
Getting out of the ivory tower – new perspectives on the entrepreneurial university

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Abstract: Based on theoretical considerations about the ‘third mission’ of universities and the discussion of different types of university-industry relations, we conclude that the entrepreneurial university is a manifold institution with direct mechanisms to support the transfer of technology from academia to industry as well as indirect mechanisms in support of new business activities via entrepreneurship education. While existing literature usually deals with one or another linking mechanism separately, our central hypothesis is that direct and indirect mechanisms should be interrelated and mutually complementary. We emphasise the importance of a more holistic view of the entrepreneurial university and empirically investigate the scope and interrelatedness of direct technology transfer mechanisms and indirect mechanisms, such as entrepreneurship education at German universities. We find a variety of activities in both fields and most universities’ technology transfer facilities and the providers of entrepreneurship education co-operate in support of innovative start-ups.

Keywords: entrepreneurial university; entrepreneurship education; technology transfer; university-industry relations.

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1 Introduction

Entrepreneurial activity is recognised to have a stimulating effect on economic development. The creation of new companies is expected to contribute to structural change, job gains and the innovativeness of firms, regions and nations (Audretsch et al., 2006; Fritsch and Mueller, 2004; Reynolds et al., 2004; van Stel and Storey, 2004). In particular, linking scientific discoveries with entrepreneurial activities as sources of new knowledge has developed rapidly as a particular driver for economic growth.

In the US, one milestone to this development was the Bayh-Dole Act. It provides incentives for universities to patent scientific results which, afterwards, can be transferred and commercialised in business enterprises. As a result, universities have strongly increased their entrepreneurial activities concerning patenting and licensing, establishing incubators and science parks and, finally, academic spin-offs (Siegel et al., 2007; Rothaermel et al., 2007). Today, most European countries also have enacted legislation that is quite similar to Bayh-Dole. Thus, a rise in entrepreneurial activities in European universities also can be observed. There has been a tremendous increase in the creation of spin-offs from universities in European countries (Mustar et al., 2006; Wright et al., 2004).

This shift inside universities towards more economic activities in the sense of knowledge commercialisation is called the ‘third mission’ of universities. In other words, knowledge commercialisation emerges as an additional task of universities, besides their traditional mandates of education and research (Etzkowitz et al., 2000).

The result of changes in legislation, institutional pressure from policy makers caused by the ‘innovation paradox’¹ and a growing recognition of the third mission of the university have resulted in an increased significance of the new role of entrepreneurial universities. This role facilitates entrepreneurial activity through various instruments such as infrastructure, consulting services and further support schemes. Incubators, science parks and technology transfer offices have been established in order to facilitate technology diffusion to business related activities. Furthermore, entrepreneurship education which calls for the responsibility of the universities to address the need for entrepreneurial competence recently has emerged as part of the academic curricula of such institutions.

The development of entrepreneurial activities at universities has attracted the increasing attention of researchers and results in an ever-increasing amount of scholarly work in this field (Rothaermel et al. 2007). Nonetheless, there is no overarching theoretical framework that encompasses the several fields of research dealing with the different mechanisms to commercialise university-based technologies. In other words, no clear link has been established between studies on direct technology transfer mechanisms and the indirect transfer activities expressed in the form of entrepreneurship education.

In this paper, we discuss the nature of business-academia links, emphasise the importance of a holistic view on it and empirically investigate the scope and interrelatedness of direct technology transfer mechanisms and indirect mechanisms expressed as entrepreneurship education at German higher education institutions (HEI). The central hypothesis of the paper is that direct and indirect mechanisms, i.e. technology transfer activities and entrepreneurship education, should be interrelated and mutually complementary. We empirically analyse universities' approaches to become entrepreneurial universities by looking at these direct and indirect ways of linking academia to business. This paper complements recent studies on academic entrepreneurship by taking a broader perspective, namely a combined view on entrepreneurship education as well as technology transfer activities represented by technology transfer offices, incubators and science parks. We use a unique dataset comprising 49 higher education institutions in Germany to scrutinise the scope and interrelatedness of entrepreneurial education and technology transfer activities.

The remainder of this article is organised as follows. In the next section, we discuss the nature of an entrepreneurial university with its different ways of directly or indirectly accessing markets for new technology. Subsequently, we provide empirical evidence from German HEIs concerning the scope and synergy of technology transfer and entrepreneurship education. We conclude with a summary and policy implications.

