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Conceptualizing academic-entrepreneurial intentions: An empirical test

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ABSTRACT

Policy makers are increasingly recognizing the catalytic role of academics' spin-off companies in a national economy, which derives from their innovativeness that result in new value generation, and job creation. Although research on academics' spin-off companies has been increasing, knowledge gaps exist as to the specific determinants and processes that characterize the emergence of academics' entrepreneurial intentions that lead them to spin off companies. This research aims to fill this gap. Drawing from psychological and entrepreneurship research on intentionality, the authors propose a conceptual model of academics' entrepreneurial intentions. They empirically test the model using structural equation modeling and a robust data set collected in two European academic settings to guide future research on this important topic.

1. Introduction

Academic spin-offs have been shown as an important means of transferring technology from academia. Prior research in academic spin-offs has focused predominantly on the contribution of spin-offs to the national economy at large; little attention has been directed to the nature of the processes that lead to their emergence. The following catalytic roles, among others, have been attributed to academic spin-offs: boosting economic activity (Di Gregorio and Shane, 2003; Nicolaou and Birley, 2003a; Roberts and Malone, 1996), generating new jobs (Perez Perez and Sanchez, 2003; Steffensen et al., 2000; Walter et al., 2006), creating new wealth (Perez Perez and Sanchez, 2003; Roberts and Malone, 1996; Steffensen et al., 2000; Walter et al., 2006), providing a strong tie between industry and science (Debackere and Veugelers, 2005), contributing to regional economic development (Mian, 1997; Nicolaou and Birley, 2003a), and helping introduce new commercial products to the marketplace (Pressman and AUTM Survey Statistics and Metrics Committee, 2002). To illustrate the importance of such companies, Carayannis et al. (1998) quote a Bank of Boston survey (BankBoston, 1997) that observed that the Massachusetts Institute of Technology (MIT) had spun off approximately 4000 companies, employing 1.1 million people and generating annual worldwide sales of US$ 232 billion. Furthermore, Mustar (1997) reported that 200 French academic spin-offs have created 3500 jobs. Policy makers in many developed countries have also responded to the importance of academic spin-offs by erecting infrastructures intended to facilitate the commercialization of scientific research output (Goldfarb and Henrekson, 2003).

Probably the most important gap in the literature on academic spin-offs concerns robust empirical studies of spin-off processes and characteristics. In specifics, the review of the literature reveals a lack of empirical evidence that investigates this important phenomenon at the individual level; that is, how academics' entrepreneurial intentions, which are key to the creation of spin-off companies, emerge. This research proposes a theoretical model of academic-entrepreneurial intentions to gain insight into the determinants of academic-entrepreneurial intentions, and perform its empirical test. Entrepreneurial intentions have been in entrepreneurship research shown as the most viable precursor of entrepreneurial behavior that results in business incorporation. Measuring entrepreneurial intentions among academics provides an assessment of expected dynamics in emergence of firms with high growth potential given the research and technological environment that incubates gestation of such start-ups. We use cross-national empirical data from academics employed in the technical departments of two major universities in the United Kingdom and Slovenia.

The paper is structured as follows. We first review prior literature on intentionality and its determinants, and then present entrepreneurial intentions model grounded in social cognitive theory and hypotheses. We then describe our research setting and methods, as well as the results of our hypotheses testing. The paper concludes with discussion, implications, limitations and future research opportunities.

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2. Academic-entrepreneurial intentions: a conceptual model

One of the key aspects of the entrepreneurship process is the opportunity recognition process, when "opportunities to create future goods and services are discovered, evaluated, and exploited" (Shane and Venkataraman, 2000, p. 218). To understand how opportunity recognition occurs, we focused on the cognitive processes that align perceptions of opportunity, ability, and control with entrepreneurial intentions. Entrepreneurial intention can be according to the theory of planned behavior (Fishbein and Ajzen, 1975) seen as an accurate predictor of planned behavior towards starting a new business. Prior theoretical research on entrepreneurial intentions has analyzed different populations of potential entrepreneurs to understand their decision-making processes with respect to becoming entrepreneurs. Because of the economic importance of high-tech companies, it is particularly important to understand the intentionality of potential academic entrepreneurs, since they have a critical role in the identification of commercializable technologies and in the subsequent transfer of the technology (Hoye and Pries, 2009).

Social cognitive theoretical origins of planned behavior postulate several building blocks to formation of entrepreneurial intentions and three theoretical frameworks have predominated in explanations of entrepreneurial intentions: Ajzen's (1991) theory of planned behavior, Shapero's model of entrepreneurial event (Shapero, 1975; Shapero and Sokol, 1982), and the entrepreneurial intentions model (Bird, 1988; Boyd and Vozikis, 1994). The intention is based on desirability (attitude toward the behavior, subjective norm), and feasibility (perceived behavioral control), with each predictor weighted for its importance in relation to the behavior and population of interest (Ajzen, 2006). As a general rule, the more favorable the attitude and subjective norm and the greater the perceived control, the stronger is a person's intention to perform the behavior in question (Ajzen, 2002). For intentionality to become a behavioral intention, an individual must cognitively process it, which results in a decision to perform a given behavior (Ajzen, 2002).

In entrepreneurship, Katz and Gartner (1988) define intention as the search for information that can help fulfil the goal of venture creation. Intentionality is a state of mind that directs a person's attention (and therefore experience and actions) toward a specific object (goal) or path in order to achieve something (an outcome) (Bird, 1988; Bird and Jelinek, 1988).

In studying why people choose to become entrepreneurs the entrepreneurial intention model advanced by Krueger and his colleagues (Krueger, 1993; Krueger et al., 2000) remains one of the most explanatory. Recognizing that starting a business is an intentional act (Krueger et al., 2000), and that intentions are the single best predictor of any planned behavior, including entrepreneurship (Krueger et al., 2000), the entrepreneurial intention's model had substantial implications for intentionality research in entrepreneurship. This model acknowledges that entrepreneurial event is a result of a dynamic interaction between individual and environment (Shane and Venkataraman, 2000), which is in agreement to social cognitive perspective of entrepreneurship. Several empirical studies have since explored and supported the relationship between entrepreneurial intentions and entrepreneurial behavior (e.g. Arenius and Minniti, 2005; Autio et al., 1997; Douglas and Shepherd, 2002; Kolvereid, 1996; Kolvereid and Isaksen, 2006; Krueger, 1993; Krueger et al., 2000).

Building on existing findings on characteristics of planned behavior in psychology and intentionality in entrepreneurship, Fig. 1 presents our proposed model of academic-entrepreneurial intentions that draws from entrepreneurial intentions model originally proposed by Bird (1988) and Krueger (1993). According to assertions of the theory of planned behavior in the context of entrepreneurship, formation of entrepreneurial intention in general is dependent on an individual's perceived ability to execute the intended behavior (that is expressed through entrepreneurial self-efficacy) of entering entrepreneurship, attitudes toward the desirability of an entrepreneurial career (that is expressed through perceived role models), and subjective norms (that are formed through interactions in one's personal networks). Prior empirical studies of academic entrepreneurs have highlighted importance of prior academic experience, experience with patenting activity, interaction with industry and overall research focus as important determinants emergence of academic-entrepreneurial intentions. In what follows we present hypotheses that describe specific relationships conceptualized in the model. We begin with entrepreneurial self-efficacy that has been demonstrated as one of the strongest drivers of goal-oriented behavior (Baum and Locke, 2004).

2.1. Entrepreneurial self-efficacy and academic-entrepreneurial intentions

Wood and Bandura (1989) argue that perceived self-efficacy refers to people's beliefs in their abilities to mobilize the motivation, cognitive resources, and courses of action needed to exercise control over events in their lives. Boyd and Vozikis (1994) suggest that the concept of self-efficacy, derived from social

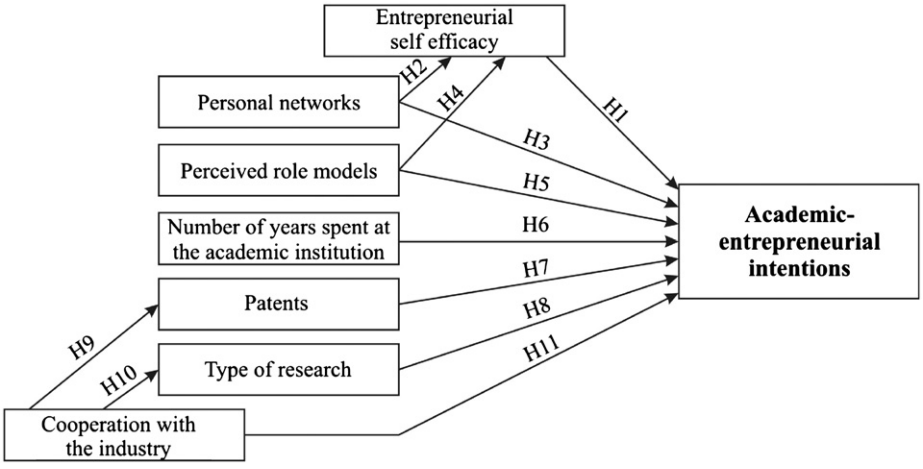

Fig. 1. The conceptual model of academic-entrepreneurial intentions.

learning theory (Bandura, 1977a, b, 1982), plays an important role in the development of entrepreneurial intentions and actions. The self-efficacy perspective is highly appropriate for the study of entrepreneurs (Chen et al., 1998) because of the following: (1) as a task-specific construct rather than a global disposition, it helps address the lack of specificity in previous entrepreneurial personality research; (2) as a belief in one's vocational abilities, it is relatively more general than is task self-efficacy; (3) being closest to action and action intentionality, it can be used to predict and study entrepreneurs' behavioral choices, persistence, and effectiveness; and (4) the relationship between self-efficacy and behavior is best demonstrated in challenging situations of risk and uncertainty, which generally typify entrepreneurship (Chen et al., 1998). In summary, entrepreneurial self-efficacy are individuals' beliefs regarding their capabilities for attaining success and controlling cognitions for successfully tackling challenging goals during the entrepreneurial tasks.

