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Scientists’ transition to academic entrepreneurship: Economic and psychological determinants

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Abstract

This study investigated academic scientists’ transition to entrepreneurship by studying their academic entrepreneurial intentions (to found a business in order to market their research knowledge) and actual founding behavior. We developed and tested a conceptual model integrating both economic and psychological perspectives. Applying the theory of planned behavior, we examined the economic factors (scientists’ human capital, social capital, expected entrepreneurial benefits) as distal predictors (background factors) of academic entrepreneurial intentions. The psychological factors (entrepreneurial attitudes, norms, control perceptions) were examined as proximal intention predictors. Findings were derived from a path analysis utilizing archival and survey data on German scientists \((N = 496)\). We found that attitudes and perceived control predicted entrepreneurial intentions. Social norms in turn had no effect. As regards the economic factors, human and social capital exhibited indirect effects on intentions via entrepreneurial attitudes and control perceptions, while additional direct effects of both capitals showed up significantly as well. Expected benefits from engaging in academic entrepreneurship (i.e., expected financial and reputational gain) only showed indirect effects on intentions via attitudes and perceived control. In addition, longitudinal results indicated that entrepreneurial intentions indeed forecasted entrepreneurial behavior, while certain barriers have a diminishing influence on this relationship. Our results are discussed with an emphasis on the long-neglected importance of the interplay of economic and psychological determinants for scientists’ transition to academic entrepreneurship.

Keywords: Academic entrepreneurship; entrepreneurial intentions; human capital; social capital; occupational choice; theory of planned behavior

PsycINFO classification: 3610, 3650, 3660

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1. Introduction

In today’s globalized markets, economies rely more and more on new knowledge and innovation (Audretsch, 2007), and academic science is seen as the hotbed for these new ideas facilitating competitive advantage (OECD, 2003). For example, academic research has been a crucial ingredient for the development of a large amount of new products and processes (Mansfield, 1998) and for the emergence of entirely new industries, like biotechnology (Audretsch & Stephan, 1996).

One important direct channel through which new scientific knowledge reaches the wider market sphere is academic entrepreneurship, that is, scientists becoming entrepreneurs by developing new products and starting their own companies to market their research knowledge and inventions (Shane, 2004). Given the largely tacit nature of new research knowledge (Pavitt, 1988), it often requires scientists’ active involvement when transforming the raw knowledge into a marketable product. This implies that a complete picture of academic entrepreneurship may only arise when considering the individual scientists and the factors that may drive their transition to the world of entrepreneurship.

Research on the entrepreneurial scientist, however, is still emerging and our knowledge about the determinants that may underlie enterprising behavior among scientists is very limited (Rothaermel, Agung, & Jiang, 2007). Caution must further be taken when simply assuming that more general entrepreneurship models also apply to the specific domain of academic entrepreneurship without actually testing such assumptions. For example, Fini and Lacetera (2010) argued that, resulting from the peculiarities of the traditionally non-commercial university environment, such as the distinct incentives and rules in academia, the processes governing the emergence of academic entrepreneurship are likely to differ from those related to the emergence of entrepreneurship from the private sector. Others called for a
unique research agenda of academic entrepreneurship, given the specific nature of scientists’ transition from academia to entrepreneurship, e.g., negotiating their scientific career and entrepreneurial activity, dealing with highly innovative products, etc. (Aldridge & Audretsch, 2011; Shane, 2004). In this regard, experts particularly criticized the lack of research on the entrepreneurial mindsets of academic scientists (Audretsch & Erdem, 2005) – a call that concurs with Hisrich, Langan-Fox, and Grant’s (2007) general call to psychology for more research on entrepreneurship.

So far, studies on academic entrepreneurship have been dominated by economic approaches and have focused on specific economic factors when explaining why some scientists engage in entrepreneurship and others do not (Fritsch & Krabel, in press; Landry, Amara, & Rherrad, 2006; for an overview see Rothaermel, Agung, & Jiang, 2007). For example, scientists’ human capital endowments and social networks were identified as relevant determinants of their entrepreneurial engagement (Aldridge & Audretsch, 2011; Mosey & Wright, 2007). Other studies modeled the entrepreneurial career decision of scientists as an “occupational choice” (e.g., Lacetera, 2009), taking into account expected benefits that may result from private business (e.g., financial gains) and comparing it with the concurrent income and reputational benefits as a scientist. However, the picture that arises from this literature may be incomplete as it largely disregards psychological theories and research. Entrepreneurship scholars have long been emphasizing that enterprising behavior in general is purposive, goal-directed, and driven by complex decision-making processes (Baron, 2004; Bird, 1988; Krueger, Reilly, & Carsrud, 2000). In particular, psychological factors described in the theory of planned behavior (TPB, Ajzen, 1991), namely attitudes as well as perceived social norms and behavioral control, have been shown to be relevant determinants of an entrepreneurial career choice (Souitaris, Zerbinati, & Al-Laham, 2007; Liñán & Chen, 2009).
Our study attempts to integrate both economic and psychological perspectives into one conceptual framework of scientists’ transition to academic entrepreneurship (in our case captured by their entrepreneurial intentions and actual entrepreneurial behavior). Following the TPB literature and entrepreneurship studies (e.g., Krueger & Carsrud, 1993; Fishbein & Ajzen, 2010), we examined the economic variables (human capital, social capital, expected entrepreneurial benefits) as distal predictors (background factors) and the psychological variables (attitudes, social norms, perceived behavior control) as proximal predictors of academic entrepreneurial intentions. Human and social capital were deemed to be associated with intentions via the more proximal psychological variables, but should also exert direct effects. Expected entrepreneurial benefits, in turn, should only exert a direct effect on intentions.

The paper continues with the introduction of academic entrepreneurial intentions as the central variable of interest. We then turn to a literature review on the economic and psychological approaches. Finally, we develop our conceptual model on scientists’ entrepreneurial career intentions to be tested in this study.

