

Vienna as a Region of Knowledge: Increasing the Generation of University Spin-offs

Final Report to the Vienna Chamber of Commerce (WKW)

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Executive Summary

In the globalized, knowledge-based economy of the 21st century, the long-term economic competitiveness and social well-being of cities and regions will depend upon their ability to generate and nurture innovative businesses and organizations. Innovative activity can occur in different types of organizations, including SMEs, large national and multinational corporations, and in entrepreneurial start-ups. One of the most important set of actors in generating innovative activity is universities. Universities can stimulate and support regional economic development in a number of ways, including through the provision of the skills and training of the future highly skilled labor force. But the knowledge produced through both basic and applied research within universities has the potential to lead to innovative activity through knowledge commercialization. Knowledge commercialization can occur in the form of patenting and licensing, or through the generation of new businesses 'spun-off' from university research projects. This study focuses on the generation of university spin-off businesses in the Vienna region. The study seeks to provide answers to two key questions: (1) what has been the incidence of university spin-offs in the Vienna region; and (2) what are the most important barriers and obstacles that have prevented the incidence of spin-offs from being higher?

The definition of a university spin-off used in this study is a new business in which the science or technology which is the basis for the new product or process was developed at a university by one or more university staff member (professor, doctoral student, other researcher). It is neither necessary that the technology be patented or have other forms of intellectual property protection, nor that the university researcher/entrepreneur has a continuing relationship with the business after it has been created.

Our study has been informed by a review of two bodies of research literature. First, university spin-offs are *entrepreneurial actions*. The literature on entrepreneurship is quite extensive. Much of it focuses on the reasons or motivations for someone to become an entrepreneur, while another strand focuses on examining the success factors of start-up businesses along different stages in a life cycle. The second body of relevant literature is concerned with the internal culture, norms, governance, and resources of universities as potential parent organizations of spin-offs. The most relevant lessons from the intersection of these two literatures are: (1) that the generation of university spinoffs is highly complex, involving many different actors operating within a diverse set of institutions, processes, and rules; (2) there is a high degree of heterogeneity among university spin-offs in terms of the 'paths' and outcomes in their respective life cycles, including, most notably, the barriers and obstacles they have to confront; (3) the high rate of failure of new business start-ups in general, extends to university spin-offs.

The potential barriers and obstacles to the generation of spin-offs, despite their heterogeneity, can be grouped into factors related to (i) the attributes, attitudes, and experiences of the individual faculty researcher/entrepreneur; (ii) culture, institutional conditions, and resources in the university and department/institute; (iii) conditions and resources in the regional milieu conducive to the creation of spin-offs; and (iv) policies and programs at the federal and EU levels that may support (or not) the generation of spin-offs.

The primary methods used in this study, in addition to the review of the relevant literature, include an extensive internet search (to identify and confirm cases of university spin-offs), data bases of new businesses procured from several support organizations, face-to-face interviews with a variety of actors, including faculty entrepreneurs, university officials, leaders of support, funding, and other intermediary organizations, policy officials in federal ministries and other governmental organizations, and other experts. A questionnaire has been used to obtain standardized responses from interviewed actors concerning which factors are perceived to be most important as obstacles to the generation of university spin-offs. Our count of university spin-offs in Vienna covers the six year period of 2007-2012, and is inclusive of all sectors and technologies. Our investigation of the obstacles and barriers to the formation of spin-offs is focused on two sectors – the life sciences and information technology – as those two sectors comprise the large majority of spin-off activities in the Vienna region. To assess how well the Vienna region has performed in the generation of university spin-offs, we use the Munich region as a benchmark, where we have estimated the number of university spin-offs over the same six year period.

The Vienna region has considerable knowledge assets for potential knowledge commercialization generally and the generation of spinoffs from university-based research specifically. Six research universities, i.e. those that award doctoral degrees and have substantial expenditures for research, are located in Vienna. Together they had 777 million Euro in research expenditures 2007 (Stadt Wien 2011). Roughly, basic research accounts for about half (48 percent) of research expenditures. We have calculated several indicators of the research intensity of Vienna's university sector compared to the research universities in Munich and Berlin. Research expenditures as a percentage of total university budgets are slightly higher in Vienna than in Munich. However, R&D spending per academic staff is less than one half of the figure for Munich, and R&D spending per student enrollment in Vienna's universities is also less than half of Munich's. In addition to the university sector, private companies represent significant regional R&D assets, as they employ more than half (56 percent) of all R&D workers in the region.

