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Petra Moog, Arndt Werner, Stefan Houweling and
Uschi Backes-Gellner

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University of Zurich, Plattenstrasse 14, CH-8032 Zurich,
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Contact Details

Petra Moog

University of Siegen

petra.moog@uni-siegen.de

Tel.: +49 (0)271 740 3012

Arndt Werner

Institute for SME Research Bonn (IfM Bonn)

Stefan Houweling

University of Siegen

Uschi Backes-Gellner

University of Zurich

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Petra Moog*, Arndt Werner**, Stefan Houweling***

and Uschi Backes-Gellner****

* Petra Moog
University of Siegen, p.moog@uni-siegen.de, Tel.: +49 (0)271 740 3012

** Arndt Werner
Institute for SME Research Bonn (IfM Bonn)

*** Stefan Houweling
University of Siegen

**** Uschi Backes-Gellner
University of Zurich

Abstract: Little is currently known about the effects of skill composition on academic entrepreneurship. Therefore, in this paper, following Lazear's (2005) jack-of-all-trades approach, we study how the composition of a scientist's skills affects his or her intention to become an entrepreneur. Extending Lazear, we examine how the effect of balanced skills is moderated by a balance in working time and peer effects. Using unique data collected from 480 life sciences researchers in Switzerland and Germany, we provide first evidence that scientists with more diverse and balanced skills are more likely to have higher entrepreneurial intentions, but only if they also balance their working time and are in contact with entrepreneurial peers. Therefore, to encourage the entrepreneurial intentions of life scientists, it must be ensured that scientists are exposed to several types of work experience, have balanced working time allocations across different activities, and work with entrepreneurial peers; e.g., collaborating with colleagues or academic scientists who have started new ventures in the past.

1 Introduction

Recent developments in university policies and governance structures are intended to foster an entrepreneurial climate in the university environment to facilitate technology transfer from the ivory tower, i.e. fostering technology development and making academic scientists more entrepreneurial (Shane 2004). In becoming entrepreneurial, academic scientists may improve their reputation, earn more income and gain more satisfaction (Lam 2010). Along this line, a continuously increasing number of academic scientists have founded university spin-offs in the last decade by using their acquired knowledge as well as patents and licenses from universities (e.g. Stuart and Ding 2006). However, compared to the general population, fewer academic scientists consider starting their own businesses: they tend to concentrate their occupational choices on being employees (Thurik 2003). Nevertheless, empirical evidence relating the background of scientist's skills and specific environmental factors such as work time allocation and peer effects to these scientists' entrepreneurial activities remains scarce (Nicolaou and Birley 2003).

Our paper tries to fill this research gap by studying how a life scientist's skill composition affects their intention of becoming an entrepreneur, moderated by work time and peer effects. Specifically, we follow Lazear's (2005) jack-of-all-trades approach and examine the effects of balanced entrepreneurial skills on scientists' propensity to become entrepreneurs. The fact that scientists – compared to non-scientists – are characterized by relatively homogeneous human capital at the beginning of their careers underlines the influence that balanced skill sets – acquired through more diverse work experience when working in academia in different academic settings – have on scientists' occupational choices. At the beginning of their careers, scientists know how to conduct research, teach and write

academic studies, but on average, they do not know how to patent, license results or start up a business with their research results (Horlings and Gurney 2013). In line with Lazear's (2005) key idea, we argue that, all else being equal, researchers who have a more balanced portfolio of skills are also more willing to transition into entrepreneurship in the near future.

Balance in the sense of Lazear (2005) means that people specialized in one aspect are 'unbalanced'. An individual is balanced in their skills and human capital when they have a broad skill set. The limiting factor in starting a business or becoming an entrepreneur is an individual's weakest skill, which results from a gap in a person's experience. Lazear (2005) discusses roles in former jobs, such as administration, technical experience, and project management. He then adds these different roles to produce a balance variable, which is measured by the total number of roles that the individual has had. We adopt this concept to measure the skills achieved during an academic career. By doing so, we screened the literature on academics and their different work tasks and experiences and came up with a list of thirteen different work fields mentioned in the recent scientific discussion (i.e. Ding 2011; Louis et al. 1989). Those are the traditional work fields of publishing research results, teaching and advising students and PhDs, contribution to committees, boards, and commissions, informal meetings and contacts as well as free sharing of research results. Moreover, scientists do contract research and share equipment, do collaborative research with academic and non-academic third parties, exhibit patent and licensing activities as well as consultancy activities. To get an impression of how much time was spend on different tasks; we followed the approach of Colbeck (1998). That is, we measured how much work time was spent on teaching, academic administration, research, non-commercial use of research findings, commercial use

of research findings, setting up new research projects and other fields of activity. In particular, we study the experiences of researchers in different academic work activities and analyze the extent to which these (combined) activities affect their entrepreneurial intentions. In addition, we analyze how balanced working time and experience with peers moderate the effect of the portfolio of skills, arguing that these aspects deliver a) additional experience in managing time and organizing a scientist's work day and b) additional skills and experiences through contact with peers with different backgrounds. Moreover, following the peer literature (Falck et al. 2010; Nanda and Sorensen 2010) we argue that peer groups with entrepreneurial background influence the decision to become an entrepreneur assuming that networks and peer groups may provide role models and thus, fostering the partial skill effects.

