Knowledge context and entrepreneurial intentions among students

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Abstract The current paper analyzes the role of the individual and regional knowledge context in forming university students' entrepreneurial intentions. As access to knowledge resources is crucial for the growth and survival of knowledge-based start-ups, we argue that an individual's decision in favor or against becoming an entrepreneur should critically depend on the multilevel context providing her with access to strategically relevant knowledge. A unique dataset for German students and regions allows us to analyze a variety of personal and regional determinants of entrepreneurial intentions among students. At the individual level we find that role models facilitating the transfer of tacit knowledge and the expectation that strong ties will provide know-how and know-who positively impact entrepreneurial intentions. At the regional level we find that a high regional start-up rate in knowledge-based industries and a high growth rate of regional knowledge production positively influence entrepreneurial intentions.
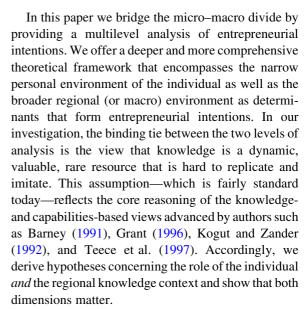
1 Introduction

In modern economies knowledge is arguably the most strategically significant resource of a firm. Its outstanding strategic importance arises from the fact that knowledge is a dynamic, valuable, and rare resource that is hard to replicate and imitate, making it a major determinant of corporate performance and sustained competitive advantage (Barney 1991; Kogut and Zander 1992; Grant 1996; Teece et al. 1997). Recent research suggests that the access to knowledge resources does not only impact the performance of incumbent firms but also—and in particular—the growth and survival of (knowledge-based) start-ups (Audretsch and Lehmann 2005b; Audretsch and Dohse 2007; Hatch and Dyer 2004; Holcomb et al. 2009; Unger et al. 2011). It is therefore straightforward to argue that an individual's decision in favor or against becoming an entrepreneur should critically depend on the multilevel context that provides her with the access to strategically relevant knowledge.

However, while it is by now widely accepted that an individual's educational attainment, work experience or prior knowledge play an important role in the

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process of opportunity perception and exploitation (Bates 1995; Dunn and Holtz-Eakin 2000; Shane 2000), we are lacking systematic evidence on how an individual's personal and regional context provide her with strategically relevant knowledge and how this impacts her entrepreneurial intention. Hence, the aim of the current paper is to systematically explore the role of the multilevel knowledge context—i.e., the social and regional environment in which an individual is embedded—in providing access to strategically relevant knowledge and forming entrepreneurial intentions.[1]

The paper builds on and contributes to the literature on the determinants of entrepreneurship. In broad terms, two different strands of the literature have developed which appear largely unconnected so far: On the one hand, there is a rich and growing literature on the individual-level (i.e., person-specific) determinants of entrepreneurship. This literature has produced ample empirical evidence that the occupational choice to become an entrepreneur depends on individual traits, ability, and skills, but also on an individual's accumulated social capital (Davidsson and Honig 2003; Arenius and De Clercq 2005; Ucbasaran et al. 2008). On the other hand, there is a more macro-oriented literature dealing with the impact of the broader regional environment (e.g., macroeconomic and institutional conditions at the regional level) on the regional rates of new firm formation (e.g., Carlton 1983; Reynolds et al. 1994; Rocha and Sternberg 2005). Although it is evident that both literatures are highly complementary, they are largely unconnected so far and take little notice of one another.[2,3]

In this paper we bridge the micro–macro divide by providing a multilevel analysis of entrepreneurial intentions. We offer a deeper and more comprehensive theoretical framework that encompasses the narrow personal environment of the individual as well as the broader regional (or macro) environment as determinants that form entrepreneurial intentions. In our investigation, the binding tie between the two levels of analysis is the view that knowledge is a dynamic, valuable, rare resource that is hard to replicate and imitate. This assumption—which is fairly standard today—reflects the core reasoning of the knowledge- and capabilities-based views advanced by authors such as Barney (1991), Grant (1996), Kogut and Zander (1992), and Teece et al. (1997). Accordingly, we derive hypotheses concerning the role of the individual *and* the regional knowledge context and show that both dimensions matter.

Our study contributes to the literature in several ways. First, this is, to the best of our knowledge, the first study that systematically analyzes the impact of the *multi-level knowledge context* on students' entrepreneurial intentions. Most of the literature on entrepreneurial intentions neglects regional-level influences. The few existing multilevel studies focus on entrepreneurship determinants other than knowledge context (we consider these other determinants as control variables in our study) or try to explain actual start-ups rather than intentions. A further distinctive feature is our focus on highly qualified people, i.e., university students in the fields of computer science, business, and electrical engineering who have finished their second year of study. We consider this a particularly interesting and important sample, as students in the sampled fields are on the one hand particularly likely to create fast-growing knowledge-based ventures and on the other hand particularly dependent on their multilevel knowledge context.[4]

A second major contribution is that we apply the knowledge- and capabilities-based view of the firm to the pre-entry (entry decision-making) phase. If we accept the view that knowledge is the critical resource determining firms' long-run growth and survival, the

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[1] Some authors alternatively use the term "self-employment intentions" (e.g., Souitaris et al. 2007).

[2] A possible explanation for this missing integration is that authors from different disciplines tend to neglect the findings of other disciplines that differ in their premises, theoretical background, and empirical methods. As Klein et al. (1999) note, the training that young researchers receive is seldom multilevel in nature. Hence, individual-level attributes and behavior may seem uninteresting or even irrelevant to the macro-trained theorist, whereas macrolevel influences may appear intractable and of little interest to the micro-trained scholar. "The micro scholar may be unable or simply disinclined to see the forest for the trees, whereas the macro scholar may be unable or disinclined to see the trees that make up the forest" (Klein et al. 1999, p. 244).

[3] There are relatively few papers that try to integrate both levels of analysis. Among these exceptions are Wagner and Sternberg (2004) and Mueller (2006).

[4] A more detailed discussion of the features and the significance of our student sample is provided in Sect. 3.1.

availability of and potential access to relevant knowledge should play a crucial role in potential founders' consideration of the pros and cons of entrepreneurship.

Third, we argue that the relevant knowledge a potential founder has to consider is not only the knowledge and social capital that she has accumulated herself or which is tied to her person (by personal contacts, etc.), but also the knowledge embedded in the potential founder's region of residence. We think that our proposed view of the entry decision-making process is highly plausible, since it is well established in the empirical literature that knowledge is rooted in regions, that regions differ considerably with respect to their knowledge resources, and that the spillover of knowledge is localized; i.e., geographic proximity matters (Glaeser et al. 1992; Jaffe et al. 1993; Audretsch and Feldman 1996).[5]

Finally, we contribute to the literature by assembling a unique multilevel dataset that combines detailed and comprehensive information about the entrepreneurial intentions of German students with regional data on the characteristics of German planning regions in which universities are embedded. This allows us to expose our hypotheses to rigorous empirical testing.