Although there are a number of R&D strengths in the Vienna region, there are three technology areas that stand out in terms of concentration of talent and competitiveness. The pre-eminent area is the life sciences (including biotechnology). There are more than 400

life science companies in the region employing about 9,000 persons, and 22 research institutions concentrating in the life sciences including five research universities. Total annual average third party funding for research in the life sciences has been estimated to be about 200 million Euro. Other areas of competitive strength, though not at the level of the life sciences, are information technology and environment/energy.

Our best estimate of the number of university spin-offs in the Vienna region, between 2008 and 2012, using the definition above, is 113. Of these, more than one-half have come from the TU Vienna. Because this was a time of severe economic crisis with many financial organizations withdrawing from making any risky investments, this estimate is not representative of the rate of university spin-offs over a longer time span. We have made an estimate of the number of spin-offs from universities in the Munich region, using the same definition and the same time period, in order to have a meaningful comparison for assessing the Vienna region's performance. Our best estimate for the number of spin-offs in the Munich region is between 100 and 150. The results indicate that Vienna has performed rather well in comparison to its benchmark of Munich, which has had a well-deserved reputation as a high tech center, with two of the best universities in Europe and a milieu conducive to the generation of spin-offs, particularly in the life sciences.

Not surprisingly, different actors have different perceptions of the obstacles to the generation of university spin-offs in Vienna. There is broad agreement, however, across a range of actors about the importance of some of the most important factors. In terms of the individual attributes of faculty entrepreneurs, the lack of business and entrepreneurial skills of researchers, a low tolerance for risk and for failure, and the lack of sufficient rewards or incentives by their universities for work that leads to commercialization are cited often. In terms of institutional (university) factors, the universities' lack of space and facilities for new spin-off businesses, an insufficient supply of seed funding to help the faculty entrepreneur take the research to the 'next step', and the lack of training opportunities for researchers to learn business skills were cited most. At the level of the *regional milieu*, the lack of sources of angel investors and venture capital within Vienna, the paucity of role models of successful entrepreneurs, and a culture of risk avoidance and shame of failure imbedded in the culture were mentioned across the full range of actors. Finally, inadequate early-stage and late-stage funding from federal government organizations were widely cited as inhibitors of the generation of spin-offs and their eventual success.

The report provides a lengthy list of actions that can potentially increase the incidence of university spin-offs. They are grouped in terms of policies or strategies that can be taken at the institutional (university) level, city or regional level, and federal government level. Some of these can be implemented and their effects seen in the short- or medium-term, such as accessible provision of business and entrepreneurial skills to university faculty

and doctoral students, and increased coordination among universities in sharing resources, information, and support, to realize economies of scale. Others, such as changing the culture of risk avoidance and the shame of failure, are longer-term efforts that need to be aimed at the primary and secondary educational curricular levels.

1. Introduction

In the knowledge-based, globalized economy of the 21st century, the long-term economic and social of cities and regions depend upon the competitiveness of their business producers. Regional competitiveness, in turn, depends upon a number of factors, but one of the most important is innovation. Cities and regions with a concentration of innovative businesses and a milieu, or culture that supports innovation and entrepreneurship will be those that will be best able to adapt to changing external conditions. Such regions will exhibit above-average rates of productivity growth and earned income, and lower rates of unemployment and underemployment. They will also be the regions that display the most resilience during macroeconomic downturns and economic crises.

Many regions in North America, Europe, and Asia have been actively developing innovation strategies with that in mind, aided and abetted with a combination of government investments in infrastructure, education, and the development of knowledge networks (Toedtling and Trippel 2005; Cooke 2002). The European Commission, at the Lisbon summit in 2000, set an objective 'to become the most dynamic and competitive knowledge-based economy' in the world.