Recent work in the entrepreneurship literature has begun to shed light on the effects of skills on the propensity of scientists to become entrepreneurs; however, most studies in this field of research focus on specialized experiences and thus neglect multifaceted experiences (e.g., Allen et al. 2007; Ding 2011). Most authors just analyze the impact of general human capital on the probability to become an entrepreneur and find especially industry experience and higher qualifications trigger the intention (i.e. Davidson and Honig 2003). Very few authors provide evidence of a difference between a more balanced or specialized human capital with regard to academic entrepreneurship and that broader skills are more helpful (i.e. Roach and Sauermann 2012). Moreover, studies focus on the general environment, such as institutional settings and networks (i.e. Colombo et al. 2010), but they rarely address more immediate environmental factors affecting scientists, such as their work time, organization or work peers (i.e. Lam 2010). Our contribution lies in the

connection of these three aspects that have in the past been more or less neglected, even when they are considered important in the general personnel economics or start-up literatures (i.e., Acs et al. 2009; Nanda and Sorensen 2010). We shed the focus on peers because we believe first that the literature results show that the peer effect in academia may be stronger than in a general work environment (Merton 1957; Göktepe-Hulten and Mahagaonkar 2010). Scientists are much more highly dependent on peer opinions, interactions and relations due to peer reviews in journals or conferences and peer evaluations when applying for an academic position. Therefore, peers' entrepreneurial behavior represents a signal that this type of behavior is acceptable for the community or, in some cases, even individually rewarding (Lam 2007). We focus on the connection to work time because if people concentrate on one or two roles in their work time, they can neither develop nor use new experiences in other fields. We contribute to the entrepreneurship literature by focusing on two new aspects: the combination of skills as a trigger for entrepreneurial intention and the combination of individual aspects related to the work environment such as work time and peers.

Using unique data collected from 480 Swiss and German life sciences researchers, we find that having a balanced skill set positively affects the intention to become an entrepreneur in cases where organizational peers have entrepreneurial ideas and where the working time is balanced between different academic activities. Thus, our main finding is that only if the environmental factors – and here especially the peer group effects – support an entrepreneurial climate, a more diverse set of skills together with a balanced working time will lead to higher entrepreneurial intentions of scientists.

The paper is organized as follows. In the next section, we discuss how the jack-off-all-trades perspective may help explain the propensity of scientists to become entrepreneurs. Section three explains our empirical method and shows our results. Finally, in section four, we discuss our results, indicate the limitations of our study and make some concluding remarks.

2 Theory and Hypotheses

2.1 General developments in academia

Recent changes and developments in university policies and governance structures aimed to foster an entrepreneurial climate in the university environment to facilitate technology transfer from the ivory tower to industry and thus to foster technological development, improve countries' competitive advantage and make academic scientists more entrepreneurial (OECD 2005). In particular, the Bayh-Dole Act in 1980 in the USA may be considered the starting point of such changes in university policies (Karlsson and Wigren 2012). Many other countries have adopted similar changes in law since this act, such as Germany in 2001/2002 and Switzerland beginning in the new millennium. The main idea of these enactments was that scientists and universities would generate more research that could be commercialized if they could benefit from their inventions in a direct way through, for example, spin-offs, licensing rewards or other income sources (Klofsten and Jones-Evans 2000). Affected by the new law, many universities have changed their policies from a Mertonian norms-influenced policy to an entrepreneurial-oriented approach. These changes did occur not only because of the chances to participate in the commercialization of scientific knowledge. Diminishing state funds are

another reason why universities and scientists were pushed to generate more third-party funds. To gain these third-party funds, universities and scientists were forced to build another type of reputation: an entrepreneurial one (Henkel 2007). Nevertheless, many scientists continue not to have entrepreneurial intentions, and not all universities have become 'entrepreneurial universities'. Consequently, several studies address the question of why some scientists decide to start new ventures while others completely avoid moving towards self-employment (e.g., Lam 2010). In sum, the results of these studies indicate that the factors motivating university scientists to transition into entrepreneurship may be very specific.

2.2   *Antecedents of academic entrepreneurship and hypotheses building*

2.2.1 Skill Approach

One of the main factors related to general entrepreneurial success is human capital (Allen et al. 2007). Especially in innovative start-ups, such as life sciences spin-offs, entrepreneurs are said to require a set of skills to transform their ideas into profitable ventures (Bygrave and Hofer 1991). Prior knowledge is regarded as a key factor in enabling a spin-off to exploit new market opportunities (Ardichvili et al. 2003), and a certain level of knowledge is a prerequisite for successfully recognizing and processing new external information. Consequently, the success of a new spin-off depends strongly on the founder's skills, knowledge and their educational background. Following Boeker and Fleming (2010), we argue in this study that these competencies are mostly related to what the founder has learned and observed during his or her previous academic job career. Put differently, past work experience and skills gained in specific working environments are considered key factors of the founder's knowledge base and their ability to manage the specific challenges related to entrepreneurship. Knowing about this relationship between

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human capital, skills and entrepreneurial success and being rational, people who currently have these skills should develop stronger intentions to become entrepreneurs. This learning may occur by undertaking different tasks with different degrees of time spent in these activities as well as through peers and interactions with them. Therefore, we focus on these three issues. Hills et al. (1999) support this view, demonstrating that 50-90 percent of start-up ideas are derived from previous work experience. Following this general idea, Kakati (2003) identified a broad range of skills that a diversified management team or a single entrepreneur should possess, i.e., both managerial and technical skills. Moreover, many studies show that employees should be exposed to working conditions that provide a specific type of job variety or diversity to develop a broad knowledge base about how businesses are run and organized and to learn how to act with great flexibility (Baron and Markman 2003). Therefore, we focus on the specific work environment and conditions of scientists.

To address this problem, Lazear (2005) developed the jack-of-all-trades approach, which differentiates between different types of skills. This approach ascertains that a specific mixture of human capital is essential for the founding of a start-up because an entrepreneur needs not only specific human capital but also a generally broader set of skills[1]. This broad set of skills is required because of the several challenges faced by entrepreneurs, such as the acquisition of capital or human resource management. In our paper, we assume that scientists may also acquire a variety of specific skills by being exposed to specific working conditions which are, in sum, conducive to entrepreneurship.