The paper is organized as follows: In the following section we develop the theoretical framework of our analysis and derive six major hypotheses. The third section describes the empirical approach, the data, and the variables used in the analysis. In the fourth section we present the results of the empirical analysis, and in the final section we discuss our findings, their implications and limitations, as well as prospects for future research.

2 Theory and hypotheses

How does an individual's personal and regional knowledge context affect her entrepreneurial intention? Before answering the core question of the current paper we briefly discuss the literatures on individual-level and regional-level determinants of entrepreneurial intentions, which appear largely unconnected so far. We argue that, to adequately deal with our core question, it is indispensable to take a multilevel approach that simultaneously considers individual- *and* regional-level influences, and we derive six main hypotheses to be tested in the empirical part of the paper.

2.1 Individual-level explanations of entrepreneurial intention

There is a large and growing literature dealing with individual-level determinants of entrepreneurship. Individual-level determinants are factors which are directly tied to an individual, such as personal traits or individual (i.e., person-specific) network contacts. By contrast, regional-level determinants of entrepreneurship are regional characteristics which are not tied to a specific individual but which are at the disposal of any inhabitant of the region.

In the literature on individual-level determinants of entrepreneurship it is argued that individuals who are, for instance, more achievement oriented (Collins et al. 2004), more risk tolerant (Stewart Jr. and Roth 2001), more independence seeking (Douglas and Shepherd 2002), more self-efficacious (Chen et al. 1998), more creative (Lee and Wong 2004), more susceptible to decision-making biases (Simon et al. 1999), male (Matthews and Moser 1996), and wealthier (Georgellis et al. 2005) are more likely to exploit a given opportunity. Similarly, individuals who possess idiosyncratic prior knowledge (Shane 2000), and who are more creative and more optimistic, are more likely to discover opportunities themselves (Ardichvili et al. 2003). With regard to knowledge, individuals with more entrepreneurial experience (Evans and Leighton 1989), work experience (Davidsson and Honig 2003), management experience (Henley 2004), and higher formal education (Arenius and Minniti 2005) are more likely to pursue entrepreneurial opportunities.

In addition to personal traits, the importance of social contacts and networks to entrepreneurship has come into focus (Aldrich et al. 1987; Johannisson 1998; Davidsson and Honig 2003; Cope et al. 2007). "The structure of a person's social network will influence what information they receive, and the

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[5] This line of reasoning reflects the famous global–local paradox which says that, paradoxically, in a globalized world the factors that make the difference in international competition are not those which are ubiquitously available but those which are bound to a specific location and cannot easily be replicated or imitated elsewhere (Storper 1997).

quality, quantity and speed of receipt of that information" (Shane 2003, p. 49). As a consequence, the social network of an individual has a decisive impact on the person's access to knowledge that facilitates both the discovery of opportunities and the ability to exploit these opportunities. With respect to social networks the literature distinguishes between strong ties (i.e., ties to people whom one trusts) and weak ties (i.e., less close relationships). Networks typically begin with close personal interactions but are likely to spread over time to include a range of contacts exceeding the immediate circle of family and close friends (Cope et al. 2007, p. 214). In other words: Strong ties are likely to be complemented by weak ties over time. Social ties and the advantages they provide in terms of network support or access to knowledge are by definition *person-specific*. Hence, they may be viewed as a special kind of individual endowment and are—from an analytical point of view—very similar to individual traits: Both are exclusive rather than inclusive, and both are observed at the individual level.

A potential shortcoming of individual-level analyses is that they leave unexplored the role of the broader regional environment, i.e., macroeconomic, macrosociological or institutional conditions in the potential entrepreneur's region of residence. Although these regional macrovariables exist independently of single individuals, they may nevertheless have an important impact on individuals' entrepreneurial intentions.

2.2 Regional-level explanations of entrepreneurial intention

Prospective entrepreneurs do not make decisions to exploit entrepreneurial opportunities in a vacuum, but instead are influenced by the context in which they operate (Shane 2003, p. 145). Apart from an individual's social capital, the characteristics of her region of residence can have an important impact on opportunity creation and exploitation. The regional context is particularly important with respect to the creation and flow of knowledge, as knowledge is rooted in regions, regions differ considerably with respect to their knowledge resources, and the spillover of knowledge is localized, as has been shown in highly prominent papers by Glaeser et al. (1992), Jaffe et al. (1993), and Audretsch and Feldman

(1996). Moreover, there is ample empirical evidence that the majority of entrepreneurs tend to set up their business in their home region and that young firms are very unlikely to change location (Michelacci and Silva 2007; Stam 2007; Zander 2004).

Taken together, this implies that the knowledge potential that a prospective entrepreneur can access is strongly influenced by the characteristics of her regional environment. Hence, entrepreneurial opportunities are essentially local, not universal (Stam 2007, p. 37), or put differently, entrepreneurship is by its very nature a regional event (Rocha and Sternberg 2005).

The importance of the regional dimension is reflected by the large regional variation in start-up rates. The self-employment rate in West Palm Beach, Florida, is nearly four times higher than the respective rate in Springfield, Ohio (Ruggles et al. 2003). Regional disparities in more knowledge-intensive sectors are even larger: The propensity that a working-age inhabitant of Munich (Germany's leading high-technology region) starts a high-technology firm is 20 times higher than the respective propensity in some East German regions (ZEW 2006).

Early macrolevel analyses of entrepreneurship have typically tried to explain regional variation in start-up rates by differences in variables such as regional unemployment, income, population density, tax rates or regional firm size structure (Carlton 1983; Bartik 1989; Reynolds et al. 1994). Theoretical developments in the new economic geography (Krugman 1991, 1998) and endogenous growth theory (Romer 1986, 1990; Lucas Jr. 1988) have substantially increased our understanding of the role of geography in economic development and the factors driving economic growth. A central result of modern growth theories is that the spillover of knowledge is the most important engine of growth in modern, highly integrated economies. These important new developments in mainstream economics have had a strong impact on the recent entrepreneurship literature: While much of the early literature on new firm formation was motivated by high levels of unemployment in old industrialized regions, much of the focus on new start-ups today is motivated by high-technology and knowledge-based start-ups, which are considered drivers of growth and prosperity in modern, knowledge-based societies (Armington and Acs 2002, p. 34). There are influential lines of research suggesting that cities and regions function as incubators of creativity

and innovation (Jacobs 1969; Feldman and Audretsch 1999; Duranton and Puga 2001; Lee et al. 2004) and that innovative clusters provide a particularly fertile soil for the formation and growth of firm start-ups (Porter 1998; Cooke 2001; Ketels 2004). However, the most advanced and probably most comprehensive theoretical framework for the analysis of regional knowledge externalities and new firm formation is provided by the knowledge spillover theory of entrepreneurship (Acs et al. 2009; Audretsch and Lehmann 2005a; Audretsch and Keilbach 2007).