In other words, entrepreneurial self-efficacy refers to the strength of an individual's belief that he or she is capable of successfully performing the roles and tasks of an entrepreneur (Boyd and Vozikis, 1994; Scherer et al., 1989). In studying different populations of entrepreneurs, Chen et al. (1998) found that the total entrepreneurial self-efficacy score differentiated entrepreneurship students from students of both management and organizational psychology, and that across the three types of students (entrepreneurship, management, and organizational psychology), entrepreneurial self-efficacy was positively related to the intention to set up one's own business. Chen et al. (1998) also found that entrepreneurship students have higher self-efficacy in marketing, management, and financial control than do management and organizational psychology students. Chen et al. (1998) later simultaneously tested effects of entrepreneurial self-efficacy and locus of control on the criteria of founders versus non-founders of businesses. After controlling for individual and company background variables, the effect of entrepreneurial self-efficacy scores was significant, but the effect of locus of control was not. More specifically, business founders had higher self-efficacy in innovation and risk taking than did non-founders.

Krueger et al.'s (2000) study showed that perceived self-efficacy is correlated with perceived feasibility, which, together with global perceived desirability and propensity to act, significantly predicts intentions. Zhao et al.'s (2005) study of 265 MBA students across five universities in the United States showed that 42% of variance in entrepreneurial intentions in time 2 is explained by entrepreneurial intentions in time 1, gender, and entrepreneurial self-efficacy in time 2 (the time 1 survey was administered to incoming MBA students; the time 2 survey was administered 2 years later, at the graduation of MBA students). That study also showed that 48% of variance in entrepreneurial self-efficacy in time 2 is explained by perceptions of formal learning in time 2, entrepreneurial experience in time 1, and risk propensity in time 1.

Perceived entrepreneurial self-efficacy is especially salient in the case of potential entrepreneurs with a non-business background, such as high-tech entrepreneurs. Many researchers have already observed that most scientists lack the business background needed to bring technology closer to market (Druilhe and Garnsey, 2004), and many spin-off companies are characterized by a lack of commercial awareness that may lead to becoming technology driven rather than market driven. Academics with technological backgrounds often prefer to rely on a product focus, driven by technological innovations, rather than on customers' needs. Failure to incorporate a customer focus is often compounded by an absence of attention to the critical role played by the diffusion of innovation in successful product launch (Berry, 1996). The ability to connect specific knowledge and a commercial opportunity requires a set of skills, aptitudes, insights, and circumstances that are distributed neither uniformly nor widely (Venkataraman, 1997). In creating a new venture, academics are involved in both the invention and the commercialization–exploitation phases (Grandi and Grimaldi, 2005); thus, they need both specific scientific knowledge and business skills. The perceived certainty of performing specific roles and tasks in entrepreneurship is represented by the entrepreneurial self-efficacy construct. Thus, this leads us to propose the following:

Hypothesis H1. Entrepreneurial self-efficacy is positively related to academic-entrepreneurial intentions

2.2. Personal networks as a predictor of entrepreneurial self-efficacy and academic-entrepreneurial intentions

The importance of personal ties to successful entrepreneurship is well established (Birley, 1985). An important step of the entrepreneurship process is to fill in gaps with needed resources. Personal networks provide entrepreneurs with information (e.g., market information, new opportunities) as well as tangible resources (e.g., human resources, financial resources) and intangible resources (e.g., social support, problem solving) held by other actors (Hoang and Antoncic, 2003; Nicolaou and Birley, 2003a, b; Shane and Stuart, 2002; Walter et al., 2006). Nicolaou and Birley (2003a) argue that business networks can benefit from opportunity identification, access to important information, and resources that cannot otherwise be obtained, timing, and receiving positive recommendations and evaluation through referrals. In specifics, Landry et al.'s (2006) study showed that the social capital assets of researchers predict the likelihood of them creating spin-offs. In measuring social capital assets, they used an index measure to assess the intensity of the researcher's links with managers and/or other professionals from three types of organizations: (1) private firms, (2) government departments, and (3) university communications departments (e.g., media relations, public affairs). In addition, personal networks have been found to be an important predictor of entrepreneurial self-efficacy (Ozgen and Baron, 2007).

Building on research findings on the importance of personal networks in the entrepreneurship process, we put forward the following:

Hypothesis H2. Academic's personal networks are positively related to the entrepreneurial self-efficacy.

Hypothesis H3. Academic's personal networks are positively related to the academic-entrepreneurial intentions.

2.3. Perceived role models as a predictor of entrepreneurial self-efficacy and academic-entrepreneurial intentions

Entrepreneurship as the creation of new organizations (Gartner, 1988) occurs as a context-dependent, social, and economic process (Reynolds, 1991). The sociology of entrepreneurship has identified role models and peers as an important driver of entrepreneurial activity (Thornton, 1999). The importance of entrepreneurial culture and mind-set is widely acknowledged (Bosma and Harding, 2007). Likewise, the importance of entrepreneurial tradition and entrepreneurship experience in successful spin-off companies is crucial for potential academic entrepreneurs. In addition, faculty members can offer moral and material support to colleagues who are trying to establish a company (Etzkowitz, 1998). Academics who have started their own firms can also become advisers to those newly embarking on a venture. The effort to found companies by pioneering faculty members can lead other faculty members to create new ventures

because it leads them to believe that doing so is an easy and desirable activity (Feldman et al., 2001). In a large sample study, Audretsch et al. (2000) provided similar results, showing that the formation of technology-based firms is, in fact, influenced by other scientists' demonstration effect of prior start-up efforts.

The above-mentioned findings suggest that academic-peer role models who have started their own companies may significantly affect academics' entrepreneurial activity. On the other hand, the broader entrepreneurship literature suggests that the relationship between entrepreneurial role models and future entrepreneurial activity is likely indirect (Carsrud et al., 1987; Scott and Twomey, 1988) through perceived self-efficacy (Krueger, 1993; Scherer et al., 1989). This is supported by Wood and Bandura's (1989) observation that role models build self-beliefs of ability by conveying to observers effective strategies for managing different situations. Role models also affect self-efficacy beliefs by means of social comparison; that is, people judge their own abilities by comparing themselves to others (Boyd and Vozikis, 1994).

On the basis of these findings, we argue that role models are directly related to academic-entrepreneurial intentions and also to entrepreneurial self-efficacy; therefore, we posit the following:

Hypothesis H4. The extent of perceived role models is positively related to the extent of entrepreneurial self-efficacy.

Hypothesis H5. The extent of perceived role models is positively related to the intensity of academic-entrepreneurial intentions.

2.4. Number of years spent at the academic institution and academic-entrepreneurial intentions

A recent Global entrepreneurship monitor report showed that younger people are more active in new firm creation than are older people (Bosma and Harding, 2007). The age distribution of early-stage entrepreneurs is comparable between high-income and middle-income countries. In particular, early-stage entrepreneurial activity is most prevalent among individuals 25–34 years of age and least prevalent among individuals 55–64 years of age (Bosma and Harding, 2007).

Levesque and Minniti (2006) present an econometric model in which individuals select a career path according to the dynamic interplay of age, wealth, and risk aversion. They argued that, for each age, there exists an individual-specific allocation of time between work and leisure that maximizes the individual's expected utility. If individuals were employed in wage labor, they would receive income at the time they perform the activity. If individuals instead were to allocate time to start a new firm, they would not receive instant income but a stream of future returns. As they get older, individuals allocate relatively more time to wage labor and relatively less time to new firm creation (Levesque and Minniti, 2006).

The research on economic benefits and costs of academic tenure using an academic life-cycle perspective (for example Thursby et al., 2007) revealed some interesting dynamics in academic's choice of distributing one's time between academic research and co-operation with industry. However, empirical results are mixed. Carmichael (1988) observed that senior faculty are willing to hire the best junior faculty to provide high research output after tenure while Lazear (2004) found lower research output of an academic after tenure. In an extensive study of pre- and post-tenure research incentives in conjunction with the incentives for applied and basic research, Thursby and Thursby (2007) found that controlling for age, publications, and the portion of research that is basic, the likelihood that a professor will co-operate with industry, also through patenting activity is higher after tenure. This makes somewhat sense given that most members of the academic community have a guaranteed income, because of tenured professorships, that does not depend on applied research (applied research provides a basis for spin-off creation). Academics' job stability and reputation normally depend on teaching and publications. Because entrepreneurship activity involves substantial inherent risk, an academic may jeopardize his or her career path by creating spin-offs and reducing other research responsibilities (Lee and Gaertner, 1994). Thus, the number of years spent at the academic institution (which highly correlates with age) is a proxy for an academic's scientific seniority, which should negatively affect academic-entrepreneurial intentions. Thus, we propose the following hypothesis:

Hypothesis H6. The number of years spent at the academic institution is negatively related to academic-entrepreneurial intentions.