2 The entrepreneurial university as a fuzzy subject of research

There is a structural shift at European universities from their traditional missions of education and research to a third mission, namely the commercialisation of new knowledge for economic development (Etzkowitz et al., 2000). Universities' key contribution and traditional assignment is to generate new knowledge and to teach in basic disciplines. Today, we observe an extension of universities' research and teaching tasks for a third mission, which originally was solely the task of industry. 'It is this 'capitalisation of knowledge' that is the heart of a new mission for the university, linking universities more tightly to users of knowledge and establishing the university as an economic actor in its own right' (Etzkowitz, 2004). The traditional institution with the primary task of the conservation and transmission of knowledge has changed into an institution where knowledge is not only created but also put into practical utilisation. In particular, the new role of an entrepreneurial university is to facilitate entrepreneurial activity through various instruments such as specific infrastructure and entrepreneurship education.

As regional and national examples show, the sole investment in new knowledge' is no guarantee for innovations generating growth, employment and international

competitiveness. Various mechanisms of knowledge and technology transfer are needed to foster the commercialisation of knowledge. Transfer is characterised by a traditional mechanism for the commercialisation of university-based intellectual property such as patenting, licensing and research joint ventures. In recent times, the role of incubators and science parks as well as entrepreneurship education has increased in importance.

The development of knowledge and technology transfer as a professional field offers new career perspectives to university employees and to students (Siegel et al., 2007; Mosey et al., 2006). Universities are confronted with a demand to develop business planning and venturing skills and particular competencies are needed to start and lead a business. Thus, education also plays an important role as an indirect mechanism and has strong consequences on the role universities play today.

As a consequence, an entrepreneurial university consists of direct and indirect mechanisms to link academia to business. Technology transfer facilities, such as technology transfer offices, incubators and university-based science parks are set up in order to patent and license new technology or to create new firms based on novel ideas. Also, a university engaged in technology transfer and entrepreneurship education would commit itself to the task of knowledge transfer in general, if not to entrepreneurial activities in particular, in the university profile or mission statement. Finally, entrepreneurship education at the university fulfils the task of providing skills and competencies for entrepreneurial activities.

When reviewing literature on these topics, one recognises that although research is growing very fast, the whole field still remains fragmented (for a literature review, see Rothaermel et al., 2007). There is no overarching framework that encompasses the different research fields which deal with the support of spin-offs. In addition to that, there is no clear link between direct technology transfer mechanisms on the one hand and entrepreneurship education on the other. At an entrepreneurial university, teachers and instructors of entrepreneurship should be important intermediaries to raise awareness of entrepreneurship and to link academia to business in the long run. Even more importantly, there is a clear need for distinct skills to identify opportunities and to plan, start and grow a business. As a result, universities are, more and more, confronted with a need to establish entrepreneurship education and to assist students and university employees who seek support to start a new business.

In the following section, we discuss theoretical considerations on both direct and indirect mechanisms of knowledge commercialisation, in particular, technology transfer and entrepreneurship education.

2.1 Technology transfer and intellectual property regime

Technology transfer refers to the process whereby invention or intellectual property from academic research is commercialised through licensing or conveyance to a for-profit organisation. This process, starting with the invention, may end with technology licenses to existing firms or the start-up of a new company (Friedman and Silberman, 2003; Thursby et al., 2001).

The role of an intermediary concerning new inventions is usually undertaken by the technology transfer office (TTO). The TTO traditionally identifies, evaluates and selects academic inventions for patent application. It evaluates the commercial value of a new technology discovered or of an idea recognised by university faculty members, students or

staff members. The TTO identifies potential cooperation partners who have the capability, interest and resources to take on the development of the new technology. Most European research universities have such technology transfer offices. They are usually named 'technology transfer office', 'technology transfer centre' or similar.

After an invention is conveyed, the TTO is responsible for checking its patent potential. In case of a successful patenting procedure, the university owns the intellectual property rights and is able to license the patented technology to a for-profit organisation outside the university. If there is no existing firm that fits the invented technology or the inventor wants to commercialise the new idea on his own, a new venture can be set up. National and regional policy makers often support new firm formation by providing seed funding and incubation capabilities (Etzkowitz et al., 2004).

In Germany, since 1999, researchers are obliged to announce inventions to their university. In 2002, with the employer invention law, inventions are owned by the employer (university) and not by the professor. According to the legal regulation, 22 patenting agencies (*Patentverwertungsagenturen*) were established in Germany, which take care of IP management for HEIs. In case of commercial use of a patent, the license income is shared between the HEI and the individual inventor. There are usually several years from patenting a technology and the realisation of license income. The increasing interest in university technology transfer to the private sector for commercialisation also can be seen in a number of empirical studies on university technology transfer and the productivity of technology transfer mechanisms (for an overview see Friedman and Silberman, 2003).

