The Journal of Technology Transfer
https://doi.org/10.1007/s10961-021-09904-y

Venture creation patterns in academic entrepreneurship: the role of founder motivations

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Accepted: 1 November 2021

Abstract
The path to academic entrepreneurship is characterized by a sequence of venture creation activities, which can be classified into operational-, financing- and commercialization activities. Academic entrepreneurship research is concerned with the question how different motives of scientists affect the patterns of these venture creation activities. Using a longitudinal two-period dataset of 165 academic entrepreneurs from 73 universities in Germany, we propose and test a multi-activity-based model that links different types of entrepreneurial motives to venture creation activities. The findings show that founder motives related to self-realization, necessity and an increased financial income increase the likelihood of completing venture creation activities, whereas work-life balance motivations and the drive to make better use of one's professional knowledge decrease that likelihood. The desire to translate research ideas into practice has no effect. Our results further show that the positive effects of seeking self-realization and an increased financial income are more pronounced for completing commercialization activities than for operational activities. Our study contributes to research on academic entrepreneurship and entrepreneurial motivations and helps university administrators and policymakers to design their entrepreneurship support programs more effectively.

Keywords Academic entrepreneurship · Academic spin-offs · Motivation · Drivers · Venture creation patterns

JEL Classification M130 · L260 · O310 · O320

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Published online: 23 November 2021

1 Introduction

Knowledge- and technology-based spin-offs are regarded as central drivers of economic, social, and ecological development (Block et al., 2017; Fini et al., 2018; Guerrero et al., 2015; Santini, 2017). As such, academic entrepreneurship research has increasingly focused on the process of venture creation (Bozeman, 2000; Djokovic & Souitaris, 2008; Mathisen & Rasmussen, 2019; Miranda et al., 2018; Mustar et al., 2006; Perkmann et al., 2013; Zhao et al., 2010). Prior research has adopted an activity-based approach to explore the venture creation process (Guerrero et al., 2020; Kleinhempel et al., 2020; Shepherd et al., 2019; Stuetzer et al., 2012). This process is characterized as a sequence of venture creation activities (Rasmussen, 2011; Stuetzer et al., 2012) ranging from the identification of an entrepreneurial opportunity to the first commercial sale of a product or service (Gatewood et al., 1995; Hansen, 1991; Hansen & Wortman, 1989; Kleinhempel et al., 2020; Liao et al., 2005). However, a high discrepancy exists between the identification of an entrepreneurial opportunity and initial entrepreneurial actions (Kollmann et al., 2017).

According to Fritsch and Krabel (2012), 28% of all university scientists in Germany plan to start their own business but only 3.2% actually bring their plans to fruition. These numbers are consistent with the latest studies on academic entrepreneurship based on British and Italian data indicating that only 3% of all scientists engage in academic entrepreneurship (Bolzan et al., 2020; Fini et al., 2021). More research is necessary to understand the drivers and patterns of venture creation activities in academic entrepreneurship (Bikard & Marx, 2020; Fayolle et al., 2014; Fini et al., 2021; Greven et al., 2020; Li et al., 2021; Sciarelli et al., 2021). We still do not know much about what motivates academic entrepreneurs and how different types of motivations predict entrepreneurial behaviors at different stages of the venture creation process (Hossinger et al., 2020). Hence, this study responds to this call and analyzes how the different motives of academic entrepreneurs influence venture creation activities. Prior studies investigating the role of entrepreneurial motives on venture creation focus merely on the effect of motivation regarding single activities such as initiation or growth (DeTienne et al., 2008; Dunkelberg et al., 2013; Farmer et al., 2011; Huyghe et al., 2016; Wood et al., 2014). However, a broader perspective is needed as the effect of entrepreneurial motives can change between different venture creation activities and different venture creation stages (Murnieks et al., 2020). Previous literature did not provide such a holistic perspective.

Using a longitudinal two-period dataset of 165 academic entrepreneurs from 73 universities in Germany, we propose and test a multi-activity-based model that links different types of entrepreneurial motives to venture creation activities. By doing so, we integrate two literature streams that have previously been unconnected. The first body of literature relates to motivation in entrepreneurship (e.g., Göktepe-Hulten & Mahagaonkar, 2009; Hayter, 2011; Lam, 2011; Murnieks et al., 2020). We use this stream of literature to divide academics' entrepreneurial motivations into three major types: transfer motives (i.e., application of research ideas, self-realization, and knowledge and skill utilization); economic motives (i.e., monetary rewards and financial necessity); and lifestyle motives (i.e., work-life balance). The second body of literature relates to venture creation stages (e.g., Bhave, 1994; Kleinhempel et al., 2020; Reynolds & Miller, 1992; Shepherd et al., 2019; Van Gelderen et al., 2006; Vohora et al., 2004). We draw on this stream of literature to conceptualize venture creation in academic entrepreneurship as operational, financing, and commercialization venture creation activities. The findings show that the most relevant motives for completing venture creation activities are seeking self-realization as well as an increased

financial income, the drive to better utilize knowledge, financial necessity, and work-life balance issues. Self-realization, the desire for an increased financial income, and financial necessity increase the likelihood of completing venture creation activities, whereas the desire to better utilize knowledge or achieve work-life balance decrease the likelihood of completing venture creation activities. The desire to translate research ideas into practice was not found to have a significant effect on the completion of venture creation activities. Moreover, the results indicate that the effects of self-realization and the desire for an increased financial income are more pronounced for commercialization activities (as compared to operational activities).

This study contributes to the literature on entrepreneurship motivations (Block & Wagner, 2010; Kirkwood, 2009; Rizzo, 2015) by showing how entrepreneurial motivations influence the amount of completed venture creation activities, how strong these influences are, and how specific motivational factors influence the discrepancy alongside the venture creation process of academic entrepreneurs. Our study also contributes to academic entrepreneurship research (Liao et al., 2005; Van Gelderen et al., 2006) by highlighting the motivational factors that increase engagement in entrepreneurial activities. Finally, our study adds to the literature on venture creation patterns. By following an activity-based approach (Guerrero et al., 2020; Kleinhempel et al., 2020; Shepherd et al., 2019; Stuetzer et al., 2012) and providing a multi-activity-based model consisting of operational, financial and commercialization activities, our study provides a context-specific perspective (Welter, 2011) and broadens the understanding of venture creation patterns in academic entrepreneurship. Apart from these theoretical considerations, our study also has practical implications. First, by showing which entrepreneurial motivations matter at what venture creation stage, our findings may help university administrators aiming to promote new venture creation through support programs (Geuna & Muscio, 2009; Siegel & Wright, 2015). Our findings help them to prioritize their resources by encouraging and enhancing those motivational forces that are positively related to venture creation in academic entrepreneurship. Second, our study shows that two groups of academic entrepreneurs deserve more attention. These are necessity founders and scientists driven by the desire to better utilize their professional knowledge. University administrators and policymakers should therefore consider offering differentiated support programs to meet the specific needs of these founders.

2 Theoretical background and hypotheses

2.1 Motivations in (academic) entrepreneurship

The success of entrepreneurship greatly depends on an individual's involvement and commitment (Lee et al., 2011; Shane et al., 2003). Previous studies have shown that individuals decide to undertake entrepreneurial activities due to a variety of individual motives (Hayter, 2015a; Murnieks et al., 2020; Van Gelderen et al., 2015). Block and Wagner (2010) identify two types of entrepreneurs: necessity entrepreneurs and opportunity entrepreneurs. Opportunity entrepreneurs voluntarily decide to create a business when they identify a potential entrepreneurial opportunity, while necessity entrepreneurs are more likely to engage in entrepreneurship due to external factors such as job dissatisfaction or unemployment (Block & Sandner, 2009). Push and pull perspectives have also been adopted in the entrepreneurship literature to categorize these two central categories of entrepreneurial motivations. The desire for independence, monetary motivation, and the desire for a

challenge or need for achievement have been found to be the most common pull factors for entrepreneurship (Antonioli et al., 2016; Kirkwood, 2009; Rizzo, 2015). In contrast, job dissatisfaction, a lack of support from one's employer, and work-life balance issues have been found to be the most relevant push factors for entrepreneurship (Kirkwood, 2009). Along those lines, Iorio et al. (2017) propose that entrepreneurial motives can also be classified according to intrinsic or extrinsic motivations. Intrinsic motivations refer to behaviors that are driven by internal rewards and originate within a person; they naturally satisfy the individual. Examples include intrinsic satisfaction (Lam, 2011), the desire for independence (Shane, 2004), and the desire to learn new skills (Benz, 2009; Hayter, 2011). The term extrinsic motivation, in contrast, refers to behaviors that are driven by external rewards that arise from external environmental factors, such as pursuing monetary or nonmonetary rewards (e.g., promotion or increase in reputation; Fini et al., 2009; Göktepe-Hulten & Mahagaonkar, 2009). For entrepreneurs, monetary returns seem to be an important motivation for self-employment (Block & Sandner, 2009). However, entrepreneurs have also been shown to be strongly attracted by nonmonetary intrinsic benefits when engaging in entrepreneurial activities. Prior literature suggests that nonmonetary benefits (such as the pursuit of greater autonomy, broader skill utilization, and the possibility of applying one's ideas) also play a significant role in entrepreneurship (Benz, 2009; Hundley, 2001). Necessity entrepreneurs are ex definition unlikely to start their venture for nonmonetary reasons (Block & Sandner, 2009) and opportunity entrepreneurs could earn more in a wage-earning job due to their qualifications (Hamilton, 2000; Block & Sandner, 2009). Monetary motives appear to be more important for necessity entrepreneurs, while nonmonetary returns have a greater impact on opportunity entrepreneurs (Blanchflower, 2000; Frey & Benz, 2003; Block & Sandner, 2009). Research on motivations in the academic context has also shown that academics are strongly driven by a sense of social responsibility and a need for knowledge and skill utilization when participating in the technology transfer process. In other words, academic scientists often devote themselves to improving society by transferring knowledge and disseminating technology based on their academic research (Berggren, 2017; Iorio et al., 2017; Morales-Gualdrón et al., 2009). Additional individual benefits for academic entrepreneurs result from specific entrepreneurial activities. These may create further stimuli for research activities, provide access to funding opportunities (grants), or enable the acquisition of new facilities for research activities. These motives are significant determinants for academics who are engaged in founding and advancing projects (Antonioli et al., 2016; Goethner et al., 2012; Hayter, 2015a). In line with this, Lam (2011) employs the following three concepts to classify intrinsic and extrinsic motivations for academic entrepreneurship: "gold" (financial rewards), "ribbon" (reputational and career rewards) and "puzzle" (intrinsic satisfaction). Academic entrepreneurs do not seem to consider financial rewards as a primary motive for entrepreneurship (Göktepe-Hulten & Mahagaonkar, 2009; Lam, 2011). Especially in Germany, scientists' entrepreneurial motivations are strongly related to the working conditions within universities. This has several reasons. Firstly, German scientists often work under limited time work contracts and lack tenured positions. Secondly, due to a lack of third-party funding, some universities cannot provide the necessary resources to advance capital-intensive research projects. As a result, the motives of necessity and the desire to use one's professional experience or knowledge may play a decisive role. Therefore, this study complements the entrepreneurial motives identified by Lam (2011) and incorporates the motivations of necessity and the desire to use one's professional experience or knowledge.

Building on this body of work (and based on the nature and characteristics of the motivations), our paper classifies the motivations that influence the venture creation patterns

of academic entrepreneurship into the following three dimensions: transfer motivations, economic motivations, and lifestyle motivations. Transfer motivations are closely related to academics' personal wish to apply their research results practically, to utilize their knowledge, or to achieve self-realization. Economic motivations consist of the desire for an increased income or financial necessity. Lifestyle motivations refer to work-life balance (i.e. how a scientist perceives their workload compared with the responsibilities that come from other work or personal duties; Balven et al., 2017).

2.2 Patterns of venture creation in (academic) entrepreneurship

The path leading to academic entrepreneurship is characterized as a sequence of venture creation activities embedded in a specific environmental context (Gartner et al., 1992; Kim et al., 2016; Kleinhempel et al., 2020; Rasmussen et al., 2014; Welter, 2011). Thus, the majority of the literature shows that new venture creation encompasses all venture creation activities ranging from the intention to start a business to the first commercial sale of a product or service (Gatewood et al., 1995; Hansen, 1991; Hansen & Wortman, 1989; Liao et al., 2005).

However, previous research also suggests that there is a substantial variation with regard to the number and sequence of these activities and their duration. The most common way to study patterns of venture creation in entrepreneurship is through an activity-based approach. This involves a definition of venture creation based on a bundle of pattern-specific key activities, milestones being reached, and the frequency and timeframe of these activities (Davidsson & Scott, 2012; Guerrero et al., 2020; Kleinhempel et al., 2020; Shepherd et al., 2019; Stuetzer et al., 2012). Based on this research stream, activities alongside the venture creation process can be categorized into distinct stages (Bhave, 1994; Guerrero et al., 2020; Kleinhempel et al., 2020; Reynolds & White, 1997). Accordingly, prior studies identified a wide range of venture stages (DeTienne, 2010) through which potential entrepreneurs need to pass to establish their venture (Baker et al., 2005; Baron, 2007; Kleinhempel et al., 2020). Although process orientation seems to be gaining momentum (McMullen & Dimov, 2013), the findings assigning creation activities to specific venture creation stages have been somewhat contradictory and fragmented. Table 1 provides an overview of how previous research categorizes venture creation activities into distinct phases, stages or activity bundles.

Vesper (1990) and Reynolds and Miller (1992) showed that a combination of activities leads to the creation of a new firm. Such activities are associated with the identification of entrepreneurial opportunities, the creation of a business structure, and the operational procedures required to pursue and exploit these opportunities. Bhave (1994) distinguished between three stages: opportunity recognition, organization creation, and exchange. The stage of opportunity recognition starts with the identification of a business concept and culminates with the commitment of realizing the first steps toward entrepreneurship. The organization creation stage covers all creation activities relating to product and service development and to the creation of the organization. Finally, the exchange stage completes the entrepreneurial loop and focuses on boundary spanning to customers and the realization of first sales (Bhave, 1994). Similarly, Reynolds and White (1997) suggest that the venture creation process starts with the recognition of a business opportunity and ends with the consolidation of a new venture. In their model, the venture creation process consists of four distinct stages that potential entrepreneurs have to pass through: the conception stage, the gestation stage, the infancy stage and the adolescence stage. Moreover, Vohora et al.

