Academic Entrepreneurship: Phase-specific Constraints and Needs

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Abstract

Purpose – Academic entrepreneurship is extremely relevant in knowledge and technology transfer (KTT). The purpose of this study is to provide insights into phase-specific constraints and needs impacting scientists' engagement in entrepreneurial activities at public research institutions.

Design/methodology/approach – In an exploratory case study, 40 qualitative, semi-structured interviews were conducted with German academic entrepreneurs in the fields of science, technology, engineering, and mathematics (STEM).

Findings – Based on the data analysis an ideal-typical founding process with phase-specific barriers and needs was identified. Many constraints and associated needs occur in more than one phase, including the lack of knowledge, the demand for exchange formats, the lack of time and financial resources, institutionalized return options, the lack of human resources, and the lack of incentives.

Research limitations/implications – Given its exploratory approach, this study has limitations regarding its generalization; however, the presented findings may induce further research and in-depth analysis on this matter.

Practical implications – Several recommendations for action are provided for each phase of the founding process to strengthen the (entrepreneurial) transfer in research organizations. Generally, a pioneering indicator of excellence in the science system should be developed to promote transfer next to publications.

Originality/value – The study contributes to existing literature on determinants of academic entrepreneurship by indicating the phase-specific constraints and needs throughout the founding process and discussing those needs in the theoretical context of current societal and technological mega-trends.

Keywords: academic entrepreneurship, knowledge and technology transfer, academic spin-off, commercialization of science, founding process, organizational culture, entrepreneurial needs

Introduction

Globalization, digitalization and interconnectedness among other incisive trends result in pressure for companies to innovate (Rump and Eilers, 2017): potentially, anyone has the means to innovate anywhere at any time. Given the change in digital structures, requirements for innovation processes have become more complex (Rump and Eilers, 2017, p. 32). Decision makers from politics have identified the key role of knowledge and technology transfer (KTT) – and academic entrepreneurship in particular – in addressing this complexity and promoting and enhancing innovation capacity as well as economic growth of a national innovation system (European Commission, 2014, 2017).

Thus, it is politically expected that academia contributes new impulses for the development of technological and social innovation by transferring research to other stakeholders in the innovation system. For instance, KTT in the form of academic spin-offs allows academics to extend their economic and social impact beyond the research system (Fini *et al.*, 2018). Therefore, KTT and the commercialization of science have become essential for academic institutions in recent years and are increasingly valued by government, policy, and funding schemes (Acs *et al.*, 2017; Carayannis and Campbell, 2009; Grimaldi *et al.*, 2011; Wissenschaftsrat, 2016).

Academic spin-offs are highly relevant in KTT as they generate a variety of long-term benefits, for example by making scientific innovations accessible to the public, creating jobs, and promoting national competitiveness as well as economic growth (Egeln *et al.*, 2003; Vincett, 2010; Walter and Auer, 2009). Given their remarkable capacity for innovation, academic spin-offs are considered to have profound economic impact across markets (Dickel, 2009).

Despite the various benefits of KTT, emerging global trends as well as political and global pressure (European Commission, 2017), only 5% of newly founded companies in Germany are academic spin-offs (Bundesministerium für Bildung und Forschung (BMBF), 2017). Although efforts to strengthen transfer as a third mission alongside research and teaching are growing at national level at research organizations, universities and research funding, there remains a strong "recognition deficit" for transfer activities as an additional performance dimension in the science system. Especially in Germany, despite widely being regarded as a highly innovative and innovation-driven economic power, this situation is prevalent (Wissenschaftsrat, 2016). The reputation of scientific achievement and quality is, for instance, still primarily measured by scientific publications (Wissenschaftsrat, 2016). In addition to the lack of recognition of other transfer activities, the Council of Science and Humanities also attests research organizations and universities in Germany a "strategy deficit". This is due to the fact that many German research institutions do not see the transfer of research findings as a systematic performance dimension adding to the traditional dimensions of research and teaching (Wissenschaftsrat, 2016).

In times of global trends such as digital transformation and the increased pressure for innovation, attention to Germany‘s innovation capacity as well as its knowledge and innovation society is growing (Eichhorst and Buhlmann, 2015; Hirnschal, 2018; Rump and Eilers, 2017; Walter *et al.*, 2013). As a consequence of the factors mentioned above, innovation alliances and open innovation models (Rump and Eilers, 2017, p. 32) as well as research on successful knowledge transfer within the innovation system have become increasingly relevant (Etzkowitz and Leydesdorff, 2000; Bercovitz and Feldman, 2006; Carayannis and Campbell, 2009; Miller *et al.*, 2018).

In the case of academic entrepreneurship, research has shown that scientists face several constraints hindering their active engagement in KTT and entrepreneurial activities (Sinell *et al.*, 2018b). However, it is unexplored which factors influence scientists’ transfer engagement in each stage of the founding process. Similarly, scientists’ needs with regard to an environment supportive of entrepreneurial activity have not been the subject of research. Based on these observations, the following analysis seeks to explore (A) which challenges academic entrepreneurs face in different phases of the founding process and (B) what kind of support they need in each phase.

This study aims to derive implications for the infrastructure and framework of academic research in the German innovation system with the objective of fostering innovation capacity.