2.5. Patents and academic-entrepreneurial intentions

Patents result from the motivation to disseminate research findings in the form of commercially applicable results (Louis et al., 1989). Rahm (1994a) has shown that researchers who have interacted with firms to transfer knowledge, know-how, or a technology (i.e., spanning researchers) are more likely to hold patents than are university-bound researchers (researchers with no technology-transfer experience). There is a moderate to strong correlation between being a spanning researcher and having filed for or having been granted a patent. Nearly 60% of spanning researchers indicate that they hold or have applied for a patent, compared with just 17% of university-bound researchers. Shane (2001a) has shown that the probability of an invention being commercialized through firm formation is influenced by its importance, radicalness, and patent scope. Patents with better coverage (domestic and international), as well as subsequent patent citations, better predict whether a technology transfer will occur via the formation of a start-up. In a different study, Shane (2001b), using data on 1397 patents assigned to MIT from 1980 to 1996, showed that four hypothesized dimensions of the technology regime (age of the technical field, tendency of the market toward segmentation, effectiveness of patents, and importance of complementary assets in marketing and distribution) influence the likelihood of a new technology being exploited through firm formation. Pressman (1997) reported that more than 80% of MIT's exclusive patent licenses are to entrepreneurial companies. Similarly, Landry et al. (2006) found that researchers who, in the prior 5 years, had carried out activities linked to the protection of intellectual property (e.g., filling out patent applications, registering copyrights for computer software or databases, registering copyrights for educational material, registering integrated circuit topographies, registering industrial designs, filling out applications for protection of trademarks, and filling out applications for plant breeders' rights) are more likely to create spin-offs than are those who had not carried out such activities.

On the basis of the above-mentioned findings, patent activity seems to drive the course of academic careers, which leads us to propose the following:

Hypothesis H7. The number of patents (applied for/granted) is positively related to academic-entrepreneurial intentions.

2.6. Type of research and academic-entrepreneurial intentions

Although the purpose of basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena without any

particular application or use in view (Organisation for Economic Co-operation and Development, 2002), industry is more interested in application and development (Rahm, 1994a), as applied research promises a more immediate return from the development of marketable products, which is extremely important for small spin-off firms. Gulbrandsen and Smeby (2005) found that professors with industry funding describe their research as applied to a greater extent. Nearly half of faculty members who were assistant professors or higher at Norway's four universities and had received industry research funding in the previous 5 years characterized their research as primarily applied research, while only one out of four of those without research funding or with research funding from other sources did.

Academics devoted to applied research generally pay much attention to industry requirements and to understanding the potential for market applications of academic research results (Grandi and Grimaldi, 2005), which could help them establish their own company or run their company more efficiently. Academics engaging in technology-transfer activities (including spin-offs) must also reconcile themselves to the conflicts between a university's basic research mission and the undertaking of applied industry research (Rahm, 1994a). For academics involved in both applied and basic research, it can be difficult to manage the conflicting interests of making research and development results public and restricting access through patents or secrecy. Rahm (1994a) found that researchers who have interacted with firms in an effort to transfer knowledge, know-how, or technology (not only those thinking about establishing their own company) are slightly more likely than other researchers to feel pressure to become involved in applied industry research efforts because they sense that grant agencies, as well as university departments or central administration look favorably on such activity. Building on existing evidence on the importance of research focus in the formation of entrepreneurial intentions, we postulate the following:

Hypothesis H8. The prevalence of applied research (type of research) is positively related to academic-entrepreneurial intentions.

2.7. Cooperation with the industry and patents, type of research, and academic-entrepreneurial intentions

At the institutional level, prior research on university–industry relations indicates that institutions with closer ties to industry generate a greater number of spin-offs and exhibit more entrepreneurial activity, such as academics consulting with industry, faculty involvement in new firms, and faculty and university equity participation in start-up firms (Cohen et al., 1998; Roberts and Malone, 1996). Further, prior findings from individual-level data indicate that industry cooperation is an important predictor of commercial research outcomes. Blumenthal et al. (1996) surveyed 2052 academics at 50 US universities in the life science field and found that industry-funded academics are more commercially productive than those who are not industry funded (industry-funded academics apply for more patents, are granted more patents, introduce more products to market, and establish more companies).

Landry et al. (2006) found that if researchers are active in consulting activities with private firms, government agencies, or organizations associated with their research field, it is more likely that they will engage in spin-off creation themselves. Corman et al. (1988) found that 90% of entrepreneurs interviewed (20 of 22) were significantly involved in technical consulting activity before, and often after, launching their own firms. Kassicieh et al.'s (1996) study found significant differences between entrepreneurs and non-entrepreneurs in terms of situational variables such as level of involvement in business activities outside the laboratory. Gulbrandsen and Smeby (2005), in their study using logistic regression analysis, found that industry cooperation positively and significantly predicts (1) the establishment of firms and (2) patenting as an output of research and development activities. Additionally, surveys by Rahm (1994b) and Morgan (1993, 1994) found some empirical association between greater faculty involvement with industry and increased levels of applied research (Florida and Cohen, 1999). Gulbrandsen and Smeby (2005) also found that industrial funding is significantly related to applied research.

Based on this discussion, we argue that there is indeed empirical evidence revealing that ties with industry are associated with academic-entrepreneurial intentions, with the type of research, and with the number of patents applied for or granted; therefore, we propose the following hypotheses:

Hypothesis H9. Cooperation with the industry is positively related to the number of patents (applied/granted).

Hypothesis H10. Cooperation with the industry is positively related to applied research (type of research).

Hypothesis H11. Cooperation with the industry is positively related to academic-entrepreneurial intentions.

3. Methodology

The methodology is discussed in terms of measurement instrument, questionnaire development, sampling and data collection process, and data analysis.

3.1. Measurement instrument

3.1.1. Academic-entrepreneurial intentions

We measured academic-entrepreneurial intentions with six items: (1) "How interested are you in setting up your own business?" Answers were given on a five-point Likert scale, ranging from "not interested at all" to "very interested" (Chen et al., 1998); (2) "How determined are you to have your own company?" Answers were given on a five-point Likert scale, ranging from "not determined at all" to "very determined" (adapted from Chen et al., (1998); (3) "If you identified possibilities for a commercial application for one or more of your inventions, you would seriously consider becoming an entrepreneur to commercialize the opportunity." Answers were given on a five-point Likert scale, ranging from "strongly disagree" to "strongly agree" (adapted from Kassicieh et al. (1997)); (4) "What is the probability (on a scale from 0% to 100%) that you will start your own business in the next five years?" (Krueger et al., 2000); (5) "What is the probability (on a scale from 0% to 100%) that you will start your own business in the next two years?" (adapted from Krueger et al. (2000)); (6) last item counts the number of activities undertaken in the past year related to starting a business. Respondents were asked to indicate which of the following fourteen activities related to starting a business they undertook during the past year (list of activities was adapted from Gatewood et al., 1995): gathering information on competitors; gathering information on products or services that could serve as a substitute for mine; gathering information on the industry and customers; gathering information on firms that could be my suppliers; gathering information on the cost of raw materials and salaries; gathering information on costs of rents, leases, and equipment; establishing a price for my product or service; making sales/revenues projections; refining or improving the business

idea; seeking financing; gathering information on legal requirements (e.g., permits, licenses); developing goals and objectives (business plan, organisation structure, strategic plan); choosing a business name and/or legal status; and finding a location for a company.

3.1.2. Entrepreneurial self-efficacy

Respondents were asked to indicate their degree of certainty in performing 11 different roles/tasks on a five-point Likert scale ranging from 1 (“completely unsure”) to 5 (“completely sure”). We adapted the following roles/tasks from Chen et al. (1998): control costs, define organizational roles, define responsibilities, develop new ideas, develop new products, develop new services, establish product’s market position, expand business, set and attain profit goals, set and attain market share goals, and set and attain sales goals.

3.1.3. Personal networks

Total personal network size refers to all first-order contacts, regardless of the type of interaction (Greve and Salaff, 2003). We assessed personal networks with three items. The first item concerns the average number of hours per week the respondent spends maintaining contacts (e.g., face-to-face, e-mail, telephone) with people with whom he or she discusses business matters (e.g., commercialization, marketing, finance) (adapted from Greve, 1995). The second item concerns the average number of hours per week the respondent spends developing new contacts with people to discuss business matters (adapted from Greve, 1995). The third item concerns the total number of people with whom the respondent discussed business matters during the previous week (adapted from Renzulli et al., 2000). Renzulli et al. (2000) stressed that the total number of people with whom respondents discuss business is a crude measure of the number of direct contacts, but it does not limit respondents to listing only strong ties.

3.1.4. Type of research

Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view (Organisation for Economic Co-operation and Development, 2002). Applied research is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily toward a specific practical aim or objective (Organisation for Economic Co-operation and Development, 2002) with market potential, and thus it is more interesting for commercialization than basic research. We measured type of research with two items. We assessed the first item as the number of hours per week the academic spends on applied research divided by the sum of the number of hours per week the academic spends on basic research and the number of hours per week the academic spends on applied research. We operationalized this item as a percentage. We operationalized the second item as the percentage of the academic research funds for applied research in the last year in complement to total research funds in the past year.