Policy makers have launched support schemes, such as programmes to facilitate technology orientated spin-offs. Public funds and incubation programmes address the financing problem and provide practical information for academic entrepreneurs. Spin-offs may profit from business support, low cost facilities and infrastructure. Financing in the early pre-seed phase of the new venture has been introduced in most European countries by governments because access to venture capital is particularly difficult in the early stage (Clarysse et al., 2007; Wright et al., 2006). In Germany, public policy instruments, like the EXIST programme with a budget of 50 million Euro, were established by the Federal Ministry of Education and Research. The programme assists spin-offs through seed capital and management support.

2.2 Entrepreneurship education

Entrepreneurship education seeks to raise awareness for entrepreneurship and to provide the knowledge and skills to encourage entrepreneurial activity as an indirect support mechanism for fruitful business-academia links. Entrepreneurship education has been widely established at European universities, since they play a key role in the creation of academic spin-offs. Education and training also promote the set up of new ventures by students after graduating from university and support general employment prospects of graduates by developing an entrepreneurial orientation within existing firms (Kuratko, 2005).

What makes entrepreneurship education distinctive is that it is focussing on the realisation of new opportunities, while management education focuses on the best way to operate with existing processes and hierarchies. New business entry is a fundamentally different activity than managing existing business (Gartner and Vesper, 1994). Education

does also include courses dealing with soft-skill development e.g. negotiation, leadership, creative thinking and opportunity identification (Kuratko, 2005).

As education and training supports the creation and establishment of new ventures, it is obvious that courses and programmes are much more closely connected to real business activities than other disciplines. Contents are taught in a more action-orientated mode and, often, entrepreneurs serve as guest speakers. Action-orientated teaching also is given through the development of business plans for start-ups. Business plan development allows students to integrate accounting, economics, finance, marketing and other general business subjects. Thus, entrepreneurship education can be regarded as a highly integrative and interdisciplinary discipline.

Entrepreneurship courses, typically, deal with very different topics. Empirical analyses from curricula in the US show that the syllabi encompass more than 100 different topics. Similar approaches are very sparse to find and the content of courses ‘varies so much that it was difficult to detect if they even have a common purpose’ (Fiet, 2001). Most of the topics stem from the established literature of other disciplines, such as strategic management, organisation theory, management, finance and economics and psychology. The fact that they have their roots in other domains indicates that the syllabi do not emphasise a particular single domain. Accredited theoretical and didactical targets do not, so far, exist. Nevertheless, very different conceptual approaches and curricula designs contribute to further develop entrepreneurship to an accredited discipline.

These aspects have a strong impact on course design as they do not emphasise a certain domain and teachers necessarily need to experiment with curricula. More importantly, an academic curriculum or a single course for entrepreneurship is a dependent variable. Since it is an action-orientated and applied discipline, it depends much more strongly on the interaction between instructor, students and overall environment in which the learning process takes place (Hindle, 2007). The role of the university is also changing with respect to the mode of instruction, i.e. methods and instruments teaching entrepreneurship. As already indicated above, entrepreneurship education requires more than a mere imparting of business knowledge such as financing, controlling or marketing.

Furthermore, target groups of entrepreneurship programmes are not only reduced to those who intend to start up a business. Hills (2003) observes a strong diversity of the target population. For example, the motivation and decision to participate in a course also can occur due to academic restrictions, as the course is mandatory and a core course in the curriculum. Students also could simply be interested in the topic of entrepreneurship but, actually, plan to work as an employee later on.

Entrepreneurship education is institutionally implemented through entrepreneurship professorships or chairs for entrepreneurship. In Germany, the assignment of such chairs for entrepreneurship started in 1998. Since then, a number of entrepreneurship chairs have been installed at universities and universities of applied sciences in Germany. At the beginning of 2007, the German Association for Entrepreneurship Research (FGF – Förderkreis Gründungs-Forschung e.V.) recorded 54 entrepreneurship professorships both at universities and universities of applied sciences in Germany. Further positions are vacant or planned.

As mentioned above, existing empirical studies deal with the issues of entrepreneurship education on the one hand and technology transfer activities of HEIs on the other hand separately. This is not very surprising in the face of the fact that both fields are rather new for European universities. However, after several years

of knowledge commercialisation and entrepreneurship education activities, one should ask whether and how far the different activities co-exist or whether they already build an integrated concept. In the following paragraphs we present empirical results on the scope and interrelatedness of entrepreneurship education and technology transfer at German HEIs.