In the following, existing research on founding processes as well as positive and negative factors influencing entrepreneurial activities of scientists is reviewed. Findings on constraints and needs within the founding processes in STEM fields within the German academic sector are presented and discussed.

1. The Founding Process and Factors Impacting Academic Spin-off Formation

Academic entrepreneurship includes patenting and licensing, contract research, and spin-off formation (Wright *et al.*, 2008). In the following, academic spin-offs are understood as i) research-based companies with business models characterized by the transfer of knowledge (i.e. technology) from an academic institution to other sectors that is ii) launched by researchers of this academic institution while or after being a member of said research organization (Clarysse and Moray, 2004).

Typically, academic spin-offs are founded in research institutions, which are historically non-commercial. The translation process from a research finding into a marketable product presents a variety of challenges in this academic environment (Vohora *et al.*, 2004). The development of technologies that form the basis of spin-offs is often at an early stage, which makes their market potential difficult to assess (Jensen and Thursby, 2001). In this characteristic, they are distinct from corporate spin-offs, which commercialize technologies bearing a certain market proximity (Zahra *et al.*, 2007).

In entrepreneurship research, the formation and development of new companies are often described using phase models. These models are based on the assumption that companies' development processes span a varying number of predictable phases. However, in their analysis of phase models developed in management literature between 1962 and 2006, Levie and Lichtenstein (2010) find no consensus on the structure of the model or number of phases.

Looking at the development of academic spin-offs specifically, Vohora *et al.* (2004) propose a five-phase model of spin-off development. In particular, they focus on the transitions between development phases, which they refer to as "critical junctures." They argue that the transitions are characterized by inherent developmental conflicts, which need to be solved to attain the next phase. This transition affects the quality of spin-offs as they reach the next phase as resources, capabilities, and social capital have changed. However, their study examines a small sample of cases from the UK bearing distinct characteristics different from the sample used in this study. Specifically the particular spin-offs analyzed are backed by private equity such as angel investors and venture capital, resulting in obligations concerning their growth strategy. Their cases aim for a timely return of investment to their investors (Vohora *et al.*, 2004, p. 149), whereas the cases studied in this article where predominantly funded by public funding schemes with rather flexible milestones.

Rodeiro-Pazos *et al.* (2017) suggest further research to investigate the effective allocation of public funding and whether the university spin-offs (USOs) survive with their own resources or with the help of their parent universities. Their explanatory analysis of the survival of Spanish USOs reveals that there are no significant differences between surviving and failed USOs, however, surviving USOs are more likely to have venture capital investors, to take out patents, to export and to operate less often in sectors and regions with high competition. Generally, USOs fail more often than non-USOs, but at the same time the life-span of failed USOs is longer than of failed non-USOs. The authors trace this result back to the support programs of parent universities, which tend to provide USOs with physical infrastructure, such as incubators or science parks, and financial resources, such as grants, proof-of-concept funds, and university venture capital funds. The authors suggest a debate about supporting USOs with low survival or economic viability with public funding instead of promoting projects that really deserve to be targeted.

Apart from the varying characteristics of the spin-offs examined in other studies, investigations into the specific development of academic spin-offs in Germany have not been done yet. National and institutional-level influences affect spin-off development: National laws, regulations and administrative procedures define the context in which entrepreneurs operate.

When establishing a business operation, aspiring entrepreneurs need to familiarize themselves with the relevant laws, directives, and administrative procedures governing the innovation system in the prospective country of operation (Expertenkommission Forschung und Innovation, 2014). Consistent with this insight, Sinell *et al.* (2018b) found that in Germany, challenges at the meta-level relate to the nationwide transfer culture and to funding guidelines and structures. According to their analysis, the German national transfer culture is characterized by a lack of sensitization to and awareness of transfer opportunities and alternative

career paths. Publications remain the first transfer priority due to a lack of incentives, including prestige or career advantages, associated with patent applications or academic spin-offs.

Considering that scientists and those responsible for human resource describe the current working conditions in the German science system as unappealing (Schütz *et al.*, 2016), it is paradox that so few scientist regard academic entrepreneurship as a career alternative (Sinell *et al.*, 2015). Characterized above all by a lack of planning certainty due to fixed-term employment contracts and thus by the difficulty of career planning and the lack of transparency of perspectives (Eagly and Carli, 2007; Jaksztat *et al.*, 2010; Hüttges and Fay, 2013; Dörre and Neis, 2008; Schütz *et al.*, 2016), researchers are under enormous pressure due to high workload and the psychological strain caused by a lack of prospects, financial insecurity and possible unemployment (Schütz *et al.*, 2016). In addition, reconciling professional and private life is proving particularly difficult for female scientists (Schone *et al.*, 2012).

Nevertheless, many scientists seem to regard academic employment as "the safer option" and prefer to endure the challenges described above rather than exposing themselves to the risks of academic entrepreneurship (Sinell *et al.*, 2015). This finding is in line with the fact that academic spin-offs constitute only a small fraction of all start-ups in Germany (Braun-Thürmann *et al.*, 2010; BMBF, 2017).

In the event of failure of the venture, academic entrepreneurs often lack the option to return to their original academic position. Another factor keeping researchers from venturing out of academia are the requirements of most German public funding programs which are perceived as strict, unfair, and complicated: grant applications require substantial effort and time and the subsequent review processes are slow and bureaucratic (Sinell *et al.*, 2018b).

