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APPROACHING THE AGORA –DETERMINANTS OF SCIENTISTS' INTENTIONS TO PURSUE ACADEMIC ENTREPRENEURSHIP

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Abstract: This study investigates predictors of scientists' intentions to commercialize their research through business founding. Analyzing a cross-sectional sample of 496 German scientists, we develop and test an intentions-based model of academic entrepreneurship combining personal and contextual factors. Empirical results demonstrate that intentions to start a science-based new venture are shaped by some personal characteristics (i.e., personal attitudes toward research commercialization, entrepreneurial control-beliefs, entrepreneurial self-identity, and prior entrepreneurial experience). Moreover, we find that the research context itself – i.e., normative influences of academic workplace peers – does not show a strong direct effect on entrepreneurial intentions. Moderator analyses deliver that peers have an influence primarily by person-context interactions via scientists' sense of identification with these peers. A mediation analysis further indicates that gender-related differences in entrepreneurial control-beliefs might help explain the widely-observed low proportion of female scientist-entrepreneurs.

Key words: Academic entrepreneurship, Entrepreneurial intentions, Entrepreneurial scientist, University-industry technology transfer, Theory of planned behavior, Gender

JEL classification: L26 - O33 - O38 - I23

1. Introduction

The economic impact of scientific research has received widespread attention (Dosi, 1988; Rosenberg & Nelson, 1994; OECD, 2003). Academic science has been a crucial ingredient for the development of new innovative products and processes (Mansfield, 1998) and for the emergence of entirely new industries, like biotechnology (Audretsch & Stephan, 1996). As a consequence, universities and public research institutions, traditionally viewed as standing out on the *"Acropolis of scholarship"* (Glassman et al., 2003, p. 353), are called to take on technology transfer and commercialization as an integral part of their activities (Etzkowitz et al., 2000). The emerging concept of the entrepreneurial university, the establishment of technology transfer offices and university patenting strategies as well as a growing interest in academic spin-off firms nicely evidence this shift in perspectives (Rothaermel et al., 2007).

At the core of this closer link between science and industry, the academic scientist is expected to combine traditional tasks in research with economic ends. While the traditional academic ethos did not permit profit from science other than in terms of scientific prestige, this perception has changed remarkably in recent decades (Etzkowitz, 1998; Stuart & Ding, 2006). Now scientists are more and more often adopting the role of entrepreneurs, funneling their research results from the laboratory bench to commercial applications. Metaphorically speaking, the "entrepreneurial scientist" (Etzkowitz, 1998) challenged the Acropolis and "descended into the *Agora*[1], the market place, at the bottom of the temple hill" (Glassman et al., 2003, p.353).

Although science-based entrepreneurship has become an increasingly important issue for scholars and policymakers alike (Toole & Czarnitzki, 2007), surprisingly little is known about "creating new ventures" as a way to commercialize scientific research (Shane, 2004). Only recently, a small body of literature has identified social, institutional, and historical

[1] The "Agora" was an open "place of assembly" in ancient Greek city-states. It served as a market place where merchants kept stalls or shops to sell their goods and where people came together and discussed their lives and the issues of the day.

determinants of entrepreneurial activity among scientists (Louis et al., 1989; Roberts, 1991; Owen-Smith & Powell, 2001; Kenney & Goe, 2004; Stuart & Ding, 2006). Most of these studies, however, draw on a *contextual perspective* focusing on characteristics of the university or the local environment but not necessarily on the individual scientist. In particular, the *scientist* as an important actor in the process of research commercialization has been a relatively neglected objective in this strand of research (Rothaermel et al., 2007). For example, while there is a compelling entrepreneurship literature looking for psychological determinants of an individual's propensity to engage in new venture creation (Krueger & Carsrud, 1993; Krueger et al., 2000), this perspective has not been explicitly linked to entrepreneurial activity in academia.

This lacuna in mind, to our knowledge we offer a first attempt to integrate core variables, both on the individual and contextual level, into a framework that targets scientists' decisions to act entrepreneurially. To this end, we follow the recommended strategy for research on the venture-creation process and apply an interdisciplinary perspective combining arguments from psychology and entrepreneurship (Gartner, 2007). In detail, we focus on the individual scientist's *intentions to start a business based upon his or her own research*. As in the case of general entrepreneurship (Bird, 1988; Krueger & Carsrud, 1993), intentions to engage in new firm formation might be seen as the focal antecedent of the decision to become an academic entrepreneur. Knowledge about the emergence of and influences on scientists' entrepreneurial intentions may therefore be crucial for both future research on the commercialization of science and public policy aiming to stimulate science-based new venture creation. With this in mind, our study aims to develop and empirically test a new *intentions-based model of academic entrepreneurship* incorporating individual characteristics and contextual attributes as well as their complex interplay. We first draw on the theory of planned behavior (Ajzen, 1991), which offers a coherent, parsimonious, and highly-generalizable framework for understanding and predicting intentions (Krueger et al., 2000).

We then extend this framework to incorporate arguments from identity theory (Stryker, 1987) and social identity theory (Tajfel & Turner, 1979; Hogg & Abrams, 1988). To test our hypotheses, we rely on a cross-sectional survey of faculty and research staff of universities and non-university research organizations in the German state of Thuringia.

The paper is structured as follows. Section 2 introduces the concept of entrepreneurial intentions and emphasizes its importance for this study. We then set out our theoretical framework and related hypotheses in section 3. This is followed in section 4 by the presentation of our data and variables used. Section 5 contains the findings of our empirical analysis. Finally, in section 6, we discuss our findings, conclude, and draw implications for future research and practice.

2. The Role of Entrepreneurial Intentions

Entrepreneurship research acknowledges the intentionality of the entrepreneurial process (Bird, 1992; Krueger & Carsrud, 1993). It is well recognized that new firms do not emerge by accident, nor are they a random or passive product of environmental conditions. Instead, acting entrepreneurially is something that people choose or plan to do (Shaver & Scott 1991). The most proximal predictor of the decision to become an entrepreneur is seen in entrepreneurial intentions (Bird, 1988). Simply put, these are cognitive representations of a person'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. Prospective entrepreneurs are therefore assumed to trigger the process of new venture creation with an expression of intentions (Bird, 1988; Krueger et al., 2000). In turn, "absent intention, action is unlikely" (Krueger 2000, p. 8). That is to say, even if people may have significant potential (e.g., a personally viable opportunity), they will refrain from making the transition into entrepreneurship when they lack the intentions

(Krueger & Brazeal 1994). Accordingly, entrepreneurial intentions represent a central variable for researching the entrepreneurial process (Krueger et al., 2000; Lee et al., in press).

Against this background, we apply the concept of entrepreneurial intentions to investigate scientists' proclivity to commercialize own research by setting up a new business, given that their research work would exhibit commercial potential. We acknowledge that starting an entrepreneurial endeavor out of the scientific research context can be deemed an intentions-driven effort. Previous studies suggest that scientists consciously decide whether to become active outside the scientific realm and if so, to what extent, e.g., whether to remain a full-time academic with limited engagement in the new firm or to leave academia and become a full-fledged entrepreneur (Murray, 2004). Hence, the general relationships to be introduced in the next section are expected to hold the same way in an academic context.

3. Theoretical Framework and Hypotheses

Despite the importance of predicting and understanding scientists' involvement in entrepreneurship, there has been a lack of theoretically-motivated research on this issue. Instead, previous studies primarily focused either on *individual-level factors*, like gender (Murray & Graham, 2007), age (Audretsch & Stephan, 1999), and academic status (Shane & Khurana, 2003) or *context-level factors*, such as university traditions (Roberts, 1991) and entrepreneurial peers (Stuart & Ding, 2006; Bercovitz & Feldman, 2008), resulting in a plethora of potentially important antecedents of academic entrepreneurship. Furthermore, both of these streams have evolved in relative isolation, by and large neglecting the fact that one's transition to entrepreneurship is the result of a complex interplay between the individual and his or her environment (Özcan & Reichstein, 2009).

A different and more comprehensive approach is grounded in social psychological research. This literature offers theory-driven models integrating both individual and contextual antecedents of intentions to pursue any deliberate behavior, such as the founding of

one's own firm. A prominent and widely-researched example of these models is Ajzen's (1991) theory of planned behavior (TPB) (for an overview see Armitage & Conner, 2001). As a growing number of studies have recently confirmed the TPB's predictive ability with respect to entrepreneurial intentions in general (Krueger & Carsrud, 1993; Krueger et al., 2000; Autio et al., 2001), we consider the TPB a useful analytical framework to analyze scientists' intentions to become an academic entrepreneur. From the perspective of policymakers and representatives of support programs, the TPB highlights predictors that are amenable to change through interventions (Fayolle, 2005). In particular, knowledge about determinants of scientists' entrepreneurial intentions may give hints as to what type of policy initiative and other university interventions would be instrumental in turning prospective scientist-entrepreneurs into actual company founders.