There are a number of potential actors involved in all strategies for building of innovative regions. Most often, government organizations, regional businesses, and educational institutions are seen as essential because each has unique assets that are vital to the innovation process. Among educational institutions, high schools and vocational schools are critically important for the development of a skilled labor force, but research universities have taken 'center stage' because of their focus on knowledge creation and their unique knowledge assets embodied in the faculty and research staff. The traditional missions of research universities since at least the mid-20th century in most of the highly developed regions of the world have been teaching and the production of knowledge. Within the last 30 years or so, and for a variety of reasons – including tapping new potential sources of revenue, greater autonomy from ministries and legislatures, pressure from regional and national governments to contribute more directly to economic growth, and the increasing globalized competition among universities for academic talent and prestige – many research universities worldwide have added economic development as an additional mission.

Research universities can contribute to economic development in multiple ways, including both teaching and basic research (Goldstein, Maier, Luger 1995). Indeed, the creation of human capital is often an underappreciated, but perhaps the most important, mechanism for HEIs to enhance regional economic development to the extent that graduates take jobs within their respective region (Goldstein and Renault 2004). But since the Bayh-Dole Act of 1980 in the U.S., the emergence of the biotechnology industry and with it a U.S. Supreme Court decision that allowed the patenting of recombinant DNA, the *commercialization of*

knowledge developed in universities took ‘center stage’ in many research universities in the U.S. This model of universities as loci for knowledge commercialization was soon replicated to the extent possible in Europe and parts of Asia (Liebeskind 2001).

Knowledge commercialization activities come in many flavors, however. They include joint university-industry research projects, the development and management of science parks and incubators, patenting and licensing, and the generation of academic spin-offs. Each offers some advantages and disadvantages, and universities often are engaged in a portfolio of knowledge commercialization activities whose mix largely depends upon local opportunities, the experience, expertise, and depth of university technology transfer professionals, and the set of laws, policies and regulations that govern the university.

In this paper we focus on the generation of university spin-offs as one of the strategic initiatives for universities to help create ‘knowledge regions’. Here, university spin-offs mean the creation of new businesses whose scientific or technological bases grew out of university research projects (in the next section of the paper we expand on our definition, noting the existence of a number of different definitions in the literature). Compared to patenting and licensing as the most commonly used mechanism of knowledge commercialization, the generation of university spin-offs have some advantages from the perspective of regional economic development. Audretsch and Lehman (2005), for example, note that there is a very high likelihood the spin-off business will locate within the same economic region (at least for a while), while the licensing of technological innovations is often to existing businesses located outside the region. On the other hand, from the perspective of the university, patenting and licensing often ‘promises’ a higher return on investment; spin-offs pose relatively higher risk.

The European Union has recognized the generation of spin-offs as a key instrument for technology innovation and for the achievement of its Lisbon goal stated above (European Commission 1998, 2000), as has the OECD (2010). Yet, to-date, the incidence and subsequent growth of university spin-offs in Europe has been disappointing. There have been a number of reasons offered, but there is no consensus. In this paper focused on university spin-offs, our specific objective is to identify the most important obstacles, or barriers, to their generation using the region of Vienna, Austria and the research-oriented universities located in Vienna as our case. In subsequent research we shall extend the study to include several other economic regions using a comparative case research design.

In section two we discuss in the context of the pertinent literature the definition we adopt for university spin-offs, and select a theoretical framework from the literature that offers the greatest insight into understanding the set of obstacles and barriers to the generation of university spinoffs, including the set of actors and institutions that should be taken into account in the process of spinoff formation.

We provide in the third section of the paper a description of Vienna as a regional context for university spin-off activity: its research universities, specific historical and institutional conditions and factors affecting spin-off activity, and the more general environment for entrepreneurship and technological development. We also describe how we have collected the empirical evidence for the case study of Vienna.

In section four we provide our estimation of the incidence of university spin-off generation in Vienna over a recent six year period. We then report on the analysis of the data we have collected on the barriers and obstacles to spin-off generation.

In the last section we develop a set policy and programmatic implications based upon our empirical findings, and offer several suggestions for further research.