The promotion of an entrepreneurial culture in higher education institutions, including the recognition of entrepreneurship in the university, its integration into strategic plans and missions as well as the development of role models and incentive systems to reward those involved in entrepreneurial activities are much needed (Rubens *et al.*, 2017).

With respect to early spin-off development and the decision to found a spin-off, several factors impacting transfer engagement on a rather operative level have been identified: Leaders of the group or colleagues experienced in technology transfer increase the probability of other scientists feeling encouraged and willing to get involved in such activities (Bercovitz and Feldman, 2008). Mission statements emphasizing transfer guidelines positively influence spin-off-related activities of scientists and academics (Clarysse *et al.*, 2005; Rasmussen and Wright, 2015). Conversely, a lack of institutional commitment to and support for academic entrepreneurship at the management level or among colleagues stymie the entrepreneurial engagement of scientists and academics (Sinell *et al.*, 2018b). In order to increase science commercialization, many research institutions have established Technology Transfer Offices (TTO), an intermediary agency between academia and industry (e.g. investors, firms) (Guena and Muscio, 2009). While TTOs play a major role in initiating spin-offs (Huyghe *et al.*, 2014), it is unclear in which way TTOs continue to influence the success of the spin-off after its launch (Mosey and Wright, 2007).

Organizational strategies and practices, such as patent and license agreements, can negatively affect academic entrepreneurship if they are strict, non-transparent, and create excessive costs for the aspiring academic entrepreneur. Furthermore, the ambivalent dual role of public research organizations often has spin-off activities compete with tasks and resources of the institute thus constraining entrepreneurial activity (Sinell *et al.*, 2018b).

Examining job profiles of academic entrepreneurs working in UK biotech firms, Gurau *et al.* (2012) identified three different profiles: (1) manager entrepreneurs who are founder-manager of an entrepreneurial firm and are typically working part-time in the research organization and part-time for their spin-off, (2) project managers in existing firms who usually initiate and manage specific scientific projects, are responsible for technology transfer and networking with the scientific community, and (3) academic scientific advisors who are typically part of the scientific board of the company, contributing to the firm's reputation and responsible for giving scientific advice, identifying scientific opportunities and networking with the scientific community or with other companies. According to Gurau *et al.* (2012) the interviewed academic entrepreneurs report a lack of time and resources due to their dual function in two organizations, as well as lack of business/marketing knowledge and challenges in collaborating and communicating with business specialists. Further, particularlyacademic project managers and academic

scientific advisors complained about the hierarchical managers' short term business orientation focusing on quick profitability.

Similarly, Sinell *et al.* (2018b) found that promoting the launch of an academic spin-off in addition to an academic schedule and unrelated project work makes it challenging to acquire the necessary entrepreneurial knowledge and network, recruit team members, and balance responsibilities related to family life. In addition to time constraints, the lack of financial resources may prevent an academic spin-off from attracting the necessary talent and human capital. Academic spin-offs can seldom offer competitive jobs for high potentials with the necessary skills making recruiting and retaining a suitable team a major challenge (Sinell *et al.*, 2018b). A comprehensive list of challenges identified by the authors can be found in table 1, including gender prevalence.

[Insert Table 1 here.]

While there are studies on spin-off formation and development as well as analysis of supporting and challenging factors, the following analysis aims to integrate those questions into a comprehensive exploration of spin-off formation in the German academic system.

2. Method and Sample

40 qualitative semi-structured interviews conducted with academic entrepreneursprovide the data for the consecutive case study. The sample consisted of scientists in STEM fields employed by universities or public research organizations of applied science throughout Germany who either planned to launch an academic spin-off in the near future or had done so in the recent past. Through online research and outreach to the respective transfer offices, the interviewees were identified. Particular attention was paid toachieving gender balance (see Table 2 for the sample description). Interviews – lasting approximately 90 minutes – were conducted between October 2016 and January 2017 either by phone or in person.

To ensure consistency and comparability, interviews were guided by a semi-structured interview guideline. The interview guideline was developed based on a review of the relevant literature that goes beyond the one presented in this article as additional fields were tackled in the interviews. Interview guidelines encouraged interviewees to speak freely about personal traits, motivations for entrepreneurial involvement, conditions and barriers for KTT and entrepreneurial activities, the specificities of decision-making and business-launching processes, gender-related experiences, their employers' working conditions and culture as well as areas where support is needed. However, the following analysis focuses on findings related to the founding process, barriers to a successful launch and needs for support. The data collected was analyzed using Mayring's (2010) open-ended, qualitative method of content analysis. The research team formed categories based on relevant extracted information, which were revised and refined in an iterative process using an extended version of Gläser and Laudel's method (Gläser and Laudel, 2009). Based on the several individual founding processes of the academic spin-offs studied, a typology of an ideal-typical founding process was derived. The typology assembles varying attributes within a category. The analysis of empirical regularities within each phase allowed checking for internal homogeneity (Kluge, 2000). In addition to the main constraints to entrepreneurial activity that have already been published in Sinell *et al.* (2018b), support needs were analyzed and assigned to the different phases of the founding process. The following sections describe the findings in detail and include interviewee quotes to support arguments (Haas and Scheibelhofer, 1998). This article thus presents the findings of a broader study on knowledge and technology transfer regarding the phases of the founding process and the respective associated barriers to and needs regarding transfer and spin-off activities in Germany. Due to its exploratory character, generalization beyond the studied sample should be made cautiously. The results of the study serve as proposals for future research in the areas of framework conditions and the development of support offers in the academic research system.