Table 1 Previous studies on venture creation patterns

Author(s)	Suggested venture creation phases, stages or activity-bundles
Kleinhempel et al. (2020)	Pre-establishment stage Young venture stage Established venture stage
Shepherd et al. (2019)	Initiation activities Engagement activities Performance activities
Van Gelderen et al. (2006)	Intention development stage Opportunity recognition stage Resource assembly stage Market exchange stage
Vohora et al. (2004)	Research stage Opportunity framing stage Pre-organization stage Re-orientation stage Sustainable returns stage
Reynolds and White (1997)	Conception stage Gestation stage Infancy stage Adolescence stage
Bhave (1994)	Opportunity recognition stage Organization creation stage Exchange stage
Reynolds and Miller (1992)	Personal commitment First sales First hiring First financial support
Vesper (1990)	Identification of entrepreneurial opportunity Creation of a business structure Establishing operational procedures

The aforementioned studies followed an activity-based approach in order to categorize creation activities into distinct stages, phases or activity-bundles

(2004) emphasize that the development of spin-offs generally occurs in five successive stages in an iterative, non-linear way (research stage, opportunity framing stage, pre-organization stage, re-orientation stage, and sustainable returns stage). Due to the deficiency of social capital, weaknesses of resources, and inadequacy of internal capabilities, the transition between each development stage is separated by critical junctures (thresholds) that must be overcome to move forward to the next stage. The development may stagnate and eventually fail if this does not occur (Vohora et al., 2004). Acknowledging this variation, Van Gelderen et al. (2006) distinguish four stages in the venture creation process. The first stage involves the development of an intention to start a business (intention development stage). The second stage entails the recognition of an entrepreneurial opportunity and the creation of a business concept (opportunity recognition stage). In the third stage, resources are assembled and the organization is created (resource assembly stage). In the fourth stage, the organization begins exchanging with the market (market exchange stage). Also building on this research stream, Shepherd et al. (2019) adopt an activity-based perspective and develop a conceptual meta-framework of entrepreneurial venture creation. As a result,

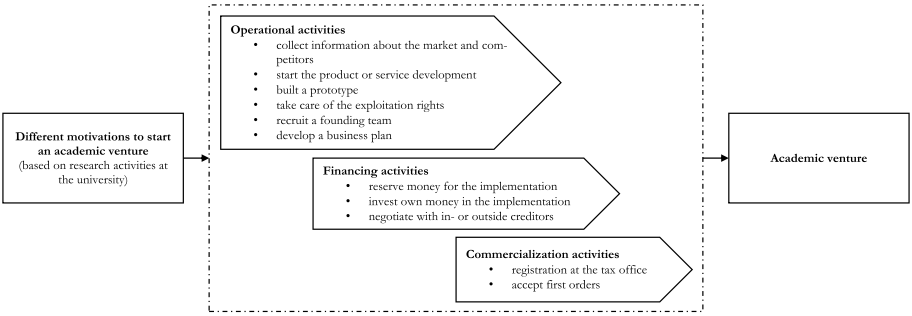

Fig. 1 Conceptualization of venture creation activities in academic entrepreneurship

they distinguish between initiation, engagement, and performance activities. Accordingly, Kleinhempel et al. (2020) conceptualize the venture creation process as the transition between the pre-establishment stage, the young venture stage, and the established venture stage.

Although prior literature is contradictory and fragmented in terms of providing a universal set of venture creation stages, phases or activity bundles, the venture creation process is characterized as a sequence of activities that need to be undertaken in order to transform a start-up project into a new venture (Samuelsson & Davidsson, 2009; Stuetzer et al., 2012). Acknowledging this variety of concepts, Van Gelderen et al. (2006) provide in our view the most comprehensive and holistic measurement of the venture creation process. This conceptual model can be adapted for academic entrepreneurship.

In contrast to entrepreneurship in general, academic entrepreneurs can draw on the infrastructures and resources of their parent organizations such as premises, facilities, employees or organizational support mechanisms. Therefore, several creation activities pertaining the assembling of resources or the creation of a business structure already take place in the opportunity recognition stage. Hence, we adapt the model of Van Gelderen et al. (2006) and distinguish between operational- financing- and commercialization activities. Figure 1 shows how we conceptualized the venture creation patterns of academic entrepreneurship.

2.3 Hypothesis development

2.3.1 Transfer motivations

A scientist's willingness to start a business is determined by a strong belief in the importance of his or her research (Lam, 2011). Caring about one's own research and wishing to translate one's own ideas or inventions into practice are regarded as central drivers for academic entrepreneurship (Berggren, 2017; Iorio et al., 2017; Morales-Gualdrón et al., 2009). As such, transfer motives are closely related to the personal expectations and objectives of academics and are an important factor in leading academics to start a venture. Moreover, this factor is the main reason why universities have become increasingly entrepreneurial; the so-called third mission has become a significant university function because of the growing societal need for universities to transfer knowledge outside of academia and to contribute to social and economic development (Etzkowitz, 2003; Huyghe & Knockaert, 2015; Iorio et al., 2017). In this context, Iorio et al. (2017) argue that many academics are driven by pro-social motives (or so-called mission motives) when engaging in knowledge

transfer activities. The aim of these activities is knowledge dissemination with the goal to improve societal well-being. In line with this argument, Ramos-Vielba et al. (2016) emphasize that academics primarily engage in knowledge transfer activities in order to apply their research ideas. We propose that academic entrepreneurs driven by transfer motivations have a strong incentive to complete the different activities of venture creation because this allows them to realize their transfer motives (D'Este & Perkmann, 2011; Lam, 2011). Thus, we formulate the following hypothesis:

Hypothesis 1a: The higher the motivation to translate one's research ideas into practice, the higher the amount of completed venture creation activities.

However, we expect that the effect of translating one's research ideas into practice will not be uniform across operational-, financing- and commercialization activities. Academic entrepreneurs motivated by transfer motives draw satisfaction primarily from activities that are closely related to their research (Lam, 2011; Gualdrón et al. 2009; Iorio et al., 2017). Hence, we expect the positive effect to be higher in relation to operational activities than in relation to financing and commercialization activities. Thus, we formulate the following hypothesis:

Hypothesis 1b: The positive effect of translating one's research ideas into practice is more pronounced with operational activities than with financing and commercialization activities.

Another important transfer motive for academics is their desire for self-realization. It has been suggested that the need for achievements, the desire for independence, and the desire for skill enhancement are among the main reasons why academics engage in venture activities, especially in the earlier venture creation stages (Antonioli et al., 2016; D'Este & Perkmann, 2011; Hayter, 2011; Huszár et al., 2016; Mueller, 2010). In line with this argument, a study of German academics proposed that the initial motivation of most researchers to engage in commercial activities is to signal their achievements and gain recognition from their peers and industrial communities (Göktepe-Hulten & Mahagaonkar, 2009). Accordingly, the need for achievement and self-realization can be considered an important characteristic of entrepreneurs that strongly influences venture creation. Scientists driven by such motivations are more likely than others to complete the different activities of venture creation (Barba-Sánchez & Atienza-Sahuquillo, 2012). The following hypothesis is formulated:

Hypothesis 2a: The higher the motivation of seeking self-realization, the higher the amount of completed venture creation activities.

However, we do not expect the effect of self-realization to be uniform across different types of venture creation activities. We argue that self-realization is primarily achieved when external success is realized. When a venture is started, it becomes visible to external parties and to the market (Morales-Gualdrón et al., 2009; Berggren, 2017; Iorio et al., 2017. The effect should be particularly strong in relation to activities where the academic entrepreneur interacts with external stakeholders marketing the product or service (e.g. Guerrero et al., 2008; Hoye & Pries, 2009; Hayter, 2011; Antonioli et al.,

2016; Barba-Sánchez & Atienza-Sahuquillo, 2018). This interaction takes place through commercialization activities. Thus, we propose the following hypothesis:

Hypothesis 2b: The positive effect of self-realization is more pronounced with commercialization activities than with operational and financing activities.

Academics are also motivated by academic benefits, such as the generation of further stimuli for research activities, access to funding opportunities (grants), and the possibility of exchanging new knowledge or obtaining new equipment for research activities. Academics may consider spin-offs as platforms for obtaining these resources to support their research (Antonioli et al., 2016; D'Este & Perkmann, 2011; Goethner et al., 2012; Hossinger et al., 2020; Iorio et al., 2017; Lam, 2011; O'Gorman et al., 2008). However, these motivational drivers may also impede venture creation when academics undertake creation activities only as a means to obtain new resources to better exploit their research and knowledge. Moreover, drawing on human capital theory, it can be argued that the specific knowledge (Becker, 1975) that scientists acquire during their time at the university can be used more productively in academia (e.g. basic research, publishing or teaching). Consequently, only a certain proportion of their specific human capital endowments is relevant for entrepreneurship (i.e. can be used to raise the individual scientist's productivity in entrepreneurship). In the spirit of human capital theory, scientists would therefore behave rationally, if they concentrated more on their research and less on transferring their knowledge by leaving the university to enter entrepreneurship (Bozeman & Mangematin, 2004; Davidsson & Honig, 2003; Mosey & Wright, 2007). As a result, several important founding steps (e.g., negotiating with creditors or investors, starting marketing campaigns, evaluating market information, and addressing exploitation rights) are likely to be neglected or postponed, which leads to the completion of fewer venture creation activities. The following hypothesis is proposed:

Hypothesis 3: The higher the motivation to make better use of one's professional experience or knowledge the lower the amount of completed venture creation activities.

2.3.2 Economic motivations

Research has also widely discussed monetary incentives as a motivational factor in academic entrepreneurship (Abreu & Grinevich, 2013; Antonioli et al., 2016; Lacetera, 2009; Rizzo, 2015). Generally, scientists do not consider financial rewards to be their primary goal when deciding to engage in entrepreneurial activities; they consider such financial rewards to be a form of collateral compensation for their time and effort (Goethner et al., 2012; Hayter, 2011; Lam, 2011; Morales-Gualdrón et al., 2009). Monetary factors seem to be less influential in academic entrepreneurship than in other types of entrepreneurship and may thus play a minor role in comparison to other entrepreneurial motives (Goethner et al., 2012; Hayter, 2011; Lam, 2011). Despite this, we propose that monetary rewards can still have a positive effect on the amount of completed venture creation activities. We argue that the income curve of most academics is relatively flat compared to that of employees in private firms (Angermueller, 2017; Stern, 2004). Starting a venture can be a way to earn an extra income alongside one's salary as a researcher. The amount of this possible additional income depends on the rules of the academic employer as well as on the outcome of individual contract negotiations between the scientists and their academic institutions. Hence,

the academic start-up can be seen as a real option to obtain a higher income. In order to maintain this option and keep it alive, the academic entrepreneur must engage in venture creation activities and advance the venture. Because of this, we propose that seeking an increased financial income as a motive will increase the likelihood of completion of venture creation activities. We posit the following hypothesis:

Hypothesis 4a: The higher the motivation of an increased financial income, the higher the amount of completed venture creation activities.

Moreover, we propose that the positive relationship becomes stronger with commercialization activities. The opportunity of earning money becomes real for the first time at this point in the venture creation process (Bhave, 1994; Reynolds & Miller, 1992). This strongly affects those academic entrepreneurs who are primarily interested in earning a financial income with their venture. Hence, we propose the following relationship:

Hypothesis 4b: The positive effect of an increased financial income is more pronounced with commercialization activities than with operational and financing activities.

Entrepreneurship research distinguishes between opportunity and necessity entrepreneurs (Block & Sandner, 2009; Block & Wagner, 2010). Opportunity-driven individuals engage in entrepreneurial activities voluntarily, while necessity-driven individuals engage in entrepreneurial activities due to external factors such as job dissatisfaction or unemployment (Block & Wagner, 2010). In the academic context, necessity-based motivations are strongly related to working conditions within universities. These working conditions (e.g., limited work contracts and non-tenured positions) are often seen as push factors. Academics may seek stability and lifelong employment in order to escape the pressure to "publish or perish" or to avoid bureaucratic routines, procedures, and governance issues (Balven et al., 2017; Neves & Franco, 2016). Furthermore, academics may engage in entrepreneurship because their current working conditions are not truly satisfying (Kirkwood, 2009). Moreover, individuals who undertake entrepreneurial activities out of necessity are generally more motivated and willing to take more steps to prove that they can do better than they did with their previous employers (Kirkwood, 2009). The fear of unemployment is a particularly important motivational factor for skilled individuals, which increases the likelihood to engage in entrepreneurial activities (Horta et al., 2016). Based on these arguments, we propose that academics are no exception from the norm. Consequently, scientists driven by necessity may be more likely than other scientists to complete activities during the venture creation process. Thus, we propose the following hypothesis:

Hypothesis 5: The higher the motivation out of necessity the higher the amount of completed venture creation activities.

2.3.3 Lifestyle motivations

In the academic context, work-life balance refers to whether academics believe that they have an appropriate workload compared with the responsibilities that come from other work or personal duties (Balven et al., 2017). This balance depends on the coordination of professional and personal activities and duties. Although many universities have implemented policies that aid work-life balance, such as leave of absence programs and on-site

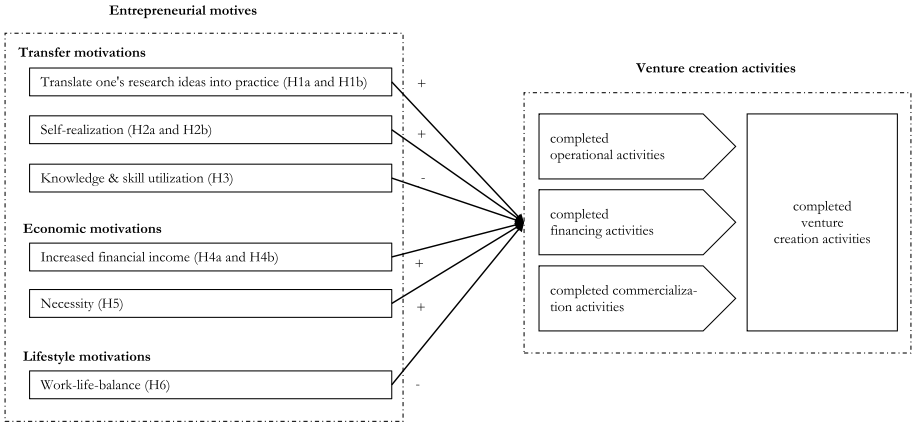

Fig. 2 Concetual model

childcare, academics still struggle to balance their work and personal lives (Kirkwood, 2009). The reason for this struggle is that academics typically fulfill multiple roles simultaneously, such as being a lecturer, an inventor, a parent, or an entrepreneur. Managing different roles is difficult (Balven et al., 2017), and academics are likely to postpone or abandon commercial or entrepreneurial activities when work-life balance becomes an issue (Balven et al., 2017). Therefore, we argue that it is especially difficult for academics to be fully engaged in both research and entrepreneurial activities. If work-life balance issues are considered important for academics, they may assign a lower priority to entrepreneurial activities and allocate their time and effort to research or to their personal activities. This will decrease the likelihood of completing venture creation activities. Thus, we propose the following hypothesis:

Hypothesis 6: The higher the motivation of seeking work-life balance, the lower the amount of completed venture creation activities.

Figure 2 shows our conceptual model and our set of hypotheses.