2. Theoretical background

2.1 Academic entrepreneurial intentions

In recent years, the study of entrepreneurial intentions has become a key approach in entrepreneurship research dealing with the complex factors underlying an individual’s transition to entrepreneurship (Krueger, 2009). Both psychological and economic entrepreneurship researchers are increasingly interested in adopting an intentions-based view on entrepreneurship because entrepreneurial intentions can be seen as a conceptual hub connecting entrepreneurial behavior with a wide range of both psychological and economic factors that may influence this behavior through such intentions (Carsrud & Brännback, 2009; Fini, Grimaldi, Marzocchi, & Sombrero, in press; Krueger, 1993).
It is widely acknowledged that entrepreneurial behavior is inherently intentional because acting entrepreneurially is something that people choose or plan to do (Bird, 1988; Krueger & Carsrud, 1993). Consistent with longitudinal findings (e.g., Lee, Wong, Foo, & Leung, 2009), the most proximal and important predictor of the engagement in entrepreneurial behavior is seen in entrepreneurial intentions (Bird, 1988). Simply put, these are cognitive representations of an individual’s readiness to engage in entrepreneurship. Entrepreneurial intentions signal how intensely one is prepared and how much effort one is planning to commit in order to carry out entrepreneurial behavior. Even if people may have significant potential, they will refrain from making the transition into entrepreneurship when they lack the intentions (Krueger, Reilly, & Carsrud, 2000).

In the specific field of academic entrepreneurship, entrepreneurial intentions have not yet received much attention (for exceptions see Obschonka, Silbereisen, & Schmitt-Rodermund, 2010; Obschonka, Goethner, Silbereisen, & Cantner, in press; Prodan & Drnovsek, 2010). Because we were interested in combining economic and psychological approaches to get the bigger picture, we adopted the intentions-based view to the specific case of entrepreneurial scientists and investigated academic entrepreneurial intentions in this study.

2.2 The economic perspective on academic entrepreneurial intentions

Drawing from the economic literature on entrepreneurship in general, and academic entrepreneurship in particular, it is important to consider economic variables when setting up a prediction model of academic entrepreneurial intentions. Entrepreneurship research already has a long tradition in studying an individual’s current human capital (Unger et al., 2011) and social capital (Kim & Aldrich, 2005) as antecedents of entrepreneurial outcomes (i.e., one’s decision to pursue an entrepreneurial career). Human capital comprises an individual’s knowledge and skills which are acquired through education, on-the-job training, and other
types of experiences which may increase one’s productivity at work (Becker, 1964). From an entrepreneurial perspective, human capital is assumed to provide the (potential) entrepreneur with superior cognitive abilities regarding the exercise of demanding activities, such as starting one’s own business (Davidsson & Honig, 2003; Schultz, 1980).

The concept of social capital was originally developed in sociology. Social capital is concerned with one’s social ties to other individuals, groups, or organizations (Granovetter, 1973). Social capital resources stemming from these ties have been shown to particularly affect the early stages of the entrepreneurial process, i.e., the initial decision to engage in entrepreneurship (Liao & Welsch, 2005; Samuelsson & Davidsson, 2009). For example, Davidsson and Honig (2003, p. 309) argue that social capital assists nascent entrepreneurs “by exposing them to new and different ideas, world views, in effect, providing them with a wider frame of reference both supportive and nurturing to the new potential idea or venture”.

The study of human and social capital may also contribute to a better understanding of academic scientists’ transitioning to entrepreneurship. Human capital endowments and social networks are recognized as the two pillars supporting scientists’ ability to contribute new knowledge to society (Bozeman & Mangematin, 2004). Throughout their careers, academic scientists seek to enhance both. Moreover, while human capital models have developed separately from social capital models, in the academic entrepreneurship context the two theoretical approaches are not easily disentangled (Mosey & Wright, 2007), suggesting that both should have a significant bearing on the entrepreneurial career decision among scientists. Indeed, the academic entrepreneurship literature emphasizes that network ties to industrial firms or governmental support agencies are conducive to an entrepreneurial career (Aldridge & Audretsch, 2011; Karlsson & Wigren, in press; Landry, Amara, & Rherrad, 2006). Interactions and linkages, such as working together with industry partners, are posited as conduits not just of knowledge spillovers but also of a demonstration effect providing knowledge and information about how scientific research can be commercialized via
entrepreneurship (Bercovitz & Feldman, 2008; Stuart & Ding, 2006). Similarly, personal entrepreneurial experience adds to the academic scientists’ specific human capital by providing direct learning and episodic knowledge about the entrepreneurial process, which in turn predicts recurrent entrepreneurial activity (Hoey & Pries, 2009). Azoulay et al. (2007) further highlight that scientists’ patenting productivity may be regarded as an indicator of their commercial research orientation. Patenting is a purposeful activity motivated to protect intellectual property that stems from research and development efforts. A general requirement for a patent is a technological invention that is novel, industrially useful, and non-obvious (Acs & Audretsch, 1989). While of minor importance to some fields of academic science (i.e., scientific disciplines in which technological inventions naturally do not play a central role, such as in social sciences), experience with applying for patent protection for the results of their research efforts has been shown to be a robust predictor of later entrepreneurial activity of academics (Krabel & Mueller, 2009; Landry, Amara, & Rherrad, 2006; Stuart & Ding, 2006).

Moreover, drawing from an economic paradigm, a considerable body of literature models the transition from employed work into entrepreneurship as an occupational choice decision where expected benefits are central (e.g., Campbell, 1992; Kihlstrom & Laffont, 1979). In the simplest form of this model, individuals choose between starting a risky entrepreneurial endeavor or working in paid employment and earning a risk-free wage (as the wage is usually fixed in an employment contract). Assuming that one possesses the necessary resources to start up and given the individual risk-taking propensity, one will choose to engage in entrepreneurship if the expected future profits from becoming an entrepreneur are larger than the sum of expected future benefits from employed work. Such economic models have recently been developed to predict scientists’ transition to academic entrepreneurship, taking account of the peculiarities of an academic work context (Lacetera, 2009). Accordingly, besides receiving a fixed wage, the academic scientist also derives direct benefit
from performing research, e.g., in the form of publications and peer recognition. Hence, for an academic to choose an entrepreneurial career, the expected entrepreneurial benefits need to be large enough to compensate (1) for the risk-free wage in academic sector employment and (2) for the recognition benefits of academic research.