[Insert Table 2 here.]

3. Findings: an ideal-typical Founding Process, Barriers and Needs

The data analysis shows that the process of spin-off formation is extremely individual. Therefore, general statements are only valid at a highly aggregated level. However, four ideal-typical phases of spin-off formation can be distinguished by the phases' milestones (MS). The phases span the process from the initial founding idea to the formal establishment of a company and beyond: (1) research phase (MS: founding decision), (2) orientation phase (MS: securing initial financing), (3) pre-founding phase (MS: formal-legal business formation), and (4) establishment phase. The length of each phase can vary and spin-offs do not necessarily progress through the phases consecutively.

Each phase of the spin-off process presents specific tasks and barriers. As previously published in Sinell *et al.* (2018b), the ten greatest challenges in launching academic spin-offs lie in (1) the development of the business idea and concept, (2) lack of support from managers and peers, (3 to 5) the lack of time, financial, and human resources, (6) inadequate license agreements, (7) the dual role of public research institutions, (8) strict requirements of funding guidelines and structures, (9) the lack of knowledge – particularly in the field of economics – as well as (10) the lack of early sensitization and awareness of transfer options and spin-offs as an alternative career pathway.

In the following, the different phases of an ideal-typical spin-off formation are described and barriers as well as needs as reported by interviewees are discussed (Figure 1).

3.1. Phase 1: Research

The research phase is the phase preceding the founding process in which scientists screen research results that have the potential to be commercialized. During the research phase, scientists are usually employed by a research organization and their research activities are influenced by organizational framework conditions. The research results which – if innovative – are commonly patented by research organizations, can form the basis for launching a company and developing a business model. These research results originate from varying research settings (i.e. governmental-funded research project or postgraduate qualification), some of which are more closely related to market applications than others.

The data analysis identified several triggers for the decision to set up a business to exploit findings from academic research: intrinsic motivation, extrinsic motivation, commitment to the idea or technology, as well as external triggers such as a technology transfer awareness measures, positive market response to one's idea, active encouragement by managers, and the immediate environment or the necessity to leave the research organization and pursue an alternative career.

Usually, a founding team exists by the time the decision to commercialize research results is made. The team often consists of people who were involved in the development of the technology. The MS marking the end of phase 1 is the decision to launch a company.

3.1.1 Challenges

In this phase, most constraints on the way toforming a business relate to external triggers. Poor early sensitization and awareness loom large in the research phase as publications are considered the most important transfer channel (Sinell *et al.*, 2018a). Interviewees perceive a conflict of interest between research commercialization in the form of academic spin-offs and ongoing research. This hampers scientists in pursuing entrepreneurial activities.

> "I believe that the pressure to publish, as an academic researcher, is certainly a very important aspect, because if you don't deliver your performance-oriented benchmarks every year, you simply have stress with your boss. But it shouldn't be the publication, rather the patent must be the focus." (University, Female Scientist)

In order to establish an organizational culture in which academic spin-offs are promoted and valued, the commitment at the management level to academic spin-offs and technology transfer plays a crucial role. However, many interviewees reported a lack of support from management, executives and peers regarding their start-up projects.

> "We were then, when we were founded, or probably still are now, always looked upon as the people who 'soiled our own nest' and were always seen as those who are now somehow capitalizing on science. We can already see that this is actually nonsense –you can earn money with the science you have made." (University, Female Scientist)

Additionally, most researchers do not have enough entrepreneurial knowledge at their disposal and no knowledge of industrial applications or the market potential of their research which does not only complicate the decision to found a company but also the first steps to initiate a spin-off.

3.1.2 Needs

To address those challenges, interviewees – independent of organization and gender – agree that additional incentives for spin-off activities must be created and that it would be helpful to raise awareness for the possibilities of KTT, particularly in the form of academic spin-offs. In principle, interviewees mention the importance of establishing an entrepreneurial culture in research organizations promoting commercialization of research at an early stage. Such an entrepreneurial culture would benefit research institutions and their training system. Through training and consulting programs linking business administration and STEM fields (mostly demanded from female interviewees) or through exchange formats with alumni, experienced founders, or other relevant stakeholders (mostly demanded from interviewees from non-university research organizations), an entrepreneurial culture could be established.

> "They have a series of [founding] seminars that they offer especially for students and workshops that build on one another. First of all, it's about if founding is down my alley, am I an entrepreneur, what does being an entrepreneur really mean? The next steps are then market exploration, business plan, financial plan, legal form" (University, Female Scientist).

> "If [research organization] has the desire to have more spin-offs, then you have to face reality and say: Yes, someone who has a fixed contract, how big is his or her motivation to found a company? Can't you make the decision a little easier?" (Research Organization, Male Scientist)

3.2. Phase 2: Orientation

After deciding to commercialize the research results by forming spin-offs, founders begin to gather information on options for funding, technology development and market entry. Activities in this phase may include (a) specifying the product and business model and conduct market analysis to assess the product's commercial potential, (b) contacting the respective institution's transfer office, (c) entering in a business plan contest or (d) making use of consulting offers to explore appropriate financing channels.