3 Data collection and description of the sample

Given the particularity of the research topic, the empirical part of this paper is based on our own data collection. We focused on HEIs that have at least one actively operating entrepreneurship professor and collected detailed information on both entrepreneurship education and technology transfer activities. The relevant HEIs in the sense of this study, which in Germany comprises universities and universities of applied sciences, have been identified from the list of entrepreneurship professors provided by the FGF.²

In Germany, the bulk of entrepreneurship education is provided through specially assigned entrepreneurship chairs. Entrepreneurship courses also may be offered by other (entrepreneurship-related) chairs but, rather, sporadically than regularly. Nonetheless, several examples show that an institutionalisation of entrepreneurship education is not necessarily bound to an entrepreneurship chair (Schmude and Heumann, 2007). It also underlines the fact that different countries have different approaches to realising entrepreneurship education at universities.

Our criterion for the selection of HEIs, i.e. at least one actively operating entrepreneurship chair (professor), makes sure that we cover HEIs regularly offering entrepreneurship education.³ At the time we ran the survey (spring 2007) we identified 49 HEIs with at least one occupied entrepreneurship chair. In addition to the basic information available from the FGF, we focused the data collection on the types and content of entrepreneurship courses and the technology transfer characteristics, such as the availability of TTO, incubator and science park. General information on the HEI, the entrepreneurship chairs and courses has mostly been taken from the internet. Missing or incomplete information has been filled in through written requests. Some information, such as information about the co-operation between professors and technology transfer offices, has been collected by telephone interviews exclusively. As a result, we created a comprehensive database on entrepreneurship education and technology transfer facilities with unique and nearly full information for all 49 HEIs.

In the sample, universities and universities of applied sciences are nearly equally represented, i.e. 22 universities (including four technical universities) and 25 universities of applied sciences. They differ with respect to their educational assignments but also with respect to size and age. In Germany, universities of applied sciences provide undergraduate education, mainly, in engineering and in management. Owing to the transition from Diploma to Bachelor Degrees, which has been broadly implemented by Universities of Applied Science in Germany, these institutions tend to exhibit a higher degree of practical orientation in comparison with their theory-orientated counterparts. Universities (including technical universities) engage in more theoretical work and retain the exclusive rights to award doctoral degrees.

The size of the HEIs in our sample, expressed as total number of students enrolled in the winter term 2006–2007, varies between 300 and 47,500. The small HEIs, mostly,

are private schools with few but specialised programmes, often in the field of business, economics or computer science. Around 21 HEIs have more than 10,000 students enrolled and they represent, predominantly, universities. Only two universities of applied sciences have more than 10,000 students.

4 Scope of entrepreneurship education

Together, the 49 HEIs in the survey account for 54 actively operating entrepreneurship professors. In the following, the term entrepreneurship professor is used for both the entrepreneurship chair and the entrepreneurship professor.⁴

Nearly half of the entrepreneurship professors (25) are endowed professorships. This means that a newly established professorship is, initially, financed externally, for example through a company, a foundation or any other private or public organisation. Commonly, the agreement between the HEI and the founder places the full financing responsibility for the chair on the part of the HEI after a period of five years. In our sample, for example, three chairs are financed by the KfW banking group, one is financed by the software company SAP, etc.

From previous studies on entrepreneurship education in Germany and German speaking countries (Achleitner et al., 2007; Klandt, 2004; Koch, 2003; Wagner et al., 2006) we know that the courses are, mostly, offered through the faculty of economics, to which most of the entrepreneurship professors belong. Our study confirms these findings. The vast majority of professors (43 out of 54) belong to the department of economics from their respective university (economics or business administration). The others belong to social sciences (2), computer science (2), engineering (3), education sciences (1), natural science (1) and other (2) departments⁵ (Table 1).

Table 1 Faculty affiliation of entrepreneurship professors

	<i>Frequency</i>	<i>Percentage</i>
Business and economics	43	79.6
Engineering sciences	3	5.6
Computer science	2	3.7
Social sciences	2	3.7
Pedagogic/education	1	1.9
Natural sciences	1	1.9
Others	2	3.7
Total	54	100

