Exploring the role of entrepreneurial passion for facilitating university technology commercialization: Insights from battery research as an interdisciplinary field

Abstract: University-industry technology commercialization (UTC) from interdisciplinary environments is promising to contribute to solutions for major socio-economic challenges. However, UTC requires considerable coordination and mediation effort and thus intrinsic motivation from the involved researchers. Thus, the objective of the present study is to explore entrepreneurial passion as a means to facilitate researchers' intrinsic motivation for UTC activities. The interdisciplinary field of battery research is used as a representative environment for the expert interview study. Drawing on qualitative content analysis, a framework is developed, which links researchers' intrinsic motivation to respective UTC activities, resulting in three distinct UTC-promoting roles. Implications for policy makers seeking to promote UTC, for research managers responsible for the implementation of transfer projects as well as actors from industry who have an interest in collaborative R&D with public research institutions are provided.

Keywords: technology commercialization; entrepreneurial passion; scientific motivation; battery research; self-determination theory.

1 Introduction

In addition to the traditional university missions of teaching and research, the so-called "third mission" was introduced in the mid-1980s in the United States, Europe and Japan to promote public research's contribution to economic and social development (Etzkowitz, 2003; Mowery and Sampat, 2004; Rasmussen et al., 2006). Particularly important for fulfilling the third mission are commercialization activities of scientific knowledge, often focusing on technological inventions (Perkmann et al., 2013; Weckowska et al., 2018).

The term university-industry technology commercialization (UTC) generally includes activities capable of generating capital returns from technological knowledge (Perkmann et al., 2013). Specifically, this comprises activities such as collaborative and contract research, financing PhD projects, academic consultancy, trainings and workshops, sharing facilities, patents and licensing as well as entrepreneurial activities such as university spin-offs (Bekkers and Bodas Freitas, 2008). UTC is particularly challenging and important at the same time in an interdisciplinary environment (Bazan, 2019), since interdisciplinary research is most promising for contributing to solving today's major challenges such as tackling climate change (MacLeod, 2018).

Despite the increasing focus on commercialization, only every fifth UTC project succeeded in gaining market access (Taheri and van Geenhuizen, 2016). Previous research has identified a set of influence factors on UTC (Borge and Bröring, 2020): organizational and institutional factors (impact of policies, organization structures, types of processes and incentives)

(Berbegal-Mirabent, 2018), market factors (consumer acceptance, public perception of technology, market authorization) as well as individual factors (i.e. researchers' characteristics such as age, previous commercialization experience, reputation).

Since academic researchers usually act as initiators of UTC projects, individual factors play a crucial part for interdisciplinary UTC projects as there is a greater need for coordination and mediation (Kotha et al., 2013). Thus, academic researchers can contribute significantly to the success of interdisciplinary UTC projects by taking advantage of personal networks and expertise. The initiation of UTC, therefore, depends to a large degree on their motivation to engage in UTC (D'Este and Patel, 2007; Rizzo, 2015).

A considerable number of studies focuses on investigating external incentives such as personal and institutional income, reputation and improved accessibility to resources (Nilsson et al., 2010; D'Este and Perkmann, 2011; Franco and Haase, 2015; Hayter, 2015; Rizzo, 2015; Olaya Escobar et al., 2017). However, few studies shed light on academic researchers' inherent motivation for UTC activities (Lam, 2011; Olaya Escobar et al., 2017). Studies in this context aim to broaden the understanding of personal and environmental factors influencing the development of motivation for UTC on a conceptual basis. However, the individual UTC activities themselves as well as their integration into academics' professional life have hardly been analyzed in detail.

Academic researchers make their involvement in UTC dependent on activities that are congruent with their academic value orientation, ranging from "traditional" via "hybrid" to "entrepreneurial" (Lam, 2011). Academic value orientation is often related to the process of scientific knowledge production from basic to applied research and experimental development (Carayannis and Campbell, 2012). Self-determination theory (SDT) provides a useful framework to analyze motivation for UTC activities since it considers the complex nature of human motivation and its relationship with social values and norms (Lam, 2011). SDT distinguishes between non-self-determined and autonomous behavior, spanning the scale along the so-called self-determination continuum (SDC) from amotivation to extrinsic and intrinsic motivation (Ryan and Deci, 2002).

It is quite straightforward that intrinsic motivation is the ideal mindset for a researcher to be in when it comes to engagement in UTC activities. Hence, activities related to spin-offs are frequently emphasized in this context (Ramaciotti and Rizzo, 2015; Neves and Franco, 2018), which is why academics often see them as the main way to engage in UTC. However, a large number of alternative activities are available, that are in fact essential building blocks of successful UTC. The question remains though, how not only researchers with entrepreneurial

academic value orientation, but also researchers with traditional and hybrid academic value orientation can be intrinsically motivated for UTC.

A promising concept to facilitate intrinsic motivation in UTC activities is entrepreneurial passion (Huyghe et al., 2016) – *"a consciously accessible, intense positive feeling, which results from engagement in activities with identity meaning and salience to the entrepreneur"* (Cardon et al., 2009). Previous studies have shown that motivation is a crucial factor for explaining effective knowledge transfer (Rajaeian et al., 2018). Consequently, entrepreneurial passion-driven activities are expected to have a positive effect on academic researchers' engagement in UTC (Deci et al., 1994). Thus, the objective of the present study is to explore passion as a means to facilitate researchers' intrinsic motivation for UTC activities. More specifically, this work seeks to answer the following research questions:

1) How does entrepreneurial passion manifest in UTC activities?
2) How can UTC activities be aligned with academic value orientation to facilitate researchers' intrinsic motivation?

For this purpose, 30 semi-structured expert interviews are conducted and analyzed to obtain in-depth insights into UTC activities for the interdisciplinary field of German battery research. Since battery technologies are decisive to create innovations, e.g. for the field of electric mobility, there is an urgent need for R&D to be transferred into industrial application (Sick et al., 2017). By this, a general proximity to commercialization activities is inherent in battery research. Battery research also represents a multifaceted field involving experts from a variety of disciplines who combine their knowledge to extend the potential of energy storage technologies. Based on a qualitative content analysis, a framework is developed which links researchers' motivation for UTC with the respective UTC activities.

This work contributes to three streams of literature. First, research on scientific motivation (Lam, 2011) is advanced as, in addition to the internalization of entrepreneurial behavior, the degree to which UTC activities are compatible with academic values is seen as a key factor in differentiating researcher motivation for UTC activities. In this context, this study contributes to SDT by introducing opportunities for multiple pathways of internalization and presenting them as more likely to realistically reflect a process of motivation formation than a single localization along the SDC intended to cover the entire field of action. Second, academic entrepreneurship literature is extended by adding the perspective of passion as a motive for entrepreneurial intentions in academia (Huyghe et al., 2016). It is shown how activities for UTC, which are congruent with academic values, can be identified. Third, literature on informal and collaborative modes of university-industry technology commercialization (Link et al.,

2007) is strengthened by emphasizing valuable and relevant alternatives to spin-off activities, which have been investigated extensively (Wright et al., 2008).

The remaining article is structured as follows: section 2 introduces the theoretical framework by discussing concepts on motivation towards UTC activities and respective forms of passion in academia. Section 3 describes the process of data collection and evaluation, while results and discussion of the study are presented in section 4. Finally, section 5 highlights contributions and limitations as well as recommendations for future research.