3.1.5. Number of years spent at the academic institution

This variable measures the academic’s total years of employment at the academic institution(s).

3.1.6. Patents

We measured patents as the number of patents granted to the academic during the prior 3 years and as the number of patents the academic applied for during the prior 3 years. Following the work of Coombs et al. (2006), we used a 3-year period to measure the academic’s patent activity rather than an aggregated measure of the academic’s total patent library.

3.1.7. Cooperation with the industry

We operationalized industry cooperation as the number of hours per week the academic spends on industry-ordered projects and as the average percentage of industry funding for the academic’s research projects.

3.1.8. Perceived role models

We operationalized perceived role models as the number of academic entrepreneurs the respondent knows personally (e.g., has met and has spoken with).

3.2. Questionnaire development, sampling, and data collection process

Hills and LaForge (1992) have emphasized the importance of conducting entrepreneurship research in international contexts. For the purposes of cross-cultural generalization of our findings, we used data from two universities (the University of Cambridge and the University of Ljubljana) in two different European countries (United Kingdom and Slovenia) for this research. Data on academics who are employed at technical faculties or departments were collected using the Internet pages of the five technical departments at the University of Cambridge (computer laboratory, applied mathematics, theoretical physics, chemical engineering, and engineering), and seven technical faculties at the University of Ljubljana (chemistry and chemical technology, civil engineering and geodesy, computer and information science, electrical engineering, mathematics and physics, mechanical engineering, and natural sciences and engineering). Because this research focuses on academic-entrepreneurial intentions of academics at technical faculties or departments, it is important to emphasize that the sample does not include academics who are employed in non-technical faculties or departments (e.g., technology management, medicine, economics). Although, recent research (e.g. Arvanitis et al., 2008; Bekkers and Bodas Freitas, 2008; Fini et al., 2008) showed that businesses creation within the academic institutions is not limited to the technical fields, we have focused only on technical departments because of the differences among the disciplines (for example there are virtually non-patents in social sciences, scholars from social sciences receive less scholarly citations, etc.).

For the questionnaire development, we employed Dillman’s (2000) tailored design method, which is a set of procedures for conducting successful self-administered surveys that produce both high-quality information and high response rates. We have also followed Dillman’s (2000) suggestions for pre-testing the questionnaire, which included (1) a review by a group of experts, (2) interviews with professors of entrepreneurship and innovation, (3) observation and “think aloud” protocols, followed by interviews with potential respondents, and (4) a final check.

The questionnaire was initially prepared in English, and for the University of Cambridge sample, the survey was administered in English. In the University of Ljubljana sample, the survey instrument was first translated into Slovenian and then back-translated (Brislin, 1970, 1980; Hambleton, 1993) into English, using the methodology that Craig and Douglas (2005) suggest. The translation followed the etic approach, an approach with little or no attempt to decenter or adapt the measure to another cultural context (Craig and Douglas, 2005), not the emic approach, which uses the local culture or context as the starting point (Craig and Douglas, 2005).

Of the 1779 surveys mailed (905 in the University of Cambridge, and 874 in the University of Ljubljana) 71 (4.0%) were returned as undelivered (Cambridge, 49, or 5.4%; Ljubljana, 22, or 2.5%). We observed no pattern among undelivered surveys (undelivered surveys were distributed approximately evenly among different departments/faculties). The number of surveyed academics was thus 1708 (Cambridge, 856; Ljubljana, 852). Respondents were asked to return the blank questionnaire if they preferred not to respond. There were 78 (4.6%) blank questionnaires returned by academics who were unwilling to participate in the study (Cambridge, 26, or 3.0%; Ljubljana, 52, or 6.1%). During the 2-month process of collecting the questionnaire two reminders were sent, one after 1 week and the other after 3 weeks. One questionnaire from a Slovenian respondent had a high proportion (more than 20%) of missing data and was therefore excluded. Of respondents, 48 had their own companies (Cambridge, 25; Ljubljana, 23), and were therefore excluded. To study academic-entrepreneurial intentions, we included only academics without their own companies in the sample. In total, we obtained a representative random sample with 547 usable responses (Cambridge, 193; Ljubljana, 354) from mail survey data from a sample of academics without their own companies. The tailored design method (Dillman, 2000), which we used to guide and support the survey process, thus resulted in an overall response rate of 39.5% (Cambridge, 28.5%; Ljubljana, 50.5%), and a valid response rate of 32% (Cambridge, 22.5%; Ljubljana, 41.5%).

The average respondent in the sample from the University of Cambridge was 30.6 years old, single (65.8%), worked an average of 45.2 h/week, and had a total of 7.9 years of professional experience (6.7 years at the academic institution[s] and only 1.2 years at other institutions). The average respondent in the sample from the University of Ljubljana was 40.3 years old, married (57.6%), worked an average of 47 h/week, and had a total of 14.4 years of professional experience (13.1 years at the academic institution[s] and only 1.3 years at other institutions).

3.3. Data analyses

We assessed potential non-response bias by comparing responses of early and late waves of returned surveys (Armstrong and Overton, 1977) for each of the two samples (sample of academics at the University of Cambridge and the University of Ljubljana). We also analyzed questionnaire items in terms of missing values. Because of the low percentage of overall missing data and no pattern in the missing data spread across variables, we considered the missing data to be missing completely at random and not to be influential (Hair et al., 1998; Rubin, 1976). We standardized all variables by using data from the overall sample. In order to examine, whether a significant amount of common method bias exists in the data, we performed Harman's (1967) single-factor test. The basic assumption of this technique is that if a substantial amount of common method variance is present, either a single factor will emerge from the factor analysis or one general factor will account for the majority of the covariance among the measures (Podsakoff et al., 2003). Results showed that no single factor accounted for a majority of variance. We assessed reliability using Cronbach's α (Cronbach, 1951) for internal consistency. We assessed constructs' convergent validity and discriminant validity using exploratory and confirmatory factor analyses (Floyd and Widaman, 1995). We performed exploratory factor analysis using the maximum likelihood extraction method and direct oblimin rotation with Kaiser normalization. In conducting a confirmatory factor analysis, we followed the analytical steps that Marsh and Hocevar (1985, 1988) have suggested. For exploratory factor analysis, we used SPSS Version 13.0 for Windows, and we used EQS Multivariate Software Version 6.1 for confirmatory factor analysis (Bentler and Wu, 2006). We estimated the structural relationships in the model of academic-entrepreneurial intentions using the elliptical reweighted least-square (ERLS) method in EQS 6.1 (Bentler and Wu, 2006), because we found a low amount of non-normality in the data (Sharma et al., 1989). To identify determinants of academic-entrepreneurial intentions that are institutionally or culturally based, we conducted a multisample analysis. In the multisample analysis, the model was constrained for equality of factor loadings and for equality of error variances, as several researchers have recommended (e.g. Jöreskog and Sörbom, 1996; Singh, 1995; Vandenberg and Lance, 2000). We have followed a six-step process of group comparisons, proposed by Hair et al. (2010). As Shook et al. (2004) recommend, we assessed model fit with multiple indices.

4. Findings

4.1. Empirical evaluation of measurement scales

We conducted exploratory factor analysis, confirmatory factor analysis, and internal consistency tests to explore the underlying structures of scales. We calculated Cronbach's αs for all scales of research variables and all were greater than the generally agreed-on lower limit of 0.70 (Hair et al., 1998); for details see Appendix 1. We performed exploratory and confirmatory factor analyses only on scales with more than three items (academic-entrepreneurial intentions and entrepreneurial self-efficacy). We performed all empirical evaluations of the measurement scales on both samples for cross-national comparison. In cross-national research, (1) all scale items should load on the same factor (or construct) in cross-national data, (2) each scale item should have the same loading (within statistical bounds) and should be on the same factor in cross-national data, and (3) all factor loadings and error variances should be identical for each scale item (Singh, 1995).

4.1.1. Academic-entrepreneurial intentions

We employed an exploratory factor analysis to examine the factor structure of the construct. As expected, exploratory factor analysis found only one factor to explain the variance in the data. The Kaiser–Meyer–Olkin measure of sampling adequacy ranged from 0.84 to 0.85 for both samples (samples of academics from the University of Cambridge, and the University of Ljubljana), which provides evidence of the appropriateness of the data for factor analysis. Bartlett's test of sphericity is significant for both samples, indicating overall significance of the correlations within the correlation matrix (Hair et al., 1998). The explained variances for both samples ranged from 58.7% (Ljubljana) to 65.8% (Cambridge). All factor loadings were greater than 0.4 (lowest factor loading was 0.56).