3.1 The Main TPB Framework

The central premise of the theory of planned behavior (Ajzen, 1991) is that behavioral decisions are not made spontaneously, but are the result of a reasoned process. The most proximal predictor of a person's behavior is thus seen in intentions or willingness to engage in that particular behavior (Ajzen 1991). *Behavioral intentions* themselves are regarded as an additive function of three latent factors: attitudes, social norms, and perceived behavioral control.

First, *attitudes* reflect the individual's enduring evaluation – positive or negative – of engaging in a particular behavior (Ajzen & Fishbein, 1980). Theorists have further argued for a distinction between affective attitudes, referring to feelings or emotions, on the one hand and cognitive attitudes, referring to beliefs, thoughts, or rational arguments, on the other (Crites et al., 1994). Scarcely existing literature on scientists' motivations and attitudes toward own entrepreneurial engagement suggests that scientists allocate their efforts and time toward entrepreneurship if they perceive entrepreneurial activity as positive and

professionally stimulating (Gulbrandsen 2003). Also, academics' entrepreneurial aspirations were found to be driven by the potential commercial benefits of their research (Owen-Smith & Powell, 2001).

The second predictor of intentions, *social norms*, refers to perceived normative pressure from a specific reference group toward engaging or not engaging in a particular behavior (Ajzen, 1991). In line with previous literature on academic entrepreneurship (Louis et al., 1989; Kenney & Goe, 2004; Bercovitz & Feldman, 2008), our study considers individual scientists' workplace peers as a salient reference group determining own entrepreneurial behavior. According to Stuart and Ding (2006), scientists were more willing to become entrepreneurs when colleagues in their university departments had been involved in entrepreneurship and when they perceived commercial technology transfer as legitimate professional activity. Similarly, Bercovitz and Feldman (2008) showed that scientists tend to adopt the behavior of entrepreneurial peers if they were at the same career stage or from the same research field. Following Cialdini et al. (1990), our study further distinguishes between two sources of normative peer influences. The injunctive norm component captures whether scientists' workplace peers would approve or disapprove of one engaging in entrepreneurship, while the descriptive norm component refers to whether workplace peers themselves actually engage in entrepreneurial behavior.

Third, *perceived behavioral control* is comparable with Bandura's (1997) concept of self-efficacy and reflects beliefs about whether one has the necessary capabilities (e.g., time, money, skills, equipment) to perform a particular behavior successfully. According to Ajzen (1988), people who do not feel able to perform the behavior are unlikely to form strong behavioral intentions, even if they have positive attitudes and an approving social environment. In the context of academic entrepreneurship, although scientists may have a positive attitude toward engaging in entrepreneurial activity and believe that their workplace peers would approve of their becoming an entrepreneur, they still may not intend to found

their own firm because they may not feel confident about their entrepreneurial skills. In support of this idea, Lockett et al. (2003) recognized that many scientists lack the competencies to undertake entrepreneurial action as it requires different skills and abilities than purely academic ones.

From this discussion of the TPB we derive five hypotheses (*H1a*)-(*H1e*). We expect affective attitude (*H1a*), cognitive attitude (*H1b*), injunctive norm (*H1c*), and descriptive norm (*H1d*) toward the founding of a firm based upon their own research as well as perceived control over the founding of a firm based upon their own research (*H1e*) to positively predict entrepreneurial intentions among scientists.

3.2 The Extended TPB Framework

Several authors have suggested that Ajzen's (1991) theory of planned behavior (TPB) may be supplemented by additional variables in order to increase the model's predictive utility (see Conner & Armitage, 1998). Among the most frequently used variables are measures of self-identity and past behavior. Evidence for their importance as intention predictors has been provided across a wide range of behaviors (see e.g., Conner & Armitage, 1998; Ouellette & Wood, 1998; Terry et al., 1999). In our study, we assess whether this is the case for intentions to commercialize one's own research through business founding.

First, the link between *entrepreneurial self-identity* and entrepreneurial intentions is grounded in identity theory (Stryker, 1987; see also Terry et al., 1999). Following this perspective, a person's sense of self is conceived as a collection of distinct roles that may be enacted in society, such as mother, spouse, scientist, and entrepreneur, for instance. As a psychological entity, self-identity may be defined as the most salient part of a person's self (Conner & Armitage, 1998). A key proposition of identity theory is that self-identity guides action, suggesting that people are likely to behave in accordance to their salient role (Callero, 1985). Recent attempts to apply this concept to academic entrepreneurship, such as the

qualitative study by Jain et al. (2009), conclude that the transition to academic entrepreneurship involves the adoption of an entrepreneurial self-identity. Scientists who engage in commercial activities were found to have a strong self-perception of being an entrepreneur in addition to their focal identity of being an academic. Accordingly, we assume an entrepreneurial self-identity to positively predict entrepreneurial intentions among scientists, above and beyond the effect of the main TPB variables *(H2a)*.

Our second additional predictor of scientists' entrepreneurial intentions is *past entrepreneurial behavior*. Capturing one's behavioral experiences, several TPB studies reported independent effects of past behavior, over and above the effects of attitudes, social norms, and perceived behavioral control (see Conner & Armitage, 1998; Ouellette & Wood, 1998, for reviews). Similarly, entrepreneurship literature suggests that past experience with firm formation increases the probability of starting-up anew (Ucbasaran et al., 2009). Experienced entrepreneurs are argued being better suited to recognizing business opportunities and even more innovative opportunities than novice entrepreneurs. Investigating the commercialization of patented university inventions, Shane and Khurana (2003) found that the likelihood of a new firm formation based on a university invention is predicted by the academic inventor's prior entrepreneurial experience. Given these arguments, we expect past entrepreneurial behavior to positively predict entrepreneurial intentions among scientists, above and beyond the effect of the TPB variables *(H2b)*.

3.3 The Person-Context Interplay

The theory of planned behavior (TPB) (Ajzen, 1991) has been criticized for its basic assumption that variables in the model are linear in their effects on intentions (and behavior) (see e.g., Conner & McMillan, 1999). It is argued that incorporating interaction effects into the TPB paradigm relaxes this linearity assumption. Interaction effects may also mark boundary conditions for a relationship between variables and may therefore further theory

development. Given that modern approaches of human behavior and development explicitly emphasize the role of person-context interactions (e.g., Elder & Shanahan, 2006), our study sought to examine such dynamics in the context of entrepreneurial behavior among scientists. We considered three interaction hypotheses regarding the interplay of individual and contextual factors in the prediction of intentions to become an academic entrepreneur. Existing theoretical and empirical considerations with respect to each of these interaction effects are justified as follows.

As a general theory of group processes and intergroup relations, social identity theory acknowledges the importance of the social context in behavioral decision-making (Tajfel & Turner, 1979; Hogg & Abrams 1988; see also Terry & Hogg, 1996). Like identity theorists, social identity theorists claim that people are likely to engage in identity-related behaviors in order to validate the salient part of their self-concept (Terry et al., 1999). The basic idea of social identity theory is that a social category, for example the group of workplace peers, which people feel they belong to, provides a source of self-definition. A psychologically important consequence of identifying oneself as a member of a particular group is that one is more inclined to behave according to the perceived norms of that group (Hogg & Abrams, 1988). Thus, whereas the previously discussed injunctive and descriptive norm components capture the direct effects of peer's normative pressure on intentions, an individual's group identification marks boundary conditions for these peer group effects. In this sense, group identification determines the individual's likelihood to follow the group's norms (Terry & Hogg, 1996; Terry et al., 1999). Applying this reasoning to the context of our study, we expect the relationship between injunctive norm *(H3a)* and entrepreneurial intentions as well as descriptive norm *(H3b)* and entrepreneurial intentions to be stronger for those scientists who show higher identification with their group of workplace peers.

Another way for the social context to determine behavioral decision-making is through reinforcing or inhibiting the effects of attitudes on intentions (Terry & Hogg, 1996).

Specifically, a relationship of *contingent consistency* has been suggested such that an individual will behave in a certain way only when both the individual's attitudes and the social environment are strongly favorable (e.g., Andrews & Kandel, 1979). In keeping with this view, academic scientists might be more likely to start their own firm when holding a favorable attitude toward entrepreneurship and when perceiving a reinforcing entrepreneurial climate at the departmental level (see Kenney & Goe, 2004). Consistent with a social identity perspective, the effect of an entrepreneurial climate at the research department – i.e., workplace peers' attitude toward entrepreneurship – might further depend on the individual scientist's level of perceived group identification (see e.g., Terry & Hogg, 1996). Accordingly, we hypothesize that the relationship between affective attitude and entrepreneurial intentions is stronger for those scientists who perceive their group of workplace peers to have a generally positive attitude toward entrepreneurship (i.e., a strong entrepreneurial climate at the departmental level), but only for those scientists who show higher identification with their group of workplace peers *(H3c)*.