2 Theoretical concept

2.1 A motivational framework for university technology commercialization

The term university technology commercialization typically refers to a subset of possible interaction channels between academia and industry (Perkmann et al., 2013). More specifically, this includes activities that potentially generate capital returns from technological knowledge. UTC activities are collaborative and contract research, financing PhD projects, academic consultancy, trainings and workshops, sharing facilities, patents and licensing as well as entrepreneurial activities such as academic incubators and university spin-offs (Bekkers and Bodas Freitas, 2008). Involvement in UTC activities is challenging for many researchers for a multitude of reasons such as time allocation (Libaers, 2012), lack of experience or conflicting objectives concerning their academic profession (Miller et al., 2018). However, researchers are expected to engage in UTC activities (Jain et al., 2009). In particular, the difficulties encountered by researchers in reconciling UTC activities with other tasks have a major impact on the final design and quality of involvement in UTC (Deci, 2014). Previous studies confirm that academic researchers' key motivation is to discover valuable knowledge, while aspects relating to commercialization activities are generally considered lower priority (Jain et al., 2009; Ryan, 2014). Consequently, academic researchers make their involvement in UTC dependent on activities that are congruent with their academic value orientation, ranging from "traditional" via "hybrid" to "entrepreneurial" (Lam, 2011). The academic value orientation is thus often related to the process of scientific knowledge production from basic to applied research and experimental development (Carayannis and Campbell, 2012).

The traditionalists believe in a clear separation between academia and industry and perceive UTC activities as contradictory to their academic values. This attitude is based on the notion of traditional scientific activity, according to the "Mertonian Norms" (Merton, 1957), which determine the generation and sharing of knowledge within the scientific community. Past studies have found a tendency for scientists engaged in basic research to be less inclined to

commercialize their research compared to those involved in applied research (Thursby and Thursby, 2002; Davis et al., 2011). Thus, basic researchers who often have a traditional academic value orientation either oppose institutional pressure on performing UTC activities or bow to this pressure in order to meet expectations as well as to achieve recognition and reputation gains.

The hybrids have an ambivalent attitude towards UTC activities due to their strong belief not only in traditional academic values but also in the importance of science to business collaboration for scientific progress. This group acknowledges the meaning of UTC-activities and balances them with other goals. As previous studies have shown, the relationship between basic research and commercial engagement is ambiguous and therefore not mutually exclusive (Lam, 2011). Thus, hybrids are more oriented towards applied research than traditionalists in that they are open to the possibilities and advantages of applying knowledge from research.

Entrepreneurial scientists, in contrast, perceive the interface between academia and industry as fluent and believe in the fundamental importance of science to business collaboration for performing commercial exploitation. In addition, they see the commercialization of knowledge as an essential part of their work and thus compatible with or even necessary for further academic tasks. According to the model of scientific knowledge production, the actions of this group of researchers can rather be assigned to applied research or even experimental development if these researchers are actively involved in entrepreneurial activities. Researchers from the engineering sciences are often mentioned as an exemplary group with entrepreneurial academic value orientation (D'Este and Patel, 2007).

It becomes apparent that motivation can be interpreted as a two-fold set of external regulations and human needs for autonomy and self-determination (Lam, 2011). A useful framework for the analysis of motivation in this ambivalent field of tension is self-determination theory (SDT). SDT is a macro theory of human motivation, which describes the motivation for a certain behavior as depending on the extent to which the three basic psychological needs for competence, social inclusion, and autonomy can be satisfied (Deci et al., 2017). Current research on SDT is conducted not only in applied psychology (Ryan and Deci, 2019), educational sciences (Ryan and Deci, 2020), and sports and health sciences (Gillison et al., 2019), but also in disciplines of business research such as organizational studies (Deci et al., 2017), marketing (Gilal et al., 2019), leadership (Kanat-Maymon et al., 2020), and human resource management (Rigby and Ryan, 2018).

SDT distinguishes between non-self-determined and autonomous behavior, spanning the scale along the so-called self-determination continuum (SDC) from amotivation to extrinsic

and intrinsic motivation (Ryan and Deci, 2002). Along with these three types of motivation, different regulatory styles refer to regulatory processes through which desired outcomes (i.e. performing UTC activities) are pursued (Deci and Ryan, 2000). Regulatory styles provide information about the necessary conditions that make a person engage in an activity. These can range from external, such as financial means and social pressure, to intrinsic such as self-fulfillment.

Combining academic value orientation with motivation and regulation along the SDC leads to the following framework of analysis for this study (see Figure 1). Researchers with a traditional academic value orientation can be amotivated or extrinsically motivated to engage in UTC activities. Amotivation means that researchers have no intention to act due to lack of interest or activity valuation. For extrinsic motivation, it is further distinguished between different regulatory styles which represent the individual's progress in transforming external regulation into inner identity (Deci and Ryan, 2000). Extrinsically motivated behavior in this case comprises the two more controlled forms of external and interjected regulation. External regulation is primarily determined by the obvious preservation of rewards or the averting of restrictions. Introjected regulation partially takes in particular regulation but regards it not as part of the integrated self and is primarily stimulated by avoiding feelings of guilt and promoting self-esteem. UTC activity takes place on this basis and with the aim of receiving further incentive-driven benefits such as additional financial resources or reputation gains.

Researchers with a hybrid academic value orientation are exclusively extrinsically motivated, more specifically relying on regulation through identification as a more autonomous form of extrinsic motivation (Ryan, 1995). Regulation through identification describes people recognizing and accepting the underlying importance of a behavior.

Researchers with entrepreneurial academic value orientation can be extrinsically and/or intrinsically motivated. Integrated regulation represents the most autonomous form of extrinsically motivated behavior where persons bring extrinsically motivated activity into harmony with personal goals (Ryan and Deci, 2002). Intrinsic motivation symbolizes that persons feel an inherent pleasure and satisfaction for performing a defined activity. It demonstrates the ideal case that, regardless of external circumstances, the possibility to engage in UTC activities is sufficient to convince actors to do so.

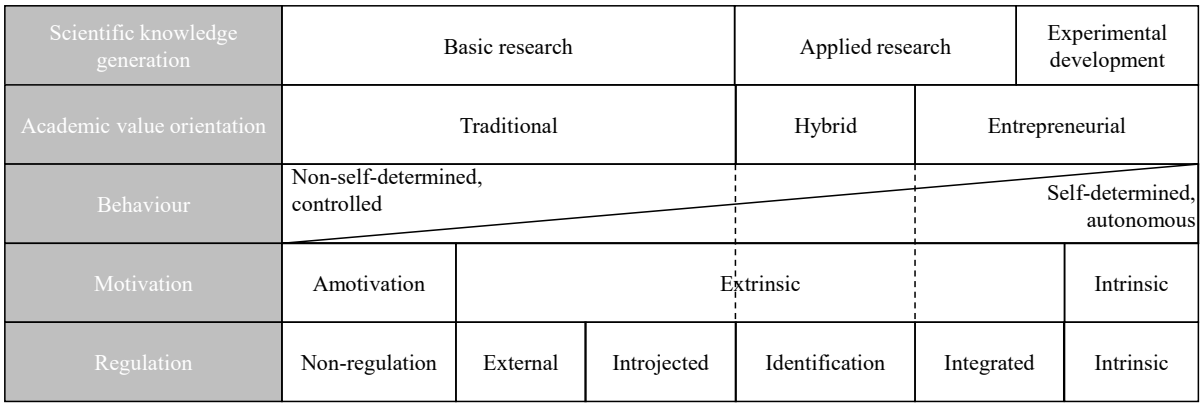

Figure 1. Framework for researchers' motivation for UTC activities combining academic value orientation with motivation and regulatory styles along the process of scientific knowledge production. Source: Based on (Ryan and Deci, 2002), (Lam, 2011) and (Carayannis and Campbell, 2012).