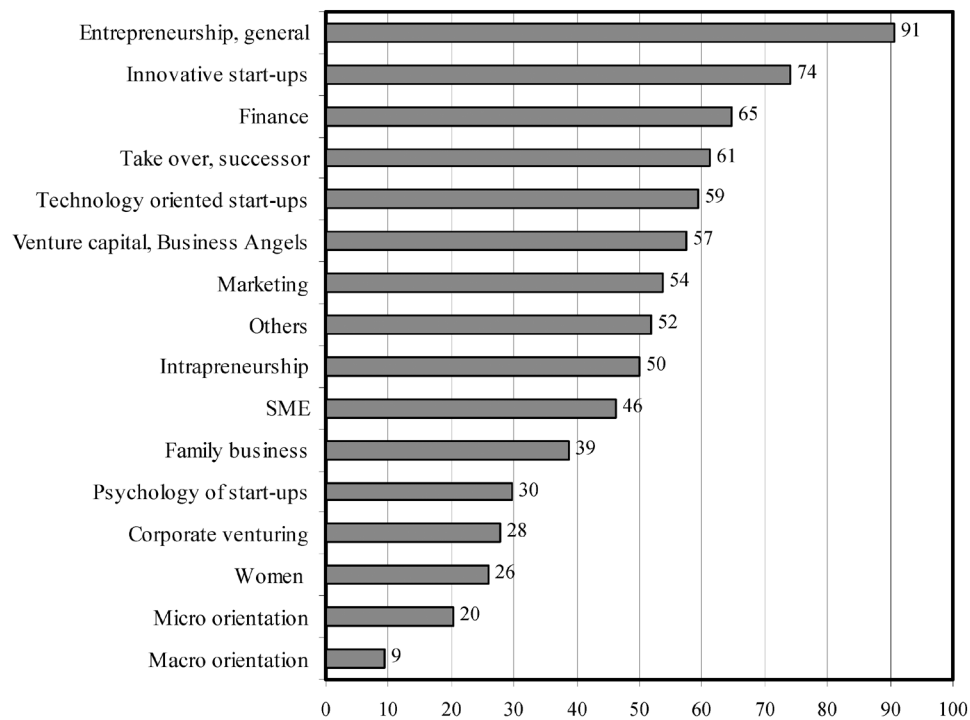
Source: Own data collection

The majority of entrepreneurship courses are offered by the department of economics. However, former empirical studies have shown that entrepreneurship courses generally address students from all academic programmes. From 172 entrepreneurship courses and their target groups analysed at German universities, around 70% of courses address students from all faculties (Wagner, 2006).

A recent university ranking of German entrepreneurship education shows that numerous efforts have been made by entrepreneurship professors to communicate, coordinate and exchange education activities between the different academic departments of their universities (Schmude and Heumann, 2007). In particular, the aim is to reach all target groups and to foster the involvement and participation from technical departments, such as natural sciences, engineering etc. where, in particular, new technologies evolve. Ideally, the entrepreneurship professor fulfils the role of first-contact-point and multiplier of new venture support.

As shown in Figure 1, the entrepreneurship professors have different specialisations. Not very surprisingly, nearly all professors deal with ‘entrepreneurship in general’ (over 90%) in their courses and programmes, followed by ‘innovative start-ups’ as an important field. Also, education frequently focuses on the fields of ‘finance’ and ‘take over/business successor’. In Germany today, many small and medium sized firms face increasing difficulties in finding adequate successors for the firm – a possible reason for the relatively high priority. Interestingly, the topic of ‘intrapreneurship’ (i.e. corporate entrepreneurship) has been addressed by every second professor as a field on which they focus.

Figure 1 Specialisation of the entrepreneurship professors in Germany



Source: FGF, own calculations (multiple answers were possible)

For the target group of entrepreneurship education, the data allow us to distinguish between ‘future entrepreneurs’, ‘future entrepreneurship researchers’ or ‘both groups’. The vast majority of entrepreneurship professors state that they intend to educate both future entrepreneurs as well as future entrepreneurship researchers. This underlines the broad understanding of entrepreneurship education which is not simply aimed at students interested in becoming self-employed sometime in the future.

Overall, the HEIs included in the survey offer 250 entrepreneurship courses throughout an academic year using different types of instruction. The two most prominent types are lectures and seminars, which together make up for around 75% of all courses (see Table 2).

Table 2 Types of instruction

	<i>Frequency</i>	<i>Percentage</i>
Lectures	97	38.8
Seminars	91	36.4
Exercise courses	19	7.6
Combinations thereof	21	8.4
Others	10	4.0
Not announced	12	4.8
Total	250	100.0

Source: Own data collection

The courses have different target groups with respect to the student’s stage of academic career (advancement). What is clearly shown by the data is that the entrepreneurship courses are, predominantly, offered for advanced students. About 46% of all courses have explicitly been announced for the *Hauptstudium*, which basically means graduate level (master).

In order to gain an insight into the content of the courses, the titles and descriptions of all 250 courses have been analysed and categories built accordingly (see Table 3). This shows that most courses fall into the group ‘Introduction to entrepreneurship/fundamentals of entrepreneurship’ (38%). This corresponds to the high priority of ‘entrepreneurship, general’ expressed as a field of interest by the entrepreneurship professors. The second largest group consists of courses dealing with ‘business plan development’ (26.4%), including the topic of business simulation. Some courses offer deeper insights into particular aspects related to entrepreneurship, such as ‘entrepreneurial finance’ (9.6%), ‘legal aspects’ (4.4%) and ‘marketing’ (2%). Another group of courses deals with ‘soft skills’ explicitly related to entrepreneurial activities (8.4%). Courses such as intrapreneurship, entrepreneurial human resource management, growth management and internationalisation of entrepreneurial activities fall into the category of ‘other topics’.