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[1] A detailed list of those variables may be found on page 15.

Whereas several empirical findings relating to start-ups in general (for an overview, see Unger et al. 2011) support the idea that human capital increases the willingness to transition into entrepreneurship as well as the success of start-ups, few studies investigate the relation of human capital and university spin-offs, and even fewer examine the jack-of-all-trades approach in the context of academic entrepreneurship (Shane 2004). Some general studies have found evidence that a more balanced, respectively diverse skill set supports entrepreneurial intentions as well as the success of new start-ups. Wagner (2004), for example, finds evidence that the probability of being self-employed in regular professions depends on the number of different types of professional training and changes in profession. Baumol (2005) demonstrates that the human capital of independent inventors who found their own business differs from that of inventors hired by large firms. Whereas large firms seek highly specialized human capital, independent inventors require a generalized human capital stock – in Lazear's terms: a balanced stock. Contrary to these findings, Silva (2007) finds no evidence for the jack-of-all-trades approach. Finally, the study of Stuetzer et al. (2012) reveals a positive relationship between a balanced set of skills or human capital portfolio and (general) entrepreneurial intentions, represented by the progress of a nascent entrepreneurial venture. We thus believe that it may be reasonable to replicate this test for a specific group of scientists as well. Moog and Backes-Gellner (2013) find evidence that students with more diverse sets of skills have stronger intentions of starting a business than other students and that this effect is stronger for male than for female students. However, none of these studies focuses specifically on scientists nor analyzes how balanced skills influence this group.

Meanwhile, empirical research on the skills, experience or professional education (human capital: PhD, tenure, research productivity, publishing and patenting activities) of academic entrepreneurs is mostly conducted from an ex-post perspective (e.g., Ding 2011; Roach and Sauermann 2012). Moreover, these studies generally do not integrate multifaceted experiences. For example, in an analysis of 400 scientists from US universities, Allen et al. (2007) present first evidence that human capital indicators are directly linked to the extent of science-industry relations and patenting rates by scientists. They find that specific human capital indicators, such as tenure, academic status, PhD experience, and discipline indicators, among others, are directly linked to the extent of science-industry relations and patenting rates by scientists. The authors argue that (faculty) patenting behavior may serve as an indicator of entrepreneurial activities; this finding provides a first hint of peer effects. However, this study does not focus on entrepreneurial activities such as start-ups or university spin-offs. Karlsson and Wigren (2012) focus on human and social capital as well as legitimacy and find first evidence that one specific type of human capital investment, such as supporting colleagues to start a business, increases academics' propensity to start a business on their own. This finding represents another hint of peer effects and in addition learning, but again neglects other academic activities. Boehm and Hogan's (2012) study finds that principal investigators - when organizing collaborative industry-academic research projects with multiple stakeholders – must act like jacks-of-all-trades following role models such as negotiators, project managers, resource developers and PhD supervisors and mentors to make their project successful. Comparing the effect of the prior activities of researchers on becoming a consultant or entrepreneur, Ding and Choi (2011) show that publication output, patent experience, co-authorships and networking are positively related to both scientific

consulting activities for companies and becoming an entrepreneur. Therefore, this latter study suggests that some specific individual skill sets support entrepreneurial intentions as well as spin-offs.

Nevertheless, a combined effect in the sense of Lazear remains to be found. Moreover, two important issues in the context of academic scientists are peer groups and work time, which may moderate the effect of balanced skills. Consequently, our contribution is to apply Lazear's jack-of-all-trades theory to the special case of the entrepreneurial intentions of scientists to demonstrate that the effect of a more balanced skill set is moderated by peer group and working time effects.

2.2.2 Work time and peers

The fact that scientists – compared to non-scientists – are characterized by relatively homogeneous human capital at the beginning of their careers underlines the influence that broader skill sets – acquired through more diverse work experience – have on their occupational choices. However, we argue that specific environmental and motivational aspects will also affect a scientist's propensity to become an entrepreneur. In other words, we believe that these specific environmental and motivational factors are the main reasons that scientists with more diverse portfolios of skills have higher propensities towards entrepreneurship. Moreover, we believe that scientists must also invest a reasonable amount of working time in the activities necessary to acquire these skills. In line with this reasoning, we believe that more balanced working time should also help to build a more diverse set of skills affecting the propensity of scientists under specific organizational circumstances to become entrepreneurs.

For instance, personal relationships and a peer-group orientation are vital for shaping individual behaviors and ambitions (Lam 2007). Young scholars are especially likely to orient themselves according to existing norms or leadership behaviors. These norms, often provided by leaders in the academic context (i.e., chair of the department or faculty), create the organizational culture. If the chair of the department is highly involved in entrepreneurial activities, they send a strong positive signal to other scientists in the department regarding these activities, whereas a chair avoiding entrepreneurial activities negatively influences the other scientists' entrepreneurial development (Bercovitz and Feldman 2008). However, organizational norms cannot be implemented solely by leaders because members of an organization could merely symbolically abide by these norms. In fact, the organizational culture is only truly able to implement behavioral norms if the majority of faculty members comply with them. According to Stuart and Ding (2006), personal relations, networks and interactions are one of the most important factors driving individual behavior and internalized norms. Peers may support entrepreneurial ideas and create pressure on individuals to internalize norms to conform to the peer group. The closeness and especially the frequency of interactions strengthen the induced learning effects. Individuals compare themselves and their behaviors to those of other individuals who are similar to them. Therefore, peers must have similar social statuses, personal skills and interests (Ellison and Fudenberg 1993). For scientists, colleagues are the relevant peer group relating to professional norms. Therefore, the level of collegial support is considered one of the most important factors related to the entrepreneurial activities of scientists (Link and Ruhm 2011). Therefore, group leaders, department chairs or PhD or post-doc colleagues who have been entrepreneurs or who are involved in university-industry cooperation are able to provide other faculty members with