Summarizing, in examining the antecedents of entrepreneurial intentions among scientists we draw on the theory of planned behavior (Ajzen, 1991), identity theory (Stryker, 1987), and social identity theory (Tajfel & Turner, 1979; Hogg & Abrams, 1988). We propose a prediction model that accounts for individual-level and context-level variables as well as their interplay, as shown in Figure 1.

4. Research Design

4.1 Sample and Procedure

A cross-sectional survey of faculty and academic research staff was conducted to provide the data for the current study. The research was carried out on a regional basis with a focus on the

German state of Thuringia.[2] Located in the center of Germany, Thuringia has a legacy of science-based entrepreneurship and a broad spectrum of research organizations like universities or non-university research institutions[3]. Data were collected using an internet-based survey.[4] To establish a sampling frame, websites of the research organizations were accessed and prospective participants of the survey were identified. A total of 4638 contact names and email addresses have been collected, comprising scientists from all scientific disciplines. From this initial list of names, a random sub-sample consisting of 2319 individuals was drawn.[5] These scientists were then sent an e-mail containing a cover letter and a link to the online questionnaire.[6]

A total of 565 scientists answered the questionnaire, resulting in a response rate of 24.4%, which is an acceptable rate compared to other studies applying a web-based design (Cook et al., 2000). Compared with official statistics (Statistisches Bundesamt, 2008), the survey sample appeared to be representative in terms of age, gender, and academic rank. Before conducting our statistical analyses, 15 surveys had to be excluded due to incomplete data or non-serious responses. As this study aimed to trace determinants of scientists' intentions to commercialize their own research results, we also omitted responses from faculty and staff members who stated in the questionnaire that they do not conduct any scientific research. This resulted in a final sample size of 496 scientists.

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[2] This study is part of the Thuringian Founder Study ("Thüringer Gründer Studie"). As an interdisciplinary research project, it examines the entrepreneurial process and its antecedents from the perspective of economics and psychology.

[3] Several institutes from three of the most important German public science organizations (Max Planck Society for the Advancement of Science (MPG), Fraunhofer Society for the Advancement of Applied Research (FhG), and Wissenschaftsgemeinschaft Gottfried-Wilhelm-Leibnitz (WGL)) are located in Thuringia.

[4] This way of collecting data was chosen for several reasons. Internet-based surveys allow for highly-standardized data collection at low cost. Furthermore, such surveys are also expected to increase the response rate because the questionnaire can be completed without having to mail any forms (Mann & Stewart, 2000). Moreover, previous research supports reliability and validity of such web-based methods (Gosling et al., 2004).

[5] A small-scale pilot study was carried out prior to the present study in order to identify any problems and omissions with the questionnaire. Following the analysis of the pilot study data, ambiguous or unclear questions were rephrased or removed. Comments and suggestions were taken into consideration for the design of the questionnaire used for this survey.

[6] Two weeks later a reminder was sent to the non-respondents that was set up the same way as the initial e-mail. After another two weeks data collection was completed.

Participants were on average 38.8 years old (*SD* = 11.55, range: 23-65) and mostly male (70.8%). Almost two-thirds worked in a university (65.4%), 10.5% worked in a university of applied sciences ("Fachhochschule") and 24.1% in non-university research institutions. In terms of academic status, 18.5% were professors or university lecturers, 69.8% worked as research associates, and 11.7% reported another field of activity, for example as project-related specialists. Almost half of the sample (46.7%) described their type of engagement in research as basic science, with the remaining being engaged in applied science. Most participants worked in the field of natural sciences (49.8%), while 31.5% were conducting research in engineering sciences and 18.7% in economics, law, or social sciences.

4.2 Measures

4.2.1 Dependent Variable: Entrepreneurial Intentions

Ajzen and Fishbein (1980) distinguish between measures of (1) conditional and (2) unconditional behavioral intentions. Other than unconditional intentions, conditional intentions consider potential barriers that could prevent individuals from intending to engage in a particular behavior. In our case and adapting from Ajzen (2002), conditional *entrepreneurial intentions* of scientists were measured by: "If my research had economic potential, I would intend to participate in the founding of a firm to commercialize the former" (five-point Likert scale; "no" to "yes"). In turn, an unconditional measure would read as: "I would intend to participate in the founding of a firm to commercialize my research". A potential barrier here might be that if respondents consider their research not to be of any commercial application entrepreneurial intentions probably do not show up.[7] To avoid this and to provide evidence on an unselected representative sample of academic scientists, we decided to adjust for the influence of the commercial orientation of scientists' research

[7] Shane (2001) shows that the characteristics of the research scientists do have an effect on the probability that their research will be commercialized through firm formation. Although important, an investigation of these aspects would clearly go beyond the scope of the present paper.

knowledge by solely focusing on conditional intentions.[8] Note that one-item measures of intentions – as we applied it here – have been successfully employed in prior entrepreneurship studies (e.g., Krueger et al., 2000).

4.2.2 Explanatory Variables

Cognitive attitude toward entrepreneurship was tapped applying an indirect, belief-based measure (Ajzen & Fishbein, 1980; Ajzen et al., 2004). First, scientists evaluated four potential outcomes of academic entrepreneurship (i.e., higher personal income, conflict of interests with administrations, additional sources of funding for future research projects, increase in scientific reputation)[9] on a bipolar scale ranging from -2 ("extremely negative") to 2 ("extremely positive"). Second, scientists assessed the probability of these outcomes occurring if they would indeed found a firm (five-point Likert scale; "not at all" to "definitely"). To produce a belief-based estimate of cognitive attitude, belief strength and the corresponding evaluation regarding each potential outcome of academic entrepreneurship were multiplied and the resulting products summed up.[10]

Affective attitude toward entrepreneurship was measured with four five-point bipolar adjective scales (e.g., undesirable – desirable, very boring – very exciting; α = .89) (Ajzen, 2001; 2002). Higher scores indicated a more positive affective attitude toward entrepreneurship.

Injunctive norm was assessed across two items (White et al., 1994), e.g., "Most of my colleagues at the university / research institute would encourage my participation in the

[8] Previous research on entrepreneurial intentions did not adequately consider this distinction, or confounded both types of intentions by taking them together into one variable (e.g., Lee et al., in press).

[9] Potential outcomes of entrepreneurial behavior of scientists were derived from the literature on academic entrepreneurship and university-industry technology transfer (e.g., Etzkowitz, 1998; Owen-Smith & Powell, 2001; O'Gorman et al., 2008) and from interviews with experts (e.g., university administrations, founders of academic spin-off firms).

[10] The internal consistency of this construct is fairly weak, with α = .51. However, as Ajzen (2002) noted, people's attitude toward a behavior may be ambivalent if they believe that the behavior is likely to produce positive (e.g., higher income) as well as negative (e.g., conflicts) outcomes. There is, therefore, no expectation that the different beliefs will necessarily correlated with each other and result in a high Cronbach's alpha.

founding of a firm to commercialize my research" (five-point Likert scale; "not at all correct" to "totally correct"; α = .68). This variable captures (perceived) *workplace peers' pressure* on the responding scientist.

Descriptive norm was determined with two items (Conner & McMillan, 1999), e.g., "How many (if any) of your at the university / research institute have already participated in the founding of a firm to commercialize their research?" (five-point Likert scale; "none" to "all"; α = .64). This variable indicates (perceived) *entrepreneurial activity among workplace peers*.

Perceived behavioral control was assessed by three items used by Ajzen and Madden (1986), e.g., "If I wanted to participate in the founding of a firm to commercialize my research, I am confident that I would succeed" (five-point Likert scale; "not at all correct" to "totally correct"; α = .84). Higher scores on this scale indicated a stronger perception of control over performing entrepreneurial activity.

Entrepreneurial self-identity was measured with three items (Sparks & Shepherd, 1992), e.g., "The idea of participating in the founding of a firm for the commercialization of my research is completely alien to me" (five-point Likert scale; "not at all" to "definitely"; α = .79). Two items were reverse scored. Higher scores reflect a stronger sense of self-perception as a (potential) academic entrepreneur.

Past entrepreneurial behavior was assessed with a single item. Respondents were asked to indicate whether they previously participated in the founding of a firm to commercialize their own research (0 = no; 1 = yes).

Entrepreneurial climate was captured with two items (White et al., 1994; Terry & Hogg, 1996), e.g., "Think about your group of colleagues at the university / research institute: How much would they agree that participation in the founding of a firm to commercialize one's research is a good thing to do?" (five-point Likert scale; "not at all" to "totally"; α = .81). Other than injunctive and descriptive norm, this construct does not imply workplace

peers' pressure or entrepreneurial behavior. It rather captures *workplace peers' general attitude toward academic entrepreneurship.*

Group identification was assessed with two items based on those employed by Terry and Hogg (1996), e.g., "Generally speaking, how much do you identify with your group of colleagues at the university / research institute?" (five-point Likert scale; "not at all" to "totally"; $\alpha = .76$). Higher scores indicate scientists' stronger sense of identification with the group of workplace peers.