2. Literature Review

In this section we discuss the alternative definitions of university spin-offs and identify from the extant literature the principal factors that have been found to influence the incidence of the generation of university spin-offs.

2.1 University spin-off definitions

Pirnay, Surlemont, and Nlemvo (2003) and Djokovic and Souitaris (2008) have conducted detailed literature reviews covering alternative definitions of university spin-offs. The definition is not a trivial matter since the measurement of the incidence of university spin-offs in any geographical area can vary considerably depending upon the definition adopted. Following Djokovic and Souitaris (2008), a valid and useful definition of a university spin-off needs to specify (i) the necessary outcome of the spinoff process, (ii) the actors that must be involved in the process, and (iii) what is it that is transferred during the process.

Just about all definitions agree that the outcome of a spin-off process is the formation of a firm (which did not previously exist). In practice it means that the new entity becomes officially and legally registered as a business. Note that this does not place conditions on the minimum length of time the firm stays in existence, its growth trajectory, or level of capitalization.

The involved parties include the parent organization; the technology originator(s) (who is mostly responsible for developing the technology from basic research to the stage at which technology transfer can occur); the entrepreneur who creates a new venture based upon the developed technology, and investors who provide funding for the new firm. It is clear that the parent organization is a university. There are good reasons, however, for including new firms that grew out of joint university-industry research projects, in which case there may be more than one 'parent', though a university must be one of the principals. The technology originator (or at least one of the principal ones if more than one) is an employee of the university, usually as a faculty member, but could be a non-faculty researcher or

graduate student. The entrepreneur need not be the same as the technology originator, nor even an employee of the university. Who the investors in the new firm are does not matter; in principle they can be public or private, individual or institutional, local or foreign. The university itself could be an investor (or not), and other investors could be from private investment firms, banks, government organizations, or wealthy individuals (angels).

Cases of new firms that are created by a university graduate or a former university employee, but the science or technology was not developed by the technology originator while that person was conducting research at the university should fall outside the definition of a university spin-off. Neither should we include cases of faculty members who decide to start a business while still employed at the university, but the basis of the business did not originate from their university research.

The elements transferred from the parent organization to the new firm might include the (1) core technology and (2) individuals who formerly worked at the parent organization that were involved in the development of the technology. Concerning the technology, Di Gregorio and Shane (2003) have stipulated that a spin-off is a new company founded to exploit some intellectual property developed within the academic institution. Similarly, Lockett et al. (2005) adopt the definition as “new ventures that are dependent upon licensing or assignment of the institution’s intellectual property for initiation,” (p. 1044). In our view, however, this is conceptually too narrow. It is often used, nevertheless, because it is consistent with, and allows the use of, the Association of University Technology Managers (AUTM) collection of spin-off data from member institutions in the U.S. We agree with Pirnay, Surlemont and Nlemvo (2003) that what is exploited by the new firm may be any knowledge, technology, or research results with commercial potential whether legally protected as intellectual property or not. Concerning the transfer of personnel from the university to the new firm, Smilor et al. (1990) posited that to qualify as a university spin-off, the firm founders must move their primary place of employment from the university to the new firm. A less restrictive condition is that the university employee must maintain an active role with the new firm. We also agree with Nicoleau and Birley (2003) that neither the technology developer nor the entrepreneur need to be actively involved in the new firm, so long as the essential condition that the technology was developed at the university.

To summarize, what we believe is essential elements in a definition of a university spin-off is that: (a) the technology as the basis for the new firm has had to have been developed at a university by a university researcher or team of researchers, referred to as technology developers; (b) the technology may or may not be in the form of intellectual property; and (c) the technology developer may or may not be the entrepreneur, and may or may not have a continuing relationship with the new firm. These criteria, we believe, are the most suitable to understanding and measuring the extent to which new knowledge generation in a university has led to new firm formation that otherwise would (probably) not have occurred.

