaning are left out, doubling of words are only transcribed if they are used as a stylistic means or to emphasize a meaning, and half-finished phrases are transcribed and the ending is marked with /
Approving expressions of the interviewer are not transcribed if they did not interrupt the flow of the interviewee
Interjections of the respective person are put in brackets
Expressions of the interviewee are put in brackets (for example, laughing)
Incomprehensible statements are marked and assumptions of the meaning are put in brackets with a question mark (for example, KSU?)
Transcription was made using f4; rules of transcription (Kuckartz et al. 2008). Rules of transcription were kept deliberately simple and focused on content.

**Table A4: Code system**

Interesting [20]	
Decision to go forward with an idea [34]	
Decision to establish a company or stop project [28]	
Critical junctures [18]	In early development [15] At the time of establishing a company, time of discontinuation, or interview [34]
Critical resources [4]	In early development [27] At the time of establishing a company, time of discontinuation, or interview [12]
Team [0]	Initial team [28] Team development [28] Final team [15]
Private influences [20]	
Attitudes of chair colleagues [19]	#
Attitudes and behaviors of the mentor [40]	
Influences of the chair setting [23]	In early development [24] At the time of establishing a company, time of discontinuation, or interview [24]
Other influences within the university context [16]	In early development [31] At the time of establishing a company, time of discontinuation, or interview [11]
Influences outside the university context [8]	In early development [23] At the time of establishing a company, time of discontinuation, or interview [10]
Development of the relationship [14]	
Expectations on the university surrounding [27]	
Determining changes [26]	
Financial and funding requirements [54]	

All categories together contain 633 different information elements.

**Table A5: Full model of analysis (own illustration based on Mayring 2010)**



**Table A6: Comparison between high and low intentions to become self-employed<sup>a</sup>**

Variable	Full sample		High intentions		Low intentions		High vs. low intentions
	Mean	SD	Mean	SD	Mean	SD	p-value
Gender	0.33	0.47	0.28	0.45	0.34	0.47	0.7267
Credit availability	2.41	0.86	2.37	0.90	2.42	0.86	0.3161
Risk-taking propensity	2.90	1.03	3.65	0.78	2.72	1.01	-5.6108***

<sup>a</sup> n = 227; 43 individuals with very high and high intentions are coded 1, 184 individuals with neutral, low and no intentions are coded 0. Note that gender is coded 1 for women. A Kruskal-Wallis equality-of-population rank test has been conducted and shows significant differences for risk-taking propensity but not for credit availability. This table shows in the last column the p-values for a two sided t-test on the equality of means. \*\*\* p<0.01; \*\* p<0.05; \* p<0.1

**Table A7: Robustness check<sup>a</sup>**

Variable	1 vs. 2 and 3		1 and 2 vs. 3		Brant test
	Mean	SD	Mean	SD	p-value
Gender	0.57	0.37	0.57	0.37	0.02
Credit availability	0.30	0.22	0.30	0.22	0.01
Risk-taking	0.42	0.21	0.42	0.21	0.02
Gender x credit	-1.28	0.44	-1.28	0.44	1.26
Gender x risk	-0.47	0.34	-0.47	0.34	1.10
Age	-0.04	0.02	-0.04	0.02	0.01
Economics	0.35	0.43	1.37	0.50	4.90**
Social sciences	-0.29	0.42	-0.29	0.42	0.97
Role model	0.53	0.33	0.53	0.33	0.99
Attitude entr.ship	1.42	0.26	1.42	0.26	0.07
Prop. to innovate	0.77	0.26	0.77	0.26	0.02
Entr.ship course	0.27	0.37	0.27	0.37	0.18

<sup>a</sup> n = 227; The reference group is the study field of natural sciences. The last column shows the p-values for a Brant test of parallel lines assumption. A positive coefficient shows that a higher value on the co-variate makes a higher value on the dependent variable more likely.

\*\*\* p<0.01; \*\* p<0.05; \* p<0.1

**Table A8: Robustness checks<sup>a</sup>**

	Model 7			Model 8			Model 9		
Gender	1.50	(0.65)	**	0.77	(0.31)	**	0.38	(0.38)	
Perc. credit avail- ability	0.58	(0.37)		0.25	(0.19)		0.34	(0.19)	*
Risk-taking	0.71	(0.34)	**	0.50	(0.19)	**	0.44	(0.18)	**
Gender x perc. credit availability	-2.05	(0.75)	***	-0.84	(0.35)	**	-1.12	(0.34)	***
Gender x risk	-0.92	(0.54)	*	-0.59	(0.28)	**	-0.61	(0.27)	**
Age	-0.10	(0.03)	***	-0.05	(0.02)	***	-0.05	(0.02)	***
Economics	1.16	(0.68)	*	0.38	(0.33)		0.34	(0.33)	
Social sciences	-1.00	(0.70)		-0.62	(0.35)	*	-1.10	(0.48)	**
Gender x social							1.28	(0.64)	**
Role model	0.72	(0.57)		0.30	(0.29)		0.36	(0.29)	
Attitude entr.ship	2.16	(0.47)	***	1.15	(0.22)	***	1.31	(0.22)	***
Prop. to innovate	1.64	(0.43)	***	0.79	(0.21)	***	0.77	(0.21)	***
Entr.ship course	1.07	(0.64)	*	0.44	(0.32)		0.63	(0.31)	**
Self-employment				1.30	(0.44)	***			
Observations	227			223			227		
Log likelihood	-267.66***			-256.33***			-264.82***		
Pseudo R <sup>2</sup> (Chi <sup>2</sup> )				0.21			0.21		

<sup>a</sup> Coefficient estimates for the stereotype logistic regression and ordered logistic regression model. Standard errors are shown in parentheses. The reference group is the study field of natural sciences. Note that gender is coded 1 for women. Model 7 presents the regression results for the stereotype logistic regression. Model 8 includes actual self-employment as an additional control variable and Model 9 includes a further interaction term between gender and the field of social sciences.

\*\*\* p<0.01; \*\* p<0.05; \* p<0.1