4.2.3 Controls

Consistent with previous research (Audretsch & Stephan, 1999; Shane & Khurana, 2003; Murray & Graham, 2007), there are several other influences that may determine scientists' likelihood of entering an entrepreneurial career. Taking this literature into consideration, this study included variables controlling for (1) *gender* (0 = female, 1 = male), (2) *age*, (3) *academic status* (0 = research associate or other field of activity, 1= professor or university lecturer), and (4) *type of research* (0 = basic research, 1 = applied research). We also controlled for scientists' field of specialization (Mansfield, 1998; Nerkar & Shane, 2003) with a series of binary variables (0 = no, 1 = yes) for (5) *engineering sciences*, (6) *natural sciences,* and (7) *social sciences*. The latter category was used as the reference category in the regression models.

4.3 Confirmatory Factor Analysis

To test whether the statistical structure of the measurement scales used in this study is supported by the data, a confirmatory factor analysis was conducted in AMOS 7.0 (Arbuckle & Wothke, 1999). The hypothesized model had eight factors, representing *cognitive attitude*, *affective attitude*, *injunctive norm*, *descriptive norm*, *perceived behavioral control*, *entrepreneurial self-identity*, *entrepreneurial climate*, and *group identification*. The model fits

the data well (χ^2 [178] = 203.37, p = .093, RMSEA = .017, CFI = .994), suggesting that the statistical structure of the measures is sound (Kline, 2005). Taken all together, these results underpin the reliability and validity of the different constructs.

5. Results

Descriptive statistics of all variables and zero-order correlations are provided in Table 1. The bivariate relations between academic entrepreneurial intentions and the expected predictors are all positive and significant. Moreover, scientists report stronger intentions when they are male, conduct applied research, or are engaged in engineering sciences. In order to test for our hypotheses, hierarchical regression analysis is carried out (e.g., Ajzen, 1991), proceeding in seven steps as shown in table 2.[11]

In *step 1*, the control variables (*gender*, *age*[12], *academic status*, *type of research*, *engineering sciences*, and *natural sciences*) are entered into the analysis. Except *gender* all other estimates show up not significant. Accordingly, male scientists report significantly higher levels of entrepreneurial intentions than female scientists (B = .35, β = .15, p < .01).

5.1 The Main TPB framework

Step 2 adds the intention predictors described in the TPB. This model accounts for 33.2% of the variance in the dependent variable, indicating a large effect (Cohen, 1988). In terms of relative contributions, scientists' *affective attitude* toward entrepreneurship (B = .35, β = .32,

[11] Hierarchical regression allows for examining the influence of predictor variables in a sequential way (Petrocelli, 2003). Hence, the relative importance of a predictor entered later in the analysis can be judged on the basis of how much it adds to the prediction of the dependent variable, over and above that which can be accounted for by predictors entered earlier in the analysis. Note that both unstandardized (B) and standardized (β) regression coefficients are reported. As our predictor variables are differently scaled (e.g., cognitive attitude is a multiplicative construct whereas affective attitude is measured on a five-point Likert scale), standardized (β) regression coefficients provide the opportunity to compare the effects of the predictors (see also Cohen et al., 2003).

[12] Entrepreneurship studies have usually found an inverse u-shaped relationship between age and entrepreneurial preferences (Reynolds, 1997). In order to take account of this effect, we additionally include a squared term of the variable age in a separate regression analysis. However, we do not find a significant relationship between age in squared terms and intentions. This might be due to the fact that entrepreneurial intentions, as measured in the current study, are conditional in nature and thus indicate a latent behavioral tendency instead of "real" firm founding behavior.

$p < .001$) and *perceived behavioral control* ($B = .33$, $\beta = .30$, $p < .001$) are the strongest predictors. This confirms Hypotheses *H1a* and *H1e*. In addition and consistent with Hypothesis *H1c*, the *injunctive norm* – the perceived pressure of workplace peers to engage in entrepreneurship – also has a positive effect ($B = .12$, $\beta = .11$, $p < .05$). Other than expected in Hypotheses *H1b* and *H1d* neither *cognitive attitude* nor *descriptive norm* show a significant effect on entrepreneurial intentions.

5.2 The Extended TPB Framework

Moreover, we assume an extended TPB model (with past entrepreneurial behavior and entrepreneurial self-identity as additional direct predictors) to explain more variance in intentions than the standard TPB model. Indeed, *step 3* of the regression analysis, accounting for two additional predictors, significantly contribute to the explanation of intentions ($\Delta R^2 = .05$, $p < .001$). *Entrepreneurial self-identity* ($B = .26$, $\beta = .24$, $p < .001$) and *past entrepreneurial behavior* ($B = .42$, $\beta = .13$, $p < .01$) positively predict academic entrepreneurial intentions, controlled for the TPB predictors (*H2a* and *H2b*) whose coefficients decrease.

5.3 The Person-Context Interplay

For the purpose of testing the observed interaction effects (Hypotheses *H3a-H3c*), we follow the guidelines by Aiken and West (1991). Accordingly, z-standardized variables are used to compute the interaction terms and to conduct the final four steps of the regression analysis. First, in *step 4*, *group identification* and *entrepreneurial climate* are included in the regression equation. Both variables show no significant direct effect. Secondly, in *step 5*, interaction terms between *group identification* on the one hand and *injunctive norm* respectively *descriptive norm* on the other hand are tested. This results in a significant increase in the explained variance ($\Delta R^2 = .01$, $p < .05$). While the interaction between injunctive norm and

group identification (*H3a*) predicts academic entrepreneurial intentions ($B = .09$, $\beta = .08$, $p < .05$), such an effect is not found for the interaction between descriptive norm and group identification (*H3b*). As suggested by Aiken and West (1991), separate (unstandardized) regression coefficients are calculated and tested for significance at high, moderate, and low levels of the hypothesized moderator *group identification*. The three resulting regression lines are illustrated in Figure 2. Supporting Hypothesis *H3a*, the *injunctive norm* positively predicts academic entrepreneurial intentions at high levels of *group identification* ($B = .22$, $p < .05$) but has no significant effect at moderate and at low levels of *group identification* ($B = .12$, *n.s.* and $B = .02$, *n.s.*).

Finally, in order to test the expected three-way interaction (Hypothesis *H3c*), *step 6* considers all lower-order interactions referring to the three-way interaction that is subsequently tested in *step 7*. These final two steps reveal an additional effect of both a two-way interaction between *affective attitude* and *group identification* ($B = -.11$, $\beta = -.10$, $p < .05$) and the expected three-way interaction between *affective attitude*, *group identification*, and *entrepreneurial climate* ($B = -.09$, $\beta = -.09$, $p < .05$, with a ΔR^2 of .01 [$p < .05$] of the final model). Regarding the significant interaction between *affective attitude* and *group identification*, Figure 3 presents separate regression lines at high, moderate, and low levels of the moderator *group identification*. Here, academic entrepreneurial intentions are positively predicted by *affective attitude* at low ($B = .31$, $p < .001$) and moderate levels ($B = .21$, $p < .01$) of *group identification*. In contrast, *affective attitude* has no significant effect on entrepreneurial intentions at high levels of *group identification* ($B = .10$, *n.s.*). To interpret the three-way interaction, separate regression lines at high and low levels of *group identification* as well as at high, moderate, and low levels of *entrepreneurial climate* are calculated. At low levels of *group identification* (see Figure 4A), *affective attitude* has a positive effect on entrepreneurial intentions at low levels ($B = .24$, $p < .01$), moderate levels ($B = .32$, $p < .001$), and high levels ($B = .40$, $p < .001$) of *entrepreneurial climate*. At high levels of *group*

identification (see Figure 4B), *affective attitude* only has a significant effect on academic entrepreneurial intentions at low levels of *entrepreneurial climate* (B = .20, p < .05). At moderate and high levels of *entrepreneurial climate*, *affective attitude* does not have a significant influence on academic entrepreneurial intentions (B = .11, *n.s.* and B = .02, *n.s.*, respectively). Hence, Hypothesis *H3c* is not supported.[13]

5.4 Additional Analysis: Exploring the Gender Gap in Academic Entrepreneurship

Step 1 of the regression analysis reveals that *gender*, in contrast to the other control variables, has a significant effect on academic entrepreneurial intentions (see Table 2). After introducing the TPB variables in *step 2*, however, this effect disappears. One might, therefore, ask whether TPB variables mediate the gender-intentions link (see e.g., Krueger & Carsrud, 1993). Given the fact that the identification of causal mechanisms underlying the often observed gender gap in academic entrepreneurship remains an important puzzle in contemporary entrepreneurship research (Murray & Graham, 2007), this question deserves further scrutiny.