2.3 The psychological perspective on academic entrepreneurial intentions

A widely researched psychological framework for understanding and predicting behavioral intentions is the theory of planned behavior (TPB; Ajzen, 1991; Fishbein & Ajzen, 2010). This parsimonious and coherent model of behavioral intentions received strong empirical support in a wide range of studies predicting very different kinds of planned behavior (Ajzen, 2001; Conner & Armitage, 1998). Recent studies broadly confirmed the TPB’s predictive utility also with respect to entrepreneurship as planned behavior (e.g., Krueger et al., 2000; Liñán & Chen, 2009). Given the general and basic nature of the TPB approach, we expected this framework to also apply in the specific domain of academic entrepreneurship with its special focus on scientists’ active participation in the entrepreneurial exploitation of new research knowledge (Shane, 2004). The core assumption of the TPB is that behavioral intentions are an additive function of three conceptually independent factors: attitudes, social norms, and perceived behavior control.

*Attitudes* reflect an individual’s enduring evaluation – positive or negative – of the behavior in question. Existing literature suggests that academic scientists allocate their efforts and time toward academic entrepreneurship if they have a favorable appraisal of entrepreneurial activity and the commercial use of research knowledge (e.g., Gulbrandsen, 2005; Owen-Smith & Powell, 2001).

*Social norms* refer to perceived normative pressure from a specific reference group toward engaging or not engaging in a particular behavior (Ajzen, 1991). In line with the literature on academic entrepreneurship (Bercovitz & Feldman, 2008; Stuart & Ding, 2006),
our study considered individual scientists’ workplace peers as salient referents determining their entrepreneurial behavior. Previous research suggested that scientists feel pressure to become involved with the commercial exploitation of their research knowledge, and are thus more likely to do so, if they sense that their academic peers look favorably on such activity (Rahm, 1994). Note that whereas in earlier times scientists’ active involvement in the commercialization of their academic research knowledge was met with consternation among academic peers, the scientific community has recently experienced a significant change of view (Owen-Smith & Powell, 2001). University faculties have come to accept and, in many institutions, to endorse the participation in entrepreneurial endeavors. As Etzkowitz (1998, p. 824) stated, “The norms of science which traditionally condemn profit-making motives are beginning to change to allow for . . . entrepreneurship”.

Perceived behavioral control is closely related to Bandura’s (1997) concept of self-efficacy and reflects the perceived ease or difficulty of performing a particular behavior successfully. The TPB would expect that scientists who do not perceive themselves to have control over entrepreneurial behavior and its outcome are unlikely to form strong entrepreneurial intentions, even if social norms and attitudes toward entrepreneurship are favorable. This is supported by entrepreneurship research which stressed the importance of self-efficacy as a mechanism for overcoming perceptions of the higher financial, technological, and legal uncertainties that are often associated with the commercialization of research knowledge via entrepreneurship (Markman, Baron, & Balkin, 2002; Obschonka, Silbereisen, & Schmitt-Rodermund, 2010).

3. Hypotheses

Figure 1 presents our conceptual model, which combines the economic and psychological perspectives outlined above. In the following, this model is discussed in detail. Note that in this conceptual model we also included the intention–behavior link and possible barriers that
may impede this link. Although this is not the core focus of this study, and therefore not relevant in the following detailed description of the model, in an additional analysis we used a small follow-up sample to test whether academic entrepreneurial intentions indeed translate into subsequent academic entrepreneurship (i.e., founding a business in order to market one’s own research knowledge), as predicted by the TPB.

According to the TPB, the psychological factors (attitudes, social norms, perceived behavioral control) should be seen as proximal intention predictors, whereas the economic variables refer to distal intention predictors, or so-called background factors in the diction of the TPB literature (Fishbein & Ajzen, 2010). As such, background factors are proposed to affect intentions via the psychological factors. More specifically, the TPB states that behind attitudes, social norms, and perceived behavior control are salient beliefs and that these beliefs “are not innate but instead are acquired in daily encounters with the real world” (Fishbein & Ajzen, 2010, p. 224). After reviewing the TPB literature and relevant entrepreneurship studies (e.g., Fini, Grimaldi, Marzocchi, & Sombrero, in press; Prodan & Drnovsek, 2010), we decided to investigate the economic variables as predictors of attitudes and perceived behavioral control (because we could relate them to salient beliefs in these domains) but not of social norms. Consistent with entrepreneurship research, we hold that social norms, in contrast to attitudes and perceived control, are less relevant for indirect effects of background factors because entrepreneurs are characterized as being inner-directed and striving for social distinction (instead of conforming to social norms; Krueger, Reilly, & Carsrud, 2000; see also Schumpeter, 1934). Applying the TPB framework, Fini et al. (in press), for example, showed that background factors such as perceived environmental dynamism (e.g., industry opportunities) or individual skills predict corporate entrepreneurial intentions (intentions to act entrepreneurially within existing small and newly established companies) indirectly via attitudes and perceived control – but not via social norms. Moreover, our literature review
revealed no clear indications for a meaningful effect of the economic factors that we study (human and social capital, expected benefits) on social norms.

3.1.1 Indirect effects via attitudes

Psychological research on attitude formation identified several factors as important determinants of behavioral attitudes (Ajzen, 2001). For example, prior behavioral experiences connected with the target behavior, either made during one’s own past behavior in this domain (comparable to human capital factors) or made via networks (comparable to social capital factors), are deemed important. Likewise, researchers examining the entrepreneurial scientist argued that direct learning through practical experience in different entrepreneurial aspects (e.g., earlier patenting and firm-founding activities) as well as the values and beliefs transmitted by network ties to the business world (e.g., through research cooperation with industrial partners and through advice and support from government-sponsored institutions) raises scientists’ awareness that their research has commercialization potential and eventually increases their desire to exploit this potential by founding their own business (Gulbrandsen, 2005; Fritsch & Krabel, in press; Mosey, Lockett, & Westhead, 2006).