contacts in the economic sector. Scientists may also acquire entrepreneurial knowledge from experienced faculty members via spill-over effects (Acs et al. 2009). As Nanda and Sorensen (2010) show for employees in different industries, even peers with negative entrepreneurial experience may influence the general thinking about entrepreneurship positively and change the motivation of co-workers, thereby facilitating their transition into entrepreneurship. Therefore, the learning effect of peers with entrepreneurial experiences should be considered when analyzing scientists' intentions to become entrepreneurs. Moreover, as previously mentioned, the environment for academic scholars has changed in the past two decades, and long-established Mertonian norms have given way to more entrepreneurial approaches (e.g., Thursby and Thursby 2002). Individuals often perceive this changing environment as creating pressure on them to change their individual attitudes, i.e., to comply with the newly established norms. Consequently, the implementation of these new organizational norms should also foster the previously discussed peer effects and, consequently, the scientists' propensity to become entrepreneurs (Thursby and Thursby 2002).

Therefore, in sum, we hypothesize the following:

Hypothesis 1: If organizational peers support entrepreneurial ideas, then a more diverse set of skills and working time will positively affect the propensity to become an entrepreneur.

3 Data and Variables

We collected data on Swiss and German scientists in 2007. A total of 1,760 scientists responded to our online survey, and 480 answered all of the questions relevant to our empirical analysis, yielding a completion rate of 23.58 percent.

Acknowledging that our sample is one of convenience, we compared it to data from the German Federal Statistical Office and the Swiss Statistical Office as well as from Life Sciences Federal organizations in both countries regarding gender or age. We find a high degree of similarity between the scientists within our sample and the scientists within other data sources and are thus confident that our sample is not seriously biased.

3.1 Dependent Variable

Propensity to become self-employed — For the composition of our dependent variable, we rely on the answers regarding the future career choices of the responding scientists. They were asked whether they planned on becoming entrepreneurs in the near future and to estimate the probability of such an occupational change in the near future on a Likert scale ranging from 1 (very unlikely) to 5 (very likely). Figure 1 shows the distribution of this variable.

> Figure 1 about here <

We realize that intention-based measures represent only the first step towards becoming an entrepreneur and acknowledge that not all of the researchers who have the intention to become entrepreneurs will actually do so. However, many empirical studies have shown that actual entrepreneurs are a sub-sample of so-called latent entrepreneurs (i.e., people who in the past have wished to become entrepreneurs). Moreover, early entrepreneurial intentions have been shown to be the single best predictors of starting a business later (i.e. Krueger et al. 2000; Villanueva et al. 2005) and represent the best measure of capturing the idea of preparing for an occupational choice.

3.2 Independent Variables

More diverse *set of skills* — Our sample includes information on a variety of specific skills that have been acquired by the scientists through exposure to specific working conditions. Following Lazear's (2005) jack-of-all-trades theory, the sum of these experiences should be conducive to entrepreneurship. In particular, we collected data on (1) patent activities; (2) licensing activities; (3) collaborative research activities with academic and non-academic third parties; (4) consultancy; (5) publications; (6) contract research; (7) free sharing of research results; (8) shared usage of equipment; (9) education of students and PhD candidates; (10) advising for master and PhD theses; (11) staff outflow; (12) contribution to committees, boards, and commissions; and (13) informal meetings and contacts. Following Lazear's (2005) number of roles measure, we have constructed an additive index of up to 13 different researcher experiences to construct a balanced skill set drawn from these activities.

$$Balanced\ Set\ of\ Skills\ =\ \sum_{i=1}^{13} Xi \qquad (1)$$

In accordance with Schmoch (2003) as well as Karlsson and Wigren (2012), we condensed the information on the different activities, i.e., the quantity of these experiences (e.g., how long, how much), by creating a set of binary variables (i.e., one indicator per activity). Each of these dummy variables takes on the value "0" if the researcher never acquired the skill and "1" otherwise. A higher index value indicates a greater balance and diversity of the skills of the responding scientist; this configuration is in line with the approach of Lazears (2005). Descriptive statistics reveal that the average scientist in our study is engaged in approximately 8.1 activities with a standard deviation of 2 of the 13 activities. Therefore, the

average scientist is highly balanced (or diversified) in his or her activities and thus experiences.

Working Time Balance — As an indicator of balanced working time, we use the distribution of the individual scientist's working time (as a percentage) with respect to the sum of his or her fields of activities and responsibilities. The seven possible categories underlying this variable include (1) teaching; (2) academic administration; (3) research; (4) non-commercial utilization of research findings; (5) commercial utilization of research findings; (6) procurement of new research projects; and (7) other fields of activity. If a scientist's working time is perfectly balanced, he or she should spend exactly 1/7 of his or her total working time on each of these activities (i.e., 14.3 percent). Not surprisingly, the observed values deviate from this balanced value. We thus constructed a balance score for each scientist based on the sum of his or her individual deviations from the perfectly balanced value. High negative values of this variable indicate a more unbalanced distribution of working time with respect to the previously mentioned fields of activity. Low negative values indicate a relatively well-balanced distribution of working time. Descriptive statistics show that, on average, scientists are characterized by a deviation of approximately 38.5 percentage points from the perfectly balanced value, with a standard deviation of 11.2 percentage points.

Peer Effects — With regard to the entrepreneurial peer groups, we include a binary variable in our regression models for whether colleagues in the department have already started a new venture. A majority of 55.2 percent of the scientists in our sample stated that at least one person among their group leaders, department chairs, PhD or post-doc colleagues had at some point been an entrepreneur.