It is quite straightforward that intrinsic motivation and thus intrinsic regulation are the ideal mindset for a researcher to be in when it comes to engagement in UTC activities. This is in line with more recent research streams on SDT from the field of work organization, which aim to contribute not only to increased well-being of stakeholders but also to higher quality performance in general through their studies on the creation of policies, concepts and practices (Deci et al., 2017). The question remains though, how not only researchers with entrepreneurial academic value orientation, but also researchers with traditional and hybrid academic value orientation can be intrinsically motivated for UTC. While previous studies have made use of SDT for the subject of UTC, they tend to investigate the underlying reasons for the corresponding positioning along the SDC without much focus on UTC activities (Lam, 2011; Wen-ting and Xin-hui, 2013; Lam, 2015; Al-Jubari et al., 2019). Thus, there is a need for further research into how academic value orientation and the subsequent positioning of researchers along the SDC are connected to UTC activities.

2.2 Passion as explanatory concept for engagement in UTC activities

A concept that is well suited to address the question of how researchers with traditional and hybrid academic value orientation can be intrinsically motivated for UTC is passion (Boyatzis et al., 2002; Vallerand et al., 2003; Cardon, 2008; Cardon et al., 2009; Breugst et al., 2012). Passion is defined as a "strong inclination toward a self-defining activity that one likes, classifies as important and invests substantial amount of time and energy in" (Vallerand et al., 2003). Thus, passion relies on a strong intrinsic motivational basis – for a clearly defined activity which is related to work (Vallerand et al., 2010) or entrepreneurial engagement (Cardon et al., 2009). This explicit reference of passion to a certain activity allows the differentiation between the entire field of UTC and individual activities.

Particularly relevant in the context of UTC is the concept of the passion orchestra, focusing on the interaction of scientific and entrepreneurial passion within the context of research commercialization in academia (Huyghe et al., 2016). The passion orchestra emphasizes the interaction between passion for activities related to the traditional scientific profession (scientific passion), which can be interpreted as work passion for research and teaching (Forest et al., 2011). Passion for entrepreneurial activities (entrepreneurial passion), in contrast, describes intense positive feelings for entrepreneurial activities (Cardon et al., 2009). Entrepreneurial passion is particularly relevant within the context of research commercialization to understand researchers' motivation for UTC (Smilor, 1997). Researchers can have entrepreneurial passion for a variety of UTC-related activities along the entire scientific knowledge production process (Bekkers and Bodas Freitas, 2008). Some researchers might be more passionate about activities related to identifying, inventing, and exploring new opportunities. Others might be more enthusiastic about starting a business to commercialize and exploit opportunities, while yet others might be interested in maintaining, growing and expanding existing ventures.

An involvement of researchers in activities they are passionate about causes negligible or no contradiction to their academic value orientation, since passion manifests for enjoyable activities that are already internalized in their identity (Vallerand et al., 2003). In addition, initial activity in the field of UTC might reduce the aversion to the overall field. Entrepreneurial passion in combination with SDT takes into account the peculiarities of specific forms of UTC activities and provides a conceptual approach to facilitate intrinsic motivation for UTC. The focus is less on the general attitude of researchers towards UTC, but rather on the fit of the activity with their individual academic value orientation. Hence, academic researchers can have entrepreneurial passion and thus intrinsic motivation for certain UTC activities. However, they do not necessarily need to embrace or prioritize the entire concept of UTC as often suggested (Lam, 2011). Entrepreneurial passion can thus serve as a complementary research perspective to motivation scales to untangle researchers' engagement in UTC.

3 Methodology

3.1 Research design, data collection and preparation

For this purpose, qualitative data was collected through an expert interview study in the field of battery research in Germany. Qualitative expert studies are particularly suitable to access and understand academic researchers' motives, visions and boundary conditions relevant to UTC

(Hansen et al., 2009; Sabatier et al., 2012; Buonansegna et al., 2014). Battery research was chosen due to its interdisciplinary character (Golembiewski et al., 2015), involving experts from fields of basic scientific research such as physics and chemistry, as well as from fields of applied research such as materials science and various engineering disciplines (Krätzig and Sick, 2017). Furthermore, and despite its essential role for providing future energy storage solutions to advance electro mobility or the use of renewable energy, commercialization of academic research is still in the early stages (Sick et al., 2018).

For the acquisition of qualitative data, expert interviews were conducted with leading German battery researchers. Four selection criteria were applied to retrieve the final sample. Firstly, the focus was on one academic system, i.e. Germany, in order to exclude differences in motivation for UTC based on systems' particularities. Secondly, battery research was chosen as an interdisciplinary field of research. An initial approach for the identification of relevant institutions is a competence landscape of battery research from the German Ministry of Education and Research to coordinate their funding initiatives (see Figure A1 in Appendix). Thirdly, the sample was restricted to experts from the field of public research and development, as the scope of the study is on commercialization of technological knowledge originating from the academic sector. Fourthly, the level of hierarchy was restricted to persons with responsibility for commercialization decisions, i.e. professors and institute directors. Since technology commercialization activities are of high strategic importance for research institutions, especially because of their financial and reputational implications, those decisions are made at the highest hierarchical levels, i.e. by heads of university institutes or directors of research institutions, usually holding a professorship at a German university.

Based on the institutions identified via the competence landscape mentioned above, the respective actors at the director and professor level could be identified via the institutions' homepages and were collected in a longlist. This was supplemented with the participant lists of two renowned national conferences on battery research, i.e. “Batterieforum Deutschland” and “Advanced Battery Power”, for the purpose of timeliness and completeness. The sample comprised 42 leading German battery researchers, who were invited to take part in the interview study.

71% of the participants or 30 leading German battery researchers agreed to take part in an expert interview. 27 of the 30 interview partners held a professorship at a German university. The remaining three had a comparable position at a public research institution. Hence, the

interview data covers insights from the most relevant actors in German battery research and is therefore well suited to represent this interdisciplinary field of research.

The sample of 30 interviewees represents the field's diversity along two dimensions (Table 1). First, experts are affiliated to 20 different institutions from all over Germany. Diversity is represented by institutions' different academic approaches, whereby universities are more inclined towards basic research, while e.g. universities of applied sciences are closer to industry and more application-oriented. Second, researchers from various disciplinary fields, of different age, gender and career path are part of the sample (Table A.1). This is particularly relevant since disciplines often differ in the way they interact with industry partners and transfer technological knowledge (Bekkers and Bodas Freitas, 2008). Twelve interviewees have working experience in industry and four of them were already involved in business start-ups.

Table 1. Number of interview partners and their characteristics

Institution	*Disciplinary affiliation*						***Σ***
	Physics	Chemistry	Material Sciences	Process Engineering	Electrical / Energy Engineering	Manufacturing Engineering	
University	1	3		1	1		**6**
Technical University	3	3		3	2	2	**13**
University of Applied Sciences		3					**3**
Public research institute	2	4	2				**8**
Σ	**6**	**13**	**2**	**4**	**3**	**2**	**30**

The interviews were semi-structured using an interview guideline (Table A.2) based on a thorough literature review (Siegel et al., 2003). In order to validate the interview guideline, pre-test interviews were conducted with three researchers from a different interdisciplinary field. The 30 final interviews were conducted face-to-face, as well as via telephone and Skype and had an average duration of 46 minutes (Glaser and Strauss, 1980; Eisenhardt, 1989). The interviews followed an interactive refinement process improving external validity by presenting

UTC issues from earlier interviews to later interviewees (Lincoln and Guba, 2007; Bryman, 2016).