3 Method and data

3.1 Sample and data collection[1]

To investigate how scientists' motivations affect the amount of completed venture creation activities, we collected data on scientists from German universities in 2013 and 2016. In November 2013, we sent a questionnaire to 36,918 scientists across 73 German universities. The universities were selected at random prior to the data collection. We first focused

[1] Our study is based on a dataset that was collected by one of the authors in cooperation with the IfM Bonn (Institut für Mittelstandsforschung). We would like to thank Christian Schröder, Simone Chlosta and Sebastian Nielen from the IfM Bonn for the excellent cooperation during the process of the data collection.

on all state universities that existed in Germany in 2013. In a next step, we excluded those universities which offered only a few or none of the courses from the following fields: STEM subjects (e.g., mathematics, computer science, natural sciences, or technology); economics (e.g., economics, business administration, or industrial engineering); creative subjects (e.g., architecture, music, design, or art); and the health field (e.g., medicine or health management). In the process of defining these fields, we followed the classification of the German Federal Statistical Office (Destatis, 2012). This left us with 175 state universities; 73 of those 175 universities were then randomly selected. In the next step of the data collection process, we scanned each departmental homepage of the 73 selected universities. Originally, we planned to ask the universities for appropriate email distribution lists in order to contact their scientists. However, these lists turned out to be outdated and incomplete. Therefore, we decided to collect the email addresses manually ourselves by applying a bottom-up approach and scanning each homepage separately. Based on the information on the websites, those scientists who could be clearly identified were included in the address list of the survey and an email distribution list of 36,918 scientists was created.

The survey was then conducted online in the fall of 2013 as a cross-sectional survey. The survey focused on scientists' entrepreneurial motivations and any actions they had undertaken to start new businesses. We received responses from 10,199 scientists. A follow-up study was conducted in 2016, in which all 7,342 scientists who had participated in the 2013 survey and who had not already started their own business in 2013 were surveyed again. 1,252 respondents participated in the 2016 survey, which corresponds to a response rate of approximately 17%. This sample was further adjusted by excluding all respondents which a) left the university between 2013 and 2016, b) did not have any founding intentions whatsoever in 2013 and 2016, c) provided inconsistent information in identical variables surveyed in 2013 and 2016 (e.g. age and sex), and/or d) did not provide information for some of the variables of interest. These steps of data collection and data cleaning led to a final sample of 165 academic entrepreneurs to test our hypotheses.

3.2 Variables

3.2.1 Dependent variables

We used four outcome variables in our analysis: (1) the total amount of completed venture creation activities, (2) the amount of completed *operational* activities, (3) the amount of completed *financing* activities, and (4) the amount of completed *commercialization* activities.

We followed the activity-based approach to venture creation (Reynolds & Miller, 1992; Samuelsson & Davidsson, 2009; Stuetzer et al., 2012) and measured the completion of eleven different venture creation activities. Together, these eleven activities depict the creation of a new venture (Kleinhempel et al., 2020; Liao et al., 2005; Shepherd et al., 2019). The measurement took place in the 2016 survey.

In 2013, the scientists were asked if they had a founding idea based on their research. The scientists who responded affirmatively were then asked in 2016 about the completion of their respective venture activities on a dichotomous scale (1 = yes; 0 = no). These activities ranged from the development of the product or service to the first commercial sale. Cronbach's alpha over all items was $\alpha = 0.785$.

In order to aggregate and categorize venture creation activities into operational, financing and commercialization activities, we conducted a principal component factor analysis

(PCA). By doing so, we predefined thresholds greater than 0.50 for the varimax rotation (Costello & Osborne, 2005). To test if the completion status of different venture creation activities in our sample is correlated, we conducted both Bartlett's test of sphericity and the Kaiser–Meyer–Olkin measure of sampling adequacy (MSA). Bartlett's test of sphericity provided significant results, indicating that the different venture creation activities in our sample were not independent. Thus, our dataset was considered to be appropriate for a factor analysis (Dziuban & Shirkey, 1974). The variable-specific MSA ranged from 0.737 to 0.873 and the overall MSA was 0.774. As a result, the sampling adequacy was regarded as meritorious (Cureton & D'Agostino, 1993; Kaiser, 1970; Kaiser & Rice, 1974). According to the latent root criterion, the results of the PCA revealed a three-factor solution explaining 55.90% of the overall variance. All venture creation activities had factor loadings higher than 0.601 and were clearly loading on one specific component or factor. The results of the PCA can be found in Table 2.

Factor 1 includes six items and represents *operational* activities. This factor focuses on the product or service development and on the acquisition of business partners and personal and material resources as well as the exploitation rights. Factor 2 consists of three items representing *financing* activities. This factor deals with the collection of financial resources. Finally, factor 3 covers two items and represents *commercialization* activities. This factor addresses the market entry and includes registration at the tax office and the acceptance of first orders.

To assess the validity and reliability of the amount of completed operational-, financing and commercialization activities, we also conducted a confirmatory factor analysis (CFA). The results of CFA showed that all items loaded significantly and strongly on each of the three activity bundles with a reasonable to good model fit (CFI = 0.917 and RSMA = 0.075). We tested for the convergent validity through the assessment of the composite reliability (CR; Fini et al., 2012; Raykov, 1997). The Raykov's factor reliability coefficient referring to CR (Fornell & Larcker, 1981) was r = 0.788 for operational activities, r = 0.608 for financing activities, and r = 0.652 for commercialization activities. Thus, all estimators were above the recommended threshold of 0.600 (Bagozzi & Yi, 1988; Padilla & Divers, 2016), indicating a satisfactory level of CR. Moreover, the $\chi 2$ difference tests comparing the model with the saturated model ($\Delta\chi 2 = 61.777$, p = 0.001; $\Delta df = 32$), and the baseline model with the saturated model ($\Delta\chi 2 = 405.511$ p = 0.000; $\Delta df = 45$) were significant. This indicated that convergent validity was supported (Santos & Cardon, 2019). To test for discriminant validity, the average variance extracted (AVE) was calculated for each activity bundle. The AVE for each activity bundle was higher than its shared variance with any other activity bundle in the model. Therefore, discriminant validity was also verified (Baum et al., 2001; Fini et al., 2012; Mehmetoglu & Jakobsen, 2016; Santos & Cardon, 2019; Werts et al., 1974). In terms of instrument reliability, Cronbach's alpha was $\alpha = 0.781$ for operational activities, $\alpha = 0.582$ for financing activities, and $\alpha = 0.633$ for commercialization activities. Although Cronbach's alpha missed the 0.700 threshold for financing and commercialization activities, the overall results indicated an acceptable degree of instrument reliability for the purpose of our study (Miranda et al., 2017; Nunnally, 1978; Taber, 2018).

The exact construction of the dependent variables for our main regressions is as follows: to obtain a score for the amount of total completed venture creation activities, we constructed a cumulative count variable with a minimum of zero and a maximum of 11. To obtain dependent variables in the different activity bundles, we specified the amount of completed *operational-*, *financing-* and *commercialization* activities as factor scores derived from the PCA described above. For our poisson regression estimated as a

Table 2 Principal component factor analysis and scale validation

Item description: Binary variable = 1 if scientists have… and zero otherwise	N of scientists that completed the respective venture creation activity	Factor 1	Factor 2	Factor 3	Cronbachs Alpha (α)	Composite validity (CR)	Average variance extracted (AVE)
Operational activities					.781	.788	.377
1 … collected information about the market and competitors	89	.682					
2 … started the product or service development	69	.707					
3 … built a prototype	45	.745					
4 … taken care of the exploitation rights	29	.587					
5 … recruited a founding team	44	.683					
6 … developed a business plan	32	.601					
Financing activities					.582	.608	.441
7 … reserved money for the implementation	40		.763				
8 … invested own money in the implementation	32		.728				
9 … negotiateed with in- or outside creditors	13		.611				
Commercialization activities					.633	.652	.535
10 … registered at the tax office	14			.856			
11 … accepted first orders	21			.867			

$N = 165$; CR above .60 and statistically significant ($p < .05$)

robustness check, we additionally constructed count variables by counting the number of completed activities in each activity bundle. The resulting count variables ranged from zero to six (operational activities), zero to three (financing activities) and zero to two (commercialization activities).

3.2.2 Independent variables

The independent variables cover the scientists' motivations towards entrepreneurship. In the initial 2013 survey, the scientists were asked to provide information about the reasons why they wanted to become entrepreneurs. A total of six different motivation items were included in the questionnaire, which we classified into three groups: transfer motives, economic motives, and lifestyle motives. Transfer motives comprised translating one's research ideas into practice, self-realization, and knowledge and skill utilization. Economic motives included increased financial income and necessity motives. Lifestyle motives refer to work-life balance motives. All items were self-reported and were measured using a five-point Likert scale (1 = strongly disagree; 5 = strongly agree; see "Appendix 1").

3.2.3 Control variables

We controlled for several factors on the individual and organizational level.

On the individual level, we controlled amongst others for gender, age, migration background, risk-taking propensity, and social capital. Previous studies indicated that male and female researchers are driven by different types of motives (Maes et al., 2014). Abreu and Grinevich (2017) suggest that female researchers perceive obstacles in the entrepreneurial venture creation process more strongly than their male counterparts. Therefore, the amount of completed venture creation activities may be lower for female than for male researchers. Furthermore, it can be assumed that scientists can only amass sufficient capital to establish a company at a relatively late stage. However, as age increases, the period in which profits can be made through entrepreneurial activities declines (Bijedić et al., 2017; Hossinger et al., 2020; Lévesque & Minniti, 2006). As a result, the amount of completed venture creation activities may be lower with increasing age. Constant and Zimmermann (2006) found that people with a migration background are more likely to be self-employed than their counterparts without a migration background. Moreover, academics with work experience in different cultures possess a greater diversity of ideas, perspectives, and creative techniques than other academics (Krabel & Mueller, 2009; McEvily & Zaheer, 1999). We therefore controlled for migration background as a proxy for cultural diversity. Risk-taking propensity is also a key factor in the early stages of academic entrepreneurship; academics who are willing to take more risks are more likely to start their own businesses (Hayter, 2015a; Huynh, 2016; Rasmussen et al., 2011, 2015; Scholten et al., 2015; Singh Sandhu et al., 2011; Walter et al., 2011). We controlled for risk-taking propensity as well as children and marital status. Furthermore, we controlled for the social capital of scientists. Previous studies indicated that contacts who facilitate entrepreneurship are of fundamental importance for the implementation of an entrepreneurial project (Hayter, 2015b; Hossinger et al., 2020; Huynh, 2016; Prodan & Drnovšek, 2010; Rasmussen et al., 2011, 2015; Rothaermel et al., 2007; Scholten et al., 2015; Walter et al., 2011). Therefore, founders with established networks may be expected to undertake more entrepreneurial activities. Additionally, role models and peers also affect the likelihood of academics engaging in entrepreneurial activities (Haeussler & Colyvas, 2011; Johnson et al., 2017; Moog et al., 2015).

Thus, we controlled for both parents and colleagues with prior entrepreneurial experience. Prior entrepreneurial or industry experience also affects the likelihood of scientists engaging in entrepreneurial activities (Abreu & Grinevich, 2013; Erikson et al., 2015; Mosey & Wright, 2007; Shane, 2004). Scientists who have already worked in the private sector or founded a company adopt a specific set of skills for coping with liabilities of newness based on previous experience (Diamanto, 2008). Consequently, entrepreneurial challenges are likely to be managed in a more routine way. As a result, the amount of completed venture creation activities is expected to be higher (Krabel & Mueller, 2009; Stuetzer et al., 2012). Therefore, we controlled for previous entrepreneurial and industry experience. We also controlled for whether a scientist had made an invention based on his or her research at the university. Scientists with inventions based on their research at the university may consider their inventions as potential entrepreneurial opportunities and may be more likely and eager to engage in entrepreneurial activities than their counterparts without an invention.

On the organizational level, we controlled for university size, type, location, faculty, position, and research discipline. Walter et al. (2013) indicate that scientists' entrepreneurial motives are determined by their ties to industry and research disciplines. Since research projects with the private sector are more common at universities of applied sciences than at research-based universities, academics at universities of applied sciences may be more likely to engage in entrepreneurial activities. Furthermore, the scientist's faculty or research field can also affect the amount of completed venture creation activities (Fini & Toschi, 2016; Hossinger et al., 2020; Huyghe & Knockaert, 2015; Moog et al., 2015; Perkmann et al., 2011). Start-up projects from the STEM, medical, and biotechnology fields are usually technology oriented and capital-intensive. Therefore, the initiation of a project requires ample financial resources. This could impede venture creation. Moreover, scientists from the aforementioned research fields usually lack sufficient business management and legal knowledge, which may make the implementation of their entrepreneurial projects more difficult (Davey et al., 2016; Neves & Franco, 2016; Zhou et al., 2011). Haeussler and Colyvas (2011) indicate that scientists with tenured positions are more likely to engage in entrepreneurial activities than those who lack tenured positions. This may be the case because such positions give greater social and financial security. Finally, Arvanitis et al. (2008) and Fischer et al. (2017) indicate that universities focusing on applied research are more likely than universities with a focus on basic research to engage in technology transfer activities.

It is important to note that the amount of completed venture creation activities between 2013 and 2016 was time-dependent to a certain degree. Therefore, we controlled for the degree of start-up project advancement in 2013 (Stuetzer et al., 2012). Moreover, as academic entrepreneurship in Germany also depends on regional clusters and regional policy, we controlled for the federal state in which the respective universities were located.

Table 3 shows descriptive statistics.