2.2 Factors that condition the decision to create a university spin-off

The creation of a university spin-off is, above all, an entrepreneurial act. Entrepreneurship theorists concede, however, that the creation of a new firm is an incredibly complex and heterogeneous process. This has given rise to the multiplicity of theories regarding why, how, when, and what new firms get created, and by whom. Different theoretical frameworks focus on a particular aspect of the entrepreneurial act, a particular temporal stage of firm creation, a specific analytic level (micro-, meso-, or macro-), or a subset of the factors considered most important for new firm creation. The latter includes foci on the personal characteristics of academics who become entrepreneurs; on university policies, procedures, assets, other institutional characteristics of the parent organization; or on environmental factors and the knowledge infrastructure in the outside region or nation. To-date, there is no one theory that has emerged to be able to coherently address all the relevant interrogative issues above (Roberts 1991; Rasmussen 2011).

Many researchers have utilized new institutional theory when the chosen focus of study has been on university behavior in the creation of spin-offs (e.g., Etzkowitz 1983). Here the emphasis has been on why and how university behavior has changed and adapted to emerging external pressures. For example in the context of the U.S., a number of studies have examined how university policies, investments, and norms were affected by the Bayh-Dole Act of 1980.

A somewhat related and common theoretical framework has been resource-dependency theories, sometimes referred to as the resource-based view (RBV) from the management science field (Wernerfelt 1984, 1995). This has been used when the focus of action and behavior is on the university – they search for new sources of funding when they perceive an actual or risk of loss of existing resources (e.g., O’Shea et al. 2005; Lockett and Wright 2005). It has also been widely used to study how new start-ups act to gain the various resources it needs to survive and grow to reach viability and sustainability in terms of attracting investors, management skills, markets, etc.

Rasmussen (2011) has usefully classified process-based theories of entrepreneurship into four categories, based upon theories of organizational change (Van De Ven and Poole 1995): life-cycle (or stage), teleological, dialectic, and evolutionary. Each of these variants examine how outcomes – here the decisions to create spinoff businesses -- are a result of a sequence of events that unfold over time. Of these, the life-cycle, or stage theory has been used most in studies of spin-offs. It assumes that processes of change proceed through well-defined and necessary stages, or phases, of development. In the context of university spin-off creation, four phases have been identified and labeled as (1) Research, (2) Opportunity framing, (3) Proof of viability, and finally, (4) Post start-up (Vanaelst et al. 2006). Teleological theory (Poole and Van De Ven 2004) adds a focus on the purposeful actions of key individuals to achieve particular goals. The key individuals are most likely to be the

technology developer and/or the entrepreneur. Dialectical theory (Poole et al. 2000) focuses our attention on the conflicting or contradictory norms, policies, and cultures between entrepreneurship on the one hand, and the academy on the other hand, and how the conflicts between multiple roles and relationships are navigated, resolved, or not. Evolutionary theory emphasizes the adaptive behavior of not only the university as an institution, but of individual actors, in the face of unpredictability in the external environment and availability of resources, path dependence, and serendipity (Nelson and Winter 1982).

Our focus is on the ecological conditions that are conducive to increasing the incidence of the generation of university spin-offs. Specifically, what factors in the university researcher's environment affect the decision to go ahead and create a spin-off business out of a given university research project. Renault (2006), in her review of the literature on academic entrepreneurship, identified three sets, or layers, of influences on the decision to create a spinoff: (i) attributes and attitudes of the entrepreneur; (ii) institutional characteristics and policies of the parent organization, in our case the university and its constituent academic units, and (iii) the resources, opportunities, and cultural attitudes in the external environment, particularly the region in which the university is located.

In a well-known study to answer the question, "why do some universities generate more start-ups than others?", Di Gregario and Shane (2003) hypothesized four macro-level explanations for variation in the incidence of university start-up activity within the context of a sample of leading research universities in the U.S.: the degree of 'richness' of venture capital in the region in which the university is located; the amount of industry-funded research within the university (more industry-funded research, more spin-offs); the intellectual status and prestige of the university (the higher the status, the more spin-offs), and (iv) adoption of university policies that provide incentives for faculty entrepreneurial activity. Their principal empirical results showed that the significant factors for increasing university spin-offs were the intellectual status of the university and university policies of making equity investments in spin-offs and maintaining a low inventor share of royalties. Most notably, the only regional environmental factor in their study – the proximity of sources of venture capital within the region -- was not a significant factor.