After recording the interviews, a transcription of the audio files to text files was carried out in order to ensure the reliability of the information (Bourgeois and Eisenhardt, 1988). To overcome general biases from interview data, a triangulation by gathering publicly available secondary data in the form of researchers' CVs and press articles was carried out (Jick, 1979). Since the interviewees are established researchers in leading positions, their respective CVs can generally be found on the corresponding homepages of their institutions. Besides, the activities of the interviewees are often featured in publications of various private and public news portals covering battery research (e.g. electrive.net, battery-news.de, handelsblatt.com, bmwi.de). Corresponding information about the disciplinary background, careers and activities of the interview partners was collected in a follow-up to the interviews in order to better place the interviews statements in the context of action and to eliminate any ambiguities during the coding process (see section 3.2). Important questions that could be addressed from additional information in the CVs and press articles and helped to facilitate the attribution of statements in the coding process were "how far did the interviewee move away from the core knowledge of his original disciplinary background when engaging in transfer activities?", "How proactive and effortful were they?" and "What is the resulting attitude toward UTC?" Efforts to reconcile information via triangulation are particularly relevant, since the disciplinary background as well as the institutional environment, especially former institutional experience with commercialization activities, can have an influence on the attitude towards UTC (D'Este and Patel, 2007; Bercovitz and Feldman, 2008).

3.2 Coding and data analysis

The subsequent evaluation is based on qualitative content analysis. Specifically, a procedural sequence called "structuring content analysis" was applied, which attempts to assess and make a cross-section out of qualitative material according to determined criteria (Mayring, 2014). These determined criteria are structured in accordance to relevant theory and subdivided into various categories aiming to lead to key examples which systematically represent characteristics of textual passages (Table 23).

Table 2. Scheme of theory-based criteria leading to the coding guide

Content Code	*Content*	*Literature Base*
Entrepreneurial Passion	Characteristic attributes of respective entrepreneurial role identities: Developer (market development, know-how transfer, resource support), Inventor (idea management, product development, opportunity recognition), Founder (network opportunities, funding strategies, resource management)	(Gartner et al., 1999; Cardon et al., 2009; Murnieks et al., 2014; Cardon et al., 2017)
Scientific Passion	Relatedness to traditional mertonian norms, Role of profession compared to other elements of life, Role of profession with regard to social impact	(Merton, 1957; Lam, 2011; Ryan, 2014; Huyghe et al., 2016)
Motivation towards UTC	Identification of important incentives to conduct UTC, Identification of motivational levels with regard to the SDC (amotivation, external / introjected / through identification / integrated regulation, intrinsic motivation)	(Ryan and Deci, 2002; D'Este and Perkmann, 2011; Lam, 2011)
UTC process	Inhibiting factors towards UTC and strategies to overcome (legal, financial, mental, operational), Usage of various means and criteria of decision making (joint research, patenting and licensing, contract research, consulting, venture creation)	(D'Este and Patel, 2007; Bruneel et al., 2010; Muscio and Vallanti, 2014; Drivas et al., 2016)
Success in UTC	Definition and assessment of success, environmental prerequisits for success in UTC, process improvements and suggestions for meeting unsatisfied needs	(Hayter, 2011; Sternberg, 2014; Hayter, 2015; Jung et al., 2015)

The initial coding guide is derived from these categories facilitating a precise structuring based on exact coding rules (Table A.3). The analytical procedure followed a sequential process from this point on (Figure 2).

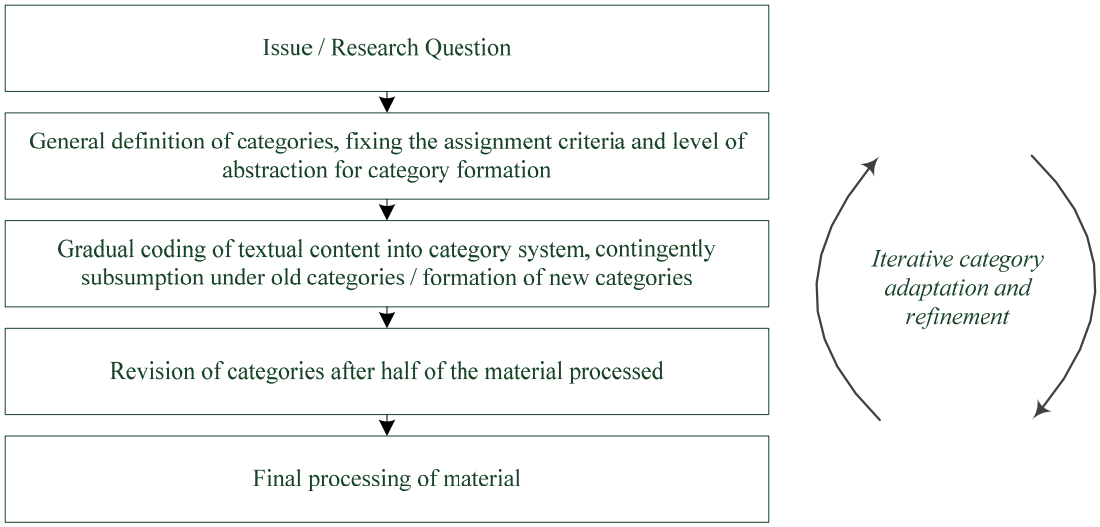

Figure 2. Flow-chart for qualitative content analysis. Source: Based on (Mayring, 2014).

The following coding step included an assignment of text passages to a respective category. The characteristic expressions of the corresponding categories were adapted and iteratively refined during the coding process. Throughout the coding process, the software "f4analyse" was used. In order to ensure inter-coder reliability and an objective analysis, the coding step was carried out independently by two researchers and critically discussed afterwards (Duriau et al., 2007). Finally, a data edit was carried out which set the focus on a summary of scattered information, as well as reduction of incorrect and redundant information. The subsequent analysis, based on coded text passages, follows a structured evaluation procedure according to Figure 3.

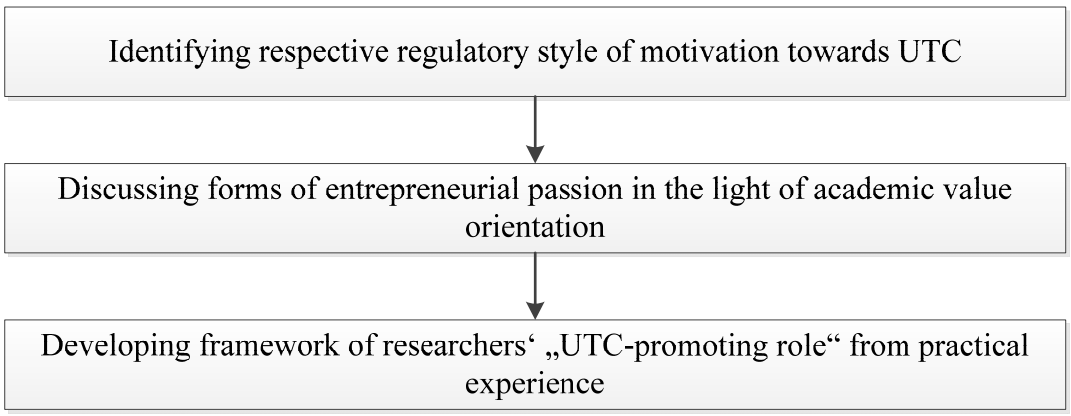

Figure 3. Sequential data evaluation approach.

First, in order to get an overview of academic researchers' attitude towards UTC activities, the prevailing levels of motivation and their distribution among battery researchers is identified. We implemented this by analyzing text sections of the code "Motivation towards UTC" (see also Table 2) from corresponding interviews. Statements of the interview partners were considered in their respective context and assigned to a motivation type or regulation according

to the Self-Determination Continuum (Deci and Ryan, 2000). Statements that we identified as characteristic enough to allow a clear assignment were subject to the logic presented in Table 4 below.