The descriptive statistics suggest that scientists completed an average of 2.60 out of 11 venture creation activities. In this regard, operational activities were the most pronounced (mean factor score = 132), followed by commercialization activities (mean factor score = 0.104) and financing activities (mean factor score = 0.051). Besides, the descriptive findings of Table 3 show that the likelihood that a particular venture creation activity is completed declines over the course of the venture creation process. For instance, 89 out of 165 scientists collected information about the market and their competitors but only 21 have already accepted first orders. This descriptive finding is consistent with the latest studies on academic entrepreneurship based on UK and Italian data (Bolzan et al., 2020; Fini et al., 2021) and the research of Fritsch and

Table 3 Descriptive statistics

Variable	Mean	Std.Dev	Min	Max
Completed venture creation activities in 2016				
Total amount of completed venture creation activities	2.593	2.532	0	11
Amount of completed operational activities	1.866	1.850	0	6
Amount of completed financing activities	.515	.823	0	3
Amount of completed commercialization activities	.212	.527	0	2
Factor 1 (operational activities)	.132	1.034	−1.303	2.528
Factor 2 (financing activities)	.051	1.103	−1.542	4.025
Factor 3 (commercialization activities)	.104	1.105	−1.119	4.231
Motivations				
Translate one's research ideas into practice	3.818	1.160	1	5
Self-realization	3.957	.967	1	5
Knowledge & skill utilization	3.724	1.032	1	5
Increased financial income	3.236	1.194	1	5
Necessity	2.175	1.066	1	5
Work-life-balance	2.612	1.346	1	5
Degree of startup project advancement in 2013	1.586	.889	1	5
University characteristics				
Invention at university	.290	.456	0	1
Applied science university	.800	.401	0	1
University size	3,141.188	2,303.510	86	8,101
Faculties				
STEM	.648	.479	0	1
Economics/ social sciences	.176	.382	0	1
Medicine	.018	.134	0	1
Arts	.012	.110	0	1
Other faculty	.145	.354	0	1
Positions				
Professor	.218	.414	0	1
Assistant professor or post doc	.218	.414	0	1
Research assistant	.521	.501	0	1
Other positions	.042	.202	0	1
Research types				
Basic research	3.078	1.401	1	5
Applied research	4.187	1.077	1	5
Interdisciplinary research	3.793	1.145	1	5
Individual characteristics				
Age	37.478	9.876	25	65
Gender	.230	.422	0	1
Migration background	.127	.334	0	1
Married	.709	.456	0	1
Children	.448	.499	0	1
Risk taking willingness	2.915	.940	1	5
Self-employed parents	.303	.461	0	1
Self-employed colleagues	1.472	.501	0	1

Table 3 (continued)

Variable	Mean	Std.Dev	Min	Max
Prior entrepreneurial experience	.212	.410	0	1
Prior industry experience	.224	.418	0	1
Entrepreneurial contacts	.775	.418	0	1
Federal States				
Baden-Württemberg	.188	.392	0	1
Bavaria	.145	.354	0	1
Berlin	.042	.202	0	1
Brandenburg				
Bremen	.018	.134	0	1
Hamburg				
Hesse	.073	.260	0	1
Mecklenburg-Western Pomerania	.030	.172	0	1
Lower Saxony	.097	.297	0	1
Northrhine-Westphalia	.145	.354	0	1
Rhineland-Palatinate	.006	.078	0	1
Saarland	.030	.172	0	1
Saxony	.109	.313	0	1
Lower Saxony	.012	.110	0	1
Schleswig–Holstein	.018	.134	0	1
Thuringia	.085	.280	0	1

$N = 165$; no observations for Brandenburg and Hamburg

Krabel (2012) as well as Kollmann et al. (2017). The latter point out a high discrepancy between the identification of an entrepreneurial opportunity and initial entrepreneurial actions.

Moreover, the descriptive statistics also show that the most important motivating factors were self-realization (mean = 3.96), followed by translating one's research ideas into practice (mean = 3.82), knowledge and skill utilization (mean = 3.72) and increased financial income (mean = 3.2). The necessity motivation had a mean of 3.24, whereas the mean for work-life balance was 2.61. In terms of university size and type, the scientists in our sample came from universities with an average of 3,312 scientific employees. Eighty percent of the scientists worked at research-based universities and 20% worked at universities of applied science. Almost 29% of the respondents had made inventions based on their research. Sixty five percent of the researchers worked at STEM faculties (e.g., mathematics, informatics and information technology, natural sciences, and technics), 17% were economic or social scientists, 2% were in medicine and health management, 1% were artists, and the remaining 15% were from other faculties. Nearly 44% of the researchers in the sample were professors (22% were full professors and 22% were assistant professors); approximately 52% were research assistants (e.g., PhD students or postdoctoral students), and 4% worked in other scientific positions. The scientists in the sample were mostly involved in applied research (mean = 4.18) followed by interdisciplinary research (mean = 3.79) and basic research (mean = 3.07).

3.3 Analytical procedure

For our main analysis, we used Ordinary Least Squares (OLS) regressions with robust standard errors (Table 4). As mentioned above, we matched two cross-sectional datasets consisting of academic entrepreneurs who were initially surveyed in 2013 and then again in 2016. The independent variables (scientists' motivations) and controls were measured in 2013 and the dependent variables (total amount of completed venture creation activities, amount of completed operational, financing, and commercialization activities) were measured in 2016. In this timeframe, scientists could decide about the amount of venture creation activities in order to advance their venture project. We regressed the different types of motivations on the total amount of completed venture creation activities and the amount of completed operational, financing and commercialization activities. This is modelled in the following way:

$$q_{ij}^{*} = \alpha_0 + \sum_{k=1}^{p} \beta_k M_{ij} + \sum_{l=1}^{q} \beta_l C_j + ei_j \quad (1)$$

where q_{ij}^{*} denotes the amount of completed venture creation activities within the respective activity bundle as measured by the factor scores derived from the PCA. M_{ij} represent the respective scientists' motivations. It is a vector of ordinal variables that is equal to one (five) if a scientist reported having low (high) motivation in the respective type of motivation. C_{ij} is the set of individual- and organizational level controls. β_0 is the constant. Next to the results of the OLS regression with the factor scores a dependent variables we also provide results of poisson regressions specifying the dependent variables as simple count variables (Table 5).

To test hypotheses H1b, H2b and H4b, we compared the regression coefficients of the predictors across the different regression models. We conducted a Wald test and tested the null hypothesis that the difference between a specific coefficient across two models was equal to zero. If the null hypothesis was rejected, the coefficients differed. We then performed a one-sided chi2-test for each predictor and model in which we tested the zero hypothesis that the coefficient of a predictor in one model was greater or smaller than the coefficient of the same predictor in the reference model (Allison, 1999; Cohen, 1983; Williams, 2009). The results can be found in Table 6.

Table 7 shows a correlation table. The correlations between the independent variables are of moderate size. Also the variance inflation factors (VIFs) of the motivation variables are relatively low ranging from 1.27 (*increased financial income)* to 1.68 *(knowledge & skill utilization)* suggesting that multicollinearity is unlikely to be an issue.

4 Results

4.1 Effects of control variables

In the models 1, 2, 3 and 4 (see "Appendix 2"), we regressed the controls on the total amount of completed venture creation activities as well as on the amount of completed operational, financing, and commercialization activities. As shown in "Appendix 2", the amount of completed venture creation activities is higher for scientists who made an

Table 4 OLS Regression results

	Model 5 (Total amount of completed venture creation activities)			Model 6 (Factor 1: operational activities)			Model 7 (Factor 2: financing activities)			Model 8 (Factor 3: commercialization activities)		
	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|
Degree of startup project advancement 2013	.965	(.272)	***	.352	(.108)	***	.158	(.126)		.381	(.133)	***
University characteristics												
Applied science university	−.773	(.638)		−.118	(.221)		−.376	(.302)		−.415	(.404)	
University size	.000	(.000)		.000	(.000)		.000	(.000)		.000	(.000)	
Invention at university	.993	(.550)	*	.501	(.197)	**	.084	(.266)		.018	(.185)	
Faculties[1]												
STEM	.011	(1.199)		.210	(.474)		−.709	(.427)		.673	(.713)	
Economics/ social sciences	.521	(1.273)		.392	(.490)		−.659	(.465)		.947	(.742)	
Medicine	−.678	(1.514)		.372	(.727)		−1.081	(.649)		−.664	(.809)	
Arts	−.357	(1.186)		.019	(.460)		−1.100	(.432)	**	1.240	(.809)	
Positions[2]												
Professor	.618	(.772)		.386	(.296)		.000	(.352)		−.228	(.363)	
Assistant professor or post doc	.400	(.599)		.173	(.219)		−.026	(.271)		.166	(.225)	
Research assistant	1.779	(1.003)	*	.441	(.505)		.600	(.390)		.836	(.402)	**
Research types												
Basic research	−.061	(.164)		.004	(.063)		−.042	(.073)		−.053	(.066)	
Applied research	−.067	(.196)		−.037	(.077)		.045	(.079)		−.048	(.082)	
Interdisciplinary research	.202	(.167)		.046	(.064)		.093	(.075)		.061	(.073)	
Individual characteristics												
Age	−.039	(.029)		−.023	(.012)	**	.002	(.013)		.005	(.014)	
Gender	−.167	(.478)		−.142	(.192)		−.082	(.187)		.329	(.212)	
Migration background	.015	(.720)		.112	(.274)		.008	(.326)		−.421	(.216)	*
Married	.111	(.480)		.047	(.182)		.108	(.208)		−.125	(.179)	

Table 4 (continued)

	Model 5			Model 6			Model 7			Model 8		
	(Total amount of completed venture creation activities)			(Factor 1: operational activities)			(Factor 2: financing activities)			(Factor 3: commercialization activities)		
	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|
Children	.212	(.505)		.177	(.200)		−.321	(.206)		.297	(.195)	
Risk taking willingness	.318	(.246)		.094	(.096)		.136	(.111)		.064	(.097)	
Self-employed parents	−.371	(.367)		−.085	(.147)		−.139	(.177)		−.196	(.139)	
Self-employed colleagues	.449	(.456)		.181	(.175)		.127	(.197)		.047	(.176)	
Prior entrepreneurial experience	−.004	(.552)		.113	(.224)		−.224	(.222)		.021	(.192)	
Prior industry experience	−.294	(.470)		−.044	(.186)		−.154	(.212)		−.078	(.205)	
Entrepreneurial contacts	1.098	(.487)	**	.463	(.194)	**	.267	(.200)		.049	(.198)	
Federal States[3]												
Baden Württemberg	2.053	(1.126)	*	.820	(.474)	*	.001	(.411)		1.002	(.619)	
Bavaria	1.732	(1.218)		.623	(.491)		−.019	(.486)		1.031	(.709)	
Berlin	1.600	(1.992)		.237	(.685)		.506	(.768)		1.410	(.848)	*
Bremen	.865	(1.704)		.655	(.768)		−.866	(.645)		.674	(.899)	
Hesse	2.237	(1.493)		.851	(.617)		.043	(.560)		1.158	(.737)	
Mecklenburg Western Pomerania	.835	(1.292)		.222	(.570)		−.390	(.512)		1.494	(.848)	*
Lower Saxony	1.710	(1.335)		.712	(.536)		.082	(.570)		.610	(.754)	
Northrhine-Westphalia	2.484	(1.206)	**	.894	(.462)	*	.135	(.481)		1.321	(.656)	**
Rhineland Palatinate	2.719	(1.503)	*	1.076	(.648)		.382	(.623)		.664	(.583)	
Saarland	1.640	(1.213)		.738	(.483)		−.017	(.465)		.516	(.618)	
Saxony	3.034	(1.438)	**	1.114	(.585)	*	−.058	(.533)		1.778	(1.607)	
Saxony−Anhalt	.729	(1.314)		.521	(.473)		−.134	(.695)		−.206	(.655)	
Schleswig–Holstein	2.253	(1.341)	*	.833	(.523)		.458	(.589)		.636	(.840)	
Motivations												

Table 4 (continued)

	Model 5 (Total amount of completed venture creation activities)			Model 6 (Factor 1: operational activities)			Model 7 (Factor 2: financing activities)			Model 8 (Factor 3: commercialization activities)		
	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|
Translate one's research ideas into practice	.263	(.178)		.114	(.072)		.062	(.074)		.008	(.071)	
Self−realization	.643	(.260)	**	.228	(.109)	**	.270	(.089)	***	−.021	(.104)	
Knowledge & skill utilization	−.648	(.221)	***	−.247	(.094)	***	−.147	(.098)		−.124	(.068)	*
Increased financial income	.326	(.161)	**	.112	(.066)	*	.103	(.070)		.065	(.063)	
Necessity	.392	(.201)	*	.175	(.080)	**	.035	(.088)		.065	(.086)	
Work-life-balance	−.280	(.158)	*	−.119	(.062)	*	.020	(.076)		−.119	(.068)	*
Constant	−4.564	(2.609)	*	−2.821	(1.016)	***	−1.443	(1.058)		−1.938	(1.343)	
Prob > F:	F(43, 120)	n.a		F(43, 120)	n.a		F(43, 120)	n.a		F(43, 120)	n.a	
R2:	.415			.433			.287			.351		
N:	165			165			165			165		

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$; robust standard errors (in parentheses); 1st. reference: other faculties; 2nd reference: other positions; 3rd reference: Thuringia; no observations for Brandenburg and Hamburg; F-Statistics could not be calculated

Table 5 Poisson regression results

	Model 5			Model 6			Model 7			Model 8		
	(Total amount of completed venture creation activities)			(Amount of completed operational activities)			(Amount of completed financing activities)			(Amount of completed commercialization activities)		
	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|
Degree of startup project advancement 2013	.268	(.079)	***	.231	(.077)	***	.204	(.135)		.901	(.313)	***
University characteristics												
Applied science university	−.372	(.209)	*	−.174	(.222)		−.698	(.366)	*	−.712	(.702)	
University size	.000	(.000)		.000	(.000)		.000	(.000)		.000	(.000)	
Invention at university	.326	(.188)	*	.439	(.170)	***	.086	(.330)		−.287	(.559)	
Faculties[1]												
STEM	.267	(.280)		.368	(.287)		.913	(.583)		−1.810	(.570)	***
Economics/ social sciences	.442	(.313)		.516	(.304)	*	1.038	(.634)		−1.385	(.678)	
Medicine	.417	(.552)		.940	(.590)		1.157	(1.222)		−18.353	(1.188)	***
Arts	.443	(.518)		−.024	(.600)		2.946	(.946)	***	−18.324	(2.190)	***
Positions[2]												
Professor	−.620	(.335)	*	−.195	(.455)		−1.115	(.446)	**	−2.699	(1.317)	**
Assistant professor or post doc	−.861	(.404)	**	−.685	(.517)		−1.021	(.657)		−1.437	(1.141)	
Research assistant	−.633	(.382)	*	−.398	(.507)		−.983	(.536)	*	−1.367	(1.051)	
Research types												
Basic research	−.008	(.056)		.018	(.057)		−.040	(.103)		.086	(.194)	
Applied research	−.043	(.071)		−.073	(.070)		.103	(.133)		−.096	(.205)	
Interdisciplinary research	.100	(.069)		.079	(.066)		.148	(.150)		.376	(.225)	*
Individual characteristics												
Age	−.017	(.011)		−.027	(.011)	**	−.008	(.022)		.050	(.033)	
Gender	.002	(.191)		−.069	(.204)		.062	(.329)		1.076	(.487)	**
Migration background	.106	(.223)		.249	(.210)		.252	(.457)		−1.236	(.830)	
Married	.058	(.180)		.025	(.182)		.115	(.284)		−.074	(.623)	

Table 5 (continued)