Moreover, besides prior experiences, the psychological literature on attitude formation further emphasizes the role of salient outcome expectations (Ajzen, 2001; Fishbein & Ajzen, 2010). This approach draws from the expectancy-value model of attitudes, which states that positive outcome expectations (beliefs about the likely consequences of a certain behavior) result in positive attitudes regarding this behavior when these consequences are valued. From a psychological perspective, expected benefits, as examined in economic studies on entrepreneurial career transitions (e.g., financial gains), are comparable to expected consequences that are indeed valued (i.e., financial gains are most likely seen as something positive). In other words, such benefits, also referred to as hypothetical incentives (Williams, 2010), imply the coincidence of outcome expectation and value, which taken together should
determine respective attitudes (Ajzen, 2001). To illustrate this point, academic scientists may
develop a positive attitude towards academic entrepreneurship when they expect to gain
reputation (which is generally valued in the scientific community as necessary for the
advancement of an academic career) as a likely consequence of commercializing their
research (Göktepe-Hulten & Mahangaonkar, 2010; Lam, 2011).

3.1.3 Indirect effects via perceived behavioral control
Social cognitive theory highlights prior mastery and helpful role models as important
determinants of personal control beliefs (e.g., whether one feels able to successfully perform a
certain behavior; Bandura, 1997). Seen from this perspective, economic factors such as
human and social capital may be indirectly associated with entrepreneurial career intentions
via perceived behavioral control. More precisely, through providing opportunities for enactive
mastery during earlier entrepreneurial episodes (Krueger, 1993; Zhao, Hills, & Seibert, 2005)
and access to business-related information, resources, and positive recommendations (Ozgen
& Baron, 2007; Peterman & Kennedy, 2003), both human capital and social capital may make
entrepreneurial behavior more feasible to the academic scientist. Vocational research further
suggests that social networks such as having contact with entrepreneurial promotion agencies
may enhance scientists’ perceptions of control over an entrepreneurial career due to role
model effects (Lent, Brown, & Hackett, 1994; see also Zhao et al., 2005) and beneficial
effects of mentoring (e.g., Day & Allen, 2004).

Past psychological research further indicates that outcome expectations directly affect
feasibility perceptions (for a review of this literature see Williams, 2010). Hence, higher
levels of expected benefits of academic entrepreneurship (i.e., expected financial and
reputational gains) should make scientists more likely (or more motivated) to perceive that
they are able to engage in such behavior.
3.2 Direct effects of economic variables

The TPB further assumes that background factors can have additional direct effects on behavioral intentions, above and beyond their indirect effects via the TPB factors (Fishbein & Ajzen, 2010). Put differently, background factors may affect behavioral intentions also independently of attitudes, norms, and perceived control. For example, empirical studies employing the TPB consistently found that the link between past behavior (i.e., when the target behavior has been shown before) and current behavioral intentions is not fully mediated by the TPB factors (Ajzen, 2002a; see also Conner & Armitage, 1998). It is argued that, with repeated performance, the respective behavior habituates and comes under the direct control of stimulus cues, affecting intentions directly (Fishbein & Ajzen, 2010; Trafimow & Borrie, 1999). These residual effects of past behavior on behavioral intentions should be particularly strong in situations where contexts are unstable and behavioral outcomes are uncertain (Ajzen, 2002a; Trafimow & Borrie, 1999), such as in the case of academic entrepreneurship (i.e., starting a business venture based upon scientific research knowledge). Empirical support is also evident in the more general entrepreneurship literature, suggesting that exposure to entrepreneurial experiences channels individuals into different “knowledge corridors”. Experienced entrepreneurs, as compared to novices, may then engage in recurrent entrepreneurial behavior with less conscious effort, that is, without carefully considering one’s behavioral attitudes and beliefs (Ronstadt, 1988; Shane, 2000).

Yet, routinization and habit with regard to entrepreneurial behavior may not only be driven by human capital attributes but may also be induced by scientists’ social capital, i.e., their embeddedness in business networks. Often described as “boundary spanners” between the academic and commercial sphere (Gulbrandsen, 2005; Rahm, 1994), academic scientists with personal ties beyond academia (e.g., to industrial research partners) should exhibit a lower threshold toward forming entrepreneurial intentions. As they routinely move back and forth along the university–industry boundary while interacting with their commercial network
partners, these academics may decide to engage in entrepreneurship without invoking the cognitive processes described in the TPB.

We had no expectations regarding direct effects of expected benefits (financial and reputational gains) on academic entrepreneurial intentions. Arguably, these benefits, other than human and social capital, are conceptually more closely linked with the psychological TPB factors such as attitudes and perceived control because they represent salient beliefs that, according to the TPB literature, may directly underlie these TBP factors (Fishbein & Ajzen, 2010). As such, expected benefits from own entrepreneurial activity may primarily affect entrepreneurial intentions via attitudes and perceived control, instead of reflecting more general behavioral habits or “automated” activities which do not involve the cognitive processes described in the TPB.

Taken together, and in accordance with the TPB and related research, in our proposed model (see Figure 1) we expected scientists’ entrepreneurial human and social capital to exert both direct and indirect effects (via the TPB factors attitudes and perceived behavioral control) on entrepreneurial intentions. In contrast, entrepreneurial benefits were expected to predict intentions only indirectly (via attitudes and perceived control).

4. Method
The present study is part of the interdisciplinary research project Thuringian Founder Study (“Thüringer Gründer Studie”). This large-scale project examines the process of business foundation in the Federal State of Thuringia, Germany, from the perspective of economics and psychology. In this paper we present data from an online survey. Web-based surveys allow for highly standardized data collection at low cost and have been shown to collect data in a valid way (Gosling, Vazire, Srivastava, & John, 2004). Furthermore, such surveys are expected to increase the response rate because the questionnaire can be completed without having to mail any forms (Mann & Stewart, 2000). Before we conducted our study we pilot-
tested and optimized the questionnaire and the procedure in an independent sample of 133 scientists in the Federal State of Saxony, Germany. We supplemented the survey data with archival information on patent applications of the participants. Accessing the database of the German Patent and Trademark Office (DPMA), we counted the number of patents which scientists had applied for within the five years prior to our survey.