Table 3. Exemplary identifiers in interviewees' statements for attribution to motivational regulation for UTC

Regulation	*Identifiers in interviewees' statements*
Non-regulation	**Contradiction with own goals, attitudes, values.** "In this respect, it is perfectly legitimate to do something like this. For me personally, it is still very far away, because we are looking at a time horizon of 10-15 years and there is still a lot of basic research to be done before we can think about spin-offs or the like." "I think I've always ruled that out for myself so far because then I would know that I would have to change my job. I can't imagine doing that in combination." **Disinterest** "Purely due to my age, I am increasingly less interested if it is the 27th modification of the 25th material that has an improvement somewhere. It is then somehow always clear to me that this improvement has potentially massive effects and can potentially also save massive amounts of money, but I prefer to leave that to the youth. I don't have to deal with that anymore."
External	**Receiving Reward** "I would never have thought that I would slide into it. But well, of course that also depends on where the funding is at the moment." **Fulfillment of external expectation (social constraints)** "And that results, of course, to some extent from our institutional guidelines, since we usually have these development contracts for evolutionary developments and services."
Introjected	**Not part of the integrated self** "I considered doing that myself at one point. I also had one or two offers to do it. But I didn't do it each time because it was (or would have become) too one-sided for me afterwards. You have to be fully involved in it. And I love the versatility of my job." "Of course, my institution does care, because there is also technology transfer available, but that is not the primary task of a university." **Eradicating feelings of guilt** "It is a kind of commercialization of my own results and I actually think that I should do more of this." **Increasing of self-esteem** "Seeing a company that only exists because I was involved, or a product that I helped bring to market..."
Identification	**Conscious appreciation of the activity** "I was in a different mood a few years ago. I have a background in basic research and have always seen this as an essential, actually as the main focus for me. However, I see that the people who say they stay in basic research and don't go into transfer sometimes also close their minds to ... well, how can you put it? Actually, it would be good to subject one's own ideas and basic results to a reality check at the end." **Advantages for the researcher** "It is possible to get very different people who enjoy these ideas and this research to work together in the entire value chain. From this one can get a much better perspective on basic research, especially on its requirements and in this respect this also sharpens the view for important questions."
Integrated	**Importance identified and linkage with own goals, values, needs accomplished** "I think for me it is a very nice result and it is very satisfying in terms of work when you take what you have researched and apply it in the end. Maybe others see it differently. They are proud of their paper and then the next paper comes along. However, as an engineer, I tend to see things a bit differently. Actually, the best result for me is the one that is

	ultimately used in the application or becomes a great commercial success. So from that point of view, of course, it's a great thing." **Entrepreneurial know-how** "I have already founded myself." "I myself am the driving force behind a spin off."
Intrinsic	**Interest, satisfaction, pleasure in the activity per se** "…that innovation management is also a bit of a hobby for me." "This is not a can, but a must. I also like to do that."

After revealing the range of attitudes toward UTC in the first step of analysis, the second step involved a consideration of various forms of entrepreneurial passion as well as specific UTC activities in the light of academic value orientation. For this purpose, passages from each interview coded as "motivation through UTC" and "scientific passion" were matched with those coded as "entrepreneurial passion" and "success in UTC". The aim was to cross-reference researchers' position along the SDC with the background of their attitude and fields of activity (academic and entrepreneurial, related to their general profession), which they are passionate about (see also Table 2). Subsequently, the passages coded as "UTC process" from the interviews were related to the previously analyzed sets of content, identifying which UTC activities had already been undertaken in the past and under which conditions, based on each motivational setting. Third, and based on the insights of steps 1 and 2, a framework is developed that links researcher types and congruent UTC activities based on intrinsic motivation. Primarily, we used text passages coded with "UTC process" and "Success in UTC" for this step.

4 Findings and discussion

4.1 Motivation for UTC-activities in German battery research

An overview of the prevailing levels of motivation and their distribution among battery researchers is provided based on the framework developed in section 2 (Figure 4). Representative statements of the interviewees are used for this purpose, which in alignment with the description of regulatory styles according to (Ryan and Deci, 2002) give a clear indication for the classification of researchers along the SDC.

Scientific knowledge generation	Basic research			Applied research		Experimental development
Academic value orientation	Traditional			Hybrid	Entrepreneurial	
Behaviour	Non-self-determined, controlled					Self-determined, autonomous
Motivation	Amotivation	Extrinsic				Intrinsic
Regulation	Non-regulation	External	Introjected	Identification	Integrated	Intrinsic
German battery researchers	9%	9%	24%	18%	34%	6%
	42%			18%	40%	

Figure 4. Researchers' motivation for UTC activities in German battery research.

Traditional academic value orientation

According to their regulatory styles, 42% of the participants show a traditional academic value orientation. The following sections analyze the three different regulatory styles and motivations in detail.

Non-regulation: Several explanations for amotivation of battery researchers towards UTC activities are found. An obvious reason would be a lacking external constraint that encourages or enforces researchers to engage in commercialization activities. More researcher-related explanations for "non-regulation" are expressed by either UTC activities contradicting researchers' objectives related to their conventional academic duties or perceiving individual competencies as unsuitable.

> "I think I've always ruled that out for myself, because then I'd know that I'd have to change my job. I can't imagine doing this in combination."

Battery research comprises researchers with different degrees of proximity to industrial application. Researchers with little application proximity are often not sufficiently informed about the numerous possibilities to contribute to commercialization. Therefore, a research commercialization activity is often equated with a spin-off and categorically rejected.

> "For me personally it (UTC) is very far away, because we have a time horizon of 10-15 years ahead of us and a lot of basic research still needs to be done before we can think of spin-offs or the like."

These findings show that there are still academics who do not yet have a connection to UTC activities. Nevertheless, the small number of 9% indicates that UTC activities are widely disseminated among German battery researchers.

External regulation: External regulation towards UTC activities can be attributed to researchers complying with institutional guidelines as well as focusing on receiving research funding. With regard to battery research, large sums of public funding have been made available over the past decade. In that respect, one of the financially most significant funding programs for research on energy storage technologies and a variety of other topics is offered by the European Union under the name Horizon2020 (European Commission, 2017). Although there is a large amount of funding available for battery research, many institutions are nevertheless under pressure to perform UTC activities. From the statements of 9% of the interview partners, it can be concluded that they perform UTC activities either to ensure future access to resources for their own organization or to meet their own institutional or project-specific requirements.

> "And that results to a certain degree out of our organizational structure, because, as a rule, we rather have these evolutionary developments and services as research contracts."

It becomes clear that external coercion can induce researchers' engagement in UTC. However, this does not originate in an intrinsic motivational basis, but rather in a controlled, stimulus-driven form. Motives of researchers with external regulation towards UTC are therefore very similar to those of amotivated researchers.

Introjected regulation: The second largest group with 24% can be assigned to introjected regulation. First, due to the versatility of battery research, there is a differentiated view on UTC activities. Researchers with a more traditional academic value orientation usually do not integrate these activities into the scope of research institutions.

> "The university does care about this, of course, since there is also a department concerned with technology transfer, but this is generally not the primary task of a university."

Second, the intention of gaining academic and industrial reputation is another strong driver, representing a form of incentive-driven benefit, alternative to financial means.

> "I have been asked what I imagine and what is important to me, then I always said that seeing a company that only exists because I was involved, or a product that I helped bring to market."

Third, social pressure can also drive researchers' UTC activity. Social pressure may arise when other actors within the same scientific community appear to be performing UTC activities more frequently and more successfully. Pressure arises when researchers are expected to perform UTC activities in order to assure their ongoing relevance in the scientific community.