The knowledge spillover theory of entrepreneurship posits that investments in knowledge by incumbent firms and research organizations such as universities will generate entrepreneurial opportunities because not all of the new knowledge will be pursued and commercialized by the incumbent firms. As Arrow (1962) pointed out, new knowledge is inherently uncertain and asymmetric. In developing a new product, drug, etc. it is not unusual that a lot of "unintended knowledge" is generated as a side-product. This new knowledge which is not directly related to the original target of the research investment may appear (or in fact be) useless at first glance, but may prove highly useful and profitable in different contexts. Thus, incumbent firms and other organizations are typically unable to recognize and act upon all of the new knowledge created by their own investments. What one (knowledge) worker perceives to be a potentially valuable idea may not actually be acknowledged as being valuable by the decision-making hierarchy of the firm. The knowledge filter (Acs and Armington 2004) refers to the extent that new knowledge remains uncommercialized by the organization creating that knowledge. It is these residual ideas that generate the opportunity for entrepreneurship.

The knowledge spillover theory has established an explicit link between knowledge and entrepreneurship within a spatial context and thus provided a more solid basis for empirical research on the regional determinants of entrepreneurship. It has also led to a consideration of regional knowledge variables [such as regional research and development (R&D) investment or R&D employment] as explanatory variables in econometric analyses of regional variation in new firm formation.

Notwithstanding this recent progress in theory-building, most macrolevel approaches still restrict themselves to explaining new firm formation from regional (macroeconomic) conditions[6] and thus neglect the influence of individual characteristics and individual networks of prospective entrepreneurs.

2.3 A multilevel approach

A major contribution of the current paper is the simultaneous consideration of individual-level *and* regional-level determinants of entrepreneurial intentions, which allows us to overcome the problems of the single-handed approaches discussed above. We focus on the knowledge context at the individual (family and friends) *and* at the regional level, considering individual traits and context variables unrelated to knowledge as control variables. Our focus on the access to knowledge is grounded in the knowledge- and capabilities-based views in strategy, which suggest that knowledge is the primary resource underlying value creation and competitive advantage (Barney 1991; Grant 1996; Kogut and Zander 1992; Teece et al. 1997). This view is typically applied to the development and growth of existing firms. However, if knowledge is the primary source of value added and competitive advantage in existing firms, the question of how to access relevant knowledge should be a primary concern for anyone planning to set up a successful new enterprise. Hence, it is straightforward to assume that the prospect of having (or not having) access to superior sources of knowledge is of utmost importance for the decision in favor or against starting a new venture. We argue that a prospective entrepreneur in the pre-entry phase has to consider (at least) three different sources of knowledge:

(i) Knowledge the individual has accumulated herself and which may hence be seen as "incorporated" in the individual.[7]

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[6] In recent contributions to knowledge spillover theory (e.g., Audretsch et al. 2008), entrepreneurial motivation and qualification have been treated as exogenous factors. However, prior research has revealed that individuals with extensive general and entrepreneurship-specific human capital are more likely to identify and (successfully) exploit entrepreneurial opportunities (Bates 1990; Gimeno et al. 1997; Davidsson and Honig 2003; Ucbasaran et al. 2008; Unger et al. 2011). Hartog et al. (2010), for instance, show that the possession of certain cognitive abilities is related to entrepreneurial career choice and performance.

[7] One could think of an individual's formal education, work experience, etc. These are—similar to other personal characteristics of the individual—considered as control variables in the subsequent empirical analysis.
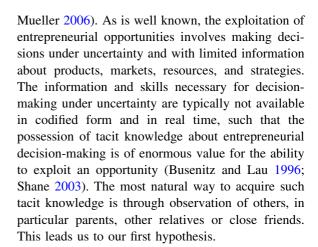
(ii) Knowledge that the individual can access through her network of friends, family or other (already existing) personal ties. This may be interpreted as the individual's accumulated social capital. Note that this accumulated social capital is directly tied to the individual.

(iii) The knowledge base of the region in which the new firm is founded, which is typically the region in which the founder lives. The knowledge base of the region exists independently of the prospective entrepreneur but can be accessed and used by the entrant after (and even before) the new firm has started its business. We argue that regions rich in R&D, with a highly qualified labor force and a strong culture of entrepreneurship provide young firms with better access to essential knowledge resources than other regions and give them a better chance of growth and survival.

The above line of argument implies that both the individual- and regional-level knowledge context should impact entrepreneurial intentions, such that multilevel analysis is the only adequate way to capture the impact of knowledge context on entrepreneurial intentions. We derive three hypotheses concerning the role of the individual-level knowledge context and three hypotheses concerning the role of the regional-level knowledge context.

2.3.1 Individual-level knowledge context and entrepreneurial intention

Parents, other relatives, and close friends are presumably the people who have the strongest impact on an individual's attitudes, intentions, and knowledge, as they have the closest and longest-term contacts with her.[8] Growing up in an entrepreneurial environment offers the opportunity to learn from the self-employed person serving as a role model and getting a realistic preview of self-employment (Chlosta et al. 2010). Entrepreneurial role models within the family or the circle of friends are unique sources of tacit knowledge about business strategy and entrepreneurial decision-making (Dunn and Holtz-Eakin 2000;

Mueller 2006). As is well known, the exploitation of entrepreneurial opportunities involves making decisions under uncertainty and with limited information about products, markets, resources, and strategies. The information and skills necessary for decision-making under uncertainty are typically not available in codified form and in real time, such that the possession of tacit knowledge about entrepreneurial decision-making is of enormous value for the ability to exploit an opportunity (Busenitz and Lau 1996; Shane 2003). The most natural way to acquire such tacit knowledge is through observation of others, in particular parents, other relatives or close friends. This leads us to our first hypothesis.

Hypothesis 1 Entrepreneurial role models within the family or the circle of friends have a positive impact on students' entrepreneurial intention.

In the long-run process of learning from observation underlying hypothesis 1, the person who is the source of knowledge serves as a role model, i.e., her part in the knowledge transfer process is a more or less passive and indirect one. However, relatives, friends or other ties may also support prospective entrepreneurs in a more direct fashion by actively providing them with knowledge relevant for the success of business.[9] This supporting knowledge is available in the short run and can either take the form of information and good advice (transfer of "know-how") or consist in the knowledge of relevant people and the procurement of contacts (transfer of "know-who").[10]

Prior research suggests that knowledge and good advice received from strong network ties are more useful, reliable, and exclusive (i.e., of higher quality) than information gained from formal sources (Brüderl and Preisendörfer 1998).[11] Moreover, prospective entrepreneurs who can rely on support in terms of

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[9] We focus on strong ties here, because Brüderl and Preisendörfer (1998) have found that support from strong ties is more important for the success of newly established businesses than support from weak ties.