3.3   Control Variables

To control for department-specific effects and financial capital endowments, the regressions include a (standardized) *faculty size* variable, reflecting the number of employees and budgets of the responding scientists' departments. Moreover, past research has also shown that socio-demographic factors may affect the propensity to become self-employed (Parker 2004). In Switzerland and Germany, as in many other countries, fewer *women* than men start new businesses. Ding and Choi (2011), for example, show that female scientists are about one fifth less likely than male scientists to become academic entrepreneurs. In addition, *older* employees are considered to be more risk-averse than younger ones and are less likely to work the long hours often required of entrepreneurs (Jain et al. 2009). We also control for the type of research a scientist is involved. In the life sciences, it is common to differentiate between basic, *applied* and *applied-oriented* research. Basic research, for example, is often considered non-commercializable because of its primarily basic and theoretical nature. Finally, we include one variable that denotes whether the university has a formal *technology transfer office* (TTO) and control for *country effects* using a country dummy variable (1=Switzerland, 0=Germany).

3.4   Analytical Approach

In our empirical models we regress scientists' propensity to leave paid employment for self-employment on more diverse skills, balanced working time, peer effects and the control variables. In addition to the diverse skill variable (additive index), we have also included the set of binary skill variables (one indicator for each activity) to control for specific activity effects so that any intervening effects on our diverse skill variable, the dependent variable, may be ruled out in this respect. Three

different specifications of the empirical model are estimated. First, we examine the role played by the set of binary skill variables and control variables discussed above, ceteris paribus (Model 1). Second, we include the variables representing a broader range of skills, balanced working time and peer effects (Model 2). Third, to test Hypothesis 1, we include a three-way interaction consisting of our three central variables: diverse set of skills, balanced working time and peer effects (Model 3). Because three-way interaction models with continuous variables are prone to multicollinearity, which may lead to numerical instability and inflated standard errors, we followed the recommendation of Aiken and West (1991) and mean centered the skill diversity and the work-time balance variables. Moreover, because our dependent variable is a five-item ordinal scale variable, the appropriate econometric model is a regression model for ordinal outcome variables. When we illustrate our results, we display the predictive probabilities that the likelihood of becoming an entrepreneur is "very likely" (Likert scale value = 5). Moreover, the empirical models presented here have robust standard errors with correction for heteroskedasticity. Table A1 in the appendix provides descriptive statistics for all variables and the correlations of key variables used in our empirical analysis.

4   Results

Table 1 presents the estimation results. As displayed in Model 3, the three-way interaction effect of *Peers*Skill Diversity*Working Time Balance* is statistically significantly different from zero at any conventional level (β=.010; p<.05). The predictive probabilities are displayed in Figure 2. The results show that scientists with a broader range of skill scores and high degrees of working time balance have a higher propensity to become entrepreneurs if they work with entrepreneurial peer groups in their departments. Therefore, Hypothesis 1 is supported by the data.

Regarding our control variables, in line with prior research (Murray and Graham 2007), we find that *female* scientists are much less willing to spin off or start a business compared to their male counterparts, all else being equal. We find stronger differences in the context of scientific entrepreneurship, where even fewer women plan becoming founders of spin-offs. This finding might be due to the working conditions in the life sciences, where it is difficult to balance family concerns and careers due to long working hours and time spent in the lab (e.g., night shifts). Moreover, with regard to *age*, we find evidence for the idea that younger scientists have a higher propensity to become entrepreneurs relative to their older counterparts. This might be caused by the specific characteristics of the life sciences, in which spin-offs often require long periods of time before generating real profits and thus, the cash-in effect will occur much later than in non-academic start-ups. Following the idea of human capital, older individuals will not invest in this "risky" occupational choice because the investment will deliver no short-term rewards. In addition, if the department falls into the category of *basic* rather than *applied research*, then the scientists in that department have a lower propensity to become entrepreneurs. Finally, with regard to the *specific skill variables*, we find a significant positive effect of consultancy and a significant negative effect of publication. In other words, scientists who are involved in consulting activities in the private sector have a higher intention of switching into entrepreneurship. Meanwhile, scientists who invest in publishing their research papers are less likely to leave the university and switch into entrepreneurship. This result implies that

successful scientific publication somewhat crowds out entrepreneurial behavior from an academic scientist's perspective. Put differently, scientists who are successfully publishing research papers appear to remain in academia because of their better career prospects in that field (Ndonzuau et al. 2002).

5   Discussion and Outlook

Despite the importance of academic entrepreneurship, empirical evidence relating scientists' backgrounds to their intentions of becoming entrepreneurs remains scant (Nicolaou and Birley 2003). Our paper has contributed to filling this research gap by studying how a scientist's human capital, as well as their work time and peers affect the intention to become an entrepreneur in the near future. By analyzing the standard working conditions to which scientists are exposed at their workplace, we find that those who are engaged in more diverse activities are also significantly more likely to have higher start-up intentions when working in an entrepreneurial environment. Thus, our results are in line with those of Ding and Choi (2011), who show that publication flow, patent experience, co-authorships and networking have a positive influence on scientists' becoming entrepreneurs, even when testing singular effects. The interesting point here is that for scientists, the effect of a more diverse skill set holds, especially when the set occurs in a peer environment that is positively related to entrepreneurship and when work time is balanced. This relation between entrepreneurial intention and peer effects may occur because of the special environment these scientists work in. Whereas some universities have adopted the entrepreneurial university approach, other universities continue to follow an approach highly influenced by Mertonian norms. Consequently, scientists are under high peer pressure. If universities want to produce more entrepreneurial scientists, they need to foster an entrepreneurial environment. Universities' policies often

focus on monetary incentives to motivate scientists to create spin-offs or on institutional measurements like TTOs and patent strategies with the aim to support university spin-offs. In this context, our main results become of high interest: we find that in this setting the jack-of-all-trades effect (balanced skill set) works more like a latent capacity for entrepreneurship that can only be activated under specific conditions like being influenced by entrepreneurial peers. So, if university policies are already in place focusing on creating scientists with balanced work skills and allocating their work time on different activities, our findings outline the importance of looking at entrepreneurial experience when hiring new key employees at universities. According to our results, this strategy should help to create a more entrepreneurial environment and complement universities entrepreneurial strategies.