The task the founding team faces is to establish a setting enabling them to transform their research results into a marketable product. This requires financial resources and material (e.g. equipment), premises, and expertise. To this end, business experts may be recruited to the team if team members with this particular skill set are lacking. Specific for the German context, the funding scheme "EXIST" requires teams applying for funding to have a member with a business background among them. In this phase, the founders usually obtain an overview of the funding landscape for technology-based start-ups and apply for suitable grants. The successful acquisition of the initial funding marks the end of phase 2.

3.2.1 Challenges

Because one of the main tasks in the orientation phase is to establish the basic prerequisites for successfully commercializing research results, lack of entrepreneurial knowledge becomes a substantial challenge in this phase. Moreover, insufficient time, financial resources, and human capital continue to stymie the development process. Interviewees report that they receive poor support from the managerial team and colleagues during this phase. Another characteristic challenge in this phase is limited awareness of the numerous external funding opportunities. Furthermore, non-transparent and inadequate funding guidelines and structures are often associated with substantial effort necessary for successful application.

Such barriers to access funding are detrimental in this phase as securing the initial financing is necessary to enter the next phase in the commercialization process.

> "And, yes, a lot of people have a bit of a problem: How do I find someone who can help me in my business matters now?" (Research Organization, Female Scientist)

> "It is often the case that this process [of applying for funding programs] takes far too long in Germany. This is a process that is connected with 20- or 30page pamphlets that then are passed through expert mills for half a year. And the expert mills then pass it on to a different expert, who still has critical questions, about which the investment manager, who decides, has no idea. And then another answer is required for that." (Research Organization, Male Scientist)

3.2.2 Needs

As some academic founders have no access to business knowledge and support, there is a high demand for exchange formats in this phase. In general, but mentioned by male scientists from non-university research organizations in particular, there is a desire for more time and flexibility to develop and promote business ideas without financial risk. Flexible models comparable to the so-called "doctoral months" – a period of time during which researchers are allowed to work on their doctoral project only – during which start-up activities can be pursued, are a viable option. Some suggestions also refer to the "20-percent time" model developed by Google allowing employees to spend 20 percent of their working time on their own projects and interests.

> "That you might get a week or so once every six months to deal intensively with start-up ideas. Where you don't have the pressure, you do something that isn't directly paid for by the project, but is still good and beneficial." (Research Organization, Male Scientist)

> "At Google or [other companies] ... once a week they have a day off and can... it should serve the goal of the company, but they can develop what they want. Practically the leap of faith. Increase it. I think that would make sense. Everything costs money and nobody wants to pay. But that, I think, would create a stir, yes." (Research Organization, Male Scientist)

3.3. Phase 3: Pre-founding

In the pre-founding phase, scientists refine their product to attain market readiness (e.g. through the phases Proof of Concept, Proof of Principle) and begin to establish organizational structures of their spin-off. The minimum requirement for these activities is the availability of financial and material resources. However, spin-off projects that are less resource-intensive can sometimes make progress without external financial support and finance themselves through bootstrapping.

During the pre-founding phase, the founders pursue various tasks: they further develop their product, negotiate the use of patents with the research organizations that hold the patents, and establish a company, including its organizational structure (e.g. location, infrastructure). Furthermore, they need to distribute roles and tasks within the team or expand the team, manage the current and explore optional follow-up funding, prepare the formal registration of the business and build relationships with customers. It is possible to even generate first sales in this phase. The formal establishment of a company marks the end of the pre-establishment phase.

3.3.1 Challenges

To reach the milestone at the end of this phase, various challenges have had to be overcome, including the lack of financial resources, material, and time (e.g. because entrepreneurial activities are an additional

obligation alongside a full-time job), problems in the technology and business development (e.g. technology development being delayed because the proof of concept fails), as well as difficulties in meeting the expectations of start-up support programs (e.g. some programs allow a maximum of 3 team members, while others require a minimum of three team members).

> "The Proof of Principle was good, the Proof of Concept was difficult. And there was a very important stumbling block, which was justified in the material itself." (Research Organization, Male Scientist)

In this phase, negotiations for license agreements with the research organization pose a major challenge. Such agreements do not only potentially impede external funding but clarification of the legal aspects is also required for the formal foundation, which is the milestone at the end of the pre-founding phase.

> "This is also a problem for the [research organization]. Because the [research organization] has a specific model for patents. Patents are not normally given to the spin-off, but only licensed." (Research Organization, Male Scientist)

3.3.2 Needs

As shown before, scientists from non-university research organizations often have different needs than researchers from universities, particularly with regard to framework conditions. Especially male scientists from non-university research institutions demand options to return to academia and transitional models in the event that the launch fails. For instance, scientists propose part-time programs in which 50 percent of the time is dedicated to institutional priorities and 50 percent of the time is available for individual entrepreneurial activities, if necessary with an appropriate compensation scheme.

> "There has to be an incentive by minimizing the risk a little. For example by going back, so that you can try things and go back [to the institute] in case things go wrong." (Research Organization, Male scientist)

This is accompanied by a need for research and office facilities, machinery, and materials to test and refine innovative ideas without financial risk. Scientists from non-university research organizations also ask for more technical support from the institute, mentoring programs – preferably with role models from academic entrepreneurship –, and less bureaucracy in start-up activities.