[10] Of course, family, friends or other ties can also support the prospective founder by direct material support unrelated to knowledge. The expectation of material support is therefore considered as a control variable in the empirical analysis.

[11] A further advantage is that the high-quality information received by strong ties can typically be accessed in a timely fashion.

knowledge and good advice from family members or friends can acquire knowledge resources below market prices or that are unavailable elsewhere (Evans and Jovanovic 1989), giving their new venture a competitive advantage and a better chance of survival. We therefore hypothesize that students expecting support in terms of knowledge and good advice from strong ties are more likely to opt for self-employment.

Hypothesis 2 The expectation that knowledge and good advice (know-how) from family members or friends will be available if students decide for an entrepreneurial career has a positive impact on students' entrepreneurial intention.

Perhaps even more important than the short-run availability of know-how is the procurement of contacts (know-who) who help the prospective entrepreneur to get access to customers, suppliers, sources of finance, and other resources crucial to the success of business. Again, because of prior ties and trust, the procured contacts should be of high quality and facilitate the access to relevant third-party contacts and knowledge. This, in turn, increases the likelihood of new firm growth and survival and should thus have a positive impact on students' entrepreneurial intentions. This is reflected in our third hypothesis.

Hypothesis 3 The expectation that support in terms of know-who (the procurement of contacts) from family members or friends will be available if students decide for an entrepreneurial career has a positive impact on students' entrepreneurial intention.

2.3.2 Regional knowledge context and entrepreneurial intention

Entrepreneurial role models are by no means restricted to friends, family, and other close ties. We argue that the general start-up dynamics in an individual's region of residence plays a similarly important role as a source of tacit knowledge. An individual who has the privilege to observe the formation, growth, and (in some cases) failure of new ventures in her immediate geographic neighborhood is more likely to learn about entrepreneurial opportunities and ways to exploit them than someone who

lives in a region where new firm formation is rarely observed. A high regional start-up intensity can contribute to reducing the ambiguity associated with entrepreneurial decision-making as it allows the potential entrepreneur to acquire skills and information about characteristics, needs, and potential pitfalls of entrepreneurship (Minniti 2005, p. 4). In addition, the observation of nearby start-ups might lead individuals to consider entrepreneurship as a relevant career alternative, and the positive example of others who "have made it" should provide a strong stimulus for people with entrepreneurial talent to try and start their own venture. Ed Glaeser has nicely summarized the principal argument in writing: "According to this view, there are some places that are intrinsically full of new ideas and a spirit of change […] If one person's decision to start a new firm makes it more likely that his neighbor will also become an entrepreneur, this could create a cascade within the city and variation across cities." (Glaeser 2007, p. 18). Minniti (2005) goes in the same direction and provides a formal model of a network externality in which entrepreneurship exhibits increasing returns to adoption. In her model, entrepreneurship creates its own self-reinforcing culture; i.e., the regional concentration of entrepreneurial activity itself is an important determinant of individual decisions in favor of (or against) entrepreneurship (Minniti 2005).

An indicator that reflects both start-up dynamics and the entrepreneurial culture of a region is regional start-up intensity, i.e., the number of start-ups per (working-age) inhabitant. Hence, it is hypothesized that a high regional start-up intensity pushes students' entrepreneurial intentions.

Hypothesis 4 The higher the start-up intensity in their region of residence, the stronger the students' entrepreneurial intention.

As explicated before, there are good reasons to view entrepreneurship as a regional event, and many entrepreneurial opportunities are by their very nature essentially local or regional (and not universal), as they depend on the availability and price of regional resources, regional knowledge, regional infrastructure, regional suppliers and customers, and so forth.

However, the stock of entrepreneurial opportunities within a given region is not fixed over time but is influenced by the economic agents themselves. An important means by which new entrepreneurial

opportunities are created is investment in R&D. The investment in R&D by incumbent firms and research institutes creates new knowledge that is only partly perceived, correctly assessed, and appropriated by the investors themselves. The residual knowledge (which may well exceed the originally intended knowledge) opens up new entrepreneurial opportunities and forms the basis of new venture creation by newcomers. Hence, the higher and more dynamic the R&D investment in a region, the higher is—ceteris paribus—the potential for knowledge spillovers that create new entrepreneurial opportunities. This is a central implication of the knowledge spillover theory of entrepreneurship (Acs et al. 2009; Audretsch and Lehmann 2005a; Audretsch and Keilbach 2007), and it is obvious that such knowledge spillovers should be particularly important for knowledge-based entrepreneurship.
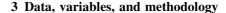
A high level of R&D investment per capita is an indicator of a high regional rate of knowledge production, and it indicates, at the same time, an abundance of knowledge spillovers that could create entrepreneurial opportunities for newcomers. Hence, a high level of regional R&D investment should have a positive impact on students' entrepreneurial intention, which is expressed in hypothesis 5.

Hypothesis 5 The higher the level of R&D investment per capita in their region of residence, the stronger the students' entrepreneurial intention.

The growth rate of R&D investment is an indicator that captures the dynamics of knowledge (and spillover) production in a region. Moreover, a high regional knowledge dynamics can accelerate productivity growth and provide opportunities to enter fast-growing regional markets. Hence, regions characterized by a high growth rate of R&D investment are hypothesized to provide a particularly stimulating and fertile soil for knowledge-based entrepreneurship. This leads us to our final hypothesis:

Hypothesis 6 The higher the growth rate of R&D investment in their region of residence, the stronger the students' entrepreneurial intention.

Note that, whereas several papers have related regional R&D measures to actual start-ups (e.g., Acs et al. 2009 or Audretsch et al. 2010), this is—to the best of our knowledge—the first time that regional R&D investment is related to entrepreneurial intentions.

3 Data, variables, and methodology

3.1 Sample composition

In order to simultaneously analyze individual-level and regional-level determinants of entrepreneurial intentions among students, we combined microlevel data from a comprehensive survey among students at German universities with regional-level data from secondary statistics. Individual-level data and regional-level data could be combined as the whole of Germany is subdivided into 97 so-called planning regions, and each university location is embedded in a larger planning region.