We build on the DiGregario and Shane study by including additional regional and institutional conditions as hypothetical factors to understand which are most important in the generation of university spin-offs, though we use a quite different methodological approach.

3. The Knowledge Assets of the Vienna Region

3.1. A brief sketch of the city and region of Vienna as a research hub

The City of Vienna, in its position as Austria's capital, has a population of about 1.7 million in an area of 415km² (Statistics Austria 2012). From 2001 to 2010 its population grew 10.6 percent (Stadt Wien 2012). Its GDP per capita of 42,600 Euro (Austria: 32,900 Euro; Statistics Austria 2009) is well above Austria's and comparable to or higher than a number of other major European cities (Munich (45,785 Euro), Stockholm (45,200 Euro); Berlin: 26,500 Euro; (Eurostat 2009). The entire metropolitan region of Vienna comprises 2.3 million inhabitants and has a somewhat lower GDP per capita of 39,552 (Eurostat 2009).

The City of Vienna is clearly Austria's research hub in which 38 percent of the Austrian scientific personnel are employed and 38% of Austria's R&D expenditures are invested (Stadt Wien 2011). The shares of expenditures in different research categories show that experimental research (44 percent) and applied research (36 percent) are funded at a higher level than basic research (20 percent). But within the higher education (HEI) sector¹, basic research is still the most important (48 percent of total R&D expenditures) with 44 percent for applied research, 8 percent devoted to experimental research). The HEI sector, however, employs only 35 percent of total R&D employment in Vienna, with private industry employing 56 percent. A large portion of the funding for R&D – 40 percent -- is sourced in the public sector and the majority of publicly funded R&D (72 percent) is awarded to the HEI sector. Private industry is the second largest source for funding R&D expenditures (36 percent), and then followed by foreign investment (21 percent).

3.2. The public funding of R&D

The public funding for R&D in Vienna is largely provided by three major national funding organizations, the Austrian Research Promotion Agency (FFG), the Austrian Science Fund (FWF) and the Austria Wirtschaftsservice Gesellschaft (AWS).

The Austrian Research Promotion Agency (FFG) is the national funding institution for applied research and development. It provides funding primary for companies (75%) also including start-ups which are seen as innovative players in Austria's research landscape (FFG 2013). The HEI sector holds a share of 20 percent of FFG funding which is offered in four different areas – the European framework program, AplusB (Academia plus Business), Bridge – knowledge transfer program, and COIN – cooperation and innovation. Vienna, however, ranks only third among the provinces – after Styria and Upper Austria – for research funding originating from FFG (Stadt Wien 2011).

The Austrian Science Fund (FWF) is the leading funding institution for basic research in Austria. Funding is offered for a broad variety of different research activities (single projects,

¹ The HEI sector in Vienna covers public universities, medical clinics, universities of arts, academy of science, applied universities, private universities, and pedagogical colleges.

grants and awards, focus area research, doctoral research programs, etc.). Notably, the total funding from FWF has not been increasing in recent years, with funding in 2010 less than the 2008 level. Fifty-nine percent of the total Austrian FWF expenditures in 2010 was allocated to the HEI sector located in the city of Vienna (Stadt Wien 2011). The three largest funding recipients were the University of Vienna (22 percent), the Vienna University of Technology (11 percent) and the Medical University Vienna (8.8 percent). Forty percent of the funding from FWF is allocated to the life sciences, 40 percent to the natural or engineering (technical) sciences, and 20 percent to the humanities and social sciences.

The Austria Wirtschaftsservice GmbH (AWS²) is the Austrian Business Development Bank offering financial (pre-seed and seed financing), IPR-services and market research for entrepreneurs, SMEs, and universities. Furthermore AWS offers coaching services and mentoring to new entrepreneurs (e.g. “jugend innovative”, close cooperation with APlusB incubators) and on providing assistance to meet challenges that can occur over different stages of the life-cycle of a company. AWS serves about 25,000 customers and funds about 5,500-6,000 projects or companies per year.