4.1.2. Entrepreneurial self-efficacy

We used SPSS 13.0 for Windows to conduct an exploratory factor analysis to determine an initial factor structure of entrepreneurial self-efficacy. There are two main reasons to determine an initial factor structure and not follow Chen et al.'s (1998) factor structure: (1) Chen et al. (1998) conducted a study of 112 MBA students, 29 undergraduate seniors (during an organizational psychology course), and 175 small business owners and executives. Since Chen et al.'s (1998) study was conducted only among those who were familiar with entrepreneurship, that factor structure may not be appropriate for those who are not

familiar with entrepreneurship (e.g., academics employed in technical faculties or departments); and (2) Drnovsek and Glas (2002), in a study of entrepreneurial self-efficacy of nascent entrepreneurs, did not find support for Chen et al.'s (1998) factor structure. We conducted exploratory factor analysis on both samples to ensure that all items load on the same factors across the samples. The exploratory factor analysis resulted in a three-factor solution in both samples. Factor 1 was interpreted as management, factor 2 was associated with innovation, and factor 3 was strongly related to marketing. Table 1 shows the three dimensions of entrepreneurial self-efficacy (and their eleven items with factor loadings).

Moreover, we conducted the confirmatory factor analysis to compare the first-order one-factor structure with the first-order three-factor structure and the second-order three-factor structure. First, we specified the first-order one-factor model. In this model, we modeled the 11 items to load on one latent, unobserved factor. Support for the model would suggest that one single factor is sufficient to explain the common variance of the 11 items. The second model constrained the items of each scale to load on factors established with the exploratory factor analysis. We modeled all factors to correlate with one another. The third model is almost identical to the second model: the only difference is that a common higher-order factor replaced the three correlation paths between the three factors. The purpose of this investigation was to test whether a single, higher-order, latent factor accounts for and sufficiently explains the shared variance of the entrepreneurial self-efficacy factors.

Table 2 shows the fit measures. As we expected, the first-order one-factor structure showed a poor fit in both samples, and the first-order three-factor structure showed a large, statistically significant improvement over the first-order one-factor structure. The second-order three-factor structure had indices of fit identical to those of the first-order three-factor structure, as Table 2 shows. To find support for the second-order model, three conditions must be fulfilled: (1) the T coefficient should be close to 1.00, (2) the goodness-of-fit indices of the second-order factor structure should indicate a fit approximately similar to that of the first-order factor structure, and (3) the second-order factor loadings should all be statistically significant (Venkatraman, 1989, 1990). The target coefficient (T coefficient) is the ratio of the χ^2 of the first-order model to the χ^2 of the more restrictive model (in this research, the second-order model). The target coefficient has an upper limit of 1.00 (Marsh and Hocevar, 1985). It is important to realize that the second-order factor model is merely a parsimonious explanation of covariation among first-order factors. Consequently, even if the second-order factor model were to effectively explain covariation among first-order factors,

Table 1
The entrepreneurial self-efficacy (ESE) dimension's item factor loadings.

Dimension/item	Factors					
	ESE-MAN		ESE-INO		ESE-MAR	
	Univ. of Cam.	Univ. of Lj.	Univ. of Cam.	Univ. of Lj.	Univ. of Cam.	Univ. of Lj.
Management (ESE-MAN)						
Control costs	0.56	0.59				
Define organizational roles	0.80	0.92				
Define responsibilities	0.94	0.83				
Innovation (ESE-INO)						
Develop new ideas			0.36	0.65		
Develop new products			0.94	0.88		
Develop new services			0.67	0.74	(0.33)	
Marketing (ESE-MAR)						
Establish position in product market				(0.34)	0.74	0.51
Expand business					0.71	0.45
Set and attain profit goals					0.82	0.81
Set and attain market share goals					0.94	0.97
Set and attain sales goals					0.98	0.92

Extraction method: maximum likelihood. Rotation method: Oblimin with Kaiser Normalization (absolute factor loadings higher than 0.30 displayed). Results vary slightly with Varimax extraction method. University of Cambridge: N=193. Bartlett's test of sphericity: approx. χ^2 of 1650.09; 55 df; sig. 0.000. Kaiser–Meyer–Olkin measure of sampling adequacy: 0.85. Variance explained: 71.0%. University of Ljubljana: N=354. Bartlett's test of sphericity: approx. χ^2 of 2449.21; 55 df; sig. 0.000. Kaiser–Meyer–Olkin measure of sampling adequacy: 0.86. Variance explained: 65.5%.

Table 2
Summary of confirmatory factor analysis fit statistics.

Sample/model	Model fit indices								
	χ^2 *	df	NFI	NNFI	CFI	GFI	SRMR	RMSEA	T
University of Cambridge									
First-order one-factor model	487.07	44	0.76	0.72	0.78	0.63	0.14	0.23	
First-order three-factor model	185.52	41	0.91	0.90	0.93	0.82	0.09	0.14	
Second-order three-factor model	185.40	41	0.91	0.90	0.93	0.82	0.09	0.14	1.00
University of Ljubljana									
First-order one-factor model	835.47	44	0.74	0.69	0.75	0.66	0.13	0.23	
First-order three-factor model	225.98	41	0.93	0.92	0.94	0.88	0.07	0.11	
Second-order three-factor model	223.70	41	0.93	0.92	0.94	0.88	0.07	0.11	0.99

* All χ^2s significant at 0.001.

the goodness of fit can never exceed that of the first-order factor model (Venkatraman, 1989). Both samples fulfilled all three conditions, in support of accepting the second-order three-factor structure over the first-order three-factor structure. Additionally, the second-order factor is supported because it explains theoretically related outcomes (entrepreneurial self-efficacy) better than the combined set of first-order factors (Hair et al., 2010).

4.2. Findings related to the structural equation model of academic-entrepreneurial intentions

The resulting model's goodness-of-fit indices indicated good model fit in the multisample analysis (χ^2=1529.447, 683 df, probability 0.000; NFI=0.90; NNFI=0.93; CFI=0.94; GFI=0.80; SRMR=0.07; RMSEA=0.07). The EQS encountered no special problems during optimization. The variance explained for the academic-entrepreneurial intentions was 73% for the sample of academics at the University Cambridge, and 50% for the sample of academics at the University of Ljubljana.

Fig. 2 depicts the model, which includes hypothesized relationships and results of the model test. Unstandardized coefficients are reported to ensure comparability across subsamples–samples of academics at the University of Cambridge and the University of Ljubljana (Singh, 1995). Table 3 also shows structural equations with standardized and unstandardized coefficients.

Hypothesis H1, which predicted that the entrepreneurial self-efficacy is positively related to academic-entrepreneurial intentions, was supported (positive, significant standardized coefficient: the University of Cambridge, 0.46; the University of Ljubljana, 0.31). A comparison of unstandardized coefficients reveals that entrepreneurial self-efficacy is approximately twice as important predictor of entrepreneurial intentions at the University of Cambridge (unstandardized coefficient of 1.22) than at the University of Ljubljana (unstandardized coefficient of 0.59). We believe that the main reason behind these results is a strong entrepreneurial tradition at the University of Cambridge. The results from both samples support Hypothesis H2, which examined the impact of individual academics personal networks on entrepreneurial self-efficacy (positive, significant standardized coefficient: the University of Cambridge, 0.58; the University of Ljubljana, 0.48). We found partial support for Hypothesis H3, which proposed that an academic's personal network is positively related to the academic's entrepreneurial intentions (the University of Ljubljana: significant, positive path coefficients of 0.13; the University of Cambridge: positive but non-significant path coefficient of 0.12). Hypothesis H4, which looked at the relationship between perceived role models and entrepreneurial self-efficacy, was not supported. The relationship between perceived role models and entrepreneurial self-efficacy was positive but not significant in either sample (standardized coefficient of 0.07 for the sample of academics at the University of Cambridge, and 0.12 for the sample of academics at the University of Ljubljana). There was support for Hypothesis H5, which looked at the relationship between perceived role models and academic-entrepreneurial intentions. As indicated in Fig. 2 and Table 3, perceived role models are positively and significantly related to academic-entrepreneurial intentions (standardized coefficient of 0.21 and of 0.14 for the sample of academics from the University of Cambridge and University of Ljubljana, respectively). Hypothesis H6 predicted that the number of years spent at an academic institution is negatively related to the academic-entrepreneurial intentions. We found empirical results in support of Hypothesis H6 (negative and significant standardized coefficient: Cambridge, −0.12; Ljubljana, −0.23). Hypothesis H7 examined the impact of the number of patents (applied/granted)

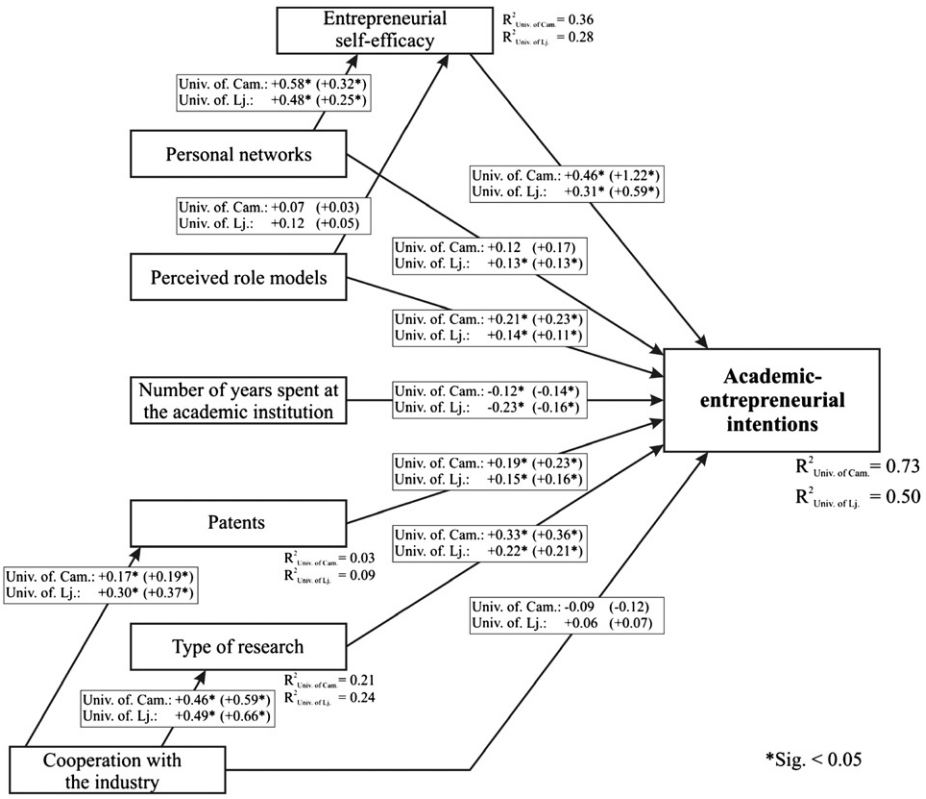

Fig. 2. The model of academic-entrepreneurial intentions (standardized and unstandardized coefficients; unstandardized coefficients in brackets).