Table 3 Content of entrepreneurship courses

	<i>Frequency</i>	<i>Percentage</i>
Principles of entrepreneurship	95	38.0
Business plan development	66	26.4
Entrepreneurial finance	24	9.6
Soft skills	21	8.4
Legal aspects	11	4.4
Commercialisation	5	2.0
Marketing	5	2.0
Other topics	23	9.2
Total	250	9.2

Source: Own data collection

From the analysis of the topics of courses, there is not much evidence that entire courses deal with the subject of technology transfer from science to industry. We found only five courses dealing explicitly with the topic of knowledge commercialisation in the sense of technology transfer. The course titles are, for example, ‘IPR and patenting’, ‘spin-offs from public research’ and ‘HEI as an incubator for entrepreneurial activity’.

In the following section we will go further by addressing the scope of the universities’ technology transfer activities and their linkages to entrepreneurship education.

5 Scope of technology transfer activities

In order to scrutinise whether and to what degree the HEIs provide technology transfer support, we collected data on the self-image of the HEIs and the availability of technology transfer facilities, such as technology transfer offices, incubators and science parks as well as entrepreneurship advisory services and patenting information services.

5.1 Technology transfer and entrepreneurial activity in the HEIs’ mission statements

In a first step, we analysed the publicly available mission statements of all HEIs in our sample and identified whether:

- commercialisation of knowledge in general
- entrepreneurship activities in particular

are mentioned as one of the university’s missions in the text. One would expect that universities engaged in entrepreneurship education by employing a professor for entrepreneurship would commit themselves, at least, to the task of knowledge transfer in general if not to entrepreneurial activities in particular. We took the mission statements from the universities’ websites where they were easily accessible. The descriptions of relevant entrepreneurial activities as reported on the universities’ websites appear under different names, such as profile, mission statement, university concept, etc. They usually

are rather brief and comprehensive descriptions of the HEIs' self-image and core competencies.

As a result of our analysis, we show that the vast majority, i.e. 40 out of the 49 HEIs, mention commercialisation of knowledge, in the sense of technology transfer, as an important task in the mission statement (see Table 4). Given the fact that entrepreneurial activities are one form of technology transfer and, assuming that HEIs have this in mind when putting together a profile, we can conclude that there is a strong commitment and awareness of the importance of knowledge commercialisation activities at the level of the HEI as a whole. In addition, 15 out of 49 HEIs, i.e. nearly every third HEI, explicitly mentioned entrepreneurship activities as an important task of the HEI. Overall, the document analysis of mission statements can be interpreted as a substantial commitment of the HEIs to technology transfer activities, including entrepreneurial activities.

Table 4 Infrastructure and services of the HEI in support of knowledge commercialisation and mission statement information

<i>Practical support of knowledge commercialisation</i>	<i>Yes</i>	<i>No</i>	<i>Not announced</i>
Mission statements:			
Technology transfer mentioned	40	9	–
Entrepreneurial activity mentioned	15	34	–
Facilities for technology transfer:			
Technology transfer offices	42	6	1
Incubators	19	29	1
Science parks	9	39	1
Services:			
Entrepreneurship advisory services	41	8	–
Patenting information service	21	27	1

Source: Own data collection

5.2 *Infrastructure and services of the HEIs in support of knowledge commercialisation*

In a further step, we analysed the availability of infrastructure and services for knowledge commercialisation at the HEIs in our sample in order to see whether and to what degree the commitment to knowledge commercialisation is expressed in practical support, through infrastructure facilities or information services.

As regards infrastructure facilities, we distinguish 'technology transfer offices', 'incubators' and 'science parks' in our database. With respect to services, usually offered through the above mentioned facilities, we identified 'entrepreneurship advisory services' and 'patenting information service' (see Table 4).⁶

The vast majority of HEIs in our survey have their own technology transfer office. We define them as an information centre or helpdesk providing services for researchers and students around commercialisation activities in general, such as patenting, spin-offs,

industry cooperation, etc. They are, usually, named technology transfer office or technology transfer centre, sometimes other terms exist. We identified 42 HEIs with a technology transfer office in the above described sense (86%). The six HEIs without a technology transfer office are, mostly, small HEIs, especially small private schools where the absence of such a facility is, mainly, a matter of resources.