	Model 5 (Total amount of completed venture creation activities)			Model 6 (Amount of completed operational activities)			Model 7 (Amount of completed financing activities)			Model 8 (Amount of completed commercialization activities)		
	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|
Children	.100	(.168)		.193	(.177)		−.351	(.282)		1.132	(.579)	**
Risk taking willingness	.130	(.089)		.083	(.086)		.270	(.160)	*	.219	(.286)	
Self-employed parents	−.217	(.141)		−.120	(.142)		−.545	(.302)		−.903	(.560)	
Self-employed colleagues	.100	(.170)		.132	(.165)		−.021	(.333)		.153	(.430)	
Prior entrepreneurial experience	−.026	(.195)		.040	(.196)		−.495	(.307)		−.507	(.498)	
Prior industry experience	−.126	(.178)		−.125	(.180)		−.236	(.309)		−.222	(.501)	
Entrepreneurial contacts	.627	(.252)	**	.678	(.255)	***	.770	(.452)	*	−.231	(.502)	
Federal States[3]												
Baden-Württemberg	−.096	(.270)		−.014	(.284)		−.603	(.503)		.750	(.867)	
Bavaria	−.247	(.327)		−.240	(.326)		−.606	(.652)		2.255	(1.503)	
Berlin	−.181	(.547)		−.796	(.701)		.396	(.612)		3.111	(.961)	***
Bremen	−.411	(.503)		−.028	(.592)		−1.718	(.917)	*	1.169	(1.499)	
Hesse	−.042	(.330)		−.054	(.343)		−.432	(.649)		.782	(.785)	
Mecklenburg-Western Pomerania	−.835	(.587)		−1.140	(.725)		−1.706	(.860)	**	.848	(1.147)	
Lower Saxony	−.260	(.293)		−.224	(.302)		−.428	(.512)		−.182	(1.638)	
Northrhine-Westphalia	.032	(.292)		−.059	(.293)		−.301	(.528)		2.793	(1.072)	***
Rhineland-Palatinate	−15.078	(1.115)	***	−14.085	(1.124)	***	−13.070	(1.268)	***	−16.249	(1.929)	***
Saarland	.332	(.391)		.358	(.428)		.006	(.877)		−14.454	(1.340)	***
Saxony	−.309	(.325)		−.195	(.327)		−.571	(.573)		−15.449	(1.097)	***
Saxony-Anhalt	.487	(.354)		.541	(.447)		−13.129	(.923)	***	2.185	(1.265)	*
Schleswig–Holstein	−.762	(.512)		−.461	(.435)		−1.018	(1.431)		−17.877	(1.360)	***
Motivations												

Table 5 (continued)

	Model 5			Model 6			Model 7			Model 8		
	(Total amount of completed venture creation activities)			(Amount of completed operational activities)			(Amount of completed financing activities)			(Amount of completed commercialization activities)		
	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|
Translate one's research ideas into practice	.092	(.065)		.115	(.065)	*	.145	(.110)		−.176	(.164)	
Self-realization	.317	(.099)	***	.274	(.108)	**	.547	(.158)	***	.431	(.228)	*
Knowledge & skill utilization	−.267	(.085)	***	−.248	(.090)	***	−.220	(.160)		−.799	(.233)	***
Increased financial income	.145	(.057)	**	.124	(.058)	**	.193	(.124)		.488	(.163)	***
Necessity	.136	(.078)	*	.146	(.075)	*	.106	(.153)		.074	(.189)	
Work-life-balance	−.173	(.069)	**	−.178	(.067)	***	−.138	(.149)		−.551	(.183)	***
Constant	−.332	(.948)		−.674	(1.058)		−3.827	(1.697)	**	−3.323	(3.555)	
Prob > Chi2:	420.48	***		399.39	***		783.71	***		3456.34	***	
Pseudo R2:	.207			.196			.209			.396		
N:	165			165			165			165		

***$p<0.01$, **$p<0.05$, *$p<0.1$; robust standard errors (in parentheses); 1st. reference: other faculties; 2nd reference: other positions; 3rd reference: Thuringia; no observations for Brandenburg and Hamburg

Table 6 Test of equality of coefficients across venture creation stages

	(1) $\beta_{\text{Commercialization activities}} >= \beta_{\text{Financing activities}}$	(2) $\beta_{\text{Commercialization activities}} >= \beta_{\text{Operational activities}}$	(3) $\beta_{\text{Financial activities}} >= \beta_{\text{Operational activities}}$
Translate one's research ideas into practice (H1b)	3.34**	3.18*	0.08
Self-realization (H2b)	0.21	0.42	3.01*
Increased financial income (H4b)	2.17	4.77**	0.39

$\chi 2$ values reported with 1 numerator degree of freedom; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

invention based on their research activities than for their counterparts without such an invention. This result is in line with the findings of Stuart and Ding (2006) and Krabel and Mueller (2009). The results also indicate that scientists without a tenured position are less likely to engage in commercialization activities, which is consistent with the findings of Haeussler and Colyvas (2011). The results further reveal that faculties play a decisive role when it comes to operational and commercialization activities. Hence, our results are in line with prior studies (Davey et al., 2016; Neves & Franco, 2016; Zhou et al., 2011). Furthermore, our results indicate that academics who are more involved in interdisciplinary research are also likely to complete more venture creation activities (Arvanitis et al., 2008; Fischer et al., 2017). The results indicate that risk-taking propensity positively affects the amount of completed financing activities, which is consistent with the findings of Singh Sandhu et al. (2011) and Hayter (2015a). We also found that scientists with prior entrepreneurial experience are less likely to perform financing activities (Haeussler & Colyvas, 2011; Johnson et al., 2017; Moog et al., 2015). The results suggest that social capital has a significant effect on both the total amount of venture creation activities and the amount of operational activities, which indicates that possessing entrepreneurial contacts facilitates entrepreneurship. In line with Stuetzer et al. (2012), the findings suggest that the degree of start-up project advancement in 2013 is positively associated with the amount of completed venture creation activities in 2016. The results also show regional effects; the federal state, in which the university is located, affects completion of financing activities.

4.2 Effects of motivation variables

In the models 5, 6, 7 and 8 of the OLS regression (see Table 4), we regressed the controls and the scientists' motivations on the amount of completed venture creation activities as well as on the amount of operational-, financing-, and commercialization activities. Overall, the results show supporting evidence for the hypotheses 2a, 2b, 3, 4a, 4b, and 5. However, we did not find support for the hypotheses 1a and 1b.

The regression results do not show a significant effect of the independent variable *translating one's research ideas into practice* on the amount of completed venture creation activities. Likewise, no significant effect could be found for operational-, financing- and commercialization activities. Therefore, we did not find support for hypothesis 1a. According to hypothesis 1b, the positive effect of translating one's research ideas into practice is more pronounced with operational activities than with financing and commercialization

Table 7 Correlation table

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
Amount of venture creation activities																										
Amount of operational activities	.93																									
Amount of financing activities	.69	.45																								
Amount of commercialization activities	.46	.27	.15																							
Factor 1 (operational activities)	.80	.96	.20	.17																						
Factor 2 (financing activities)	.48	.23	.95	.02	−.03																					
Factor 3 (commercialization activities)	.36	.17	.10	.98	.06	−.02																				
Translate one's research ideas into practice	.18	.20	.13	−.02	.20	.08	−.05																			
Self−realization	.14	.11	.16	.01	.06	.18	−.01	.14																		

Table 7 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
Knowledge & skill utilization	.01	−.01	.01	.06	−.03	.02	.06	.26	.35																	
Increased financial income	.20	.17	.15	.12	.12	.12	.12	.13	−.03	.20																
Necessity	.07	.07	.03	.06	.05	.02	.06	−.17	.08	.10	−.06															
Work−life−balance	−.08	−.11	.03	−.03	−.15	.10	.00	.06	.37	.14	.14	.17														
Degree of startup project advancement in 2013	.47	.46	.25	.26	.40	.17	.22	.19	.11	.18	.20	.08	.03													
Applied science university	−.04	.05	−.07	−.23	.11	−.07	−.26	−.01	.10	−.11	−.14	.05	.05	−.14												
University size	−.12	−.05	−.21	−.10	.01	−.20	−.09	−.07	−.01	.04	.00	.07	.11	−.13	.46											
Invention at university	.26	.31	.09	.02	.33	.01	−.03	.12	−.09	.04	−.02	−.08	−.21	.31	.09	.05										
STEM	.07	.11	.08	−.14	.11	.06	−.14	.11	−.09	−.09	.02	.05	−.04	.12	.23	.08	.16									
Economics/social sciences	.02	.02	.00	.03	.02	−.01	.01	−.11	.11	.06	.02	−.04	−.09	−.09	−.01	.00	−.23	−.63								
Medicine	.02	.06	−.03	−.05	.07	−.03	−.05	.02	.03	−.05	−.10	.17	.11	.11	−.05	.07	.01	−.18	−.06							
Arts	−.03	−.05	.07	−.04	−.07	.07	−.05	−.08	−.17	−.08	−.02	.09	.03	−.07	−.08	.03	.05	−.15	−.05	−.02						
Other faculty	−.12	−.17	−.11	.19	−.18	−.08	.21	−.02	.04	.09	.00	−.12	.11	−.09	−.27	−.14	.00	−.56	−.19	−.06	−.05					
Professor	.18	.17	.08	.12	.16	.03	.11	.15	−.11	.07	.08	−.20	−.22	.34	−.40	−.24	.21	−.10	.10	−.07	−.06	.07				

Table 7 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
Assistant professor or post doc	−.08	−.06	−.06	−.07	−.03	−.05	−.08	−.18	−.09	−.10	−.17	.27	−.10	−.09	.23	.10	.08	−.01	.06	.04	−.06	−.05	−.28			
Research assistant	−.09	−.08	−.05	−.10	−.06	−.03	−.09	.05	.19	.03	.08	−.12	.26	−.21	.19	.13	−.21	.13	−.10	−.05	.00	−.05	−.55	−.55		
Other Positions	.02	−.05	.09	.14	−.11	.10	.16	−.04	−.07	.00	−.02	.15	.02	.00	−.12	−.04	−.07	−.10	−.10	.20	.25	.08	−.11	−.11	−.22	
Basic research	.01	.07	−.07	−.07	.10	−.06	−.09	.16	−.03	−.08	.00	.07	.02	.06	.31	.16	.07	.06	.00	.06	−.01	−.10	−.05	.24	−.10	−.14
Applied research	.09	.06	.09	.08	.04	.08	.07	−.08	−.11	−.07	.07	−.19	−.12	.18	−.19	−.08	.12	.03	−.10	−.02	−.17	.12	.18	−.17	−.02	.05
Interdisciplinary research	.15	.13	.10	.10	.11	.06	.09	.07	.14	.13	.02	.02	−.03	.11	.22	.11	.16	.01	−.03	−.02	−.13	.06	.07	.10	−.13	−.01
Age	.14	.09	.10	.22	.04	.08	.23	.02	−.13	.11	.03	.08	−.22	.34	−.34	−.26	.19	.02	−.06	−.05	−.01	.05	.65	−.01	−.59	.16
Gender	−.14	−.16	−.10	.05	−.16	−.06	.07	−.06	.06	.07	.05	.13	.28	−.11	−.12	.05	−.22	−.08	.05	.03	.07	.02	−.11	−.05	.12	.03
Migration background	.05	.08	.05	−.08	.07	.04	−.07	.00	−.01	−.09	.03	.11	.07	.04	.10	.09	.08	.13	−.03	−.05	−.04	−.11	−.11	.02	.04	.10
Married	.06	.06	.00	.06	.05	−.01	.06	−.03	−.07	.09	−.02	.03	−.12	.12	−.02	−.05	.09	−.02	−.02	−.01	.07	.04	.18	−.02	−.19	.13
Children	.05	.04	−.06	.19	.03	−.07	.21	−.03	−.09	.10	.01	.06	.02	.14	−.19	−.09	.04	.03	−.10	−.03	.01	.08	.26	.05	−.28	.05
Risk taking willingness	.19	.18	.15	.04	.16	.11	.02	.06	.12	.09	.02	−.21	−.03	.15	.07	−.07	.06	.10	.06	−.13	−.23	−.07	.24	−.12	−.04	−.14
Self–employed parents	−.01	.03	−.06	−.07	.04	−.05	−.06	−.08	.12	.02	.00	.05	.00	.08	.07	.07	−.07	.07	.01	.01	−.07	−.09	−.06	.03	.02	−.01
Self–employed colleagues	−.14	−.14	−.03	−.11	−.13	.00	−.10	−.19	−.15	−.21	−.05	.00	−.01	−.27	−.01	−.08	−.21	−.04	−.02	.05	.12	.02	−.21	.12	.13	−.14

Table 7 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)		
Prior entrepreneurial experience	.02	.02	−.07	.13	.04	−.10	.12	.07	−.02	.07	−.04	−.11	.00	.05	−.22	−.06	−.04	.01	−.08	−.07	−.06	.12	.19	−.13	−.10	.11		
Prior industry experience	.01	.01	.02	−.02	.01	.03	−.05	−.02	−.02	.04	.11	−.08	−.17	.01	.01	−.05	.01	−.12	.21	−.07	.07	−.06	.07	−.07	.02	−.04		
Entrepreneurial contacts	.24	.24	.14	.08	.21	.11	.05	.13	−.08	.28	.18	.00	−.16	.27	−.09	−.11	.15	.00	.06	.07	−.07	−.07	.14	.11	−.20	−.03		
Baden−Württemberg	.02	.03	−.04	.04	.05	−.04	.03	.00	−.01	−.08	.14	−.16	.00	.02	−.03	.06	.03	−.07	−.02	−.07	.09	.11	.12	.01	−.10	−.02		
Bavaria	−.06	−.05	−.09	.03	−.04	−.10	.05	−.01	.06	.10	.05	−.04	−.01	−.02	.08	.53	−.04	−.02	.08	−.06	−.05	−.02	−.09	−.05	.15	−.09		
Berlin	−.04	−.10	.09	.03	−.14	.12	.04	.03	−.02	.00	−.04	.09	.04	−.07	.03	.04	.06	.09	−.02	−.03	−.02	−.09	−.04	.18	−.10	−.04		
Bremen	.00	.01	−.03	.03	.02	−.06	.04	−.14	.10	.06	.05	.04	−.06	.05	−.27	−.16	−.09	−.09	.18	−.02	−.02	−.06	.26	−.07	−.14	−.03		
Hesse	.06	.06	.05	.02	.04	.04	.03	−.06	.17	.06	−.04	.06	−.04	.08	.08	−.05	−.03	.16	−.13	−.04	−.03	−.05	−.03	−.09	.08	.06		
Mecklenburg−Western Pomerania	−.07	−.08	−.07	.06	−.09	−.04	.08	.00	.10	−.04	−.15	.14	.10	−.02	−.18	−.10	−.04	−.09	−.08	.51	−.02	.03	−.09	−.01	−.04	.31		
Lower Saxony	.02	.02	.07	−.09	.03	.08	−.13	−.09	.07	.02	−.15	−.04	−.09	.02	.11	−.11	.06	.03	.12	−.04	−.04	−.14	.03	.12	−.14	.03		
North-rhine−West-phalia	.07	.08	−.01	.10	.08	−.03	.08	.11	.01	.07	.02	.06	.13	.04	.16	−.03	.04	−.06	.08	.07	−.05	−.02	−.01	−.01	.05	−.09		
Rhineland−Palatinate	−.08	−.08	−.05	−.03	−.07	−.03	−.03	.08	−.16	.10	.12	−.09	−.09	−.05	−.16	−.09	.12	−.11	−.04	−.01	−.01	.19	.15	−.04	−.08	−.02		
	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)	(50)	(51)	(52)	(53)	(54)
Saarland	.03	.05	.02	−.07	.05	.00	−.06	.06	−.19	.01	.02	.10	−.03	−.02	.00	−.03	−.04	.13	−.08	−.02	−.02	−.07	.08	.08	−.11	−.04		