Social pressure in that respect paves the way for "regulation through identification", since the general importance of UTC is recognized – though not as personally important.

> "It is a kind of commercialization of my own results but I actually think that I should do more of this."

At this point, information from researchers' CVs also assists in differentiating whether UTC activities are classified as personally relevant or, as in the case described here, merely as a means of securing their position in the scientific community.

Hybrid academic value orientation

Based on their regulatory style, 18% of battery researchers show a hybrid academic value orientation.

Regulation through identification: As opposed to the previously discussed researchers with traditional academic value orientation, the decision to participate in UTC activities for researchers with hybrid academic value orientation no longer depends solely on personal consequences such as achieving benefits or avoiding threats. Rather, the task of further developing an entire scientific field, such as battery research, is perceived as important.

> "I come from basic research[1] and have always considered it to be an essential part of my work, actually the main focus. However, I can see now that people who say that they stay in basic research and don't even consider to go into transfer, sometimes close their minds. … I'm not interested in commercialization. It's about the way into the application."

UTC activities are perceived as a tool for achieving application and evaluated according to their contribution to this. Research on battery technologies is currently receiving strong social and political support aiming at applying latest insights to electric vehicles and to integrate renewable energies into current energy infrastructure. This supportive environment plays a major role in sharpening the profile for regulation through identification.

> "I think the special thing about battery research or storage research - and you can also include hydrogen-based storage systems in a broader sense - is that there is a tremendous market pull or a societal pull, as you might say. It can be felt

[1] A corresponding alignment for data triangulation purposes provides in this case the information that the interviewee is of disciplinary origin from the field of chemistry.

> that research is needed in the field, and not least exactly this is stimulating research."

Entrepreneurial academic value orientation

According to their regulatory styles, 40% of the participants show an entrepreneurial academic value orientation. The following sections analyze their different regulatory styles and motivations in detail.

Integrated regulation: The largest group of battery researchers (34%) shows a general compatibility of academic objectives with their engagement in UTC-activities. A particular feature of researchers with integrated regulation towards UTC is the adaptation of a product-oriented application idea to their identity as an obligatory goal.

> "Actually, the best result for me is the one that will make its way to application or that will be a big commercial success."

Further features are close proximity to industry, the frequently mentioned "engineer identity" with the transfer of research into application as a primary objective, as well as being results-oriented and thinking on a large scale.

> "From my point of view as an engineer, it must always be possible - and perhaps necessary - to provide a benefit in the end. However, this is nearly always the case referring to the close connection with the industry. This may not be so pronounced in basic research projects, but in my opinion research must not be an end in itself."

Battery research comprises a considerable number of researchers from engineering and other applied research fields. From the interviews with these researchers it turned out that UTC-related tasks are generally well integrated into their scientific everyday life. Thus, limited motivation for researchers with integrated regulation do not result from general rejection, but rather from limited available resources such as time, monetary resources or a limited network.

> "I would definitely be involved in more spin-offs in the future. I would actually like to do more and I also have further ideas. It's only because of employees who don't have the necessary skills to be self-employed and take the risk."

> "The primary focus is money and where the customers are. And where the customers are, that's where they (large corporations) settle. And since we don't

> yet have any large cell manufacturers here locally (Germany), we are having a hard time. Exactly, that is the number one issue."

Intrinsic regulation: The smallest group among battery researchers (6%) demonstrated intrinsic regulation towards UTC activities. This low percentage is somewhat surprising given the close intertwining of R&D and industrial application, as batteries have to be custom-tailored to the respective usage (Sick et al., 2018). On the other hand, for the vast majority of researchers the generation of valuable knowledge as the central driver for their actions and intrinsic motivation rarely develops for an entire field of activity. Nevertheless, researchers in this group have fully integrated UTC activities into their role identity and enjoy performing them.

> "It may also be difficult and that's why I wanted to make it clear that I was very, very much in industry and the whole environment and that innovation management is also a bit of my hobby"

Battery researchers who have developed an intrinsic motivation for UTC activities were, with regard to their CVs and other published experiences, all working in industry before (re-) entering academia. It seems that they had a passion for technology commercialization and have "imported" it into the academic environment. This finding is in accordance with (Marion et al., 2012) demonstrating a higher number of researchers with an intrinsic motivation towards UTC activities for those with industrial working experience.

In summary, we see a distribution across battery researchers' academic value orientations (from traditional to entrepreneurial) of approximately 40, 20 and 40%. The first 40% of the interviewed battery researchers could be assigned to externally controlled forms of motivation for UTC. This goes hand in hand with a close connection to a traditional academic role identity. This often contradicts a broad engagement in UTC activities and thus explains limited motivation. 20% of battery researchers find themselves in the hybrid in-between stage. In this stage, the relevance of UTC activities for the progress of one's own research field is recognized and thus a motivational basis is created. However, UTC activities are not yet considered as equal to traditional research and teaching activities in the researchers' day-to-day work. The remaining 40% of battery researchers show an entrepreneurial value orientation, according to which UTC activities can be easily integrated into daily routines. Low performance cannot be attributed to motivational problems, but to the lack of time, financial or human resources.

4.2 Researchers' UTC promoting roles facilitated by entrepreneurial passion

Based on these insights, entrepreneurial passion was identified from the interviews for researchers with traditional, hybrid and entrepreneurial academic value orientation. This was mapped to UTC activities so that researchers can be empowered to engage in UTC activities based on intrinsic motivation. Based on this, three archetypical UTC-promoting roles were developed: Mediating commercializers showing traditional academic value orientation, progress-oriented pioneers for hybrid academic value orientation and application-oriented commercializers unveiling entrepreneurial academic value orientation (see Figure **5**).

4.2.1 Traditional academic value orientation

For battery researchers with traditional academic value orientation, scientific publications and lectures play a key role:

> "When commercialization is done, it is great to have achieved a nice result. But ultimately it is more important that we have successful graduations, that we publish them in an exciting manner and have adequate conference contributions. This is actually the important and exciting main theme."

It becomes clear that the use of classic knowledge transfer activities is prioritized and that there is an essential need to feel connected to the academic environment (Lam, 2011). As possibilities to conduct UTC-activities fitting to traditional academic value orientation, instruments of knowledge transfer, e.g. consulting assignments (Perkmann and Walsh, 2008) or industrial trainings (Mowery and Sampat, 2004) offer promising possibilities for UTC. Not only do these instruments offer transferring tacit knowledge, they also align well with traditional teaching activities. Moreover, the provision of resources (e.g. office/laboratory space, technological infrastructure and know-how) to graduates, which are interested in start-up activities offer a way of generating and sharing knowledge (McAdam and McAdam, 2006; Fuzi, 2015). Researchers can act as supporters, mentors, advisors and co-founders, which is more related to traditional scientific activities.

> "It was necessary for us to host this emerging company as an institute, which means that we provide office and laboratory space. We support it by the resources available to us at the institute."

The constant presence of a relation to personal research work is identified as particularly important for this group. Thus, researchers are often willing to engage in UTC activities when following the transformation of their research projects into application. This approach is

generally reinforced by the incentive of creating a certain industrial reputation. Advantages for research institutes include access to industrial resources. The short-term nature of such commercialization instruments (Arza, 2010) also allows rapid implementation as well as largely standardized operations. Researchers thus take the role of mediating valuable knowledge for UTC purposes. Furthermore, these supporting activities can be used to solve specific problems in industry (Mansfield and Lee, 1996), e.g. via the contribution of academic researchers to idea generation in the front-end of innovation via crowdsourcing (Zhu et al., 2014).