> "I see there are so many labs [in the institute], they're barely used. Not used 24 hours a day. If you had the opportunity to use these laboratory capacities... that would be important." (Research Organization, Male Scientist).

While scientists from universities do not explicitly mention any of these wishes, they hope above all for improved and more transparent patenting processes.

3.4. Phase 4: Establishment

The establishment phase is characterized by the growing formalization of the spin-offs and a related change in their legal status due to the formal foundation. From now on, support from the parent organizations will only happen to a limited extent. However, academic spin-offs are often still linked to their parent organizations, at least through the license agreements. From this moment on, founders have to pay rent for the premises and equipment (or must purchase them) and spin-offs are starting their business activities. Depending on their capital requirements, founders can grow their company through current sales, equity capital, or involvement of external investors. The often required equity financing pose a considerable risk not all founders are ready to take. The spin-offs can also apply for state funding or business development programs due to their status as a corporation.

3.4.1 Challenges

Challenges related to the dual role of the institutes may still arise as spin-offs usually continue to be linked to their parent organizations, at least through license agreements (see phase 3). Additionally, a lack of follow-up financing as well as difficulties in finding affordable and suitable premises, acquiring costly equipment, and attracting and retaining employees are constraints specific to the period after the formal launch of the spin-off.

> "In this phase it's just extremely difficult to get good team members, because you can't offer anything. You can neither offer a job, nor can you offer any other security..." (University, Female Scientist)

According to some interviewees, they faced difficulties finding investors to ensure the follow-up funding, as those either expect private equity or were deterred by the fact that not the spin-off itself but the research institute owned the licenses or patents.

> "Institutes always try to keep the IP [intellectual property] in house and issue licenses. And that is counterproductive for spin-offs. No investor goes into a license history. An investor always wants to have the IP in the company. And then there are terribly protracted negotiations with the investors and also with the institutes that the IP is to enter the company and that then the license... there can still be agreed upon a license fee." (Research Organization, Male Scientist)

Moreover, spin-offs with a high degree of innovativeness struggled to overcome incredulity of the industry.

However, since individuals in the sample studied by Sinell *et al.* (2018b) and this analysis only include entrepreneurial scientists who are still in the process of founding, further barriers in this phase can only be hypothesized.

3.4.2 Needs

Similarly to the challenges, it can merely be speculated about the needs that arise in this phase. However, the presumption is obvious that not only in phase 1 but also in phase 4, incentives for the launch of spin-offs are hugely significant both for attracting human capital and as a motivation for the potentially risky step into self-employment.

> "...creating compensation. I think it can only be done through funding. That you can find a lever or a financing model." (Research Organization, Male Scientist)

However, according to the interviewees, it is also crucial to offer the institutes more incentives to promote spin-offs and to really let their own employees go.

> "...the incentive for the institutes to sell out their technology [is] actually low. Because especially when it's a promising technology, I'd rather pocket the money than say: 'Here you go, have fun with it.'" (Research Organization, Male Scientist)

[Insert Figure 1 here.]

4. Discussion

Many constraints identified by Sinell *et al.* (2018b) and associated needs occur in more than one phase, including the lack of knowledge, the demand for exchange formats, the insufficiency of time and financial as well as human resources, and the lack of time and flexibility to develop ideas, institutionalized return options, and incentives for launching a spin-off to begin with.

These findings are not surprising in the face of current societal developments, in particular the trend towards individualization and a shift in values regarding working and living environments (Rump and Eilers, 2017; Walter *et al.*, 2013). Individualization – mainly found in developed affluent societies – is promoted by digitalization, which allows for new levels of interconnectedness (Rump and Eilers, 2017). People face an increasing number of options in all areas of their lives (Gross, 1994). Consequently, a great diversity in career paths can be observed (Haaf and Bauer, 2012). This trend raises the importance of individual relative to traditional rules and norms which become less relevant (Walter *et al.*, 2013). Changes in expectations encountered in the working world are a consequence of that trend: self-realization, scope of action, a successful work-life balance, working hours, and workspaces that are aligned with individual life plans become a priority and increasingly replace traditional professional incentives such as status or income (Hay Group, 2011; Schuldt and Ehret, 2015). Iffländer *et al.* (2018) show that scientists are motivated – among other things – by their sense of purpose, self-fulfillment, or career aspirations, but also by the possibility to transfer research results to the public and expand their application and impact. Although founding is in line with the aspects discussed above and wedded to similar activities, overall conditions, and personalities of researchers, most postdoctoral students surveyed by Sinell *et al.* (2015) regard entrepreneurship as a risky and serious undertaking.

Individual actions change the values for individuals and society, which, however, differ between generations. The so-called Digital Natives destined to shape the world of work in the future strive for personal development, cooperative leadership, purpose, and fun but also display a particularly high need for safety (Walter et al. 2013). Moreover, freedom in the choice of workspace and working hours, facilitated by digitalization, is attractive for and expected by the younger generation (Schuldt and Ehret, 2015). A study of the Münchner Kreis (2013) reveals that knowledge and project workers in particular increasingly demand working relationships with a high degree of collaboration, characterized by permanently available access to personalized work equipment, as well as exchange of experience and networking. Specifically, the relevance of high-quality networking is emphasized as a crucial factor for professional and personal success, which aligns with interconnectedness as a megatrend for the future (Schuldt and Ehret, 2015). This finding seems particularly interesting, considering the research questions of this papers and study results which show that academic researchers often lack the necessary industry experience or market knowledge to set up a company on the basis of their research activities (Bercovitz and Feldman, 2008; Marion *et al;* Sinell *et al.*, 2015).