Table 3
Structural equations for the model of academic-entrepreneurial intentions.

Independent variables	**University of Cambridge**								**University of Ljubljana**							
	Dependent variables								**Dependent variables**							
	Patents		Type of research		Entrepreneurial self-efficacy		Academic-entrepreneurial intentions		Patents		Type of research		Entrepreneurial self-efficacy		Academic-entrepreneurial intentions	
	St. coeff.	Unst. coeff.	St. coeff.	Unst. coeff.	St. coeff.	Unst. coeff.	St. coeff.	Unst. coeff.	St. coeff.	Unst. coeff.	St. coeff.	Unst. coeff.	St. coeff.	Unst. coeff.	St. coeff.	Unst. coeff.
Cooperation with the industry	+0.17*	+0.19*	+0.46*	+0.59*			−0.09	−0.12	+0.30*	+0.37*	+0.49*	+0.66*			+0.06	+0.07
Perceived role models					+0.07	+0.03	+0.21*	+0.23*					+0.12	+0.05	+0.14*	+0.11*
Personal networks					+0.58*	+0.32*	+0.12	+0.17					+0.48*	+0.25*	+0.13*	+0.13*
Entrepreneurial self-efficacy							+0.46*	+1.22*							+0.31*	+0.59*
Number of years spent at the academic institution							−0.12*	−0.14*							−0.23*	−0.16*
Patents							+0.19*	+0.23*							+0.15*	+0.16*
Type of research—more applied research							+0.33*	+0.36*							+0.22*	+0.21*
Error	0.99		0.89		0.80		0.52		0.95		0.87		0.85		0.71	
R^2	0.03		0.21		0.36		0.73		0.09		0.24		0.28		0.50	

Legend: * Sig. < 0.05; St. coeff.—Standardized coefficient; Unst. coeff.—Unstandardized coefficient
Note: University of Cambridge: N=193; University of Ljubljana: N=354.

on academic-entrepreneurial intentions. We found positive and significant standardized coefficients in support of Hypothesis H7 (Cambridge, 0.19; Ljubljana, 0.15). Hypothesis H8, which proposed that applied research (type of research) is positively related to academic-entrepreneurial intentions, was supported. The results indicate a significant relationship between applied research and academic-entrepreneurial intentions (positive, significant standardized coefficient: Cambridge, 0.33; Ljubljana, 0.22). Hypothesis H9, which proposed that industry cooperation is positively related to the number of patents (applied for/ granted), was supported. The results indicate a significant relationship between industry cooperation and number of patents (positive, significant standardized coefficient of 0.17 for the sample of academics at the University of Cambridge, and of 0.30 for the sample of academics at the University of Ljubljana). There was also support for Hypothesis H10, which proposed that industry cooperation is positively related to applied research. The results presented in Fig. 2 and Table 3 show that industry cooperation has a significant, positive, and high path coefficient of 0.46 and of 0.49 for the samples of academics from the University of Cambridge and University of Ljubljana, respectively. We found no support for Hypothesis H11, which looked at the relationship between industry cooperation and the intensity of academic-entrepreneurial intentions. Empirical results showed that co-operation with the industry is not directly, significantly related to the academic-entrepreneurial intentions (path coefficient: Cambridge, −0.09; Ljubljana, 0.06). Nevertheless, as shown earlier, industry cooperation is related to academic-entrepreneurial intentions indirectly, through patents (Hypothesis H9) and type of research (Hypothesis H10).

Hypotheses related findings are summarized in Table 4.

5. Discussion, implications, limitations, and future research opportunities

5.1. Discussion and implications

In this research, we aimed to develop a conceptual model of the formation of entrepreneurial intentions in academic settings at technical universities and to empirically test the model across cultures to better understand drivers of academic spin-off companies. The proposed conceptual framework integrates evidence on entrepreneurial intentions formation and planned behavior in psychology and entrepreneurship, facilitates the examination of outstanding questions about the emergence of spin-off companies, and invites empirical testing across cultures and research environments.

Overall, results of the empirical test indicate that entrepreneurial self-efficacy, type of research, perceived role models, number of years spent at an academic institution, and patents are significantly related to the formation of academic-entrepreneurial intentions, regardless of cultural context. The results of the multisample test are similar across the two universities, which validates our model's robustness and applicability to further empirical testing.

The results revealed that entrepreneurial self-efficacy had the highest path coefficient among all predictors of academics' entrepreneurial intentions in both universities. This result is congruent with prior findings (e.g. Ozgen and Baron, 2007; Zhao et al., 2005) that entrepreneurial self-efficacy is the most important predictor of entrepreneurial intentions. The entrepreneurial self-efficacy construct also mediated effects of personal networks on the formation of entrepreneurial intentions. Although entrepreneurship education may contribute to an individual's higher entrepreneurial self-efficacy, until now, en-

trepreneurship courses and seminars for academics at technical faculties or departments have been rare. This indicates that academic institutions have not sufficiently considered this important aspect of technology transfer from academia to new firms. Therefore, drawing from our research results, we suggest that entrepreneurial cultures at universities be enhanced by introducing entrepreneurship courses and seminars specifically tailored to the needs of doctoral students and senior researchers at technical faculties or departments.

Our research results are congruent with Gilsing et al. (2010), who emphasized the importance of the presence of an 'entrepreneurial climate' at the university. Research results shows that, environments conducive to the emergence of spin-off companies can be further strengthened by introducing different events (e.g., presentations of success stories, entrepreneurial workshops) on a regular basis to facilitate networking among academics with and without business experience, and most important to practitioners. Networking and personal networks are a significant predictor of entrepreneurial intentions.

Greater numbers of years spent at an academic institution hinder the formation of academic-entrepreneurial intentions. Because tenured professorships guarantee academics' basic socioeconomic status, they are less motivated to endanger their research by redirecting interest and energy to business matters. To overcome this problem, entrepreneurial academic institutions should allow a leave of absence for more than 1 year for academics who are starting their own company based on academic research so that they can primarily focus on one activity.

Although we hypothesized that the extent of industry cooperation was positively related to academic-entrepreneurial

Table 4
Summary of hypotheses related findings.

Hypotheses		Results			
		University of Cambridge		University of. Ljubljana	
		St. coeff.	Hypothesis supported	St. coeff.	Hypothesis supported
H1	Entrepreneurial self-efficacy is positively related to academic-entrepreneurial intentions	+0.46*	Yes	+0.31*	Yes
H2	Academic's personal networks are positively related to the entrepreneurial self-efficacy.	+0.58*	Yes	+0.48*	Yes
H3	Academic's personal networks are positively related to the academic-entrepreneurial intentions.	+0.12	No	+0.13*	Yes
H4	The extent of perceived role models is positively related to the extent of entrepreneurial self-efficacy.	+0.07	No	+0.12	No
H5	The extent of perceived role models is positively related to the intensity of academic-entrepreneurial intentions.	+0.21*	Yes	+0.14*	Yes
H6	The number of years spent at the academic institution is negatively related to academic-entrepreneurial intentions.	−0.12*	Yes	-0.23*	Yes
H7	The number of patents (applied for/granted) is positively related to academic-entrepreneurial intentions.	+0.19*	Yes	+0.15*	Yes
H8	The prevalence of applied research (type of research) is positively related to academic-entrepreneurial intentions.	+0.33*	Yes	+0.22*	Yes
H9	Cooperation with the industry is positively related to the number of patents (applied/granted).	+0.17*	Yes	+0.30*	Yes
H10	Cooperation with the industry is positively related to applied research (type of research).	+0.46*	Yes	+0.49*	Yes
H11	Cooperation with the industry is positively related to academic-entrepreneurial intentions.	−0.09	No	+0.06	No

Legend: * Sig. <0.05; St. coeff.—standardized coefficient
Note: University of Cambridge: $N=193$; University of Ljubljana: $N=354$.

Table A1
Measurement scales: number of items, sources of items, reliability and variance extracted.