While prior research on nascent entrepreneurship has typically sampled from the overall population (e.g., Reynolds et al. 2004; Wagner 2005; Mueller 2006), the current paper focuses on a high human capital sample, i.e., university students who have finished their second year of study. There are several reasons why a sample of university students is particularly well suited for studying the impact of the multilevel knowledge context on entrepreneurial intentions: First, the knowledge spillover theory of entrepreneurship suggests that entrepreneurship provides a mechanism translating knowledge into economically relevant knowledge, new value, and ultimately economic growth (Acs et al. 2009; Audretsch and Lehmann 2005a; Audretsch and Keilbach 2007). To transform the current state of knowledge into something new and valuable obviously requires a certain level of accumulated human capital, creativity, and absorptive capacity on the part of nascent entrepreneurs. Second, there is empirical evidence (e.g., Cooper et al. 1994; Colombo and Grilli 2005) that founders' accumulated human capital has a positive impact on post-entry performance, and popular examples such as Facebook or Microsoft illustrate that university students in the sampled fields (computer science, business, and electrical engineering) have the potential to create fast-growing knowledge-based ventures. Third, the years at university are often the time when individuals choose a concrete career as researcher, wage-employed or self-employed and acquire career-critical knowledge. Finally, students are trained to accumulate, process, and refine large amounts of knowledge and can therefore be expected to be particularly receptive to external sources of knowledge. In sum, students in

the sampled fields constitute a particularly interesting and important sample for the study of knowledge-based entrepreneurship.

Trained interviewers conducted the student survey at the beginning or the end of one popular or compulsory lecture per department. Choosing a short time frame of 3 weeks for our data collection reduced the risk that time-variant influences, such as a change in the general economic situation, bias our data. Of 7,925 questionnaires, 6,037 were returned. To factor out several confounding influences (e.g., Cooper and Dunkelberg 1986), we only retained respondents who had finished their second year of study, had worked less than 4 years full time, were not likely to succeed into a family business, and were German citizens. We focused on three fields of study (computer science, electrical engineering, and business) that tend to produce knowledge-intensive start-ups with high growth potential. Our final sample consisted of 1,816 male students in 38 regions. We focused on males as we lack data from female students of computer science and electrical engineering, reflecting the usual under-representation of females in technical fields. The average student had 1 year to graduation. Given this short time to the next career decision, we assume a high validity of self-reported entrepreneurial intentions as a predictor of actual behavior (Ajzen 1991).

The regional-level dataset was compiled from various sources of secondary statistics, the most important of which are Eurostat, the German Federal Statistical Office, the German Federal Agency of Labor, and the Mannheim Center of European Economic Research (ZEW). The regional cross-section consists of 97 functional regions, so-called planning regions, which comprise several counties (Nomenclature of Territorial Units for Statistics 3 level) linked by intense commuting. According to a definition by the German Federal Office for Building and Regional Planning (BBR), planning regions are intended to be comparable regions "that reflect in acceptable approximation the spatial and functional interrelation between core cities and their hinterland" (BBR 2001, p. 2).

3.2 Measures

3.2.1 Dependent variable

Entrepreneurial intention measures the self-reported likelihood of becoming self-employed within 5 years after graduation. We focus on entrepreneurial intentions because they are measurable without unpredictable time lag, potential survival bias, ex post rationalization by respondents, or the risk of identifying consequences instead of determinants of self-employment. A meta-analysis by Armitage and Conner (2001) shows that intentions explain up to 31% of the variance in general, self-reported behavior and 20% of the variance in observed behavior. We derived our three-item measure conceptually based on Kolvereid (1996b). As for all other constructs, unless otherwise stated, we used seven-point Likert scales (1 = "I completely disagree", 7 = "I completely agree"). Our measure is reliable at an alpha of 0.81, indicating high internal consistency. The Appendix provides an overview over all items.

3.2.2 Explanatory variables

Existence of entrepreneurial role models. Role models are unique sources of tacit knowledge about business strategy and entrepreneurial decision-making. We measure the variable with a dummy coded 1 for the presence of a role model within the family or the circle of friends, and 0 otherwise.

Access to know-how. This variable measures the extent of support in terms of business knowledge and good advice that a person expects to receive when deciding to become self-employed after graduation. Based on the extant literature and interviews with students, we measure this formative construct on a seven-point Likert scale (1 = "no support", 7 = "great support") with one item for each source of support, including parents, steady partner, and friends. The sum of these items yielded our final measure.

Access to know-who. This variable is defined analogously to the previous variable. However, in contrast to the previous measure, the expected support here is related to the procurement of contacts (know-who) and not to the transfer of know-how.

Regional start-up intensity. We measure regional start-up intensity as the average annual number of start-ups per 10,000 inhabitants between 2002 (average respondents' first year of study) and 2005 (year of our survey). We focus on the sectors of technology-oriented services and knowledge-intensive, nontechnical advisory and consulting services, because these are classical fields of entrepreneurship for people

with high educational attainment and these sectors were most frequently stated by the respondents as areas for potential self-employment. The underlying data source is the ZEW Start-up Panel (see Metzger and Heger 2005 for details).

R&D investment per capita. This variable measures total private R&D investment per regional population in 2005. The data are drawn from Eurostat's Regio Data Base.

Growth rate of R&D investment. This variable measures the compound annual growth rate of regional R&D investment in the period 2003–2005. The data source is the same as for R&D investment per capita.

3.2.3 Individual-level control variables

Access to material support. This measure denotes the degree to which an individual expects to receive material support, such as financing or office equipment, when deciding to pursue an entrepreneurial career after graduation. The construct was measured analogously to "access to know-how" and "access to know-who."

Need for achievement. This measure describes expectations of doing something better or faster than anybody else or better than one's own earlier accomplishments (Hansemark 2003). An entrepreneurial career comprises activities, such as striving for concrete feedback regarding individual performance (Collins et al. 2004), that are typical for achievement-oriented individuals and, thus, attract them. Following Cassidy and Lynn (1989), we use a seven-item formative measure of vocational achievement motivation. The Appendix provides an overview of the items.

Need for independence. This measure describes the need to do and say as one likes despite conventional expectations. Independence is one key rationale for choosing an entrepreneurial career (Kolvereid 1996a). Having no directly applicable scale, we developed a job-related, formative measure. Its four facets comprise the freedom to decide on working hours, work contents, work processes, and to operate without supervision, which were then summed.

Risk-taking propensity. This measure reflects the tendency of a decision-maker either to take or to avoid risks (Sitkin and Pablo 1992). Given the more

unstructured and uncertain problems, entrepreneurs are often believed to be more risk-taking (Stewart Jr. and Roth 2001). Our measure draws on the established Risk Style Scale (Schneider and Lopes 1986). A detailed description is provided in the Appendix.

Work experience. An alternative way to acquire critical knowledge is through work experience. This was measured as the number of months as a wage-employee, including professional training and full time. The extant literature has also suggested two additional types of experience. The first is entrepreneurial experience, which was measured as the number of months as self-employed. Because only 66 respondents (4%) reported to have such experience, the variable was excluded from our analysis. The second type is management experience. Prestudies indicated that students in Germany have typically collected no leadership experiences at that age. Data on management experience was therefore not collected.