In summary, the "mediating commercializer" focuses on the handling of knowledge, preferably resulting from their own research activities, as well as corresponding resources. They are a typical knowledge intermediary and pursue UTC activities that are closely related to traditional teaching and publication activities.

4.2.2 Hybrid academic value orientation

For researchers with hybrid academic value orientation, the goal of contributing to the overall progress of a field of research is another central motivation beyond the traditional notion of creating and disseminating knowledge. UTC is used as a tool to realize research ideas on a larger scale and to transfer basic knowledge into application. This is in line with findings by Iorio et al. (2017), highlighting that researchers' motivation can also be based on current social and societal issues. This motivational driver is most relevant for the field of battery research since the contribution to environmental-friendly technologies is a socially desired outcome. In this context, a shift in UTC-promoting activities from more teaching-related activities to research-related activities can be observed, resulting from a changed perception of UTC activities. These are interpreted by this group of researchers as suitable means to contribute to the progress of entire fields of research. This provides a suitable starting point for analyzing UTC activities congruent to conventional university activities.

> "In principle, I do not see this as separated topics – I would like to link this very explicitly."

A strong process-orientation for researchers with hybrid academic value orientation is observed, which is demonstrated by the early planning of activities that allow for commercialization. Accordingly, active product solutions and exploitation possibilities are already being promoted in the project planning phase.

> "In this respect, we are also thinking about potential strategic products from the results of our research or in which direction we could route our development so

> that certain usable products can emerge, which we can then commercialize accordingly."

Despite known difficulties, UTC activities related to interaction with industry are particularly promising since these activities facilitate the implementation of larger projects via sharing resources (Bruneel et al., 2010). Exemplary UTC activities are joint research projects or financing PhD projects with industry support.

> "This is best done with long-term collaboration. Whether these are university collaborations or whether these are industrial collaborations; the goal should always be scientific advantage."

Joint research involving academia and industry offers the advantage of a mutual knowledge flow, which results in mutual learning curves for both partners (Arza, 2010). In summary, the "progress-oriented pioneer" transcends the boundaries they are familiar with from the traditional academic environment with the goal of advancing their field of knowledge. They recognize the value of UTC activities for achieving their goal and often choose the path of collaborative forms of UTC activities to beneficially combine previously separated fields of knowledge.

4.2.3 Researchers as application-oriented commercializers

As expected, a multitude of possibilities for entrepreneurial passion reveals itself to researchers with entrepreneurial academic value orientation. The motivational basis for academic activities lies in a clearly stated application orientation. In that respect, exploitation of inventions from academic work is already seen as an integral part of the research process itself:

> "From my point of view as an engineer, there should always be a benefit on the horizon - and maybe also has to. In 90 percent of the cases this is actually given by the close connection with industry anyway. This may not be so pronounced in the basic research projects, but research must ultimately not be an end in itself."

Furthermore, the primary motivation to commercialize is not financial benefit, but is rather characterized by a process-oriented, and in particular autonomous, will of exploitation (Lam, 2011). Thus, the motivation of receiving financial resources is often of subordinate nature. Similar to hybrid academic value orientation, the aim of promoting superior research ideas is the center of interest, though with a clear identification of entrepreneurship as most suitable instrument. Considering the clear application focus of researchers with entrepreneurial

academic value orientation, UTC activities that offer the independent exploitation of research results and e.g. venture creation are congruent activities. Also, UTC activities where industrial companies play a leading role would not contradict the idea of application, so that for example licensing activities could also be considered as congruent activities.

Hence, there is no greater satisfaction for the "application-oriented commercializer" than to see the knowledge they have created successfully applied in practice. In doing so, they unerringly resort to UTC activities that enable them to achieve this goal individually. Figure 5 provides an overview of the archetypal UTC-promoting roles that match UTC activities and academic value orientations.

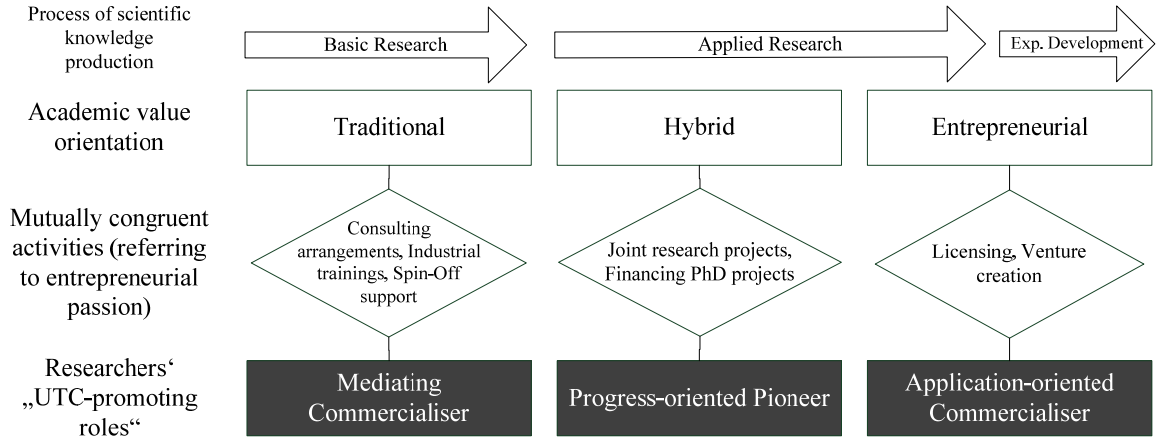

Figure 5. Researchers' UTC-promoting roles and activities related to academic value orientation.

5 Conclusion and implications

This study set out to explore how entrepreneurial passion can be used to increase researchers' intrinsic motivation for UTC. The findings suggest that entrepreneurial passion facilitates an individual approach to UTC by identifying UTC activities, which align with researchers' academic value orientation. The role of passion for facilitating UTC is twofold. First, passion plays an explanatory role as it shifts the focus towards UTC activities and emphasizes the need for alignment with academic value orientation. Second, passion plays a promoting role by reducing aversion to UTC and encouraging researchers' regular involvement in UTC.

Based on these insights, a framework was developed that links academic value orientation and UTC activities, identifying three UTC-promoting roles. Researchers with primarily traditional academic value orientation are prone to consulting and supportive UTC activities, e.g. trainings, spin-off support and consulting arrangements. Their role in the UTC process can be seen as *mediating commercializer*. Researchers with hybrid academic value orientation favor interactive, collaboration-intensive UTC activities such as joint R&D and financing PhD

projects, which makes them *progress-oriented pioneers.* Researchers with entrepreneurial value orientation prefer activities that are directly attributable to commercialization such as licensing and venture creation, thus being *application-oriented commercializers.*

This work contributes to self-determination theory by adding the explanatory value of entrepreneurial passion. The findings of this study point to the need for a more differentiated understanding of the range of activities to be attributed to a field of application before investigating motivation. In this context, entrepreneurial passion provides a conceptual basis for the development of a practical instrument to promote UTC by revealing a kaleidoscope of possible alternative pathways for UTC. It also contributes directly to alternative concepts in other fields of knowledge to the extension of SDT, in that multiple pathways of the internalization mechanism could be more likely to explain motivation than a single positioning along the SDC.

Furthermore, this work contributes to a number of streams in technology transfer literature. It advances research on scientific motivation and academic entrepreneurship by highlighting the compatibility of UTC activities with academic values as a critical factor for explaining researcher motivation. Furthermore, the study contributes to technology commercialization literature by emphasizing informal and collaborative UTC activities as equally valuable and relevant options for engagement, alternative to more well-known UTC activities such as spin-offs and licensing. In particular, opportunities for involvement in UTC provided through the use of informal and collaborative activities can make a significant contribution to boost intrinsic motivation for UTC activities. This is particularly relevant in basic research, as these activities have a bigger overlap with researchers' usual professional activities.