3.3. Universities in Vienna

Vienna hosts nine of the 22 Austrian public universities. Six of these universities are research universities, i.e., they award doctorate degrees, and together had 777 million Euro in research expenditures in 2007 (Stadt Wien 2011). This equates to 30 percent of the total R&D expenditures in Vienna. The areas of R&D spending by universities in Vienna are distributed among the natural sciences (30 percent), medical/life sciences (26 percent), engineering and technology (14 percent), the social sciences (13 percent), the humanities (9 percent), and agriculture, forestry, and veterinary medicine (8 percent) (Stadt Wien 2011).

Table 1 provides an overview about the five research universities³ in terms of student numbers, graduates, academic and non-academic staff, income obtained from R&D projects and the allocated global budget provided by the federal Ministry of Science and Research.

² See <http://www.awsg.at/Content.Node/dieaws/46608.php> (retrieved on 9 August 2013)

³ These five have substantial research activity concentrated in either the life sciences and/or information technology. Although the Vienna University of Economics and Business has an important role to play in entrepreneurial education and training, we have excluded it from our analysis of spin-off activities based upon their research profile.

Table 1: Research universities in the Vienna region

	Universities				
	University of Vienna	Medical University of Vienna	Vienna University of Technology	University of Veterinary Medicine	University of Natural Resources and Life Sciences
Student numbers (fall term 2012)	92,486	7,468	27,923	2,286	11,394
Graduates (2011/2012)	10,506	827	2,321	279	1,432
Bachelor	4,204	--	1,087	50	744
Master⁴	5,678	767	963	185	576
Doctoral	624	60	271	44	112
Staff	9,695	5,341	4,518	1,218	2,464
Academic	6,732	2,949	3,306	648	1,769
Non-academic (fall term 2012)	2,963	2,392	1,212	570	695
Income R&D projects (in Mio Euro)					
2011	71.25	81.69	68.79	9.00	36.64
2010	66.21	74.59	66.16	7.42	30.38
Global budgets (in Mio Euro)	412.40	332.07	304.50	87.74	115.00 ⁵

Sources: uni:data database; annual reports of the universities

University of Vienna

University of Vienna is the oldest university in the German speaking world, founded in 1365 (University of Vienna 2013) and it is still one of the largest universities in Central and Eastern Europe. More than 92,000 students are currently (Fall term 2012) enrolled and who can choose among 56 Bachelor, 117 Master and 11 Ph.D. programs. The University is organized into 15 faculties and four centers which offer a broad variety of specializations in the fields of natural sciences, social sciences, life sciences, theology, law, business and economics. With 9,700 staff members (academic as well as non-academic) it is by far the largest

⁴ Including former degree programs („Diplomstudien“).

⁵ This is the calculated demand published in the development plan 2012.

teaching and research institution in Austria. The core mission of the University of Vienna is to focus on “creating and sustaining top-quality research and teaching, which are regarded as one inseparable entity (research-guided teaching)” in the Humboldtian tradition (University of Vienna 2013). The most recent development plan for the university, however, calls for pursuing technology commercialization more actively than in the past, and with applied research given equal recognition as basic research at the institutional level. The overall future research profile for the University has been characterized by the Vice-Rector for Research as a threefold strategy focusing on interdisciplinary research, high risk research as well as research that is aiming at solving ‘big’ challenges both in science as well as in society.

Medical University of Vienna

The Medical University of Vienna was founded in 2004 as an independent university that formerly had been part of the University of Vienna. In that sense the university has a much longer tradition than its founding year implies, and has had a reputation as historically one of the most renowned medical universities in Europe. More than half of the 5,341 staff members (academic and non-academic) employed at the university are medical doctors and researchers. In the fall 2012 term, 7,468 students were enrolled in three Master⁶ and three Doctoral programs and one PhD program making the university the largest medical university in the German speaking World. The university hosts 31 clinics, 12 centers and 30 laboratories for research. The university offers laboratory space (48,000m²) for clinical research. Five research clusters are organized as interdisciplinary centers. The Medical University has the largest amount of R&D funding of all universities in Vienna (81.7 million Euro) (Medical University of Vienna 2013). The Vice-Rector for Research has indicated, however, that the Medical University has reduced its emphasis and activity to support the commercialization of research as a result of budgetary pressures combined with increasing demands in fulfilling the historical core missions of medical teaching/training and basic research.