Fewer HEIs in our sample have incubator facilities. The general idea of an incubator is to offer promising entrepreneurs particular support in an early stage of their start-up activity. The support usually includes:

- the provision of physical space (rooms, laboratories)
- management coaching
- administrative services
- technical support
- business networking
- advice on intellectual property rights
- sources of financing.

Incubators can differ with regard to the scope of support, the target group (people with advanced business plans or pre-entrepreneurial ideas) and location (integrated into the HEI buildings or in an affiliated organisation, etc.) (Stahlecker and Lo, 2004). In the survey, there is no differentiation between the various types of incubator. We identified any facility that corresponds to the general definition outlined above as an incubator. Finally, we found 19 HEIs in our sample offering an incubator facility.

Science parks are considered to be a location where firms and other organisations focus on product development and innovation in high-tech branches (different from industrial parks where firms focus on manufacturing). In Germany, science parks are usually associated with or operated by public research or higher education institutions and also can be called technology or research parks. In our sample, we found nine HEIs that are affiliated with or run their own science park, typically larger universities with a focus on engineering or natural sciences.

With respect to the provision of services, the data show that TTOs are usually in charge of providing entrepreneurial advisory services for the members of the HEIs, also and especially in the early stage of business ideas. The absence of a technology transfer office does, however, not automatically mean that there is no advisory service on entrepreneurial activities, etc. If we look at the provision of entrepreneurial advisory services, we see that some of the HEIs without a TTO offer such services anyway. Often, it then takes place through the entrepreneurship professor in person. In total, 41 HEIs do, explicitly, offer entrepreneurship advisory services for researchers, students and other members of the HEI.

Twenty one HEIs engage in patenting information services. Information services around patenting have strongly increased in Germany after the change of the so-called 'professor privilege' in 2002. Since 2002, university scientists are, no more, exclusive owners of their inventions. They now have to announce every invention at the university, which in turn checks within a certain time period whether the university intends to file

a patent application. After the abolishment of the ‘professor privilege’, patenting became a much stronger topic at German HEIs.

In some cases, the tasks between the different types of technology transfer activity as described above may overlap. The division of labour between the facilities may differ between the HEIs. For example, entrepreneurial advisory services are provided through a technology transfer office at one HEI, while somewhere else they are provided through an office at the incubator. Overall, nearly each HEI included in our sample has one or another infrastructure facility and information service in support of technology transfer. Best equipped are the technical universities, where technology transfer is nearly inherent. Most interestingly, the four technical universities in our survey exhibit the full programme, which means a technology transfer office, incubator and science park facilities as well as entrepreneurship and patenting advisory services. However, one has to keep in mind that they are large universities specialised in engineering, natural sciences and/or information science.

6 Co-operation between entrepreneurship professors and technology transfer activities

According to our understanding of an entrepreneurial university, entrepreneurship education provided by the professors and technology transfer support offered by different institutions at the universities should be interrelated in order to fully serve the mission of entrepreneurial activity. An interrelation in this sense is not easy to detect and information about this aspect could only be collected through personal requests at the universities.

Firstly, we identified the institution mainly responsible for advisory services on entrepreneurship activities at each HEI. Our data reflects that, in most cases, the technology transfer offices are in charge, while sometimes a service point at the incubator or science park is responsible. Through telephone interviews, we asked the relevant institution whether co-operation with the entrepreneurship professor regularly exists. From those cases where data could be collected (missing values for 14 cases) only two HEIs indicated a lack of co-operation. In 17 cases the entrepreneurship professor and the relevant institution actively co-operate. Furthermore, in 16 cases the entrepreneurship professor himself is the provider of entrepreneurship advisory services at the relevant HEI (see Table 5). In the latter case, the professor offers particular consultation hours at the faculty to which he belongs or he fills an extra position at the university’s technology transfer office where he or she provides entrepreneurship advisory services.

An engagement of the professors in the universities’ overall knowledge commercialisation activities, not only with respect to entrepreneurship advisory services, seems to be nothing unusual. There are several cases where the entrepreneurship professor holds further position(s) in local associations in support of entrepreneurial activities, business development, etc.

Table 5 Cooperation between technology transfer offices and entrepreneurship education providers (professors)

	<i>Frequency</i>	<i>Percentage</i>
Cooperation exists	17	34.7
Chair itself provides advisory services	16	32.7
No cooperation exists	2	4.1
Not announced	14	28.5
Total	49	100

Source: Own data collection

To sum up, future synergy potentials are expected in the cooperation of education contents. Entrepreneurship education contents and methods need to be customised, as only a few courses so far are entirely devoted to the subject of technology transfer or knowledge commercialisation. Topics such as intellectual property rights, patent application, licensing etc. should play a more important role in the entrepreneurship curricula. These developments would contribute to a better link and co-operation with technology transfer activities. Conversely, technology transfer consultants also could benefit from a complementary supply in business planning and venturing.