This study provides practical implications for policy makers seeking to promote UTC, for research managers who are responsible for the operational implementation of transfer projects as well as actors from industry who have an interest in collaborative R&D with public research institutions. Policy measures should initially focus on providing information and support for developing a tailored integration concept, e.g. through expert workshops and individual support. This offers more sustainable support than conventional programs primarily focusing on financial support. Thus, the framework provides an orientation for policy makers which transfer activities are best suited to which type of researcher when developing an integration concept. Further considerations are that initial UTC activities can lead to an intensified exchange with responsible persons of public and research policy and thus, for example, contribute to a more purposeful allocation of venture capital for higher-risk development

projects. The development of business model innovations at R&D institutions could also be spurred by continuous experiences in UTC. Drawing on the deeper understanding of how researcher motivation for UTC is related to individual activities, research managers can make more efficient decisions regarding the allocation of tasks and responsibilities in interdisciplinary research projects. One way to encourage this would be to have a technology transfer office as a mediator, either within the institute or centrally controlled, in which training courses for faculty transfer officers can be coordinated by transfer experts. For actors from industrial research, the further disclosure of researcher intentions to UTC can lead to a facilitation of cooperation projects with public research institutions and ease the way towards open innovation projects.

The main limitation of this study is rooted in its qualitative nature and the nationally limited database covering one interdisciplinary field. Further qualitative studies from alternative interdisciplinary research fields could successively present a comprehensive current state of motivation for UTC. Cross-national studies, in contrast, could make an important contribution by providing information on how the influence of different disciplines on the motivation for UTC is to be assessed considering environmental conditions like culture-dependent perceptions of UTC, regulations, and innovation systems. Quantitative studies can moreover be a promising next step to provide a solid foundation for the introduced framework within the scope of large-scale studies.

Appendix

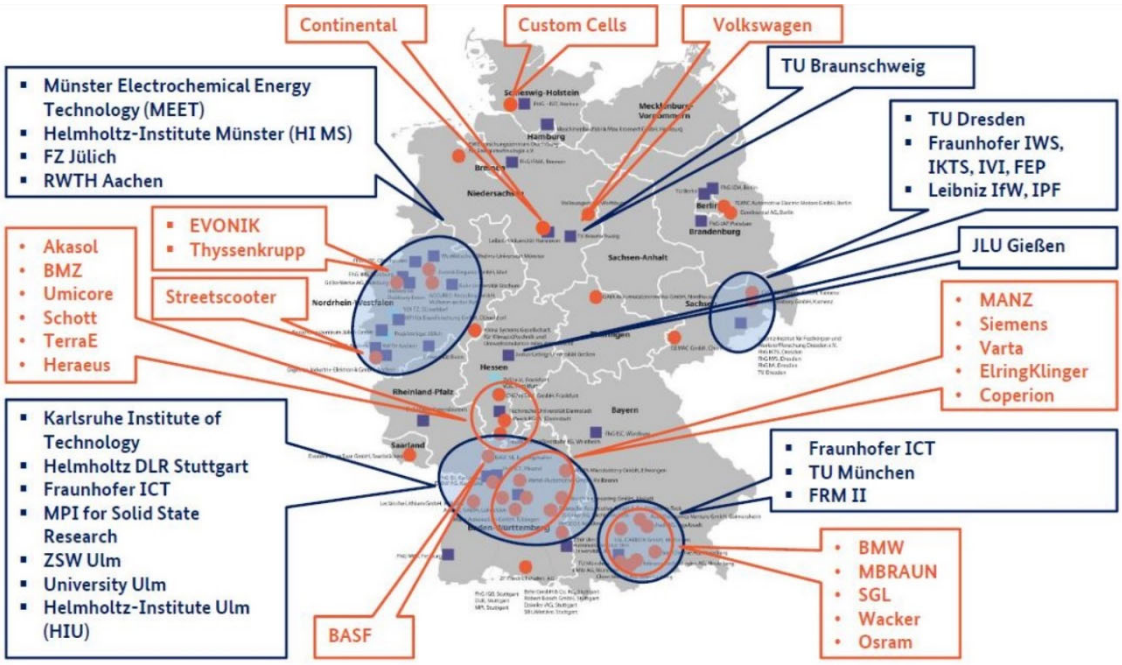

Figure A.1. Schematic representation of the "hot spots" of battery research in Germany. The blue squares illustrate actors from the public research and development sector, the orange circles illustrate industry actors, and the light blue circles represent other actors. Source: Based on (Federal Ministry of Education and Research, 2019).

Table A.1. Interviewees' socio-demographic characteristics

Characteristics	*Specifications*	*Quantity*
Gender	Male	28
	Female	2
Year of birth	1941-1950	2
	1951-1960	5
	1961-1970	12
	1971-1980	8
	1981-1990	3
Disciplinary background	Physics	6
	Chemistry	13
	Material Sciences	2
	Chemical Engineering	2
	Electrical Engineering	2
	Energy Engineering	1
	Process Engineering	1
	Mechanical Engineering	3
Educational level	Professorship	27
	PhD	3

Industry experience	Yes	12
	No	18
Entrepreneurial experience	Yes	4
	No	26

Table A.2. Interview questions in sequential order

Interview section	Question
Welcome	• How long have you been interested in research in the field of battery technology? • What are the characteristics of battery technology research?
Early detection of successful technology commercialization	• What distinguishes technology commercialization's success stories from failed examples according to your experience? • An example: If you compare all successfully commercialised technology projects you know about – Are there certain characteristics of success before a financial success can be observed?
Commercialization of research output	• What kind of technology transfer (Spin-Offs, Consulting requests, Trainings, Contract research, Joint Research, Patent licensing…) is involved in the commercialization of research findings at your institution? And how frequently are they used?
Identification of primary inhibitors and success factors for technology commercialisation	• What are the main obstacles (contacts & communication, financial support, cultural differences with regard to field of employment,…) to the commercialization of technological inventions?
Proposals for solutions and action approaches	• How do you specifically deal with these problems? • How can these issues be solved elsewhere (administrative / institutional approach)?
Licensing of patents	• What is the role of patents and their licensing activities in battery research? • Does a market or adequate know-how of potential technology users exist to use technology?
Spin-Offs	• Were there any spin-offs from your institution, and if so, how did the process work? • Will you continue to participate in creating spin-offs in the future? • What kind of process-related changes / support would you prefer concerning the creation of spin-offs or the realization of other commercialization activities?
Cooperate Partnerships	• Could you describe the relationships (e.g.: business, networking, activities,…) you have with the industry / technology users? • How do you find out about the current (product) needs of technology users?
Synergies and perceiving of roles	• What role does dealing with the commercialization of research results play for you? • In which areas can synergies between teaching / research and technology commercialization be leveraged?
Personal attitudes	• How do you see the role of scientists as entrepreneurs in the context of technology commercialization, does it fit together? • What is the value of scientific research for you?

• Do you find it exciting to find new solutions for current market needs?

Table A.3. Applied coding rules

In the case of immediate cause-effect-relationship, subdivisions are subdivided into subcategories
For superordinate cause-effect-relationships, a division is arranged at the same level
If the superordinate categories are already in the causal context, then insert the corresponding subclasses at a suitable place
It is also possible to assign partial sections within a sentence to several categories if this can be clearly delineated
In the case of content which is not clearly assigned to a subcategory but clearly describes a bundle of several categories, the statement is assigned to several subcategories
In the case of an obvious 3-way causal chain, the middle step is called "status". This is framed by cause in upstream and effect in downstream position.

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