To test our hypothesized path model, we employed the technique of path analysis using AMOS (Arbuckle, 2006). On the basis of fit indices this procedure tests whether, and how well, the hypothesized model fits the data. In this study, we focus on $\chi^2$, CFI, and RMSEA as fit indices. A non-significant $\chi^2$ indicates good fit but relying solely on $\chi^2$ as a fit statistic is problematic as it is affected by the sample size and the size of the correlations in the model. Thus, experts suggest considering other fit statistics such as CFI and RMSEA when evaluating model fit. As a rule of thumb, a CFI value greater than .90 indicates a reasonably good fit. With respect to the RMSEA, values ≤ .05 indicate a close approximate fit, and values between .05 and .08 suggest a reasonable error of approximation (Kline, 2005).

4.1 Participants

In a first step of sample selection we accessed the Internet websites of all research organizations in the German Federal State of Thuringia in order to collect contact names and email addresses of scientists working there. Located in the center of Germany, Thuringia has a broad spectrum of research organizations, like universities and non-university research institutions (e.g., Max Planck institutes, Fraunhofer institutes), providing a fertile ground for the emergence of academic entrepreneurship. Using the resulting list of all available email addresses (4,638 entries), a random sub-sample consisting of 2,319 email addresses was then selected as the basis for our survey. In June 2008, we received completed questionnaires from 565 participants, representing a response rate of 24.4%. Compared to other web-based studies, this is an acceptable rate (Cook, Heath, & Thompson, 2000). Before conducting our analysis,
we excluded 15 participants due to incomplete data or non-serious responses. We also excluded 54 participants who reported that they do not conduct any research, as this study targeted scientists’ intentions to commercialize their own research. The final sample consisted of 496 scientists.

On average, participants were 38.8 years old ($SD = 11.55$, range: 23–65) and male (70.8%). About two-thirds worked in a university (65.4%), 24.1% worked in a non-university research institution, and 10.5% worked in a university of applied sciences (“Fachhochschule”). Regarding their occupational status, 69.8% worked as research associates, 18.5% were professors or university lecturers, and 11.7% reported another field of activity, for example as technical assistant. Half of the sample (53.3%) described their type of engagement in research as applied science, and the remainder (46.7%) as basic science. The largest group of participants worked in the field of natural sciences (49.8%), whereas 31.5% worked in engineering and 18.7% in economics, law, or social sciences. Compared with official statistics on research personnel in Germany (Statistisches Bundesamt, 2008), this survey sample appeared to be representative in terms of age, gender, and academic rank.

4.2 Measures

4.2.1 Academic entrepreneurial intentions

Three items assessed scientists’ intentions to engage in a start-up firm to market their own research (Krueger et al., 2000) (Item 1: “In the foreseeable future, do you intend to participate in the founding of a firm to commercialize your research?”; five-point Likert scale; 1 = no, 5 = yes; Item 2: “In your opinion, how high is the probability that, in the foreseeable future, you will participate in the founding of a firm to commercialize your research?”; 1 = 0%; 6 = 100%; Item 3: “I have recently sought information about the ways and means of founding a firm with the object of commercializing my research”; five-point Likert scale; 1 = no; 5 =
yes). We z-standardized and averaged the three items, resulting in the final variable academic entrepreneurial intentions (\(M = -.00, SD = .88, \alpha = .86\)).

4.2.2 Human capital indicators

Patenting experience captured whether participants had applied for at least one patent between 2004 and 2008 (0 = no; 1 = yes; \(M = .12, SD = .33\)) (Landry, Amara, & Rherrad, 2006). Entrepreneurial experience (whether successful or not) was measured with “Have you already participated in the founding of a firm in the past to commercialize your research?” (0 = no; 1 = yes; \(M = .11, SD = .31\)) (Krabel & Mueller, 2009).

4.2.3 Social capital indicators

We measured cooperation linkages with industry with the item “I have many business contacts/contacts with research partners in industry.” (1 = completely disagree; 5 = completely agree; \(M = 2.36, SD = 1.24\)) (Karlsson & Wigren, in press; Krabel & Mueller, 2009). Scientists’ linkages to entrepreneurial promotion agencies were measured with the item “I know of public promotion agencies which would support me in the founding of a firm for the commercialization of my research.” (1 = completely disagree; 5 = completely agree; \(M = 2.33, SD = 1.23\)) (Liao & Welsch, 2005).

4.2.4 Expected entrepreneurial benefits

Two items were included to capture scientists’ expected entrepreneurial benefits, following Göktepe-Hulten and Mahangaonkar (2010). Both items were preceded by the stem “Please assess the likelihood of these consequences if you were to participate in the founding of a firm in order to commercialize your own research.” The first consequence referred to expected reputational gain and was measured with the item “Additional scientific reputation” (1 = very unlikely; 5 = very likely; \(M = 2.81, SD = 1.02\)). The second consequence referred to expected
financial gain and was measured with the item “Higher personal income” (1 = very unlikely; 5 = very likely; $M = 2.99$, $SD = 1.18$).

4.2.5 Intention predictors in the TPB (attitudes, social norms, perceived behavioral control)

Scientists’ attitudes toward academic entrepreneurship were measured with the mean of four five-point bipolar adjective scales (“My personal attitude toward participation in the founding of a firm to commercialize my own research is that this is…”; e.g., 1 = “unattractive” vs. 5 = “attractive”; $M = 3.41$, $SD = .96$, $a = .89$) (Ajzen, 2001; 2002b). Social norms were assessed with the mean across two items, each referring to academic workplace peers (e.g., “Most of my colleagues whose opinions matter to me…”; e.g., “…would encourage my participation in the founding of a firm to commercialize my own research”; five-point Likert scale; 1 = “not at all correct” to 5 = “totally correct”; $M = 3.06$, $SD = .81$, $a = .68$) (Ajzen, 2002b). Following Ajzen and Madden (1986), perceived behavioral control was measured with the mean of three items (e.g., “If I wanted to participate in the founding of a firm to commercialize my own research, I am confident that I would succeed”; five-point Likert scale; 1 = “not at all correct” to 5 = “totally correct”; $M = 2.95$, $SD = 1.01$, $a = .84$).