Opportunity perception. Perceiving a business idea with market potential can shape entrepreneurial intentions, and vice versa (Bhave 1994). Hence, students were asked if they had perceived an entrepreneurial opportunity at the time of the survey. Perception of an entrepreneurial opportunity was captured with a dummy variable (0 = "no opportunity perceived", 1 = "opportunity perceived").

3.2.4 Regional-level control variables

Unemployment among highly qualified. This variable measures the ratio of unemployed people with a university or college degree to employed people with university or college degree within a region in 2004 (Source: Institute for Employment Research, IAB) and is an indicator of the severity of unemployment among the highly qualified within a region. A high rate of unemployment among highly qualified people in a region may affect entrepreneurial intentions in two opposite ways: On the one hand, it increases the pressure to become self-employed. On the other hand, it may indicate weak economic performance and below-average entrepreneurial opportunities in the region.

Share of large firms. This variable is defined as the share of employees in large firms (i.e., firms with more than 500 employees) in total regional employment (Data Source: Institute for Employment

Research, IAB). A high share of large firms is typically held to be negatively related to new firm creation, since large incumbents that dominate the regional economy tend to erect effective entry barriers to newcomers (Armington and Acs 2002).

Population density. Population density is defined as inhabitants per square kilometer in the German planning regions. A high density of economic activities in a region is held to have a positive impact on regional start-up activities (Reynolds et al. 1994; Armington and Acs 2002; Fritsch and Falck 2007).

3.3 Estimation method

We use hierarchical linear modeling (HLM; Raudenbush and Bryk 2002) with restricted maximum-likelihood estimates. This approach is superior to traditional methods for analyzing hierarchical data as it avoids aggregation or disaggregation bias by examining each variable at the appropriate level of analysis and by considering the partial interdependence between individuals within the same group (Hofmann 1997). Our hypotheses suggested direct influences of variables at both levels on the individual-level outcome (students' entrepreneurial intentions). Consequently, we used intercepts-as-outcomes models to test them.

Tests similar to analyses of variance (ANOVAs) by regions confirmed there was sufficient between-department variance in the outcome to warrant further analysis. We centered all individual-level predictors around their group mean to reduce multicollinearity and make the intercept more interpretable, representing the entrepreneurial intention of a student with a group-average score on all individual-level predictors (Hofmann 1997). However, using uncentered data produced the same pattern of results. Moreover, the extant literature suggests six assumptions of hierarchical linear models with two levels (Raudenbush and Bryk 2002, p. 255): (1) independent and normally distributed level 1 errors, (2) independence between level 1 predictors and level 1 errors, (3) independent and identically distributed level 2 errors, (4) independence between level 2 predictors and level 2 errors, (5) independence between level 1 errors and level 2 errors, and (6) no correlation between predictors at one level and errors at the other level. We performed the usual tests, which confirmed

that all the necessary conditions of hierarchical linear models with two levels were met.

4 Results

The descriptive statistics and the correlation matrix for the variables in the study are reported in Table 1. As can be seen from Table 1 the highest correlation between any two of the independent variables is $r = 0.65$ between *access to know-how* and *access to know-who*. Not surprisingly, expected support by strong ties in terms of know-how is not independent of the expected support in terms of know-who, such that we estimated the impact of *access to know-how* (models 1 and 3 in Table 2) and the impact of *access to know-who* (models 2 and 4 in Table 2) separately. The correlation between the other explanatory variables is much lower, such that multicollinearity problems are unlikely to arise.

Table 2 reports the results of the HLM regressions predicting students' entrepreneurial intentions. Drawing on techniques suggested by Raudenbush and Bryk (2002, p. 149), we estimated the variance explained at both levels of analysis. The individual-level variables explained 16% of the variance in entrepreneurial intentions (models 1 and 2). The regional-level variables accounted for 68% (69%) in the interregional variance of model 3 (model 4).

Models 1 and 2 in Table 2 show the impact of individual-level knowledge context on students' entrepreneurial intentions. We find that entrepreneurial role models within the family or the circle of friends, which may be seen as important sources of tacit knowledge, have a significantly positive impact on students' entrepreneurial intentions. In addition, and perhaps even more important, the results support hypotheses 2 and 3: *Access to know-how* and *access to know-who* (provided by friends, family or steady partner) both have a significantly positive impact on students' entrepreneurial intention. By contrast, we find no significant impact of expected access to material support by friends or family members on students' entrepreneurial intention.

In addition to the individual-level knowledge context, models 3 and 4 in Table 2 analyze the impact of regional-level explanatory variables. First of all, it is notable that regional-level variables significantly impact students' entrepreneurial

Table 1 Descriptive statistics and cross-level correlations

Variable	Mean	s.d.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Entrepreneurial intention	3.21	1.40	–														
2. Regional start-up intensity	6.16	3.35	0.07	–													
3. R&D investment per capita	5.67	10.17	0.01	0.49	–												
4. Growth rate of R&D investment	0.01	0.04	0.06	-0.01	0.16	–											
5. Unemployment among highly qualified	0.07	0.02	0.02	-0.15	-0.32	-0.22	–										
6. Share of large firms	0.21	0.07	-0.01	0.54	0.55	-0.03	-0.16	–									
7. Population density	523.60	700.98	0.04	0.43	0.21	-0.15	0.53	0.52	–								
8. Role models	0.29	0.45	0.17	0.02	-0.01	0.02	-0.01	0.00	-0.03	–							
9. Access to know-how	9.47	3.67	0.11	-0.03	0.01	-0.01	-0.04	-0.02	-0.03	0.12	–						
10. Access to know-who	11.41	3.80	0.14	-0.03	-0.02	0.01	0.00	-0.05	-0.02	0.18	0.65	–					
11. Access to material support	8.29	3.23	0.07	-0.03	0.00	0.01	0.00	-0.02	-0.01	0.12	0.53	0.45	–				
12. Need for achievement	32.60	5.62	0.20	0.01	0.02	0.00	-0.04	0.00	-0.03	0.05	0.09	0.11	0.05	–			
13. Need for independence	4.67	1.05	0.15	0.02	0.05	0.02	0.00	0.02	0.02	0.04	-0.04	-0.02	-0.03	0.24	–		
14. Risk-taking propensity	1.66	1.28	0.12	-0.03	-0.06	0.00	-0.02	-0.08	-0.09	0.04	0.11	0.10	0.10	0.10	0.01	–	
15. Work experience	7.64	14.06	0.05	0.00	-0.05	0.03	0.04	-0.06	0.00	0.05	0.02	0.01	0.00	0.00	0.02	0.00	–
16. Opportunity perception[a]	0.15	0.35	0.32	0.02	0.01	0.03	-0.01	0.04	0.04	0.06	0.08	0.09	0.01	0.14	0.12	0.06	0.13