Peer-related results for more diverse human capital for the general population of other studies support our findings (e.g., Bercovitz and Feldman 2008; Acs et al. 2009). Therefore, our results add one more contribution to the discussion of academic entrepreneurship in terms of considering the three-way interaction. These results provide significant support for our hypothesis, which proposes that the positive moderating effect of entrepreneurial peers and more diverse skills is significantly stronger when scientists balance their working time across different activities. Technically speaking, this finding implies that these scientists are perfectly established in the new scientific mode described by Etzkowitz (i.e., 2003): they 'live' according to the entrepreneurial university. Surprisingly, the three-way interaction also shows that a high skill score (together with a low working time balance) only result in high entrepreneurial intention under weak peer effects. We have two explanations for this effect. First, we follow Campell et al. (2012) and

Werner and Moog (2009), explaining that quite often highly skilled individuals who do not find support in their work environment may be pushed into entrepreneurship to generate more satisfying career or working conditions. In this specific case of researchers with even low work balance, not only the peer group but also the work environment might frustrate the individual. A second explanation may be that some scientists who feature a broader set of skills but a low work-time balance and a weak peer effect have non-job-related learning settings where they diversify their skillsets. These scientists are able and willing to become entrepreneurs, but because of the lack of peer support, they concentrate on specific working areas, such as cooperation with industry, where they may find personal contacts with experienced entrepreneurs and firms. Those contacts may later help the scientists become entrepreneurs themselves.

Another interesting issue is the changing environment in academia. If universities in Switzerland and Germany develop as expected and transition to the US model, which features teaching and research universities, we will observe both effects on work-time balance and peer effects. At teaching universities, it might become increasingly difficult to generate a positive intention due to bad conditions – or, as mentioned previously, scientists will escape this environment and start their own company. In research universities that are highly interrelated with industry, we may find stronger positive effects.

However, future research could analyze each working condition in greater detail, by, for example, examining the length, extent, scope or range of the experience or how specific activity sets interact and differ in quality. Moreover, in our paper, we analyzed how individuals engaging in the generation of the previously mentioned skill combinations develop stronger intentions to become self-employed by viewing

this type of occupational choice as a chance to earn higher income or utility in later stages of their careers – either outside academia or in combination with an academic career. In contrast to this approach, Åstebro and Thompson (2011:1) claim that the relation of varied work histories to entrepreneurship can also be explained by "…the simple story that individuals with a taste for variety prefer to become entrepreneurs because doing so provides utility.". Ghiselli (1974) defined this as 'hobo syndrome.' Both theoretical approaches positively relate work or experience variety to entrepreneurship. In our paper, we do not discuss or analyze this aspect due to data restrictions. Therefore, further research could explore these two approaches and attempt to discriminate between them in the academic field by relating variety to income data. However, this phenomenon again would require testing using different data, particularly longitudinal data.

With regard to the controls our data do not enable us to support previous findings that *TTOs* and entrepreneurship courses for scientists have a positive impact on the entrepreneurial intentions of researchers. Therefore, even though most of the literature supports the notion that the presence of a TTO supports the entrepreneurial activities of scientists (i.e. Nosella and Grimaldi 2009), this effect appears to depend on the quality of the TTO (e.g., size, age, specialization of the TTO employees, incentives).

In conclusion, we believe that our work on the entrepreneurial intentions of scientists provides a useful starting point for more comprehensive studies on the occupational choices of researchers. Despite some limitations, we believe that our study provides novel insights into the career decisions of scientists. We provide first evidence that researchers with broader experience through diverse academic working conditions develop stronger intentions of becoming academic

entrepreneurs when working in a peer-supported entrepreneurial environment. This finding, in turn, highlights the importance of recognizing that researchers' experiences in different academic tasks (teaching, research and transfer) represent the most important factors determining entrepreneurial intentions. Therefore, the notion supported in life science faculties - and in other faculties - of focusing increasingly on publications in journals in making career decisions could be detrimental to the entrepreneurial initiatives of scientists; in contrast, it would be helpful to also foster or honor collaboration with industry or when young scientists are applying for a research group leading position or a professorship. However, our analysis is only a first step. Future research should provide more in-depth analyses of the human capital of scientists, the quality and quantity of different skill combinations related to different peer or institutional environments and the resulting synergy effects. This future research should help researchers more explicitly examine how the experience and skill profiles of scientists relate to their entrepreneurial intentions, their founding of start-ups and the success of their entrepreneurial activities.