4.2.6 Control variables

Following earlier research on academic entrepreneurship (Fritsch & Krabel, in press; Landry, Amara, & Rherrad, 2006; Levin & Stephan (1991); Murray & Graham, 2007; Shane, 2004), there are other potential influences on the likelihood of academic scientists’ transition to entrepreneurship. Taking this literature into consideration, we controlled our analysis for gender (0 = female; 1 = male; $M = .70$, $SD = .46$), age ($M = 38.8$, $SD = 11.55$, range: 23–65), PhD degree (0 = no; 1 = yes; $M = .46$, $SD = .50$), and type of research (0 = basic research; 1 = applied research; $M = .53$, $SD = .50$).
5. Results

5.1 *Preparatory analysis on the intentions–behavior link*

Before we conducted our main analysis, which refers to the prediction model with academic entrepreneurial intentions as the outcome variable, we took a closer look at the intentions–behavior link as additionally outlined in our framework in Figure 1 (right part). In this relationship, important barriers should play a role in that they could prevent some scientists from ultimately engaging in entrepreneurial behavior (e.g., due to worsening of macro-economic conditions). To investigate this intentions-behavior link and possible barriers empirically, we conducted a follow-up survey 18 months after the baseline survey. Here, respondents were asked whether they had pursued entrepreneurship since T1. In December 2009 (T2), we were able to collect follow-up data on entrepreneurial behavior from 219 of our participants, using the item “Since the last survey in June 2008, did you participate in the founding of a firm to commercialize your research?”. We found that scientists’ entrepreneurial intentions (mean of the three z-standardized intention variables) indeed forecasted actual engagement in academic entrepreneurship ($r_s = .32, p < .001$). Our expectation on the link between intentions and actual behavior thus received support.

However, although the correlation between intention and behavior is substantial it also makes clear that some scientists did not engage in founding behavior even though they had reported the intention to do so in the near future. Participants of the follow-up survey who did not report entrepreneurial behavior since T1 but had had the intention to do so were asked to rate the degree to which four potential barriers inhibited their engagement in a start-up firm to market their own research (i.e., current financial crisis, current workload, recent negative experiences of workplace peers with founding their own firm, private circumstances). As expected, the participants’ reports indicate that barriers indeed played a role. The most important reasons for postponing or abandoning an entrepreneurial project since the baseline survey were scientists’ current workload, e.g., research and teaching duties (five-point Likert
scale; 1 = “not at all correct” to 5 = “totally correct”; $M = 3.48, SD = 1.54$), and obstacles in their personal circumstances, e.g., family duties, leisure opportunities (five-point Likert scale; 1 = “not at all correct” to 5 = “totally correct”; $M = 2.73, SD = 1.53$). Interestingly, the current financial crisis (five-point Likert scale; 1 = “not at all correct” to 5 = “totally correct”; $M = 1.79, SD = 1.41$) and recent negative experiences of workplace peers with founding their own firm (five-point Likert scale; 1 = “not at all correct” to 5 = “totally correct”; $M = 1.70, SD = 1.02$) did not seem to function as strong barriers to entrepreneurial behavior among scientists. This quite unexpected finding can be explained by the fact that the German economy performed relatively well during the global financial crisis of 2008/2009 compared to other economies (World Economic Forum, 2010).

Note that there was substantial attrition (58.7%) from T1 to T2. With regard to the baseline variables, participants who answered the follow-up questionnaire differed from those who did not in that they had a more positive attitude toward entrepreneurship ($t[493] = -2.02, p < .05$). In view of this indication for non-random sample attrition and the reduced number of observations, we decided not to include the follow-up data into our main analysis since the results would not be robust (and the $N$ and thus the statistical power would be much smaller).

5.2 Main analysis

5.2.1 Correlations

Table 1 presents the zero-order correlations between all variables used to investigate the prediction models for the explanation of academic entrepreneurial intentions. To test for the existence of multicollinearity, variance inflation factors (VIF) were computed for all predictor variables. VIF scores were well below 2. Thus, no evidence of multicollinearity was indicated (Hair et al., 1998). Among the control variables, gender and type of research were associated with academic entrepreneurial intentions: Males as well as scientists working in fields of applied research reported stronger intentions to found a new business. Age and PhD degree, in
contrast, showed no association with the outcome variable. With respect to the psychological factors described in the theory of planned behavior (TPB), namely attitudes, social norms, and perceived behavioral control, all variables correlated positively with intentions, which is in line with our conceptual model. As expected, there were also positive and significant correlations between the factors proposed by the economic approaches (social capital approach, human capital approach, expected benefits) and the TPB factors and between the economic factors and the outcome variable.

5.2.2 Path model

We then tested our path model in AMOS, proceeding in two steps. We first tested the hypothesized model and, in a second step, trimmed this model by eliminating non-significant paths and irrelevant variables. This more parsimonious model then served as our final empirical model that we report and discuss in detail.

As just mentioned, we first tested the hypothesized model. All effects were controlled for gender, age, PhD degree, and type of research. This model achieved a very good fit ($\chi^2 [2] = 1.05, p = .590, CFI = 1.000, RMSEA = .000$). Second, aiming at finding a more parsimonious model, we excluded non-significant paths from our model. Moreover, we also left out a TPB variable, namely social norms. In the full model, we found that only attitudes ($\beta = .31, p < .001$) and perceived control ($\beta = .14, p < .01$) predicted intentions, but not social norms ($\beta = -.05, ns$). Given this non-significant effect, we decided to leave out social norms in our more parsimonious model.