Construct		Num. of items	Source	Cronbach α		Variance extracted	
First ord.	Second ord.			Univ. of Cam.	Univ. of Lj.	Univ. of Cam.	Univ. of Lj.
Entrepreneurial self- efficacy	Management	3	Adapted from Chen et al. (1998)	0.84	0.82	71.0%	65.5%
	Innovation	3	Adapted from Chen et al. (1998)	0.75	0.82		
	Marketing	5	Adapted from Chen et al. (1998)	0.94	0.91		
Personal networks		3	Adapted from Greve (1995) and Renzulli et al. (2000)	0.89	0.82	–	–
Perceived role models		1	(/)	–	–	–	–
Number of years spent at the academic institution		1	(/)	–	–	–	–
Cooperation with the industry		2	(/)	0.74	0.78	–	–
Patents		2	Adapted from Coombs et al. (2006)	0.90	0.94	–	–
Type of research		2	(/)	0.86	0.86	–	–
Academic-entrepreneurial intentions		6	Adapted from Chen et al. (1998), Kassicieh et al. (1997), Krueger et al. (2000), Gatewood et al. (1995)	0.92	0.89	65.8%	58.7%

Note: Entrepreneurial self efficacy is a second-order construct.

Table A2
Measurement items' descriptive statistics and correlation matrix for the University of Ljubljana.

Construct	Item	Min	Max	Mean	Correlations																											
					(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)
Entrepreneurial self-efficacy: management	(1)	1.00	5.00	3.70	1.00																											
	(2)	1.00	5.00	3.77	0.57	1.00																										
	(3)	1.00	5.00	3.97	0.51	0.75	1.00																									
Entrepreneurial self-efficacy: innovation	(4)	2.00	5.00	4.21	0.14	0.26	0.25	1.00																								
	(5)	1.00	5.00	3.81	0.21	0.34	0.27	0.55	1.00																							
	(6)	1.00	5.00	3.68	0.25	0.37	0.30	0.52	0.72	1.00																						
Entrepreneurial self-efficacy: marketing	(7)	1.00	5.00	3.05	0.26	0.42	0.33	0.28	0.52	0.46	1.00																					
	(8)	1.00	5.00	3.04	0.33	0.47	0.36	0.22	0.46	0.40	0.75	1.00																				
	(9)	1.00	5.00	2.92	0.38	0.45	0.38	0.18	0.34	0.37	0.56	0.52	1.00																			
	(10)	1.00	5.00	2.75	0.36	0.45	0.38	0.15	0.36	0.37	0.59	0.56	0.81	1.00																		
	(11)	1.00	5.00	2.79	0.37	0.42	0.37	0.14	0.36	0.38	0.60	0.57	0.75	0.86	1.00																	
Personal networks	(12)	0.00	5.00	1.05	0.24	0.26	0.22	0.05	0.21	0.15	0.36	0.42	0.24	0.27	0.30	1.00																
	(13)	0.00	3.16	0.60	0.26	0.29	0.24	0.10	0.21	0.19	0.37	0.35	0.28	0.34	0.33	0.66	1.00															
	(14)	0.00	7.07	1.08	0.27	0.27	0.25	0.13	0.19	0.22	0.32	0.36	0.18	0.22	0.21	0.63	0.52	1.00														
–	(15)	0.00	10.00	1.19	0.15	0.19	0.20	0.11	0.09	0.10	0.24	0.16	0.18	0.12	0.17	0.16	0.24	0.29	1.00													
–	(16)	0.50	42.00	13.11	−0.09	−0.05	0.04	0.03	−0.10	−0.13	−0.11	−0.16	−0.18	−0.11	−0.14	0.03	0.12	0.06	0.16	1.00												
Cooperation with the industry	(17)	0.00	50.00	7.63	0.11	0.13	0.06	0.05	0.20	0.17	0.21	0.19	0.15	0.14	0.12	0.27	0.26	0.25	0.16	−0.07	1.00											
	(18)	0.00	100.00	17.59	0.13	0.18	0.14	0.05	0.19	0.15	0.24	0.26	0.16	0.16	0.13	0.31	0.30	0.31	0.25	0.08	0.64	1.00										
Patents	(19)	0.00	2.45	0.18	0.10	0.10	0.10	0.14	0.22	0.09	0.18	0.14	0.09	0.07	0.10	0.16	0.22	0.17	0.11	0.24	0.23	0.25	1.00									
	(20)	0.00	2.24	0.12	0.10	0.08	0.06	0.08	0.16	0.10	0.18	0.10	0.07	0.04	0.05	0.14	0.22	0.13	0.11	0.24	0.20	0.22	0.89	1.00								
Type of research	(21)	0.00	100.00	51.93	0.09	0.16	0.13	0.03	0.21	0.20	0.24	0.23	0.14	0.15	0.16	0.23	0.20	0.24	0.23	−0.04	0.41	0.34	0.10	0.09	1.00							
	(22)	0.00	100.00	47.47	0.12	0.16	0.14	0.07	0.18	0.19	0.24	0.25	0.15	0.14	0.16	0.29	0.27	0.29	0.21	0.02	0.33	0.33	0.14	0.14	0.76	1.00						
Academic-entrepreneurial intentions	(23)	1.00	5.00	3.01	0.27	0.33	0.23	0.20	0.35	0.35	0.44	0.49	0.32	0.32	0.38	0.28	0.28	0.31	0.20	−0.20	0.25	0.27	0.22	0.21	0.33	0.40	1.00					
	(24)	1.00	5.00	2.64	0.26	0.29	0.23	0.18	0.33	0.29	0.40	0.45	0.32	0.31	0.35	0.28	0.28	0.34	0.25	−0.16	0.22	0.26	0.20	0.20	0.32	0.37	0.78	1.00				
	(25)	1.00	5.00	3.53	0.26	0.16	0.08	0.12	0.20	0.19	0.20	0.24	0.18	0.14	0.19	0.18	0.12	0.18	0.15	−0.23	0.17	0.19	0.11	0.10	0.19	0.25	0.56	0.57	1.00			
	(26)	0.00	100.00	25.03	0.27	0.26	0.20	0.20	0.37	0.30	0.41	0.41	0.28	0.25	0.30	0.34	0.33	0.40	0.31	−0.16	0.28	0.32	0.21	0.19	0.29	0.37	0.71	0.70	0.50	1.00		
	(27)	0.00	10.00	2.14	0.21	0.19	0.13	0.19	0.31	0.23	0.35	0.36	0.24	0.21	0.27	0.32	0.32	0.32	0.26	−0.03	0.23	0.28	0.24	0.24	0.21	0.28	0.61	0.56	0.37	0.83	1.00	
	(28)	0.00	14.00	1.82	0.27	0.28	0.21	0.22	0.34	0.27	0.30	0.35	0.25	0.22	0.23	0.22	0.27	0.27	0.23	−0.06	0.21	0.22	0.19	0.17	0.15	0.25	0.50	0.47	0.31	0.61	0.52	1.00

Legend: (1) Control costs; (2) Define organizational roles; (3) Define responsibilities; (4) Develop new ideas; (5) Develop new products; (6) Develop new services; (7) Establish position in product market; (8) Expand business; (9) Set and attain profit goals; (10) Set and attain market share goals; (11) Set and attain sales goals; (12) The average number of hours per week the respondent spends maintaining contacts∗; (13) The average number of hours per week the respondent spends developing new contacts with people to discuss business matters∗; (14) The total number of people with whom the respondent discussed business matters during the previous week∗; (15) the number of academic-entrepreneurs the respondent knows personally∗; (16) the academic's total years of employment at the academic institution(s); (17) the number of hours per week the academic spends on industry-ordered projects; (18) the average percentage of industry funding for the academic's research projects; (19) the number of patents granted to the academic during the prior 3 years∗; (20) the number of patents the academic applied for during the prior three years∗; (21) the number of hours per week the academic spends on applied research divided by the sum of the number of hours per week the academic spends on basic research and the number of hours per week the academic spends on applied research; (22) the percentage of the academic research funds for applied research in the last year in complement to total research funds in the past year; (23)Interest in own business; (24)Determined to have own company; (25) Considering to establish own company if opportunity was identified; (26) Probability of starting a business in five years; (27) Probability in starting a business in two years∗; (28) the number of activities undertaken in the past year related to starting a business.

Note: N=354. Correlations higher than 0.14 are significant at the 0.01 level. Correlations higher than 0.10 are significant at the 0.05 level. ∗Items were transformed by employing the square-root transformation because of extreme skew and/or kurtosis.

Table A3
Measurement items' descriptive statistics and correlation matrix for the University of Cambridge.