$n = 1{,}816$ for evaluating pairwise correlations between individual-level variables or between individual-level and regional-level variables; $n = 38$ for evaluating pairwise correlations between regional-level variables. Pearson product moment correlations are reported for pairs of continuous variables; Spearman rank correlations are reported for pairs of continuous and dichotomous variables

[a] Coding: $0 =$ no opportunity perceived, $1 =$ opportunity perceived

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Table 2 Results for HLM analysis of individual-level entrepreneurial intentions

Variables	Parameter estimates							
	Model 1		Model 2		Model 3		Model 4	
	b	s.e.	b	s.e.	b	s.e.	b	s.e.
Individual-level hypotheses (individual knowledge context)								
Role models (β_{1j})	0.09***	0.06	0.10***	0.05	0.09***	0.05	0.10***	0.05
Access to know-how (β_{2j})	0.07***	0.01			0.07***	0.01		
Access to know-who (β_{3j})			0.04**	0.01			0.04**	0.01
Individual-level controls								
Access to material support (β_{4j})	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.01
Need for achievement (β_{5j})	0.12***	0.01	0.13***	0.01	0.12***	0.01	0.13***	0.01
Need for independence (β_{6j})	0.08***	0.03	0.08***	0.03	0.08***	0.03	0.08***	0.03
Risk-taking propensity (β_{7j})	0.07***	0.02	0.07***	0.02	0.07***	0.02	0.07***	0.02
Work experience (β_{8j})	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00
Opportunity perception (β_{9j})	0.28***	0.08	0.28***	0.08	0.28***	0.09	0.28***	0.08
Regional-level hypotheses (regional knowledge context)								
Regional start-up intensity (γ_{01j})					0.06***	0.01	0.06***	0.01
R&D investment per capita (γ_{02j})					0.00	0.00	0.00	0.00
Growth rate of R&D investment (γ_{03j})					0.05***	0.49	0.05***	0.49
Regional-level controls								
Unemployment among highly qualified (γ_{04j})					0.00	2.60	0.00	2.60
Share of large firms (γ_{05j})					−0.09**	0.87	−0.09**	0.86
Population density (γ_{06j})					0.06	0.00	0.06	0.00
R^2 (individual level)[a]		0.16		0.16		0.16		0.16
R^2 (regional level)						0.68		0.69

Individual level, $n = 1{,}816$; regional level, $n = 38$; standardized coefficients are reported

[a] Variance-explained statistics recommended by Raudenbush and Bryk (2002, p. 74)

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$ (two-tailed test)

intentions, even when controlling for a wide variety of individual-level determinants. Hypotheses 4 and 6 concerning the impact of the regional knowledge context are supported: We find that regional start-up intensity and the growth rate of regional R&D investment both have a positive impact on students' entrepreneurial intentions. By contrast, hypothesis 5 is not supported; i.e., we find no significant effect of the level of R&D per capita on entrepreneurial intentions among students.

The consideration of control variables discussed in the pertinent literature does not lead to any major changes in the signs, the significance or the magnitude of the main variables discussed so far. With regard to our individual-level controls, we find a positive impact of need for achievement, need for independence, risk-taking propensity, and opportunity perception,

whereas work experience and the expectation of material support by strong ties have no significant impact. As concerns the regional-level controls, we find the expected negative impact of the share of employees in large firms on students' entrepreneurial intentions. By contrast, regional population density and unemployment among the highly qualified are not significant.

5 Discussion and implications

5.1 Discussion of main results

The question of why people decide for an entrepreneurial career is a classic one, and there is a rich and growing literature dealing with it. Notwithstanding

the dynamic development of the literature, the role of the multilevel knowledge context in forming entrepreneurial intentions has received relatively little attention so far. The current paper is an attempt to fill this gap. Our central argument is the following:

If knowledge is the primary resource underlying value creation and sustainable competitive advantage (as the knowledge- and capabilities-based views in strategy suggest) the prospect of having (or not having) access to superior sources of knowledge should be of utmost importance for the decision in favor or against starting a new venture. In other words: The knowledge context that a prospective entrepreneur faces should have an important impact on her entrepreneurial intentions.[12] Our empirical analysis has established that both the individual knowledge context (i.e., the accumulated social capital directly tied to the individual) *and* the regional knowledge context (that exists independently of the prospective entrepreneur but that can be accessed and used by her) do matter.

At the individual level, the existence of entrepreneurial role models and the expectation that support by strong ties (parents, steady partner or friends) in terms of know-how and know-who is available have a significantly positive impact on entrepreneurial intentions. While the finding that role models as sources of tacit knowledge positively impact entrepreneurial intentions confirms and enhances the results of related research on role models and self-employment (e.g., Dunn and Holtz-Eakin 2000; Mueller 2006; Chlosta et al. 2010), our results concerning the effects of expected short-term availability of *know-who* and *know-how* add important new insights on the role of close ties as knowledge providers. As both expected support in terms of know-how and expected support in terms of know-who have a significantly positive impact on students' entrepreneurial intentions, our findings suggest that the impact of strong ties on students' entrepreneurial intentions goes far beyond that of a mere role model but includes the active, short-term disposable provision of *knowledge* on *how and with whom to do business*. It is notable

that, whereas the expectation to have access to knowledge resources appears to be an important determinant of entrepreneurial intentions, the expectation to be provided with material resources by strong ties has no significant impact on students' entrepreneurial intentions.

At the regional level, start-up intensity and the dynamics of regional R&D investment stand out as regional-level drivers of entrepreneurial intentions. A high regional start-up intensity in areas such as technology-oriented services and knowledge-intensive (nontechnical) consulting indicates that there is an abundance of entrepreneurial role models in knowledge-based sectors in the region. It appears quite natural that the example of others who "have made it"[13] has a stimulating effect and encourages students to start their own firm. Moreover, a high regional start-up intensity may also indicate that a region is a good seedbed for young firms and disposes of an entrepreneurial culture which facilitates the life of young entrepreneurs. A high growth rate of regional R&D investment indicates a high dynamics of knowledge creation in the region, which generates a large potential for knowledge spillovers, which in turn create entrepreneurial opportunities for newcomers. It is quite obvious that such knowledge spillovers are particularly important for knowledge-based new ventures, as would-be entrepreneurs need a certain absorptive capacity in order to perceive, assess, and put into practice the opportunities created by the new knowledge. Opposed to expectations, the level of R&D investment per capita was not significant at the 10% level. Hence, our results suggest that the *regional dynamics* of knowledge creation may be more important in forming entrepreneurial intentions than the *average level* of R&D investment in a region.

In a nutshell, our findings indicate that the nature of one's residential area influences students' entrepreneurial intentions: Living in a region characterized by a high start-up intensity in knowledge-based industries and a high growth rate of R&D investment makes it more likely that a given individual will opt for an entrepreneurial career.