Not surprisingly, this parsimonious model (without non-significant paths and without social norms) also achieved a very good fit ($\chi^2 [6] = 5.60, p = .469, CFI = 1.000, RMSEA = .000$). Again, gender, age, PhD degree, and type of research served as control variables. This final empirical model, which accounted for 44% of variance in intentions, is depicted in Figure 2.
TPB factors as proximal predictors of academic entrepreneurial intentions

The TPB factors attitudes ($\beta = .30$, $p < .001$) and perceived behavioral control ($\beta = .14$, $p < .05$) had a positive effect on intentions in our final model. Given that we had found no effect of social norms on intentions, we must conclude that our expectation on the TPB–intentions link was only partly supported. It was supported for attitudes and perceived control, but not for social norms.

Indirect effects of economic variables

Regarding the indirect effects of the economic variables, we found the following. Each of the economic variables, except for linkages with public support institutions, showed indirect effects on intentions via attitudes. The effects on attitudes were all positive and ranged from $\beta = .13$ (patenting experience) to $\beta = .23$ (expected financial gain). In sum, 25% of variance in attitudes could be explained in the model.

Moreover, each of the economic variables, except for patenting experience and expected reputational gain, showed indirect effects on intentions via perceived behavioral control. The model explained 41% of variance in perceived control and the effects on control were all positive and ranged from $\beta = .17$ (expected financial gain) to $\beta = .26$ (cooperation linkages with industry).

Taken these results together, we found support for our expectations that human and social capital indicators as well as perceived entrepreneurial benefits would show indirect effects on intentions via TPB factors. Entrepreneurial experience, cooperation linkages with industry, and expected financial gain had an indirect effect via both attitudes and perceived control. Patenting experience and expected reputational gain only showed indirect effects via attitude, and not via perceived control. Linkages with public support institutions and expected...
financial gain, in turn, only showed indirect effects via perceived control, and not via attitudes.

**Direct effects of economic variables**

We had also expected that human and social capital would show direct effects on intentions, above and beyond their indirect effects via the TPB factors. This expectation was supported for (some of the) human and social capital indicators. We found entrepreneurial experience ($\beta = .14, p < .001$), cooperation linkages with industry ($\beta = .12, p < .01$), and linkages with public support institutions ($\beta = .18, p < .001$) to positively predict academic entrepreneurial intentions. Consistent with our model, there were no direct effects of expected reputational and financial gains.

**Summary of path model results**

Finally, summarizing the findings from our path model analysis, in Table 2 we provide an overview of the direct effect as well as of the total indirect effect and the total effect (sum of direct effect and total indirect effect) for each of the economic variables studied in this paper. This effect decomposition allows the examining of (1) whether an economic variable has only indirect effects, direct effects, or both, (2) how large the direct and indirect effect of each economic variable is, and (3) to what extent each economic variable contributes in total to variance explanation of academic entrepreneurial intentions. Regarding the latter, we found that entrepreneurial experience and the two social capital indicators contributed the most in explaining variance in intentions (strongest total effects). Behind these total effects were both direct and indirect effects. In contrast, the total effects of patenting experience and of the two benefit variables were solely indirect and rather small.

So far, we had controlled all effects for gender in our path model analysis. Academic entrepreneurship, however, is mostly pursued by males (Murray & Graham, 2007) and simply
controlling for gender would not reveal whether our final empirical model would also hold true when looking at males only. In an additional analysis, we thus re-ran the two-step path model analysis as described above but only including male participants in the sample \((n = 349)\). As a result, we ended up with exactly the same model as shown in Figure 2 (we had to exclude the same non-significant paths and social norms from the hypothesized model). Compared to the effects in the final empirical model derived from the full sample (males and females), the effects in the final “male” model were in the same direction and comparable in size. This presents evidence that our final “full sample” model illustrated in Figure 2 indeed applied to male scientists, to the protagonists of academic entrepreneurship.

6. Discussion

Acknowledging and demonstrating the intentionality of academic entrepreneurship, in this study we tested a model that combines past entrepreneurship research, research on the entrepreneurial scientist (which mainly focused on economic approaches), and the theory of planned behavior approach (TPB), a well-established psychological model of behavioral intentions in the context of planned behavior. More specifically, we studied economic variables (scientists’ human and social capital characteristics as well their expected benefits resulting from an engagement in academic entrepreneurship) as distal predictors, and attitudes, social norms, and perceived behavioral control as proximal predictors of academic entrepreneurial intentions (i.e., the intention to start a private business to market new research knowledge). It was our expectation that the economic variables would show indirect effects (via attitudes and perceived behavioral control), and, in the case of human and social capital, also direct effects on academic entrepreneurial intentions.

Referring to the proximal intention predictors described in the TPB (attitudes, social norms, perceived behavioral control), only social norms turned out not to be relevant in the prediction of intentions. While this result contrasts with previous research proposing that a
scientist’s decision to found his own firm is socially conditioned (Bercovitz & Feldman, 2008; Stuart & Ding, 2006), it is in line with more general TPB studies on entrepreneurial intentions, which also found non-significant effects of social norms (Krueger, Reilly, & Carsrud, 2000). When looking at TPB factors only, it seems that entrepreneurial intentions are mainly driven by the personal TPB factors (attitudes and perceived control), whereas norms associated with the social context (in our case perceived expectations and behaviors of scientists’ workplace peers) are less important. According to social identity theory, it may well be that the effect of social norms on entrepreneurial intentions is moderated by group identification (Terry, Hogg, & White, 1999). Accordingly, perceived expectations and behaviors of scientists’ workplace peers may only matter for entrepreneurial intentions when the scientists strongly identify with these peers.

Regarding the indirect effects of the economic variables, the other two TPB factors, attitudes and perceived behavior control, however indeed helped to better understand the effect of the economic variables on scientists’ intentions to engage in academic entrepreneurship. Although our results are correlational in nature and further longitudinal evidence is needed to infer more causal interpretations, they add an important perspective to the study of the entrepreneurial scientist by tackling the question why economic variables may be relevant for scientists’ transition to the entrepreneurial arena. In this respect our study delivers promising results on how to combine established economic and psychological approaches in order to get the bigger picture, an interdisciplinarity that is often called for but rarely applied in entrepreneurship research (Gartner, 2007).