Construct	Item	Min	Max	Mean	Correlations																											
					(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)
Entrepreneurial	(1)	1.00	5.00	3.19	1.00																											
self-efficacy:	(2)	1.00	5.00	3.36	0.57	1.00																										
management	(3)	1.00	5.00	3.70	0.57	0.75	1.00																									
Entrepreneurial	(4)	1.00	5.00	4.19	0.27	0.32	0.40	1.00																								
self-efficacy:	(5)	1.00	5.00	3.31	0.38	0.41	0.30	0.41	1.00																							
innovation	(6)	1.00	5.00	3.06	0.38	0.36	0.25	0.29	0.79	1.00																						
Entrepreneurial	(7)	1.00	5.00	2.49	0.44	0.39	0.32	0.14	0.53	0.60	1.00																					
self-efficacy:	(8)	1.00	5.00	2.45	0.47	0.42	0.33	0.11	0.50	0.61	0.87	1.00																				
marketing	(9)	1.00	5.00	2.68	0.41	0.24	0.20	0.10	0.47	0.51	0.67	0.64	1.00																			
	(10)	1.00	5.00	2.34	0.39	0.31	0.25	0.11	0.47	0.55	0.75	0.72	0.81	1.00																		
	(11)	1.00	5.00	2.38	0.39	0.26	0.21	0.09	0.42	0.55	0.75	0.73	0.78	0.90	1.00																	
Personal networks	(12)	0.00	3.16	0.62	0.25	0.27	0.16	0.10	0.33	0.33	0.35	0.35	0.33	0.34	0.38	1.00																
	(13)	0.00	2.24	0.39	0.30	0.25	0.19	0.15	0.38	0.35	0.38	0.38	0.40	0.39	0.40	0.75	1.00															
	(14)	0.00	4.58	0.60	0.27	0.24	0.17	0.18	0.32	0.32	0.37	0.36	0.31	0.30	0.36	0.73	0.68	1.00														
–	(15)	0.00	7.07	1.45	0.13	0.22	0.18	0.16	0.15	0.10	0.13	0.19	0.12	0.16	0.11	0.17	0.28	0.17	1.00													
–	(16)	0.10	43.00	6.70	0.06	0.13	0.08	0.11	−0.16	−0.11	−0.16	−0.09	−0.14	−0.08	−0.12	0.06	0.05	0.06	0.35	1.00												
Cooperation with	(17)	0.00	65.00	6.20	0.11	0.12	0.11	−0.05	0.15	0.08	0.13	0.11	0.05	0.04	0.07	0.09	0.12	0.10	0.04	−0.07	1.00											
the industry	(18)	0.00	100.00	20.43	0.14	0.15	0.13	0.02	0.11	0.08	0.13	0.09	0.11	0.10	0.07	0.18	0.18	0.07	0.17	0.04	0.58	1.00										
Patents	(19)	0.00	3.16	0.21	0.13	0.21	0.13	0.08	0.18	0.09	0.19	0.23	0.05	0.00	−0.01	0.21	0.30	0.32	0.22	0.13	0.08	0.17	1.00									
	(20)	0.00	3.16	0.10	0.02	0.15	0.03	0.01	0.11	0.08	0.19	0.24	0.01	−0.01	−0.01	0.22	0.25	0.29	0.18	0.06	0.07	0.16	0.81	1.00								
Type of research	(21)	0.00	100.00	61.42	0.11	0.08	0.04	0.05	0.31	0.24	0.22	0.18	0.11	0.12	0.10	0.27	0.28	0.19	0.21	0.00	0.32	0.41	0.14	0.18	1.00							
	(22)	0.00	100.00	56.98	0.15	0.16	0.11	0.13	0.30	0.23	0.21	0.21	0.17	0.17	0.14	0.32	0.31	0.26	0.21	0.08	0.17	0.36	0.19	0.20	0.76	1.00						
Academic-	(23)	1.00	5.00	2.80	0.34	0.35	0.27	0.24	0.53	0.50	0.54	0.52	0.44	0.41	0.41	0.40	0.50	0.47	0.36	−0.02	0.10	0.27	0.34	0.26	0.43	0.54	1.00					
entrepreneurial	(24)	1.00	5.00	2.53	0.38	0.39	0.27	0.21	0.51	0.47	0.54	0.56	0.48	0.46	0.46	0.41	0.53	0.47	0.36	0.01	0.08	0.24	0.34	0.26	0.40	0.48	0.89	1.00				
intentions	(25)	1.00	5.00	3.36	0.24	0.31	0.22	0.16	0.34	0.31	0.42	0.41	0.28	0.31	0.32	0.32	0.37	0.34	0.27	−0.16	0.02	0.17	0.18	0.17	0.32	0.34	0.74	0.69	1.00			
	(26)	0.00	100.00	23.51	0.32	0.24	0.21	0.15	0.45	0.41	0.49	0.52	0.39	0.41	0.40	0.38	0.47	0.46	0.34	−0.06	0.06	0.17	0.38	0.33	0.37	0.45	0.79	0.76	0.61	1.00		
	(27)	0.00	10.00	1.80	0.25	0.20	0.16	0.13	0.41	0.33	0.37	0.40	0.26	0.26	0.28	0.34	0.43	0.43	0.38	−0.02	0.04	0.11	0.36	0.29	0.36	0.40	0.68	0.63	0.54	0.84	1.00	
	(28)	0.00	14.00	1.68	0.26	0.33	0.25	0.14	0.37	0.33	0.37	0.36	0.32	0.29	0.30	0.41	0.41	0.44	0.28	0.14	0.04	0.13	0.22	0.14	0.26	0.31	0.54	0.53	0.42	0.54	0.54	1.00

Legend: (1) Control costs; (2) Define organizational roles; (3) Define responsibilities; (4) Develop new ideas; (5) Develop new products; (6) Develop new services; (7) Establish position in product market; (8) Expand business; (9) Set and attain profit goals; (10) Set and attain market share goals; (11) Set and attain sales goals; (12) The average number of hours per week the respondent spends maintaining contacts∗; (13) The average number of hours per week the respondent spends developing new contacts with people to discuss business matters∗; (14) The total number of people with whom the respondent discussed business matters during the previous week∗; (15) the number of academic-entrepreneurs the respondent knows personally∗; (16) the academic's total years of employment at the academic institution(s); (17) the number of hours per week the academic spends on industry-ordered projects; (18) the average percentage of industry funding for the academic's research projects; (19) the number of patents granted to the academic during the prior 3 years∗; (20) the number of patents the academic applied for during the prior 3 years∗; (21) the number of hours per week the academic spends on applied research divided by the sum of the number of hours per week the academic spends on basic research and the number of hours per week the academic spends on applied research; (22) the percentage of the academic research funds for applied research in the last year in complement to total research funds in the past year; (23)Interest in own business; (24)Determined to have own company; (25) Considering to establish own company if opportunity was identified; (26) Probability of starting a business in 5 years; (27) Probability in starting a business in 2 years∗; (28) the number of activities undertaken in the past year related to starting a business.

Note: N=193. Correlations higher than 0.19 are significant at the 0.01 level. Correlations higher than 0.14 are significant at the 0.05 level. ∗Items were transformed by employing the square-root transformation because of extreme skew and/or kurtosis.

intentions, the study revealed that there is no direct, significant influence of industry cooperation on entrepreneurial intentions. However, industry cooperation is related to academic-entrepreneurial intentions through type of research and patents. Moreover, we found that type of research and patents are two important predictors of academic-entrepreneurial intentions. Therefore, academic institutions should actively promote cooperation between academics and industry, and the institutions should place greater importance on an individual's number of granted patents in the habilitation process.

To summarize, we believe that universities should take steps to promote entrepreneurial activity in their environments. Indeed, our research findings indicate that there are measures that universities can undertake in order to facilitate venture creation process in their environments. First, since stronger entrepreneurial self-efficacy consecutively leads to higher entrepreneurial intentions of an individual and since entrepreneurial self-efficacy can be enhanced through entrepreneurship education, we suggest that universities introduce entrepreneurship courses and seminars specifically tailored to the needs of doctoral students and senior researchers. Second, since networking and personal networks are a significant predictor of academic-entrepreneurial intentions, we propose to introduce different networking events, such as presentations of success stories and entrepreneurial workshops. In addition, academic institutions should allow a leave of absence for academics that are starting their own company based on academic research, actively promote cooperation between academics and industry, and place greater importance on an individual's number of granted patents in the habilitation process.

5.2. Limitations and future research opportunities

As with any research, several limitations should be noted. First, the model tested in this study includes variables that are, according to prior literature, the most probable determinants of intentions. There are other important variables that could be considered for inclusion, but this would make empirical examination less feasible. Second, despite the fact that we conducted this study in two different European countries, there are specific cultural determinants that may affect the results. To enhance the model's robustness, it would be interesting to compare the findings of this research to findings based on samples from the United States, which is the heart of academic entrepreneurship, and to findings based on samples from China, the largest developing country in the world. Third, it would also be interesting to identify reasons that lead to nuanced differences between the University of Cambridge and the University of Ljubljana. Fourth, because the research sample included only academics employed at technical faculties or departments, research findings cannot be generalized to academics from all research areas. Future research in academic-entrepreneurial intentions should consider the extent to which the findings of this study apply to academics from other research areas (e.g., life sciences, social, and behavioral sciences). Fifth, although the theory suggested the hypothesized causal directions, the cross-sectional nature of this study cannot prove causation but can only support a set of hypothesized paths (Kline, 2005). Therefore, we cannot eliminate the possibility of reverse causality. As Kline (2005) noted, to eliminate the possibility of reverse causality, longitudinal research is needed to determine the direction of causality of the relationships and to detect possible reciprocal causation. A longitudinal study could also reveal how many academics who have entrepreneurial intentions indeed became entrepreneurs after a few years. Sixth, this study used single-item measures for some of the independent variables (number of years spent at the academic institution and perceived role models). Although it is important to limit the number of items that respondents are asked to complete, we suggest that the future studies employ the multiple-item measures for these constructs and thus reduce the measurement error.

Appendix A

See Tables A1–A3.

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