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Tables included in the text

Table 1: Ordered Probit Estimation Results

DV: Entrepreneurial Intentions (5-item-Likert scale)	Model 1 Coef.	Model 2 Coef.	Model 3 Coef.
Controls			
Faculty Size	-0.003 [0.037]	-0.004 [0.038]	-0.001 [0.038]
Gender (1=female)	-0.327** [0.139]	-0.321** [0.140]	-0.281** [0.142]
Age (in years)	-0.022*** [0.007]	-0.021*** [0.007]	-0.022*** [0.008]
Country (1 = Switzerland)	0.044 [0.160]	0.025 [0.162]	0.003 [0.163]
Basic Research[1]	-0.294** [0.136]	-0.307** [0.138]	-0.284** [0.138]
Applied-oriented Research[1]	0.163 [0.122]	0.169 [0.123]	0.178 [0.124]
TTO	-0.008 [0.119]	0.002 [0.119]	0.002 [0.119]
Skill Dummy Variables			
Patent Activity	0.257** [0.124]	0.064 [0.182]	0.076 [0.184]
Licensing Activities	0.150 [0.122]	-0.034 [0.187]	-0.024 [0.187]
Collaborative Research Activities	0.027 [0.143]	-0.157 [0.209]	-0.140 [0.210]
Consultancy	0.540*** [0.136]	0.377** [0.189]	0.350* [0.188]
Publications	-0.753** [0.380]	-0.932** [0.397]	-0.930** [0.413]
Contract Research	0.236 [0.149]	0.078 [0.194]	0.096 [0.195]
Free Sharing of Research Results	0.333 [0.280]	0.111 [0.334]	0.137 [0.347]
Shared Usage of Equipment	-0.006 [0.196]	-0.171 [0.254]	-0.168 [0.255]
Education of Students and PhDs	-0.397 [0.289]	-0.583 [0.348]	-0.522 [0.349]
Coaching of Master and PhD Thesis	0.094 [0.356]	-0.082 [0.403]	-0.007 [0.428]
Contribution to Committees etc.	0.090 [0.144]	-0.064 [0.192]	-0.032 [0.194]
Informal Meetings and Contacts	0.090 [0.126]	-0.101 [0.119]	-0.100 [0.195]
Central Variables			
Skill Diversity		0.166 [0.131]	0.166 [0.137]
Work Time Balance		-0.001 [0.006]	-0.006 [0.008]
Skill Diversity*Work Time Balance			-0.004 [0.004]
Peers		0.136 [0.119]	0.061 [0.127]
Peers*Skill Diversity			-0.013 [0.065]
Peers*Work Time Balance			0.007 [0.011]
Peers*Skill Diversity*Work Time Balance			0.010** [0.005]
Log likelihood	-487.4	-485.9	-483.6
Observations	480	480	480

[1]Reference: Applied Research.. Robust standard errors in brackets. ***, **, * indicate significance at 1%, 5%, and 10% level, respectively.

Figures included in the text

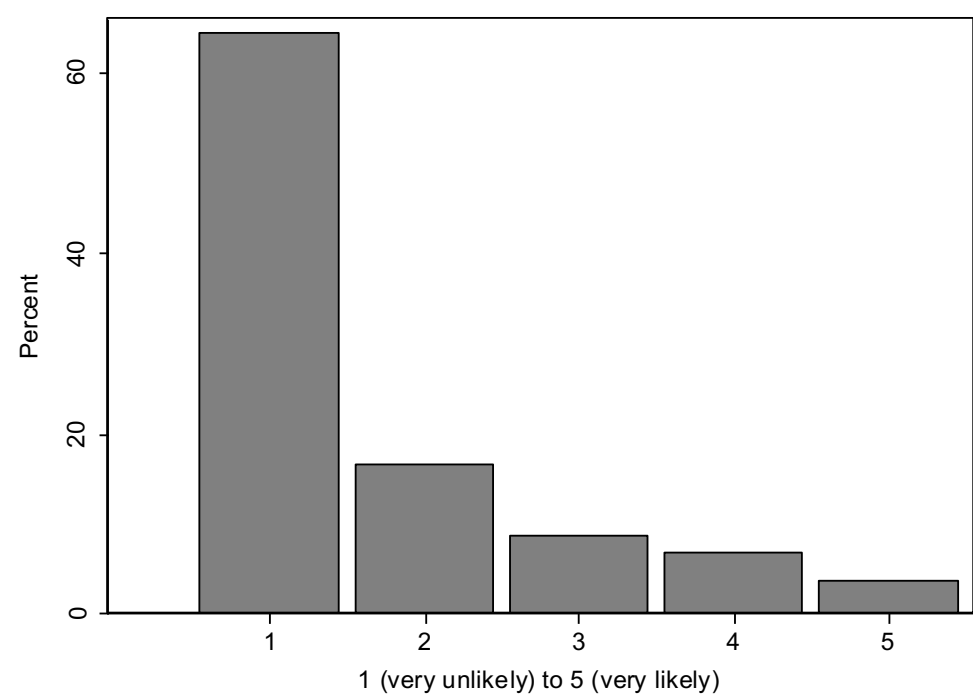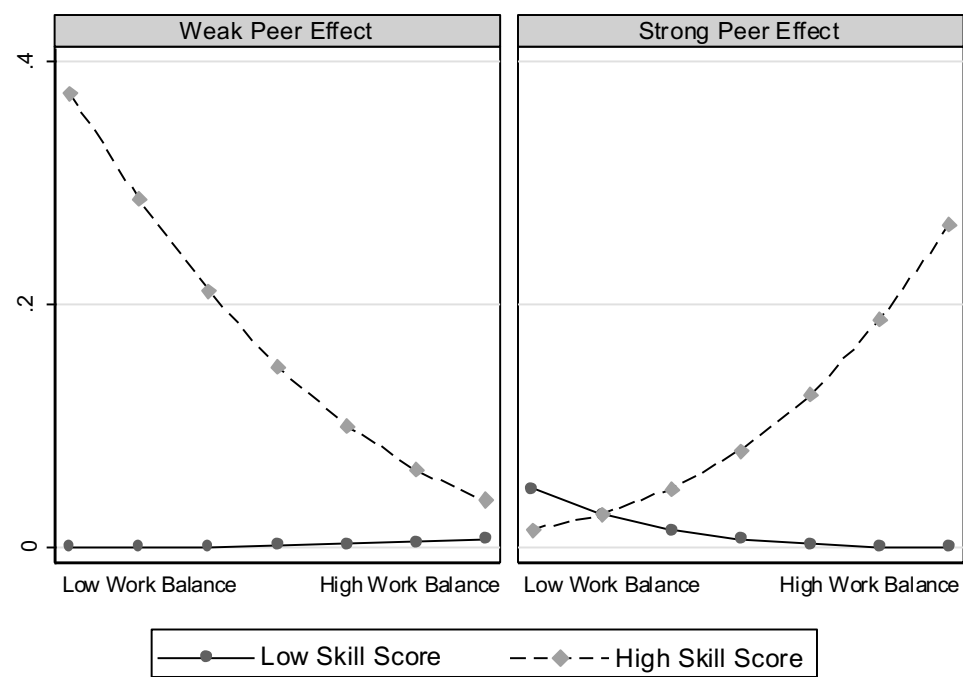**Figure 1: Distribution of the Propensity to become Self-Employed**