According to Baron and Kenny (1986), a mediation effect is given when (1) the independent variable predicts both the dependent variable and the mediator variable, (2) the mediator variable has an effect on the dependent variable after controlling for the effect of the independent variable, and (3) the effect of the independent variable on the dependent variable is significantly reduced after taking the mediator variable into account. Given the intercorrelations of the variables (zero-order correlations shown in Table 2 along with partial correlations adjusted for the control variables) and the results of step 2 in the regression analysis, only *perceived behavioral control*, among the TPB variables, seems to be a

[13] We assume the dependent variable *entrepreneurial intentions* to be a continuous scale. However, one could also have argued that this scale is an ordinal measure. Rather than hierarchical OLS regression, a common recommendation is then to use ordinal logistic regression models (Zumbo & Ochieng, 2002). As a robustness check of our results, we additionally applied ordered logistic regression. Note that results for both statistical methods do not differ, suggesting that the results presented in this paper are robust in this respect.

candidate for a mediating role, which is in line with previous suggestions in the literature (Wilson et al., 2007; Zhao et al., 2005).

To test for such a mediation effect, regression analyses and a Sobel test with an additional bootstrapping procedure are conducted.[14] As illustrated in Figures 5A and 5B, respectively, *gender* predicts entrepreneurial intentions (B = .36, β = .15, p < .01) and *perceived behavioral control* (B = .63, β = .29, p < .001). Next, controlling for the effect of *perceived behavioral control* (which was: B = .52, β = .49, p < .001), *gender* does not predict entrepreneurial intentions (B = .02, β = .01, *n.s.*). Moreover, a bootstrapping procedure estimates the (unstandardized) indirect effect of *gender* on academic entrepreneurial intentions via *perceived behavioral control* to lie between .21 and .45 with 95% confidence. As a consequence, the indirect effect is significantly different from zero at p < .05. Furthermore, the Sobel test reveals that the effect of *gender* on academic entrepreneurial intentions is significantly reduced following the addition of the possible mediator (z = 5.58, p < .001). In sum, we find support for a mediation effect of gender-related differences in *perceived behavioral control* that might account for the relation between gender and entrepreneurial intentions among scientists.[15]

6. Discussion

The purpose of this study was to provide empirical evidence on antecedents of scientists' intentions to commercialize their own research through founding a new venture. Drawing from Ajzen's (1991) theory of planned behavior, identity theory (Stryker, 1987), and social identity theory (Tajfel & Turner, 1979; Hogg & Abrams, 1988), we propose an intentions-based model of academic entrepreneurship that incorporates individual and contextual

[14] An SPSS-macro provided by Preacher and Hayes (2004) is used to conduct the mediation test.

[15] Note that we also test for interaction effects between gender and perceived behavioral control. Using an interaction term of gender and control-beliefs in hierarchical linear regression, we do not reveal significant effects. This again supports our mediation result as we could rule out the possibility of a moderator effect artificially appearing as a mediator effect (Baron & Kenny, 1986).

predictors as well as their interplay (see Figure 1). In a nutshell, our model proves to be a useful analytical framework. It accounts for 45.4% of the variance in entrepreneurial intentions, which compares favorably to both the 35–42% of explained variance in previous entrepreneurship studies applying intentions-based models (e.g., Krueger et al., 2000; Autio et al., 2001) and the 39% of the variance typically explained across a wide range of other planned behaviors (e.g., dieting, quitting smoking, seatbelt usage) (for a review, see Armitage & Conner, 2001). To begin with, we find more than one-third of the respondents intending to become an academic entrepreneur.[16] While the creation of science-based new ventures is argued to represent a minority phenomenon (Shane 2004), there appears to be a general disposition toward entrepreneurial activity.

Turning to the individual-level predictors of the model (i.e., attitudes, perceived behavioral control, entrepreneurial self-identity, past entrepreneurial behavior), our hypotheses are widely supported by the data. Regarding scientists' attitudes toward entrepreneurship, the emotional component (*affective attitude*) turns out to be a relevant predictor, while the rational component (*cognitive attitude*) does not have an effect. It is therefore a positive feeling and opinion toward research commercialization that predicts scientists' intentions to engage in entrepreneurial activity. This is in line with previous findings emphasizing the "emotional underpinning" of entrepreneurial behavior in non-academic settings (e.g., Smilor, 1997; Cardon et al., in press).

Furthermore, *perceived behavioral control* emerges as a key variable in our model as a scientist's perception of his or her ability to succeed as an entrepreneur has a significant effect on his or her intentions to step into the entrepreneurial realm. This finding concurs with a growing body of research underlining the importance of entrepreneurial control-beliefs (e.g., self-efficacy beliefs) within the entrepreneurial process (see e.g., Rauch & Frese, 2007). The significant relation between these control-beliefs and entrepreneurial intentions further

[16] 37.2% of the surveyed scientists answered with "yes" or "more likely yes" when asked whether they would intend to participate in the commercialization of their research, given the opportunity.

highlights the importance of policy initiatives and support programs aiming to increase the rate of start-ups from the science field. In this regard, sensitizing and qualifying scientists for an entrepreneurial career could be pointed out as a potentially effective strategy.

Entrepreneurial self-identity appears to be the most powerful predictor of academic entrepreneurial intentions. Fully in accord with identity theory (Stryker, 1987), the stronger scientists' sense of themselves as potential entrepreneurs, the higher their intentions to participate in new venture creation. This finding adds empirical evidence to the notion that understanding the (potential) entrepreneur's perception of "I am an entrepreneur" plays a critical role in understanding entrepreneurial activity (Krueger, 2007). Surprisingly, the concept of entrepreneurial self-identity has not yet been explicitly linked to research on academic entrepreneurship. Our paper, together with the recent contribution of Jain et al. (2009), may thus offer a useful first step at bringing the thoughts of identity theorists into this research area.

Our results confirm previous studies (e.g., Delmar & Davidsson, 2000; Ucbasaran et al., 2009) showing that *past entrepreneurial behavior* is an important stimulus for the actual decision to engage in entrepreneurship. We find that scientists' intentions to create a new business in response to a personally-viable opportunity are enhanced by prior firm-founding experience. Hence, there might to be a learning effect on those scientists who are experienced in entrepreneurial activity, making them more likely to start a further new venture (Politis, 2005; Krueger, 2007).

It is notable that context-level parameters, i.e., *descriptive norm* (whether workplace peers actually engage in entrepreneurship) and *injunctive norm* (whether workplace peers would approve of the respondent's entrepreneurial activity), do not emerge as strong direct predictors of academic entrepreneurial intentions. Two explanations for our findings are plausible. First, individual-level factors, such as personal attitudes, control-beliefs, or self-perceptions, might be more influential with respect to entrepreneurial activity among

scientists than the social context, i.e., a scientist's group of workplace peers. Similarly, Krueger et al. (2000) suppose that the "lone entrepreneur's" tendency toward inner-directedness might reduce the impact of social forces. Second, the social context might matter in some but not other conditions. There might be boundary conditions determining the influence of workplace peers on a scientist's decision to participate in research commercialization. Indeed, we find the effect of injunctive norm on entrepreneurial intentions to be moderated by *group identification* (i.e., a scientist's sense of identification with his or her group of workplace peers) (see Figure 2). Note that we do not find such an effect for descriptive norm. This corroborates the distinct nature of peer influences modeled by these two norm constructs. On the one hand, injunctive norm refers to whether entrepreneurial behavior *ought* to be shown by members of the research department, implying concrete expectations and wishes of the scientists' workplace peers. As indicated by the graphs in Figure 2, scientists might be more willing to comply with the expectations and wishes of their group of workplace peers if they feel strongly committed to being a member of this group. On the other hand, descriptive norm captures whether entrepreneurial behavior *is* actually shown by members of the group of workplace peers. However, it does not explicitly impose social pressure to conform and does not show any effect on entrepreneurial intentions. Adding to previous research (Louis et al., 1989; Kenney & Goe, 2004; Stuart & Ding, 2006), these findings demonstrate that instead of working in close proximity to entrepreneurial peers it seems to be *the will to comply with the social pressure of one's peers* that stimulates academic entrepreneurial activity.

Interestingly enough, both the hypothesized interaction between injunctive norm and group identification and the additionally-revealed interaction between affective attitude and group identification (see Figure 3) add up to a pattern of results that is consistent with social identity theory (Tajfel & Turner, 1979; Hogg & Abrams, 1988). Following this pattern, we might argue that there is a continuum between high and low levels of group identification and

that shifts along this continuum determine the extent to which either context-level factors – i.e., injunctive norm – or individual-level factors – i.e., affective attitude – are shaping scientists' entrepreneurial intentions. For example, when scientists report higher levels of identification with their own group of workplace peers, depersonalization occurs, such that the decision to become an academic entrepreneur is guided more by expectations and wishes of the peers at the research department and is less affected by the scientists' own personal attitudes. On the other end of the continuum, for scientists who report lower levels of identification with their group of workplace peers, personal attitudes and beliefs regarding entrepreneurship have a stronger impact on entrepreneurial intentions than the behavioral expectations of their peers.