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[12] Obviously, this should hold true in particular for highly qualified nascent entrepreneurs starting knowledge-based ventures.

[13] Even examples of failure may be stimulating, if you have an idea what went wrong and think you could make it better.

5.2 Limitations

Despite the important findings, our study is not without limitations. First, the focus of our study is on the entrepreneurial intentions of highly qualified people, i.e., university students who have finished their second year of study. One may argue that people with high educational attainment are more likely to start knowledge-intensive businesses and are therefore more dependent on knowledge context than others.[14]

Second, the predictive validity of intentions has been established only in a general context (Armitage and Conner 2001), not in an entrepreneurial context, such that we cannot predict (1) how many students will actually realize their self-reported intentions and (2) how many students will be driven by opportunity to enter self-employment, without intending it to date (Bhave 1994).

Third, as our study was limited to the German context and to male students in three programs of study (computer science, electrical engineering, and business), further research is necessary in order to establish whether our findings are applicable to other countries, females, and people with other (or no) university background.

5.3 Implications for future research

Our results have important implications for theory building as well as for empirical research. It has become clear that an adequate theory of entrepreneurial intentions should give due attention to the contextual framework in order to capture the "entrepreneurial event" in its various dimensions.

The knowledge context—which is the main focus of the current paper—deserves particular attention, since access to superior knowledge is arguably the most important source of competitive advantage and hence invaluable for incumbent firms but also—and perhaps even more so—for newcomers. We have argued theoretically and shown empirically that both the individual and the regional knowledge context play important roles in explaining why some people intend to become entrepreneurs and others do not.

As concerns empirical research, we need richer datasets that reflect the different dimensions that affect entrepreneurial intentions and empirical approaches that cross the traditional divide between macro and micro analyses. Multilevel analysis is a powerful instrument for studying entrepreneurship in its various dimensions, yet multilevel research in this area is remarkably scarce. We hope that the current paper will contribute to make multilevel modeling more popular and widespread in entrepreneurship research.

Moreover, as this study is focused on students and their individual and regional knowledge context, it would be highly interesting and demanding to explore whether there is a similar interplay of individual- and regional-level factors in forming entrepreneurial intentions of people without university background.

5.4 Normative implications

This study has examined the role of the knowledge context in forming entrepreneurial intentions and provides a number of useful practical implications. First, our results show the importance of strong ties (friends, family, and steady partner) in forming entrepreneurial intentions. Strong ties do not only serve as role models that facilitate the transfer of tacit knowledge, as suggested, e.g., by Dunn and Holtz-Eakin (2000) or Chlosta et al. (2010). In addition, and perhaps even more importantly, they are important sources of active, short-run support in terms of know-who (contacts to suppliers, customers, sources of finance, etc.) and know-how.

Second, our study shows the importance of the regional environment in forming entrepreneurial intentions. Our analysis has revealed that a regional environment characterized by a high start-up intensity in knowledge-based industries has a positive impact on students' entrepreneurial intentions, which implies that regional entrepreneurship may be viewed as a self-reinforcing process: Once a region has reached a certain level of entrepreneurship (reflected in a high start-up rate), this has a positive impact on students' entrepreneurial intentions, which in turn increases the number of regional start-ups. Our empirical results with respect to the role of regional start-up intensity lend support to theoretical reasoning by Minniti (2005) and Glaeser (2007).

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[14] Note, however, that we have no information on whether students' actual start-up ideas are indeed knowledge based or not.

Moreover, the analysis has shown that the regional dynamics of R&D investment has a positive impact on entrepreneurial intentions. This finding suggests that the knowledge spillover theory of entrepreneurship (Acs et al. 2009; Audretsch and Lehmann 2005a; Audretsch and Keilbach 2007) applies already to the earliest phases of an entrepreneurial career (the pre-entry career choice phase) and that spillovers from R&D foster opportunity identification and creation as well as opportunity exploitation. This finding, again, makes it very clear that the characteristics of their region of residence—which may partly be influenced by public policy—have a significant impact on students' entrepreneurial intentions. An important policy implication is that local or regional policies targeted at creating favorable conditions for regional R&D investment are—at least in the longer run—also conducive to entrepreneurship.

Appendix: Study measures

Entrepreneurial intention (measure based on Kolvereid 1996b; seven-point Likert scale from 1 = "I completely disagree" to 7 = "I completely agree"; $\alpha = 0.81$).

(1) "There is no doubt that I will become self-employed as soon as possible.", (2) "I plan on becoming self-employed within 5 years of the successful completion of my studies."; (3) "I plan on becoming self-employed some time after the successful completion of my studies".

Access to know-how (seven-point Likert scale from 1 = "no support" to 7 = "great support").

"To what extent would the following social groups support you if you became self-employed after your studies? (Please answer even though you do not plan on becoming self-employed)". Respondents reported the extent to which three different sources, including family, steady partner, and friends would provide "information and good advice (regarding business development and management)."

Access to know-who was measured analogously to access to know-how, but includes "procurement of contacts" as type of support.

Access to material support was measured analogously to access to know-how and access to know-

who, but includes "material support (e.g., funding, office equipment,…)" as type of support.

Need for achievement (measure adopted from Cassidy and Lynn 1989; seven-point Likert scale from 1 = "I completely disagree" to 7 = "I completely agree").

(1) "Hard work is something I like to avoid." (r), (2) "I frequently think about ways I could earn a lot of money.", (3) "I believe I would enjoy having authority over other people.", (4) "I find satisfaction in exceeding my previous performance even if I don't outperform others.", (5) "I care about performing better than others on a task.", (6) "I would rather do tasks at which I feel confident and relaxed than ones which appear challenging and difficult." (r), (7) "I would like an important job where people look up to me."

Need for independence (seven-point Likert scale from 1 = "I completely disagree" to 7 = "I completely agree").

"In group and projectized work…" (1) "having freedom of choice over when I do my work is important to me.", (2) "I prefer to determine the content of my work as far as possible on my own.", (3) "I would rather set the sequence of my work tasks on my own.", (4) "I dislike being subordinated to other people."

Risk-taking propensity (measure adopted from Schneider and Lopes 1986).

"In the following you will be confronted with 5 situations in which you please either decide on being paid a safe amount of money or instead participating in a lottery. Your answers for these situations should be independent of each other. In every situation please imagine that you can dispose of a total wealth of EUR 1,000."

(1) an 80% chance of winning EUR 400, or receiving EUR 320 for sure,
(2) receiving EUR 300 for sure, or a 20% chance of winning EUR 1,500,
(3) a 90% chance of winning EUR 200, or receiving EUR 180 for sure,
(4) receiving EUR 160 for sure, or a 10% chance of winning EUR 1,600,
(5) a 50% chance of winning EUR 500, or receiving EUR 250 for sure.

(r) = reverse coded

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