The above-mentioned trends and developments are part of the concept termed “new work” by Hackl *et al.* (2017), a movement that emerged from the work of the social philosopher Frithjof Bergmann and is a common synonym for the profound changes in the world of work and their consequences. However, it is not only an expression of and reaction to disruptive processes on the macro and meso level but also has direct effects at the micro level, i.e. on individual organizations. Bergmann developed an alternative model to wage labor in the economic system in which individuals spend one third of their time in classic employment, use one third of their time for work that they are individually interested in, whilst dedicating the remaining third of their time to operating their own high-tech production (Hackl *et al.*, 2017). Under this model, the relevance and chances to launch academic spin-offs may be expected to improve.

5. Conclusion and Practical Implications

The present study contributes to existing literature on determinants of academic entrepreneurship by indicating the phase-specific constraints and needs within the founding process and discussing the needs in the theoretical context of current mega-trends. This study also breaks down common gender stereotypes, by gender-specifically examining the needs expressed by scientists with spin-off experience. Accordingly, the needs of the male interviewees elucidate the importance of security during the start-up process and corresponding role models. They want a protected and financially low-risk environment in which they can develop, test and advance their ideas. This is an interesting finding, as scientists surveyed often assumed women to be more risk-averse than men and, as a result, less likely to found a company.

Taking into account this study’s and other current research’s results, recommendations for action for the design of organizational infrastructure and/or support offers for the respective phases in the spin-off process were derived (see Table 3).

To increase awareness of the variety of transfer channels in the first phase of the founding process, information material, calls for tenders, and selection procedures for funding programs should address the heterogeneity of spin-off motivations among the scientists (Iffländer *et al.*, 2018). Iffländer *et al.* (2018) reveal that women tend to move more often towards idealistic founding motives than their male colleagues. This heterogeneity of start-up motivations should be deliberately addressed in calls for tenders and selection procedures for funding programs in order to unlock unexploited spin-off potential. According to the authors, it is also important that for decision makers and decision-making bodies to have a balanced number of both women and men in order for them to recognize and exploit the potential of diversity.

Additionally, compulsory modules for basic knowledge of business operation and business administration should be part of each degree program to provide students as prospective scientists with the knowledge necessary for engaging in start-up activities. Integrating entrepreneurship education into the curricula of all degree programs could raise awareness for the importance of academic spin-offs as a transfer channel among students and provide them with knowledge central to the launch of academic spin-offs. In the first two phases of the founding process, awareness of exploitation options can be raised by establishing exchange formats with representatives from business, academic alumni and professionals from other sectors with founding experience, as well as scientists. In doing so, such programs could initiate a cultural change in the academic system.

To overcome the lack of time and financial resources in phase 2 and 3, special programs enhancing the compatibility of traditional academic and spin-off projects should be institutionalized to enable researchers to pursue their founding ideas alongside additional professional obligations. Possible formats could be internal cross-innovation days, part-time models or spin-off sabbaticals, as they help to reconcile parallel work in the research institution and the spin-off. Gurau *et al.* (2012) point out alternatives to founding academic spin-offs for scientists with an entrepreneurial mindset: for rather senior scientists, the job profile of an academic scientific advisor could be an attractive career opportunity as scientists in this position are only episodically involved in the activities of firms. For those academics who are not willing to found their own spin-off, the position of an academic project manager for initiating and managing scientific projects, technology transfer and networking in the scientific community, may be a suitable alternative to becoming an academic entrepreneur (Gurau *et al.* 2012).

In order to establish spin-offs as a career alternative at an early stage, personnel development and research exploitation should be considered together. It is necessary to create incentives for managers so that spin-off activities are not associated exclusively with the loss of resources for the research institute. Positive stimulus can be created, for example, through public appreciation for managers supporting founding activities or monetary incentives.

As this study's results show, the conditions under which spin-offs are set up play a major role for scientists. Therefore, incentives providing researchers with greater scope of action, for example with regard to licensing agreements and company shares should be created. Since licensing or academic spin-offs are not yet included in the measurement of scientific excellence, a pioneering indicator of excellence in the science system should be developed taking the requirements of the market and thus the social significance of transfer into account. This would promote transfer channels next to publications. Specifically, the development of new incentives for the holistic exploitation of scientific results is crucial for the successful implementation of an entrepreneurial culture. As a result, employer brand and innovation capacity can improve and thus support the future viability of the German science system.

[Insert Table 3 here.]