Our study does not only investigate context-level predictors of entrepreneurial intentions as they were conceptualized in the theory of planned behavior (Ajzen, 1991). We draw from social identity theory (Tajfel & Turner, 1979; Hogg & Abrams, 1988) to also focus on the perceived *entrepreneurial climate* at the research department (i.e., whether workplace peers are perceived as having a generally positive attitude toward entrepreneurship). Following the contingent-consistency hypothesis (e.g., Andrews & Kandel, 1979), we examine whether an entrepreneurial climate at the research context reinforces the effect of scientists' attitudes on entrepreneurial intentions. We do not find a reinforcing effect of an entrepreneurial climate for those scientists who report lower levels of identification with their workplace peers (see Figure 4A). These low-identifiers might generally rely on their own attitudes and beliefs when making the decision to become an entrepreneur, whether or not the departmental climate is perceived as entrepreneurial. Interestingly, our data do not support the contingent-consistency hypothesis in the case of high-identifiers (see Figure 4B). Instead, we find that the effect of scientists' attitudes on entrepreneurial intentions to be reinforced by a departmental climate that is perceived as being incongruent (i.e., non-entrepreneurial). It is possible to speculate, however, that under adverse conditions, a compensation effect occurs

between scientists' personal attitudes and the perceived attitude of the group of workplace peers. For instance, even if scientists personally think of entrepreneurial activity as an unattractive or unpleasant option concerning future career plans (at the left section of the abscissa in Figure 4B), they report higher levels of entrepreneurial intentions if the departmental climate is perceived as highly entrepreneurial. In turn, if scientists feel entirely positive about the option of their own entrepreneurial career (at the right section of the abscissa in Figure 4B), they report higher levels of entrepreneurial intentions even though the departmental climate would have stipulated the opposite.

Finally, our study provides unique evidence on the widely-observed *gender gap in academic entrepreneurship*. According to this notion, female scientists are less likely to participate in the commercialization of their ideas than their male colleagues (Ding et al., 2006; Murray & Graham 2007). An established explanation for the lower proportion of female academic entrepreneurs is that women are underrepresented in fields from which scientists typically launch entrepreneurial activity. Consistent with this argument, we find that female scientists, on average, less often report to conduct research in engineering sciences and in applied sciences, both of which are associated with higher levels of entrepreneurial intentions (see Table 1). Broadly speaking, women might choose scientific career trajectories leading them away from opportunities to get involved with entrepreneurial activities (Rosa & Dawson, 2006). More importantly, our mediation analysis significantly extends this line of argumentation by pointing at a mechanism still missing in the literature on academic entrepreneurship. We find that the effect of gender on entrepreneurial intentions almost completely vanished after taking perceived behavioral control as mediator into account (from $\beta = .15$, $p < .01$ to $\beta = .01$, *n.s.*) (see Figure 5). It seems that female scientists develop lower perceptions of control over entrepreneurial behavior than male scientists and therefore show strong intentions of becoming an entrepreneur less frequently. Indeed, the notion that gender-related differences in perceived career options can be an expression of different levels in

control-beliefs figures prominently in research on vocational behavior (Betz & Hackett, 1981). To date, however, there is to our knowledge no study applying this perspective to the field of academic entrepreneurship. We should note though that other authors did not find the gender-entrepreneurial intentions link to be mediated by entrepreneurial control-beliefs (see e.g., Zhao et al., 2005). One possible explanation might refer to their sample characteristics, with graduating MBA students being the unit of observation. Unlike the scientists in our study, these students might be rather homogeneous in their beliefs of being able to succeed as entrepreneurs given that they have received almost the same amount of entrepreneurship-related education. Nevertheless, the results of our mediation analysis have to be interpreted with caution until they are replicated in future studies.

6.1 Limitations

Our study does not come without limitations. First, the data used is correlational and does not allow for strict causal testing of our hypotheses. Second, all information is collected from the same source by using "only" one method. In contrast to multi-informant/multi-method procedures, this method of data collection may result in common-method bias or may suffer from systematic answering tendencies. Nevertheless, our hypothesized model is grounded in well-established theories and provides results that match with existing theoretical and empirical evidence. Therefore, it seems plausible to assume adequate reliability and validity of our results. A third caveat is that this study is limited to the population of German scientists. This might come at the expense of a more general application of our results in other national contexts. Finally, the dependent variable in this study refers to *conditional* intentions rather than manifest (unconditional) intentions to engage in academic entrepreneurship. However, we are interested in studying an unselected representative sample and not exclusively focusing on scientists whose research is most likely to possess commercial

potential. Our dependent variable therefore relies on a general behavioral tendency that is independent from the condition of commercial potential of scientists' research.

6.2 Implications for Practice and Future Research

Given today's radical social and economic changes, public authorities strive for mechanisms that enable individuals and societies to actively adapt and respond to the new challenges (Silbereisen, 2005). Moreover, economists emphasize the importance of entrepreneurship as an individual's career choice and the entrepreneurial exploitation of scientific research as a particular driver of economic growth (Audretsch, 2007). Consequently, policy schemes targeting academic entrepreneurship might be particularly important.

However, new firms facilitating the commercialization of science do not emerge and form spontaneously in response to formal policies, such as incubators, technology transfer organizations, or start-up programs. It also takes the entrepreneurial scientists actively creating and pursuing commercial opportunities based on new scientific ideas and knowledge. In this respect, our study suggests that interventions targeting scientists' affective attitudes, entrepreneurial control-beliefs, and entrepreneurial self-identity and experiences might be fruitful. Interventions informed by intentions-based models, such as the theory of planned behavior (Ajzen, 1991), have already proved to be 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). Likewise, there is a growing body of empirical evidence indicating that interventions are able to promote *entrepreneurial* mind-sets (e.g., attitudes, self-efficacy beliefs; see Krueger, 2007) and intentions (Souitaris et al., 2007). Consequently, entrepreneurship scholars strongly recommend the use of intentions-based models in the context of entrepreneurship education and training (e.g., Fayolle, 2005). For example, a targeted intervention could teach scientists critical entrepreneurial competencies to foster perceived behavioral control (Krueger et al.,

2000). Information provision and persuasive communication (see Hardeman et al., 2002) to convincingly demonstrate the benefits of academic entrepreneurship might help change attitudes and create an entrepreneurial self-perception among scientists.

Public support schemes may further benefit from understanding that norms and rules of the individual departmental context within which scientists are embedded determine entrepreneurial activity. Specifically, the importance of injunctive norm (i.e., workplace peers' expectations and wishes toward entrepreneurship) advocates an active role for the scientist's group of superiors and colleagues in providing positive pressure to engage in research commercialization. In the light of our findings, policy interventions should be designed to both foster a departmental climate that favors entrepreneurship and strengthen group identification (i.e., scientists' feelings of belongingness to their own group of workplace peers) in order to assist in developing stronger entrepreneurial intentions in academia.

This study also hints at the need for gender-sensitive promotion of academic entrepreneurship. Given the relatively low share of female scientist-entrepreneurs (e.g., 12% in the UK) (Rosa & Dawson, 2006), and the potential entrepreneurial returns stemming from female scientists' research, interventions that are informed by empirical findings seem to be strongly required here. In this regard, our results suggest that fostering female scientists' entrepreneurial control-beliefs might be beneficial in closing the gender gap in academic entrepreneurship (Wilson et al., 2007). However, far more research is needed on gender-specific issues, such as gender-related opportunity structures. We already know from other research that women may encounter greater obstacles than men in the world of work (Haase et al., 2008). These obstacles might also prevent female scientists from starting an entrepreneurial career even though they would like to do so.

Finally, future research needs to explore how scientists' entrepreneurial intentions precipitate into entrepreneurial action. While this paper illuminates antecedents of intentions

"to approach the Agora," possible triggers and barriers beyond intentions, either facilitating or impeding the creation of science-based new ventures, still remain an uncharted area. In this sense, our results invite longitudinal testing of the proposed intentions-based model to further our understanding of scientists' transition to entrepreneurship.

6.3 Conclusion

This study elaborates on the dynamics underlying the occurrence of academic entrepreneurship. Our results suggest that differences in scientists' intentions to approach "the Agora" – the commercial sphere beyond academia – might be best understood when considering scientists as both self-determined agents in their own career development (Lerner & Busch-Rossnagel, 1981) and agents in contexts (Bronfenbrenner, 1979). While previous research revealed a number of important predictors of general entrepreneurial activity either from the individual or the contextual domain, we draw a somewhat different and more elaborate picture. In detail, the results demonstrate the importance of scientists' individual entrepreneurial characteristics. Academic entrepreneurship, like entrepreneurship in general, is a challenging task and scientists may only intend to engage in it if a fit between their mind-sets and this task is given. Furthermore, the academic context (i.e., normative influences of scientists' workplace peers) appeared to operate primarily through interactions with individual characteristics. It therefore seems that in order to understand scientists' transition to entrepreneurship we have to consider both the individual scientists and their contexts (Lee et al., in press; Özcan & Reichstein, 2009), as well as the interplay of both (Reynolds 1997).