Our results indicate that the TPB fully accounts for the indirect effect of expected entrepreneurial benefits, which is probably due to the cognitive nature of these benefits. In contrast, regarding direct effects of economic factors, human and social capital indicators also seem to operate “outside” of the TPB framework in that they relate to academic entrepreneurial intentions independently of the TPB factors. This, of course, also
demonstrates the limits of the TPB approach, which often cannot fully explain the link between background factors and intentions, a result well known, for example, from more general TPB research on the role of past behavior as a background factor (Ajzen, 2002a; Conner & Armitage, 1998). Interestingly, earlier studies on academic entrepreneurship broadly neglected the important role of past entrepreneurial behavior but instead seem to assume that the scientists under investigation are starting a business for the first time (Mosey & Wright, 2007; Hoye & Pries, 2009).

What are the implications of this study? Our research could inform higher education leaders and policymakers seeking to further promote the emergence of entrepreneurial activity in academia. Rather than creating rigid policy tools, our findings hint at the importance of fostering scientists’ entrepreneurial mindsets and networks. Past entrepreneurial behavior as well as entrepreneurial competence growth and network-building appeared as central antecedents of scientists’ entrepreneurial attitudes and control perceptions and thus of their intentions to engage in academic entrepreneurship. Measures may thus include intensive interaction with business practitioners during seminars, workshops, and other structured educational experiences such as formal university-based training (Mosey, Lockett, & Westhead, 2006; Souitaris, Zerbinati, & Al-Laham, 2007). Our results further reveal an interesting aspect of social ties to public support institutions. While we do not have information on the factual provision of counseling services by these organizations, it seems that knowing where entrepreneurship-related advice is available already contributes to scientists’ perceived efficacy with respect to starting an entrepreneurial career. This suggests that entrepreneurial promotion programs should also be well advertised among the target group of academic scientists. Finally, our results on scientists’ expected benefits from engaging in academic entrepreneurship (e.g., expectations of financial and reputational rewards) add to the recent debate on implementing the concept of the “entrepreneurial university” (Clark, 1998). Whereas others argued that the promotion of such reward
perceptions may directly lead to an entrepreneurial career choice among scientists (Lam, 2011), our findings put the focus on entrepreneurial attitudes and control beliefs through which benefit expectations may actually affect intentions to engage in academic entrepreneurship. In this sense, policies to encourage entrepreneurship among university faculties may not primarily aim at reward perceptions, but at the more proximal determinants of entrepreneurial intentions, namely attitudes and control beliefs towards entrepreneurship. Related to this point, more general research showed that interventions targeting psychological characteristics as described in the TPB are efficacious in changing intentions and behavior among participants who, prior to the intervention, either did not contemplate performing the behavior or were disinclined to do so (Fishbein & Ajzen, 2005).

Regarding implications for future research, an aspect that deserves further scrutiny refers to additional predictors that could possibly extend our intentions-based model and add to its predictive ability. Researchers may consider other psycho-social characteristics that are known to impact on behavioral intentions, e.g., habit or self-identity (Ajzen, 1991; Conner & Armitage, 1998). Moreover, to enhance the robustness of our findings, it would be interesting to replicate this study in the US and UK, which are often referred to as powerhouses of academic entrepreneurship, and China, the world’s largest developing economy. A cross-cultural validation of our path model may further provide promising opportunities for future research, as cultural aspects have recently been shown to be relevant in explaining entrepreneurial intentions (Liñán & Chen, 2009; Prodan & Drnovsek, 2010). Finally, future research could further examine how intentions to opt for an entrepreneurial career precipitate into entrepreneurial behavior. In this sense, we provide some evidence on potential barriers which may inspire future longitudinal testing of the intentions–behavior link in the context of academic entrepreneurship.

Before concluding it is important to consider several limitations of this study. Although the hypothesized path model is grounded in well-established theories, the
correlational design of our study does not allow for strictly causal interpretations. A further limitation is the fact that all information was collected from a single source, except for archival data on scientists’ earlier patenting experience. Finally, due to length constraints in the questionnaire, scientists’ human and social capitals were only assessed using single-item measures. While limiting the number of items that respondents are asked to complete is important, future research may also employ multiple-item measures for these constructs.

7. Conclusion

Although it is always a challenging task to work at the interface of two disciplines, this study could demonstrate the advantages of combining economic and psychological perspectives in the study of academic entrepreneurial intentions. Whereas benefits only affected intentions via the TPB factors, human and social capital indicators also exerted direct effects independently of the TPB framework, and particularly these direct effects may deserve more attention in future studies. Taken together, we thus conclude that the interplay between economic and psychological factors plays an important role for scientists’ transition from academia to entrepreneurship and that future research should continue to shed light on this interplay, preferably in an interdisciplinary manner and using longitudinal designs.
References


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Liao, J. & Welsch, H. (2005). Roles of social capital in venture creation: Key dimensions and


Figure 1. Conceptual model for the prediction of academic entrepreneurial intentions.
Table 1

*Correlations Between the Variables*

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*p < .05. **p < .01. ***p < .001.
Figure 2: Final empirical model for the prediction of academic entrepreneurial intentions. Note. Standardized effects are given. Paths depicted in black represent direct effects and paths depicted in grey indirect effects. This model only includes significant paths. The TPB factor social norms was not included in this model due to the missing effect on intentions. All effects are controlled for gender, age, PhD degree, and type of research (basic vs. applied). Correlations between the economic variables and the control variables as well as between the two residuals of attitudes and perceived control were allowed. $N = 496$. 
Table 2

*Effect Decomposition: Direct, Indirect and Total Effects of the Distal Predictors (Economic Variables) on Academic Entrepreneurial Intentions*

<table>
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*Note.* Standardized values are given.