Table 7 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
Saxony	−.05	−.02	−.03	−.14	−.01	−.01	−.13	.09	−.08	.01	.06	−.02	.03	−.04	−.07	−.02	.03	.09	−.11	−.05	−.04	.02	−.04	−.04	.06	.02
Saxony–Anhalt	.00	−.02	−.07	.17	−.01	−.08	.16	−.13	−.02	−.02	−.02	.01	.11	−.07	−.08	−.06	−.07	−.15	.09	−.02	−.01	.11	−.06	−.06	.11	−.02
Schleswig–Holstein	−.07	−.06	−.03	−.05	−.05	−.02	−.04	.06	−.11	−.05	.05	−.07	−.06	.06	−.27	−.18	−.09	−.09	.06	−.02	−.02	.07	.04	−.07	.04	−.03
Thuringia	.04	.01	.13	−.04	−.02	.13	−.05	−.07	−.09	−.19	−.12	.03	−.09	−.04	.04	−.27	−.05	.00	−.08	−.04	.17	.06	−.11	.00	.07	.04
Basic research	1																									
Applied research	−.36																									
Interdisciplinary research	.06	.13																								
Age	−.05	.08	.04																							
Gender	.08	−.15	−.24	−.17																						
Migration background	−.06	.03	−.12	−.07	.09																					
Married	−.02	.01	.05	.25	−.03	.00																				
Children	−.04	.08	.06	.48	−.09	−.13	.39																			
Risk taking willingness	−.06	.12	.11	.12	.00	.02	.01	.13																		
Self–employed parents	.15	−.05	.00	−.07	.11	.06	−.07	−.06	.14																	
Self–employed colleagues	.05	−.12	−.24	−.23	.09	.00	−.12	−.22	−.11	−.07																

Table 7 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
Prior entrepreneurial experience	−.05	.12	.09	.20	.03	−.06	.04	.10	.13	.14	−.22															
Prior industry experience	−.10	.08	.08	−.01	−.02	.01	−.04	−.13	.00	.02	.04	−.28														
Entrepreneurial contacts	.03	.11	.08	.24	−.15	−.06	−.06	.08	.09	.04	−.28	.07	.05													
Baden–Württemberg	−.04	.06	−.06	.09	−.01	.05	.17	.07	−.06	−.01	−.02	.09	−.04	−.04												
Bavaria	−.02	.06	.01	−.16	.02	−.11	−.11	−.13	−.04	.03	−.05	−.09	.07	.02	−.20											
Berlin	.14	−.04	.09	−.01	−.04	.10	−.06	−.01	−.05	−.07	.04	−.04	−.04	.04	−.10	−.09										
Bremen	−.20	−.02	−.05	.15	.03	−.05	.09	−.03	.06	.01	.05	.04	.04	−.04	−.07	−.06	−.03									
Hesse	.12	.04	.11	.06	−.04	.17	−.03	−.06	.08	.17	−.08	.03	−.04	−.02	−.13	−.12	−.06	−.04								
Mecklenburg–Western Pomerania	−.01	.00	−.06	−.03	.07	.04	−.04	.05	−.21	.04	−.03	−.01	−.10	.01	−.09	−.07	−.04	−.02	−.05							
Lower Saxony	−.02	.06	.10	.08	−.08	−.13	−.06	.03	.20	−.04	−.02	−.02	−.08	.13	−.16	−.14	−.07	−.04	−.09	−.06						
North-rhine–Westphalia	.11	−.22	.09	−.03	−.02	.05	.00	−.06	−.07	−.01	.02	−.05	.11	−.03	−.20	−.17	−.09	−.06	−.12	−.07	−.14					
Rhineland–Palatinate	−.06	.06	.01	.07	−.04	−.03	.05	.09	−.08	−.05	.08	−.04	.15	.04	−.04	−.03	−.02	−.01	−.02	−.01	−.03	−.03	1			
Saarland	−.04	.03	−.22	.05	−.01	.04	.04	.12	.05	−.04	.05	−.01	−.10	.10	−.09	−.07	−.04	−.02	−.05	−.03	−.06	−.07	−.01	1		
Saxony	−.08	−.04	.05	−.11	−.01	.04	−.03	−.04	−.01	−.02	−.06	.06	−.05	−.09	−.17	−.14	−.07	−.05	−.10	−.06	−.11	−.14	−.03	−.06	1	

Table 7 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)		
Saxony–Anhalt	−.09	.08	.02	−.06	.20	−.04	.07	.12	.01	−.07	.01	.21	−.06	−.07	−.05	−.05	−.02	−.02	−.03	−.02	−.04	−.05	−.01	−.02	−.04	1		
Schleswig–Holstein	−.04	.06	−.25	−.03	.14	−.05	−.01	−.03	−.13	−.09	−.04	−.07	.04	−.04	−.07	−.06	−.03	−.02	−.04	−.02	−.04	−.06	−.01	−.02	−.05	−.02	1	
Thuringia	.03	.01	−.06	.02	−.01	−.12	.00	.08	.12	.04	.15	−.05	.10	.01	−.15	−.13	−.06	−.04	−.09	−.05	−.10	−.13	−.02	−.05	−.11	−.03	−.04	1

activities. Although the chi-squared test revealed that the effect of *translating one's research ideas into practice* is statistically greater with operational activities than with commercialization activities ($\chi 2 = 3.18$ $p = 0.074$), we reject hypothesis 1b because we could not find a significant effect for commercialization activities.

The regression results show a positive relationship between the independent variable *self-realization* and the amount of completed venture creation activities ($\beta = 0.642$; $p = 0.015$). Thus, hypothesis 2a is supported by the data. Moreover, the results also illustrate that *self-realization* has a significant positive effect on operational- ($\beta = 0.227$; $p = 0.038$) and financing activities ($\beta = 0.269$; $p = 0.003$). However, no significant effect could be found in for commercialization activities ($\beta = -0.021$; $p = 0.840$). Therefore, our regression results indicate that academics who are driven by an intrinsic pursuit of self-realization complete more venture creation activities than those who are not. This outcome indicates that the extent to which scientists strive for self-realization is of utmost importance when it comes to operational and financing activities. In terms of hypothesis 2b, the results of the chi-squared test show that the significant positive coefficient of self-realization is statistically larger for financing activities than for operational activities ($\chi 2 = 3.01$; $p = 0.082$). However, no significant differences could be found for the comparison between commercialization and operational activities. Hence, hypothesis 2b is partially supported.

The results show that the independent variable *knowledge and skill utilization* ($\beta = -.647$; $p = 0.004$) has a significant negative effect on the amount of completed venture creation activities. This indicates that the amount of completed venture creation activities decreases as the motivation of *knowledge and skill utilization* increases. This outcome supports hypothesis 3. In addition, the regression results show a significant negative effect of the desire for *knowledge and skill utilization* on both operational ($\beta = -0.246$; $p = 0.010$) and commercialization activities ($\beta = -0.123$; $p = 0.070$). In contrast, no significant effect could be found for financing activities.

We also found support for hypothesis 4a. The results demonstrate a significant positive effect of the motive *increased financial income* on the amount of completed venture creation activities ($\beta = 0.326$; $p = 0.045$). Thus, being motivated by financial rewards such as improved earning opportunities is positively associated with the amount of completed venture creation activities. Moreover, the results also show that a desire for an increased financial income is positively associated with the amount of completed operational activities ($\beta = 0.111$; $p = 0.094$). The results suggest that scientists who are motivated by an increased financial income will concentrate more on operational than financial- and commercialization activities. Additionally, the outcome of the chi-squared test across the models revealed that the effect of an *increased financial income* is statistically greater with commercialization than with operational activities ($\chi 2 = 4.77$; $p = 0.028$). However, we reject hypothesis 4b, because we could not find a statistically significant effect for commercialization activities.

Moreover, our regression results demonstrate a significant positive effect of a *necessity* motivation on the total amount of completed venture creation activities ($\beta = 0.392$; $p = 0.054$). Thus, hypothesis 5 is supported by the data. This effect is particularly high when it comes to operational activities ($\beta = 0.175$; $p = 0.031$). However, no significant effect could be found for financing- or commercialization activities. Overall, these findings suggest that academics who are driven by *necessity* are more likely to engage in operational activities than those who are not.

Finally, our results demonstrate a significant negative effect of *work-life balance* on the total amount of completed venture creation activities ($\beta = -0.279$; $p = 0.080$), which indicates that scientists driven by *work-life balance* motives complete fewer venture creation

activities. This outcome confirms hypothesis 6. Regression results show a significant negative correlation between *work-life-balance* and the amount of completed operational ($\beta = -0.118$; $p = 0.060$) and commercialization activities ($\beta = -0.119$; $p = 0.082$). However, no significant effect could be found for financing activities. Therefore, the results indicate that academics who are driven by work-life balance motives complete fewer venture creation activities when it comes to operational and commercialization activities.

4.3 Robustness checks

We ran several robustness checks.

First, since the survey consists of two waves, we tested for potential sample attrition bias by testing the mean differences for the independent variables between the attritors and non-attritors. The results show no significant mean differences, indicating that attrition is most likely not an issue in our analysis (Menard, 1995; Ghanem et al., 2021). In addition, we also tested for potential sample attrition bias by following a logistical regression approach. Again, no significant relationships could be found for either start-up motivations or the control variables, indicating that there are no differences between the stayers and the dropouts (Goodman & Blum, 1996; Hausmann & Wise, 1979; Heckman, 1979). Hence, we can conclude that sample attrition bias is unlikely.

Second, to further ensure the quality of the data, we tested for potential non-response bias. Therefore, we compared the respondents' characteristics (e.g., faculty, position at the university, research type, and location) with the non-respondents' characteristics (Armstrong & Overton, 1977; Lambert & Harrington, 1990). No significant mean differences were found. Moreover, we also assessed the existence of a non-response bias by applying a two-step Heckman procedure (Heckman, 1979; Meoli et al., 2020). In a first step, we developed a selection model estimating the likelihood of a respondent having completed the 2016 survey (Heckman, 1979). The predictor variables used for this selection model were those of our main regressions (Grotzinger et al., 1994; Sales, 2004). As the instrument variable, we chose the scientists' working time as reported in 2013. This variable affected the likelihood of completing the follow-up survey in 2016 ($\beta = 0.013$; $p = 0.034$) without affecting our dependent variables. We assumed, that scientists who reported a higher number of weekly working hours were more likely to be online and check their emails more frequently. This might in turn affect their likelihood of completing the follow-up survey in 2016. Based on the results of the selection model we then calculated the corresponding inverse Mills ratios for the second stage of the equation model. In a second step, we included the inverse Mills ratio as a further predictor variable in our main regression models. As a result, the inverse Mills ratio was not found to be significant ($\beta = 0.391$; $p = 0.573$). Similarly, no significant changes in the estimators of the other predictors could be observed. Thus, the results indicate that non-response bias is unlikely to be an issue in our study.

Third, as the variables used in the empirical models were mainly from the same data source, we also tested for potential common method bias. In order to do so, we performed Harman's single-factor test (Harman, 1967). It is assumed that there is a common method bias if a single factor results from the required unrotated factor analysis or if one factor explains the majority of the overall variance (Podsakoff & Organ, 1986; Podsakoff et al., 2003). The results of the unrotated factor analysis showed 19 factors with eigenvalues greater than one, which cumulatively explained 72.28% of the overall variance. The factor with the highest Eigenvalue accounted for only 9.06% of the explained variance. Thus, the

results of Harman's single-factor test indicated that common method bias was not of concern in our study.

Fourth, to check the robustness of our OLS results from Table 4, we estimated a further OLS regression with the dependent variables specified as count variables; Table 3 shows the descriptive statistics of the count variables. Next to this OLS regression, we also estimated a poisson and a negative binomial regression using the same count variables. Finally, we checked both an ordered probit and a seemingly unrelated regression with the amount of venture creation activities specified as count variables. Table 5 shows the results of the poisson regression. The results of the other robustness checks can be found in the Appendix (see "Appendix 3"). Overall, the results regarding our hypotheses and our main independent variables remain similar.

5 Discussion

5.1 Summary of main results

In this study, we connected different types of entrepreneurial motives with different venture creation activities to show how these motives affect venture creation patterns in academic entrepreneurship. Our findings show that founder motives related to self-realization, necessity and an increased financial income increase the likelihood of completing venture creation activities, whereas work-life balance motivations and the drive to make better use of one's professional knowledge decrease that likelihood. The desire to translate research ideas into practice has no effect. Our results further show that the positive effects of seeking self-realization and an increased financial income are more pronounced for completing commercialization activities than for operational activities. Table 8 provides an overview of the formulated hypotheses and their empirical support.

5.2 Interpretation of main results

We show that the desire for self-realization has a positive effect across all types of venture creation activities. Such a desire is only fulfilled when the scientists' plans have been transferred into actual steps in entrepreneurship (such as developing products and services, collecting material and financial resources, seeking potential business partners, or accepting first sales) and hence the positive effect occurs across all venture creation stages.

We find a negative effect of the desire to use experience or knowledge on the amount of completed venture creation activities. This effect is noteworthy and can be explained through spillover effects of the venture creation for subsequent research projects (Fini et al., 2021). Scientists engaging in entrepreneurial activities usually tend to work on new topics. This, however, could shift a scientist's attention towards new bodies of knowledge entailing the potential for impactful future research. In such a case, the venture creation activity serves as an attractive research platform and the scientists are distracted from the commercial exploitation of their research via entrepreneurship. Another explanation is that scientific recognition within academia is mostly achieved by publishing research in international peer-reviewed journals. Thus, the success and reputation of scientists is primarily measured within the community by the number and ranking of their publications (O'Gorman et al., 2008; Wright et al., 2009). Scientists may concentrate on their publication activities during venture creation rather than on developing their products and services or gathering

Table 8 Overview of supported and not supported hypotheses

Hypotheses		
H1a:	*The higher the motivation to translate one's research ideas into practice, the higher the amount of completed venture creation activities.*	✕
H1b:	*The positive effect of putting one's research ideas into practice is more pronounced with operational activities than with financing and commercialization activities.*	✕
H2a:	*The higher the motivation of seeking self−realization, the higher the amount of completed venture creation activities.*	✓
H2b:	*The positive effect of self-realization is more pronounced with commercialization activities than with operational- and financing activities.*	✓/✕
H3:	*The higher the motivation to better make use of one's professional experience or knowledge the lower the amount of completed venture creation activities.*	✓
H4a:	*The higher the motivation of an increased financial income, the higher the amount of completed venture creation activities.*	✓
H4b:	*The positive effect of an increased financial income is more pronounced with commercialization activities than with operational- and financing activities.*	✕
H5:	*"The higher the motivation out of necessity the higher the amount of completed venture creation activities."*	✓
H6:	*The higher the motivation of seeking work-life balance, the lower the amount of completed venture creation activities.*	✓

✓/✕: partly supported; ✓: fully supported; ✕: not supported

resources and undertaking commercialization activities. Academics who are driven by this specific motive are more likely to either postpone or quit their new venture plans in favor of using this time for publication. Consequently, venture creation projects either proceed very slowly or are abandoned altogether.