Figure 2: Three-Way Interaction: Skill Diversity, Time Balance and Peers

Appendix

Table A1: Descriptives and Pair-Wise Correlations

		Mean	S.D.	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
(1)	Entr	1.68	1.10	1.00	5.00	1.00																						
(2)	FacSize	0.07	1.15	-0.68	14.52	0.06	1.00																					
(3)	Female	0.25	0.43	0.00	1.00	-0.12	-0.14	1.00																				
(4)	Age	45.81	8.85	29.00	68.00	-0.02	0.23	-0.19	1.00																			
(5)	Country	0.14	0.35	0.00	1.00	0.02	0.15	-0.11	0.10	1.00																		
(6)	BasicR	0.69	0.46	0.00	1.00	-0.17	-0.08	-0.04	-0.01	0.03	1.00																	
(7)	AplR	0.42	0.49	0.00	1.00	0.17	0.05	-0.07	-0.04	-0.04	-0.32	1.00																
(8)	TTO	0.61	0.49	0.00	1.00	0.01	0.05	-0.06	0.11	-0.04	0.00	0.04	1.00															
(9)	Patent	0.44	0.50	0.00	1.00	0.16	0.20	-0.10	0.18	0.04	-0.04	0.17	0.06	1.00														
(10)	Licensing	0.40	0.49	0.00	1.00	0.14	0.09	-0.12	0.23	0.03	-0.07	0.08	0.02	0.33	1.00													
(11)	Collaboration	0.79	0.41	0.00	1.00	0.07	-0.03	-0.09	0.01	-0.00	-0.08	0.06	-0.02	0.02	0.01	1.00												
(12)	Consulttancy	0.23	0.42	0.00	1.00	0.24	0.22	-0.13	0.23	0.08	-0.13	0.13	0.08	0.18	0.22	0.08	1.00											
(13)	Publication	0.97	0.16	0.00	1.00	-0.06	0.06	-0.05	0.10	-0.00	-0.03	0.01	0.05	0.10	0.08	0.07	0.03	1.00										
(14)	ContractR	0.25	0.43	0.00	1.00	0.21	0.10	-0.06	0.10	0.06	-0.27	0.25	0.07	0.15	0.24	0.14	0.22	0.10	1.00									
(15)	FreeSharing	0.94	0.24	0.00	1.00	0.05	0.04	-0.09	0.13	0.01	0.07	0.05	0.13	0.11	0.12	0.03	0.06	0.12	0.07	1.00								
(16)	SharedUsage	0.11	0.32	0.00	1.00	0.10	0.09	0.02	0.04	0.17	-0.12	0.14	-0.05	0.06	0.10	0.11	0.14	0.06	0.33	-0.07	1.00							
(17)	Education	0.96	0.19	0.00	1.00	-0.04	0.06	-0.12	0.09	0.02	0.03	-0.05	0.05	0.02	0.00	-0.05	0.08	-0.03	-0.04	0.08	-0.17	1.00						
(18)	CoachingPhD	0.96	0.20	0.00	1.00	0.04	0.02	0.00	0.01	-0.06	-0.06	0.08	0.02	0.03	-0.03	-0.01	0.07	0.03	0.05	0.03	-0.02	0.12	1.00					
(19)	Committees	0.73	0.44	0.00	1.00	0.02	0.18	-0.25	0.29	0.14	0.05	-0.02	0.02	0.17	0.16	0.03	0.08	0.19	0.09	0.12	0.03	0.10	0.15	1.00				
(20)	InformalCont	0.62	0.49	0.00	1.00	0.14	0.04	-0.05	0.01	0.09	-0.09	0.16	0.03	0.11	0.13	0.14	0.21	0.11	0.29	0.10	0.25	-0.06	0.11	0.05	1.00			
(21)	SkillDiversity	0.00	2.01	-6.14	4.86	0.26	0.22	-0.21	0.28	0.14	-0.13	0.22	0.06	0.51	0.54	0.34	0.49	0.25	0.55	0.30	0.38	0.12	0.21	0.42	0.54	1.00		
(22)	WorkTimeB	-0.00	11.18	-37.21	29.22	0.09	0.11	-0.07	0.06	-0.03	-0.09	0.12	0.05	0.17	0.18	0.03	0.19	0.13	0.20	0.13	0.09	0.25	0.21	0.35	0.05	0.36	1.00	
(23)	Peers	0.55	0.50	0.00	1.00	0.11	0.09	-0.06	0.02	0.06	-0.04	0.03	0.08	0.20	0.16	0.07	0.10	0.11	0.05	0.17	0.02	-0.02	0.01	0.06	0.07	0.21	0.06	1.00