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Table 1

Descriptive Statistics and Intercorrelations

Variable	M	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) Gender	0.71	0.46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(2) Age	38.80	11.55	0.24***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(3) Academic status	0.18	0.39	0.25***	0.48***	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(4) Research type	0.53	0.50	0.13**	0.15**	0.03	-	-	-	-	-	-	-	-	-	-	-	-	-
(5) Engineering sciences	0.32	0.47	0.10*	0.09	0.02	0.35***	-	-	-	-	-	-	-	-	-	-	-	-
(6) Natural sciences	0.50	0.50	-0.08	0.01	-0.08	-0.31***	-0.68***	-	-	-	-	-	-	-	-	-	-	-
(7) Social sciences	0.19	0.39	-0.02	-0.12*	0.07	-0.02	-0.33***	-0.48***	-	-	-	-	-	-	-	-	-	-
(8) Descriptive norm	1.62	0.68	0.17***	0.16**	0.14**	0.19***	0.27***	-0.17***	-0.10*	-	-	-	-	-	-	-	-	-
(9) Injunctive norm	3.06	0.81	0.06	0.10*	0.05	0.06	0.12**	0.10*	0.02	0.31***	-	-	-	-	-	-	-	-
(10) Cognitive attitude	3.41	0.96	-0.09*	-0.12**	0.01	0.01	0.02	-0.03	0.02	0.01	0.17***	-	-	-	-	-	-	-
(11) Affective attitude	9.30	8.28	0.08	-0.03	-0.04	0.21***	0.16**	-0.13**	-0.02	0.19***	0.38***	0.26***	-	-	-	-	-	-
(12) Perceived behavioral control	2.95	1.01	0.28***	0.11*	0.18***	0.16***	0.11*	-0.21***	0.14**	0.21***	0.28***	0.21***	0.52***	-	-	-	-	-
(13) Entrepreneurial self-identity	3.21	1.09	0.17***	0.15**	0.12**	0.25***	0.16**	-0.19***	0.06	0.21***	0.26***	0.14**	0.59***	0.54***	-	-	-	-
(14) Past entrepreneurial behavior	0.11	0.31	0.18***	0.24***	0.22***	0.11*	0.09	-0.08	-0.01	0.18***	0.17***	0.08	0.29***	0.35***	0.33***	-	-	-
(15) Group identification	3.57	0.79	0.08	0.02	-0.02	-0.00	0.02	0.04	-0.08	-0.00	0.15**	0.01	-0.01	0.05	0.05	0.09	-	-
(16) Entrepreneurial climate	3.16	0.87	0.11*	-0.01	-0.01	0.07	0.07	-0.06	-0.01	0.32***	0.63***	0.10*	0.27***	0.21***	0.22***	0.08	0.14**	-
(17) Entrepreneurial intentions	3.17	1.07	0.15**	0.00	0.04	0.13**	0.10*	-0.11*	0.03	0.12*	0.33***	0.22***	0.51***	0.50***	0.51***	0.32***	0.03	0.24***

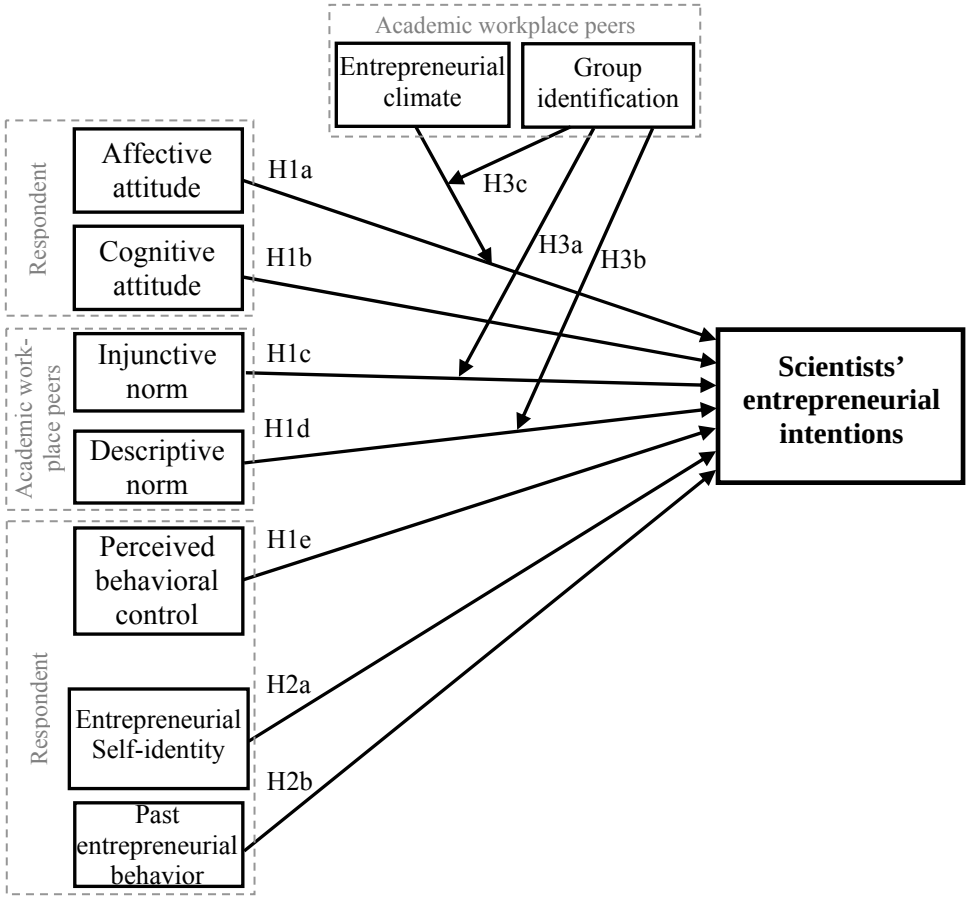
*$p < .05$. **$p < .01$. ***$p < .001$.

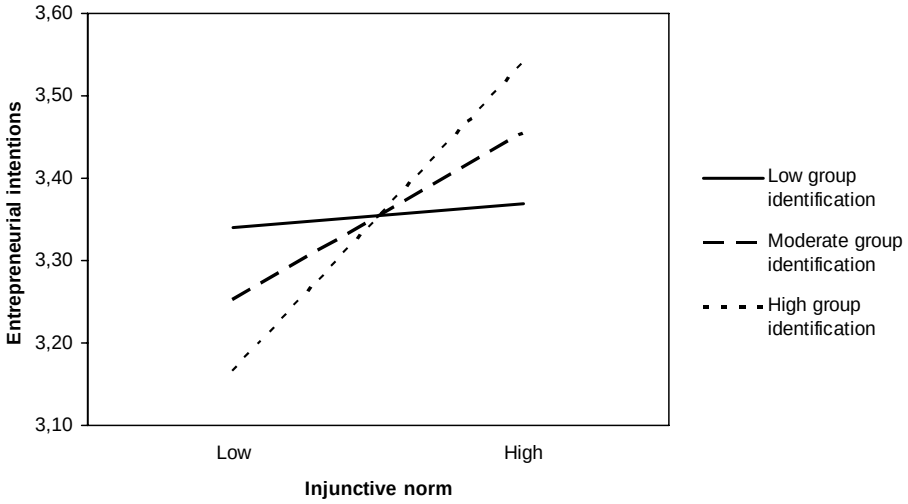
Table 2

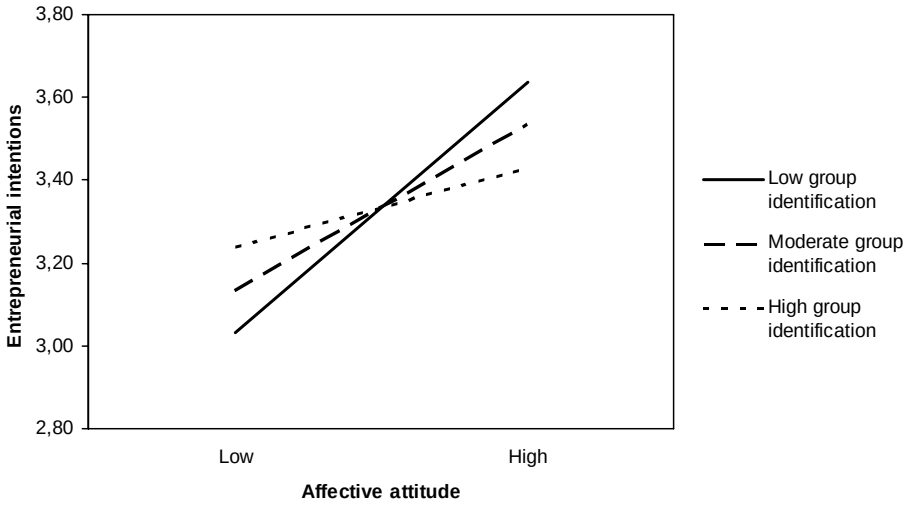
Hierarchical Regression Analysis Predicting Scientists' Entrepreneurial Intentions ($N = 402$)