In line with prior research, our results indicate that seeking an increased financial income is positively associated with the amount of completed venture creation activities (Goethner et al., 2012; Hayter, 2011; Lam, 2011; Morales-Gualdrón et al., 2009). Interestingly, the positive effect of a desire for an increased financial income is relatively small compared to the effects of non-monetary motives. A possible explanation for this finding may be that scientists do not consider financial rewards to be the primary goal when deciding to engage in entrepreneurial activities; instead, they may view such rewards as a form of collateral compensation for the time and effort they invest in their research activities (Goethner et al., 2012; Hayter, 2011; Lam, 2011; Morales-Gualdrón et al., 2009). This finding strengthens the findings of Fini et al. (2009) and Hayter (2011). It suggests that intangible rewards (such as traditional academic recognition reputation and promotion) are the primary motives for most academics when participating in entrepreneurial activities.

Our findings also highlight that academic entrepreneurs motivated by necessity tend to complete more venture creation activities than other academic entrepreneurs. This appears to be especially true when it comes to operational activities. This result is also in line with prior findings (Kirkwood, 2009) and may be attributed to the difficult working conditions at German universities. Many scientists constantly have to search for new jobs in order to avoid unemployment due to time-limited or part-time working contracts. Starting a venture can be an attractive opportunity to escape from this vicious circle.

We find a negative effect of seeking work-life balance. Starting a business requires a high degree of personal time and effort. Entrepreneurs have to work hard and often only have limited time for personal matters (such as leisure time, family, or hobbies), which

affects their work-life balance negatively. Academic entrepreneurs driven by work-life balance motivations prioritize personal over professional matters and are consequently less likely to complete entrepreneurial activities.

Finally, the desire to translate one's research ideas into practice seems to have no effect on the likelihood of completing venture creation activities. A possible explanation for this finding could be be that such scientists may also have a strong passion for their research, which may work against the positive effects from the transfer motives.

5.3 Theoretical and practical implications

From a theoretical perspective, our findings support the notion that the identity of academics plays a dominant role in their participation and progress in venture creation activities. Academic entrepreneurs are driven by a strong inner self-realization motive and a need for experience or knowledge utilization. They devote themselves to improving society by transferring and disseminating technology (Berggren, 2017; Iorio et al., 2017; Morales-Gualdrón et al., 2009). Another theoretical implication of our findings is that for academic entrepreneurs different types of motives seem to be important throughout the different (early) phases of venture creation. This finding complements the literature on entrepreneurial competencies and motives that are needed in different phases of venture creation highlighting the importance of heterogeneity of individual psychological dimensions for academic (team) entrepreneurship (Klotz et al. (2014).Different tasks exist and matter in different phases of the venture creation process and different motivations may be needed to master these tasks. Entrepreneurial teams composed of team members with heterogeneous motivations might be faster and more efficient in the venture creation process than homogeneous entrepreneurial teams (e.g., Cooper & Daily, 1997; Kor & Mahoney, 2000; Brinckmann & Hoegl, 2011). The findings in our study also indicate that the high discrepancy between founding intention and implementation in the academic context observed by Kollmann et al. (2017) and Fritsch and Krabel (2012) may be bridged by encouraging and enhancing motives that are positively related to academic entrepreneurship. Specifically, this study provides empirical evidence that transfer-related motives are the most important motives in the context of academic entrepreneurship. Moreover, scientists who are driven by economic motives are more likely to engage in entrepreneurial activities than those driven by opportunity. The latter finding also contributes to the literature related to the push and pull theory, suggesting that scholars should focus more on this interesting group of entrepreneurs. Finally, our study also contributes to the literature on the venture creation patterns. By drawing on prior literature (e.g., Gatewood et al., 1995; Hansen, 1991; Hansen & Wortman, 1989; Liao et al., 2005; Reynolds & Miller, 1992; Vesper, 1990) and by following an activity-based approach (Guerrero et al., 2020; Kleinhempel et al., 2020; Shepherd et al., 2019), our study conceptualizes academic venture creation as consisting of operational, financing, and commercialization activities. By doing so, our study provides a context-specific perspective (Welter, 2011) and enhances the understanding of venture creation patterns in academic entrepreneurship.

In terms of practical implications, our study shows that transfer-related motives are highly relevant in driving venture creation. Therefore, academic entrepreneurs need to maintain linkages to their parent organizations. In this regard, Bolzani et al. (2020) show that scientist maintaining strong linkages to their parent organizations receive access to unique resources and knowledge, which in turn positively affects their market performance. Moreover, university administrators and their technology transfer programs should

specifically focus on meeting the needs of academics. Scientists who aim to start a new venture often require legal, financial and mentoring support. Therefore, organizational support mechanisms such as incubators, university technology transfer offices (TTOs), patenting offices and specific university support programs are known to play important roles in facilitating academic entrepreneurship (Algieri et al., 2013; Grimaldi et al., 2011; Korosteleva & Belitski, 2017; Siegel & Wessner, 2012). Such institutions could concentrate on helping scientists search for suitable business partners, conduct market analyses, solve legal problems or address exploitation rights. In this respect, TTOs might for example create network activities, bringing researchers into contact with experts from industry as well as VCs (Clarysse et al., 2011; Siegel et al., 2003). Then again, science parks, incubators and support programs could provide access to markets by bringing scientists into contact with potential customers and offering support with regard to of exploitation rights. This would enable scientists to focus on their research and prototype development rather than struggling with the commercial exploitation of these products or services. Finally, university administrators need to encourage scientists to become proactive in starting knowledge cooperations with the private industry. Bikard and Marx (2020) indicate that university-to-industry cooperations could boost academics' productivity and increase the quality of their work. Scientists who are involved in university-to-industry cooperations tend to achieve greater levels of specialization as they can leave the financing and commercialization activities to their industry partners. Such scientists are able to focus on their research activities in terms of product and service development (Bikard et al., 2019). This way, a more effective resource allocation could be achieved, which might reduce the negative effects of the skill utilization motive and increase the amount of completed venture creation activities.

5.4 Limitations and future research avenues

This study is not without limitations. First, the research used voluntary self-reported surveys. Therefore, a potential selection bias may exist. Second, the data are from only one country (Germany), which means that the findings may not be applicable other countries with different cultural and regulatory backgrounds (Guerrero et al., 2020). Third, our study does not consider every feasible predictor from prior entrepreneurship studies. Thus, omitted variable bias might be an issue. For example, prior entrepreneurship studies indicate that available financial resources or the amount of time invested are critical for the early success of a start-up project (Davidsson & Scott, 2012; Stuetzer et al., 2012). Moreover, the academic entrepreneurship literature has demonstrated the importance of founder teams for science-based businesses. By omitting these predictors, our empirical model may overestimate or underestimate the influence of start-up motives on the amount of completed venture creation activities. Besides, the attrition between T1 and T2 could still be an issue as some of the scientists left academia between 2013 and 2016. The main reason for this is that –due to the Law on Working Contracts in Higher Education and Research[2]– some of the scientists in our initial 2013 survey had fixed-term working contracts limited to three years. Since scientists' email addresses are generally deactivated shortly after they leave the university, we could not contact all respondents again in 2016. This may have caused attrition in our study. Finally, another limitation could be found with regard to the

[2] Gesetz über befristete Arbeitsverträge in der Wissenschaft (Wissenschaftszeitvertragsgesetz—WissZeitVG).

assumption of linearity in the venture creation process. Some venture creation activities are more complex than others and therefore require more time and effort. Moreover, some activities might be interdependent (e.g., external financiers often require prototypes, patents or other types of proof of concept). As a result, feedback loops in the venture creation process as well as complementarities and substitutional relationships among venture creation activities might lead to the repetition of specific activities (e.g., negotiations with inside or outside creditors or developed a business plan), while other activities only have to be carried out once (e.g., registration at the tax office) or may even be skipped temporarily (Vohora et al., 2004).

In light of these limitations, future research should consider multi-national comparisons and examine whether (or to what extent) our results are generalizable to other countries with different cultural and regulatory backgrounds. In addition, more qualitative research is needed to understand how and in which sequence venture creation activities are carried out in academic entrepreneurship. Furthermore, the potential causes and consequences of entrepreneurial motivation deserve further analysis. Future research should address how to bridge the discrepancy between founding intention and implementation by encouraging and enhancing the motives that are positively related to academic entrepreneurship. It should also investigate how to readjust or reduce the influence of the motivating factors that show negative effects. Several other issues deserve further study, such as the extent to which the different motivation categories vary between the different types of entrepreneurs and how the types of founders, their research, their faculties, and their positions within the university may moderate or mediate the effects of these motives. Finally, future research should engage more in analyzing how organizational mechanisms put at place by universities and incubators may effectively support academics to translate their different forms of entrepreneurial motivations into actual behaviors.

Appendix 1

See Table 9.

Table 9 Variable description

Variable	Description
Dependent variables:	
Amount of completed venture creation activities	Total number of completed venture creation activities to advance a start-up project by university scientists (from zero to 11). What steps have you taken to further advance your start-up project? Please refer to Sect. 3.2.1 for detailed description of each item
Amount of completed operational activities	Number of completed operational activities to advance a start-up project by university scientists (from zero to six). What steps have you taken to further advance your start-up project? Please refer to Sect. 3.2.1 for detailed description of each item
Amount of completed financing activities	Number of completed financing activities to advance a start-up project by university scientists (from zero to three). What steps have you taken to further advance your start-up project? Please refer to Sect. 3.2.1 for detailed description of each item
Amount of completed commercialization activities	Number of completed commercialization activities to advance a start-up project by university scientists (from zero to two). What steps have you taken to further advance your start-up project? Please refer to Sect. 3.2.1 for detailed description of each item
Motivations:	
Translate one's research ideas into practice	Why do you (would you) want to become self-employed? Practical application of own research ideas (from 1 to 5): 1 = strongly disagree; 5 = strongly agree
Self-realization	Why do you want to become self-employed? Self-realization and independence (from 1 to 5): 1 = strongly disagree; 5 = strongly agree
Knowledge & skill utilization	Why do you want to become self-employed? Improved utilization of professional experience/ knowledge (from 1 to 5): 1 = strongly disagree; 5 = strongly agree
Monetary	Why do you want to become self-employed? Higher and better earning opportunities (from 1 to 5): 1 = strongly disagree; 5 = strongly agree
Necessity	Why do you want to become self-employed? Dissatisfaction with the current work situation and/ or afraid of unemployment (from 1 to 5): 1 = strongly disagree; 5 = strongly agree
Work-life-balance	Why do you want to become self-employed? Improved work-life balance (from 1 to 5): 1 = strongly disagree; 5 = strongly agree
Degree of startup project advancement 2013	To what extent have you already put your founding idea into action? I have a) a business plan, b) negotiated with external and/or equity investors, c) cared about the exploitation rights, d) acquired/contacted important business partners, and e) introduced myself to (potential) customers. Constructed 5 item Scale, measured on a five-point Likert scale (from 1 to 5): 1 = strongly disagree; 5 = strongly agree
University characteristics:	

Table 9 (continued)

Variable	Description
University size	Total number of scientific employees working at the university including all types of professors, research assistants, postdocs and other scientific staff (objective Data from Federal ministry of education and research)
Applied science university	Binary variable = 1 if founder works at university of applied science; zero otherwise
Invention at university	Binary variable = 1 if founder has made an invention based on a research project at the university; zero otherwise
Faculties:	
STEM	Binary variable = 1 if founder works at the faculty of mathematics, natural science, technique or physics; zero otherwise
Economics/ social sciences	Binary variable = 1 if founder works at the faculty of economics/ social sciences; zero otherwise
Medicine	Binary variable = 1 if founder works at the faculty of medicine/ health management; zero otherwise
Arts	Binary variable = 1 if founder works at the faculty of Music, design, art, zero otherwise
Positions:	
Professor	Binary variable = 1 if founder is a full professor; zero otherwise
Assistant professor or post doc	Binary variable = 1 if founder is an assistant professor or a post doc; zero otherwise
Research assistant	Binary variable = 1 if founder is a research assistant; zero otherwise
Research types:	
Basic research	How would you characterize your research activities at the university? Basic research (from 1 to 5): 1 = strongly disagree; 5 = strongly agree
Applied research	How would you characterize your research activities at the university? Applied research (from 1 to 5): 1 = strongly disagree; 5 = strongly agree
Interdisciplinary research	How would you characterize your research activities at the university? Interdisciplinary research (from 1 to 5): 1 = strongly disagree; 5 = strongly agree
Individual characteristics:	
Age	Metric variable. Please state your age
Gender	Binary variable = 1 if founder male and zero if the founder is female
Migration background	Binary variable = 1 if founder has a migration background; zero otherwise
Married	Binary variable = 1 if founder is married; zero otherwise
Children	Binary variable = 1 if the founder has at least one child; zero otherwise
Risk taking willingness	Are you generally a risk-averse person or do you try to avoid risks? (from 1 to 5): 1 = low risk-taking propensity; 5 = high risk-taking propensity

Table 9 (continued)

Variable	Description
Self-employed parents	Binary variable = 1 if the founder has self-employed parents; zero otherwise
Self-employed colleagues	Binary variable = 1 if the founder has self-employed colleagues; zero otherwise
Prior entrepreneurial experience	Binary variable = 1 If the founder has already started a business in the past; zero otherwise
Prior industry experience	Binary variable = 1 if the founder worked in the private industry; zero otherwise
Entrepreneurial contacts	Binary variable = 1 if the founder has contacts which are helpful for the implementation of the founding project; zero otherwise
Federal states	Binary variable representing the federal state in which the university of the founder is located. Each variable takes the value 1 if the university of the founder is located in one specific German federal state and zero otherwise

Appendix 2

Table 10.