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Appendix

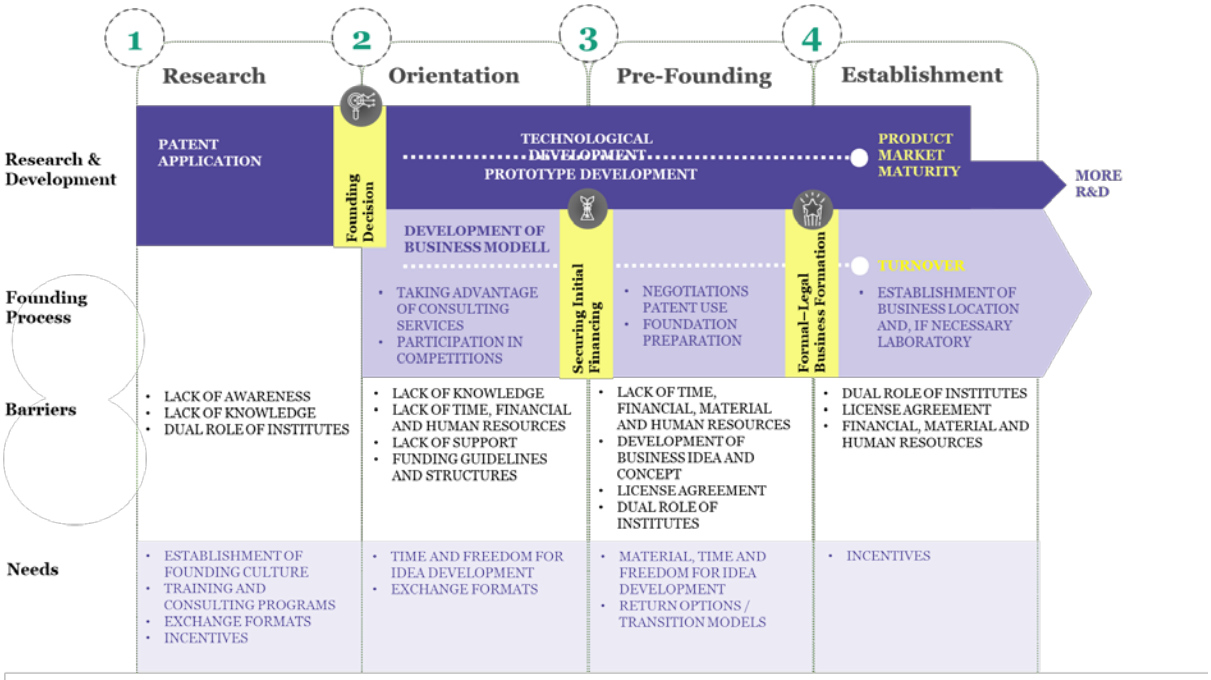

Figure 1. The 4 phases of an ideal-typical founding process with related barriers and needs. Yellow passages visualize the milestones at the end of each phase.

Table 1. Identified meta-level and operational constraints impacting entrepreneurial attitudes and transfer engagement. Prevalence indicates the frequency at which the constraint was mentioned by interviewees; gender difference indicates which gender experienced the specific constraint (Sinell *et al.*, 2018b, p. 20).

Level and Constraint	Prevalence	Gender Difference
META-LEVEL		
Nationwide transfer culture		
Early sensitization and awareness raising	20%	–
Offering alternative career pathways	17.5%	Male
Counterproductive transfer priorities	12.5%	Male
Incongruence of science and industry	10%	–
Lack of role models	5%	Male
Funding guidelines and structures		
Strict requirements	22.5%	Female
Insufficient financing	15%	–
Interaction with investors	12.5%	Male
Deficient process of programs	10%	Male
OPERATIONAL LEVEL		
Organizational strategies and practices		
License agreements	25%	Female
Dual role of institutes	22.5%	Male
Organizational culture		
Lack of support from managers and peers	45%	–
Non-transparency of processes and responsibilities	10%	Male
Individual attributes and attitudes		
Business idea and concept	50%	Male
Lack of time	40%	Female
Lack of financial resources	40%	Female
Lack of human resources	37.5%	Female
Lack of knowledge	20%	Female
Lack of exchange with peers	17.5%	Female
Mentality	17.5%	Male
Lack of networks	12.5%	Male
Interaction with externals	10%	Male
Compatibility of family and work	7.5%	Male

Table 2. Sample demographics

Item and Sample Size	Category	Female	Male	Total
		19	**21**	**40**
Age in years n=37	20–29	5	3	8
	30–39	8	13	21
	40–49	2	3	5
	50–59	2	1	3
Most recent employer n=40	University	10	2	12
	Research institute	8	17	25
	Business firm	1	2	3
Field of expertise n=36	Physics or Mathematics	3	2	5
	Chemistry, Biology, or Medicine	7	3	10
	Humanities	1	2	3
	Engineering	5	12	17
	Media Technology	1	0	1

Table 3. Recommendations for action to strengthen the (entrepreneurial) transfer in research organizations.

Phase		Goal	Recommendation
1.	Research	Increasing the awareness for (entrepreneurial) transfer channels	Consideration of heterogeneous motivations in calls for proposals and selection processes for funding programs
			Establishment of foundation as a career alternative through incentives
1.+2.	Research and Orientation	Providing necessary knowledge	Integration of Entrepreneurship Education into the curricula of all degree programs
			Offers of exchange formats between business, (founding affine) alumni and researchers
2.+3.	Orientation and pre-founding	Increasing the support and security	Provision of models for the compatibility of profession and spin-off projects
4.	Establishment	Fostering academic spin-off as career alternative	Establishment of foundation as a career alternative through incentives
			Development of a pioneering indicator of excellence in the science system