	Controls (Step 1)		TPB (Step 2)		Extended TPB (Step 3)		Social Identity Hypotheses (Step 4)		(Step 5)		Contingent-Consistency Hypothesis (Step 6)		(Step 7)	
	B	β	*B*	β	*B*	β	*B*	β	*B*	β	*B*	β	*B*	β
Constant	3.12		3.16		3.34		3.34		3.38		3.36		3.36	
Gender (male = 1)	.35	.15**	.13	.06	.10	.04	.10	.04	.09	.04	.11	.05	.10	.04
Age	-.01	-.10	-.00	-.04	-.01	-.09	-.01	-.09	-.01	-.11*	-.01	-.10*	-.01	-.10*
Academic status	.12	.04	.03	.01	-.02	-.01	-.02	-.01	.02	.01	-.02	-.01	-.02	-.01
Type of research	.19	.09	-.03	-.02	-.06	-.03	-.06	-.03	-.07	-.03	-.07	-.03	-.05	-.02
Engineering sciences	.15	.07	.09	.04	.10	.05	.10	.05	.12	.05	.13	.06	.11	.05
Natural sciences	-.02	-.01	.06	.03	.10	.05	.10	.05	.12	.05	.11	.05	.11	.05
Cognitive attitude			.06	.06	.06	.05	.06	.05	.06	.05	.06	.06	.07	.06
Affective attitude			.35	.32***	.23	.21***	.22	.21***	.20	.19**	.20	.18**	.22	.20***
Injunctive norm			.12	.11*	.11	.10*	.09	.09	.10	.09	.11	.10	.10	.09
Descriptive norm			-.03	-.03	-.04	-.03	-.04	-.04	-.03	-.03	-.02	-.02	-.02	-.02
Perceived behavioral control			.33	.30***	.22	.20***	.22	.20***	.21	.20***	.22	.20***	.23	.20***
Entrepreneurial self-identity					.26	.24***	.26	.24***	.26	.24***	.26	.24***	.26	.24***
Past entrepreneurial behavior					.42	.13**	.43	.13**	.38	.12**	.39	.12**	.42	.13**
Group identification							-.00	-.00	.00	.00	.00	.00	-.00	-.00
Entrepreneurial climate							.03	.02	.03	.02	.03	.02	.03	.03
Injunctive norm x Group identification									.09	.08*	.14	.14*	.14	.14*
Descriptive norm x Group identification									.07	.06	.06	.06	.06	.06
Group-identification x Entrepr. climate											-.08	-.07	-.08	-.08
Affective attitude x Group identification											-.11	-.10*	-.11	-.10*
Affective attitude x Entrepr. climate											-.00	-.00	-.00	-.00
Affective attitude x Entrepr. climate x Group identification													-.09	-.09*
F	3.037**		21.356***		21.910***		18.915***		17.509***		15.361***		15.033***	
R^2	.044		.376		.423		.424		.437		.446		.454	
ΔR^2			.332***		.047***		.000		.013*		.010		.007*	
Adjusted R^2	.030		.358		.404		.401		.412		.417		.424	

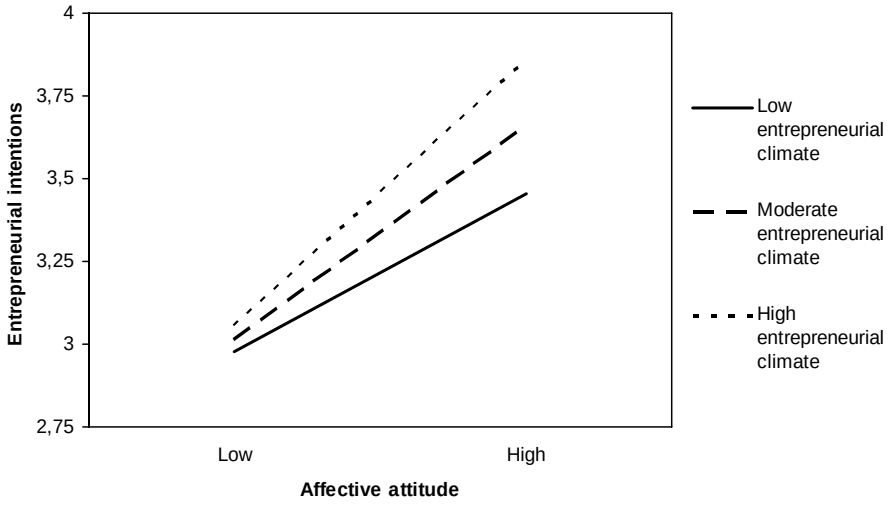
*$p < .05$. **$p < .01$. ***$p < .001$.


Academic workplace peers
Entrepreneurial climate
Group identification
Respondent
Affective attitude
Cognitive attitude
Academic work-place peers
Injunctive norm
Descriptive norm
Respondent
Perceived behavioral control
Entrepreneurial Self-identity
Past entrepreneurial behavior
H1a
H1b
H1c
H1d
H1e
H2a
H2b
H3a
H3b
H3c
Scientists' entrepreneurial intentions

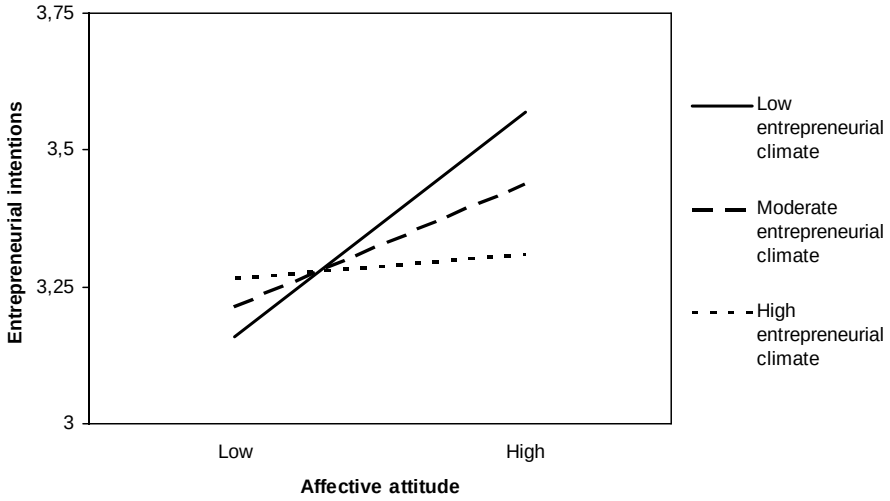

3,60
3,50
3,40
3,30
3,20
3,10
Entrepreneurial intentions
Low
High
Injunctive norm
Low group identification
Moderate group identification
High group identification


3,80
3,60
3,40
3,20
3,00
2,80
Entrepreneurial intentions
Low
High
Affective attitude
Low group identification
Moderate group identification
High group identification

A **Low group identification**



B **High group identification**



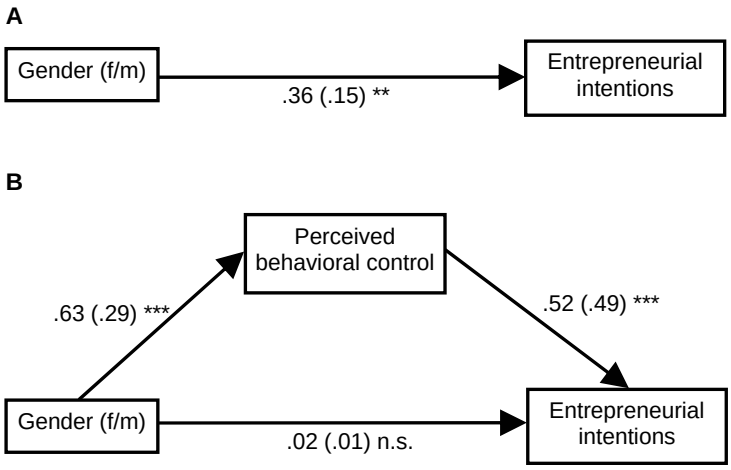

A
Gender (f/m)
.36 (.15) **
Entrepreneurial intentions
B
Perceived behavioral control
.63 (.29) ***
.52 (.49) ***
Gender (f/m)
.02 (.01) n.s.
Entrepreneurial intentions

Figure Captions

Figure 1: Hypothesized intentions-based model of academic entrepreneurship.

Figure 2: Two-way interaction between injunctive norm and group identification on entrepreneurial intentions.

Figure 3: Two-way interaction between affective attitude and group identification on entrepreneurial intentions.

Figure 4: Three-way interaction between affective attitude, entrepreneurial climate and group identification on entrepreneurial intentions (contingent-consistency hypothesis).

Figure 5: Perceived behavioral control as a mediator between gender and entrepreneurial intentions; 5A: Direct effect of gender on entrepreneurial intentions, 5B: Mediation model. *Note*. Unstandardized coefficients with standardized coefficients in brackets are given. $^{**}p < .01$. $^{***}p < .001$.