Table 10 Regression results (controls only)

	Model 1			Model 2			Model 3			Model 4		
	Venture creation activities			Factor 1 (operational activities)			Factor 2 (financing activities)			Factor 3 (commercialization activities)		
	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|
Degree of startup project advancement 2013	1.089	.260	***	.395	.103	***	.243	.129	**	.338	.120	***
University characteristics												
Applied science university	−.690	.723		−.089	.234		−.323	.305		−.441	.446	
University size	.000	.000		.000	.000		.000	.000		.000	.000	
Invention at university	.923	.557		.480	.206	**	.012	.268		.061	.182	
Faculties[1]												
STEM	.626	1.347		.435	.468		−.520	.593		.723	.583	
Economics/ social sciences	1.150	1.410		.614	.486		−.445	.606		.981	.623	
Medicine	.292	1.716		.751	.760		−.807	.752		−.615	.688	
Arts	−.068	1.336		.099	.447		−.872	.594		1.130	.677	*
Positions[2]												
Professor	.463	.784		.311	.300		−.004	.342		−.245	.351	
Assistant professor or post doc	.365	.592		.138	.221		.085	.265		.067	.195	
Research assistant	1.754	1.039	*	.422	.521		.601	.410		.865	.362	**
Research types												
Basic research	.016	.174		.035	.066		−.030	.076		−.031	.063	
Applied research	−.102	.206		−.053	.081		.017	.076		−.019	.084	
Interdisciplinary research	.275	.176		.075	.068		.116	.077		.062	.070	
Individual characteristics												
Age	−.034	.029		−.020	.011	*	−.001	.013		.008	.013	
Gender	−.327	.438		−.208	.176		−.053	.187		.228	.198	
Migration background	.282	.728		.220	.281		.056	.312		−.368	.201	*
Married	−.049	.466		−.006	.174		.018	.207		−.112	.169	

Table 10 (continued)

	Model 1			Model 2			Model 3			Model 4		
	Venture creation activities			Factor 1 (operational activities)			Factor 2 (financing activities)			Factor 3 (commercialization activities)		
	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|
Children	.042	.488		.103	.190		−.318	.201		.239	.189	
Risk taking willingness	.259	.253		.066	.099		.146	.107		.039	.095	
Self-employed parents	−.314	.394		−.066	.157		−.132	.176		−.177	.142	
Self-employed colleagues	.277	.456		.115	.176		.032	.187		.096	.161	
Prior entrepreneurial experience	−.209	.543		.038	.219		−.290	.234		−.002	.196	
Prior industry experience	−.287	.463		−.041	.179		−.177	.207		−.045	.205	
Entrepreneurial contacts	.740	.469		.328	.187	*	.145	.174		.042	.171	
Federal States[3]												
Baden Württemberg	2.788	.980	***	1.065	.384	***	.338	.380		.973	.540	*
Bavaria	2.385	1.113	**	.850	.415	**	.270	.462		.980	.638	
Berlin	2.020	1.841		.379	.608		.782	.768		1.251	.773	
Bremen	1.822	1.313		.980	.588	*	−.447	.602		.638	.826	
Hesse	2.746	1.214	**	1.022	.476	**	.296	.505		1.070	.637	*
Mecklenburg Western Pomerania	1.421	1.224		.429	.523		−.068	.421		1.331	.737	*
Lower Saxony	2.087	1.216	*	.834	.466	*	.299	.514		.514	.637	
Northrhine-Westphalia	2.806	1.115	**	.997	.404	**	.346	.443		1.216	.580	**
Rhineland Palatinate	3.233	1.735	*	1.287	.752		.511	.576		.667	.570	
Saarland	2.098	1.141	*	.898	.433	**	.179	.465		.486	.559	
Saxony	3.408	1.297	***	1.238	.537	**	.072	.472		1.816	1.493	
Saxony−Anhalt	1.270	1.279		.734	.452		−.094	.697		−.039	.595	
Schleswig–Holstein	2.995	1.231	**	1.117	.458	**	.637	.508		.709	.787	
Constant	−2.960	2.569		−2.208	.960	**	−.435	1.028		−2.527	1.178	**

Table 10 (continued)

	Model 1			Model 2			Model 3			Model 4		
	Venture creation activities			Factor 1 (operational activities)			Factor 2 (financing activities)			Factor 3 (commercialization activities)		
	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|
Prob > F:	F(37, 126)	n.a		F(37, 126)	n.a		F(37, 126)	n.a		F(37, 126)	n.a	
R2:	.331			.352			.227			.316		
N:	165			165			165			165		
	Model 1			Model 2			Model 3			Model 4		
	(Amount of completed venture creation activities)			(Amount of completed operational activities)			(Amount of completed financing activities)			(Amount of completed commercialization activities)		
	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|
Degree of startup project advancement 2013	.268	(.062)	***	.233	(.061)	***	.292	(.118)	**	.585	(.190)	***
University characteristics												
Applied science university	−.352	(.236)		−.219	(.220)		−.424	(.381)		−.356	(.728)	
University size	.000	(.000)		.000	(.000)		.000	(.000)	**	.000	(.000)	
Invention at university	.351	(.166)	**	.467	(.156)	***	.084	(.302)		.035	(.516)	
Faculties[1]												
STEM	.434	(.266)		.531	(.268)	**	.892	(.466)	*	−1.024	(.603)	*
Economics/ social sciences	.667	(.320)	**	.731	(.309)	**	1.014	(.552)	*	−.217	(.594)	
Medicine	.646	(.513)		1.200	(.515)	**	.994	(1.049)		−16.671	(1.053)	***
Arts	.252	(.545)		−.094	(.607)		2.057	(.967)	**	−17.017	(1.829)	***
Positions[2]												
Professor	−.603	(.348)	*	−.170	(.473)		−1.025	(.512)	**	−2.635	(1.071)	**
Assistant professor or post doc	−.725	(.361)	**	−.492	(.483)		−.881	(.595)		−1.636	(.987)	

Table 10 (continued)

	Model 1			Model 2			Model 3			Model 4		
	(Amount of completed venture creation activities)			(Amount of completed operational activities)			(Amount of completed financing activities)			(Amount of completed commercialization activities)		
	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|
Research assistant	−.530	(.339)		−.262	(.477)		−.700	(.494)		−1.673	(.899)	*
Research types												
Basic research	.027	(.055)		.055	(.055)		−.028	(.093)		.050	(.116)	
Applied research	−.013	(.079)		−.040	(.077)		.047	(.138)		.159	(.236)	
Interdisciplinary research	.141	(.075)	*	.116	(.072)		.263	(.144)	*	.212	(.214)	
Individual characteristics												
Age	−.010	(.010)		−.019	(.011)	*	.003	(.018)		.040	(.027)	
Gender	−.157	(.181)		−.227	(.197)		−.101	(.302)		.401	(.546)	
Migration background	.198	(.223)		.328	(.218)		.216	(.390)		−1.299	(1.038)	
Married	.037	(.173)		.028	(.172)		.119	(.275)		−.426	(.546)	
Children	−.015	(.175)		.072	(.175)		−.542	(.293)		1.068	(.542)	**
Risk taking willingness	.101	(.090)		.051	(.087)		.278	(.160)	*	.098	(.295)	
Self−employed parents	−.133	(.138)		−.051	(.137)		−.388	(.262)		−.417	(.546)	
Self−employed colleagues	.095	(.166)		.095	(.166)		.012	(.282)		.313	(.443)	
Prior entrepreneurial experience	−.077	(.176)		.013	(.180)		−.603	(.296)	**	.080	(.475)	
Prior industry experience	−.101	(.165)		−.071	(.162)		−.313	(.292)		.117	(.490)	
Entrepreneurial contacts	.455	(.244)	*	.505	(.248)	**	.571	(.401)		−.270	(.546)	
Federal States[3]												
Baden−Württemberg	−.133	(.307)		−.094	(.314)		−.322	(.461)		.793	(1.125)	
Bavaria	−.314	(.356)		−.359	(.339)		−.414	(.602)		1.679	(1.396)	
Berlin	−.518	(.554)		−1.091	(.688)		.235	(.587)		1.709	(1.166)	
Bremen	−.352	(.427)		−.057	(.509)		−1.367	(.923)		1.308	(1.484)	

Table 10 (continued)

	Model 1 (Amount of completed venture creation activities)			Model 2 (Amount of completed operational activities)			Model 3 (Amount of completed financing activities)			Model 4 (Amount of completed commercialization activities)		
	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|
Hesse	−.202	(.286)		−.225	(.293)		−.507	(.480)		.723	(1.059)	
Mecklenburg−Western Pomerania	−.930	(.606)		−1.282	(.706)	*	−1.279	(.838)		−.254	(1.284)	
Lower Saxony	−.397	(.272)		−.361	(.263)		−.467	(.434)		−.461	(1.483)	
Northrhine−Westphalia	−.195	(.300)		−.271	(.291)		−.483	(.478)		1.751	(1.234)	
Rhineland−Palatinate	−13.918	(1.097)	***	−14.254	(1.101)	***	−13.447	(1.230)	***	−16.252	(2.125)	***
Saarland	.095	(.481)		.128	(.537)		.006	(.728)		−14.568	(1.067)	***
Saxony	−.446	(.329)		−.367	(.318)		−.530	(.539)		−14.789	(1.273)	***
Saxony−Anhalt	.197	(.334)		.177	(.429)		−13.246	(.902)	***	1.275	(1.154)	
Schleswig–Holstein	−.776	(.568)		−.523	(.502)		−.938	(1.344)		−15.679	(1.336)	***
Constant	.222	(.968)		−.143	(1.045)		−2.143	(1.697)		−4.508	(2.650)	
Prob > Chi2:	274.54	***		310.17	***		695.19	***		4241.63	***	
Pseudo R2:	.159			.155			.169			.325		
N:	165			165			165			165		

***$p<0.01$, **$p<0.05$, *$p<0.1$; robust standard errors (in parentheses); 1st. reference: other faculties; 2nd reference: other positions; 3rd reference: Thuringia; no observations for Brandenburg and Hamburg

***$p<0.01$, **$p<0.05$, *$p<0.1$; robust standard errors (in parentheses); 1st. reference: other faculties; 2nd reference: other positions; 3rd reference: Thuringia; no observations for Brandenburg and Hamburg; F-Statistics could not be calculated

Appendix 3

Table 11.

Table 11 Robustness checks

	Model 5			Model 6			Model 7			Model 8		
	(Amount of of completed creation activities)			(Amount of completed operational activities)			(Amount of completed financing activities)			(Amount of completed commercialization activities)		
	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	
Negative binomial regression (DVs specified as count variables)												
Controls (blanked)	–	–		–	–		–	–		–	–	
Translating one's research ideas into practice	.106	(.070)		.115	(.066)	*	.144	(.110)		−.176	(.164)	
Self−realization	.354	(.113)	***	.281	(.111)	**	.547	(.158)	***	.431	(.228)	*
Knowledge & skill utilization	−.323	(.098)	***	−.257	(.093)	***	−.220	(.160)		−.799	(.233)	***
Increased financial income	.150	(.063)	**	.123	(.059)	**	.193	(.124)		.488	(.163)	***
Necessity	.155	(.080)	*	.149	(.075)	**	.106	(.153)		.074	(.189)	
Work−life−balance	−.174	(.066)	***	-.177	(.066)	***	-.138	(.149)		-.551	(.183)	***
Constant	-.300	(.999)		-.666	(1.049)		-3.827	(1.697)	**	-3.322	(3.555)	
Prob > Chi2:	489.320	***		543.780	***		2911.910	***		3008.640	***	
Pseudo R2:	.113			.136			.189			.374		
Ordered probit regression (DVs specified as count variables)												
Controls	–	–		–	–		–	–		–	–	
Translating one's research ideas into practice	.115	(.084)		0.142	(.087)		.164	(.101)		−.086	(.124)	
Self−realization	.416	(.129)	***	0.397	(.143)	***	.523	(.138)	***	.208	(.163)	
Knowledge & skill utilization	−.416	(.111)	***	−0.358	(.120)	***	−.306	(.141)	**	−.555	(.156)	***
Increased financial income	.157	(.079)	**	0.143	(.085)	*	.165	(.096)	*	.422	(.141)	***

Table 11 (continued)

	Model 5 (Amount of of completed creation activities)			Model 6 (Amount of completed operational activities)			Model 7 (Amount of completed financing activities)			Model 8 (Amount of completed commercialization activities)		
	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	
Necessity	.194	(.100)	*	0.177	(.102)	*	.079	(.126)		.239	(.156)	
Work−life−balance	−.177	(.780)	**	-0.185	(.080)	**	-.606	(.108)		-.428	(.128)	***
Prob > Chi2:	582.150	***		560.39	***		1204.270	***		1367.230	***	
Pseudo R2:	.133			0.155			.189			.392		
Ordinary least squares regression (DVs specified as count variables)												
Controls	–	–		–	–		–	–		–	–	
Translating one's research ideas into practice	.263	(.178)		.210	(.133)		.051	(.060)		.002	(.037)	
Self-realization	.643	(.260)	**	.430	(.201)	**	.228	(.073)	***	−.015	(.054)	
Knowledge & skill utilization	−.648	(.221)	***	−.454	(.174)	***	−.131	(.079)		−.063	(.035)	*
Increased financial income	.326	(.161)	**	.203	(.123)		.089	(.058)		.035	(.033)	
Necessity	.392	(.201)	*	.326	(.149)	**	.027	(.072)		.040	(.046)	
Work-life-balance	−.280	(.158)	*	−.225	(.116)	*	.011	(.062)		−.066	(.036)	*
Constant	−4.564	(2.609)	*	−3.318	(1.890)	*	−.493	(.862)		−.753	(.715)	
Prob > F:	n.a			n.a			n.a			n.a		
R2:	.415			.430			.293			.352		
Seemingly unrelated regression (DVs specified as count variables)												
Controls	–	–		–	–		–	–		–	–	
Translating one's research ideas into practice	n.a			.210	(.136)		.051	(.068)		.002	(.041)	

Table 11 (continued)

	Model 5 (Amount of of completed creation activities)			Model 6 (Amount of completed operational activities)			Model 7 (Amount of completed financing activities)			Model 8 (Amount of completed commercialization activities)		
	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	p>|z|	Coef	Std. Err	
Self−realization	n.a			.430	(.185)	**	.228	(.092)	**	−.015	(.056)	
Knowledge & skill utilization	n.a			−.454	(.166)	***	−.131	(.082)		−.063	(.050)	
Increased financial income	n.a			.203	(.126)		.089	(.062)		.035	(.038)	
Necessity	n.a			.326	(.151)	**	.027	(.075)		.040	(.046)	
Work-life-balance	n.a			−.225	(.125)	*	.011	(.062)		−.066	(.038)	*
Constant	n.a			−.927	(2.164)		−.629	(1.073)		.667	(.658)	
Prob > F:				2.080	***		1.140	n.s		1.500	**	
R2:				.430			.293			.352		

***$p<0.01$, **$p<0.05$, *$p<0.1$; robust standard errors (in parentheses); the controls from the main analysis are included in the models but not shown here; n.a. = not available

Funding Open Access funding enabled and organized by Projekt DEAL.

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