The intention to collect data on the number of new ventures resulting from the entrepreneurship education, as well as from the technology transfer activities of the HEIs has, unfortunately, proved to be impossible. Most offices and professors state that there is no documentation of start-ups. This also has to do with the fact that the final outcome of business ideas discussed in the technology transfer offices or somewhere else at the HEIs often remains unknown. In addition, a business idea born at the HEI might become real only years after a student's graduation or a researcher's leaving.

7 Summary and conclusion

The entrepreneurial university has no strong tradition in Europe but the recognition of entrepreneurial activities as an important factor for economic development has increased over time and, with it, the knowledge commercialisation activities. In recent years, there have been numerous efforts to make European universities more entrepreneurial. A look at German higher education institutions shows that much already has been reached, particularly in the last ten years. Technology transfer offices, incubators, entrepreneurship professors, etc. no longer are rare institutions. In spring 2007, there were 49 higher education institutions with, together, 54 actively operating professors for entrepreneurship in Germany. The analysis of entrepreneurship courses shows a large variety of issues dealt with, whereby fundamentals of entrepreneurship and business plan development play the most important role. However, only a few courses, so far, are entirely devoted to the subject of technology transfer or knowledge commercialisation.

With regard to the complementarity between entrepreneurship education and overall technology transfer activities, one can tell that the vast majority of higher education institutions in our sample has a technology transfer office in charge of advisory services and support services in different fields, such as industry cooperation, patenting, start-ups

etc. Depending on the size and specialisation of the higher education institutions, we also found other infrastructure facilities in charge of technology transfer, including start-up support. Moreover, we found evidence that there is a vital interaction between technology transfer offices and entrepreneurship professors. Very often the entrepreneurship professor holds, also, a position at one of the university's infrastructure facilities for technology transfer, especially in the field of entrepreneurship advisory services. These interconnections built through persons in key positions are particularly valuable since start-up ideas generated by students in class can be further developed and assessed through the facilities of technology transfer.

In general, one can conclude that entrepreneurship education has gained much importance and acknowledgement over the last years at German HEIs. Many of the HEIs included in the survey explicitly mention 'entrepreneurship' as an important task in their mission statement. However, in order to fulfil the legally subscribed mission of German universities to become more entrepreneurial, there seems to be a need to increase the number of entrepreneurship professors, as well as a strengthening of the technology transfer facilities. Thereby, endowed professorships will probably remain an important factor. The fact that most entrepreneurship chairs belong to an economics department might be seen as a weakness, since a large part of knowledge ready for commercialisation occurs in technically orientated faculties. However, this aspect has been recognised by the relevant stakeholders and future development of entrepreneurship education has to address this point.

Finally, as mentioned before, a measurable outcome of entrepreneurship education is, so far, not possible. Therefore, quantitative analyses of the effects will only be possible in the long run but should be regarded as a major challenge for future research in the field of entrepreneurship education.

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Notes

- ¹ European policy-makers believe in the so-called 'innovation paradox' which emphasises that Europe leads in producing publications but lacks commercial skills. (European Report on S&T Indicators, 1994; EC Green Paper on Innovation, 1995).
- ² We thank the FGF for the provision of information and friendly support. The list includes the name and address of the HEIs, the name and specialisation of the professors and some other general information. It lists HEIs with occupied, vacant and planned chairs. Our empirical study is restricted to HEIs which have at least one specially assigned entrepreneurship professor. For HEIs with vacant or planned chairs the information relevant for this study would hardly be detectable.
- ³ The FGF provides a list of 'entrepreneurship affiliated' chairs but this is an exemplary and selective list. Achleitner et al. (2007) identify 45 entrepreneurship affiliated chairs in Germany. However, it remains difficult to generate a reliable and full list of HEIs providing entrepreneurial education in Germany.
- ⁴ In the German system, not all professors automatically hold a chair (Lehrstuhl) in the sense that they have a (tenured) position with additional financial resources for personnel and research. This applies especially for universities of applied sciences, where professors usually do not have assistants and further resources for research. Two entrepreneurship professors in our sample are honorary professors. Honorary professor is a title awarded to people who have a particular connection to an HEI for several years, give at least one lecture each semester, etc. while regularly working somewhere else.
- ⁵ In the case of 'others' we could not identify the faculty because no typical differentiation between faculties existed at that HEI.
- ⁶ These categories do not follow any particular (international) standard and they are strongly connected to the German technology transfer system. To identify these categories we started with an exploratory study of what is offered at the HEI and then determined adequate categories accordingly.