Vienna University of Technology

The Vienna University of Technology was founded in 1815 as a polytechnic institute of the monarchy and subsequently transformed into a University in 1872. The university is the largest natural and technical science based institution in Austria and has a very good reputation in these areas within Europe (TU Vienna 2013). With 27,923 enrolled students (fall term 2012) it has the second largest student enrollment of all universities in Vienna (about 28,000 students), and offers 13 Bachelor, 41 Master and three Doctoral programs. More than 4,500 staff members (academic as well as non-academic) are employed at the Vienna University of Technology. The university is organized into eight faculties: architecture and planning, three faculties of engineering (civil, electrical and mechanical),

⁶ Including also two former degree programs (‘Diplomstudien’).

mathematics, physics, technical chemistry and informatics. The TU Vienna has sharpened its research profile by defining five research focus points⁷: computational science and engineering, quantum physics and quantum technologies, materials and matter, ICT, and energy and environment. The Vice-Rector for Research has stated that the university's mission is to fulfill the innovation triangle – teaching, research and innovation. The latter includes a clear commitment to increase even further its emphasis on collaboration with external industry partners in all three areas of research, teaching, and technology development.

University of Veterinary Medicine

The University of Veterinary Medicine was founded in 1767 under Empress Maria Theresia and was located for a long period in the center in the third district. In 1996 it moved to a new campus across the Danube River. The university is unique in Austria since it is mainly focused on the fields of veterinary medicine and biomedical sciences. With 2,286 students (fall term 2012) and 1,218 staff members (academic and non-academic) it is the smallest of the research universities in Vienna. In addition to its teaching and research functions the university operates an animal hospital. The university offers two Bachelor (one of these in collaboration with BOKU), five Master⁸, one Doctoral and one PhD program. The university has defined five research areas – physiological processes, infection and prevention, focus on farm animals, animal models and veterinary biotechnology, food safety and risk analysis, and animal behavior and human-animal-interactions (University of Veterinary Medicine 2013). The university sees opportunities for creating additional synergies with other universities, and in particular is planning to collaborate with the other research universities in Vienna in order to coordinate the provision of commercialization support activities.

University of Natural Resources and Life Sciences (BOKU)

The University of Natural Resources and Life Sciences was originally founded as an agricultural university in 1872. Nowadays it is specialized in the life sciences and offers nine Bachelor (one in collaboration with the Veterinary University) and 25 Master and one Doctoral program for the 11,400 enrolled students. The university employs about 2,500 staff members (academic and non-academic) and operates at two different campus locations in Vienna. In the university's mission statement, sustainability has been selected as one of the keystones of its vision for the future (University of Natural Resources and Life Sciences 2013). The Vice-Rector for Research identified as one key aspect of BOKU's research strategy: the stimulation of basic research in areas in which the university's faculty has strong potential to receive third party funding and which can enhance collaboration with other universities as well as with companies. Besides individual research at the departmental

⁷ TU Wien 2013

⁸ Including also one former degree program („Diplomstudien“).

level, BOKU has bundled its research in eight interdisciplinary competence centers – land ecosystems, water and the environment, habitats and landscapes, renewable resources, food, biotechnology, nanotechnologies, and resources and societies.

Aggregate indicators for Vienna universities

Several indicators of the research intensity of Vienna’s universities can be calculated from the above data. Research expenditures as a percentage of total university budgets show 26.32 (2011). R&D spending per academic staff is 16,654 Euro (2011), and R&D spending per total student enrollment is 1,682 Euro (2011). These values for Vienna can be compared to those for Munich in Table 2.

Table 2: Aggregate indicators for Vienna and Munich universities

2011	Vienna ⁹	Munich ¹⁰
Research expenditures as a percentage of total university budget	27.52%	23.59%
R&D spending per academic staff	17,592 Euro	38,997 Euro
R&D spending per total student enrollment	1,932 Euro	4,681 Euro

Sources: uni:data database; facts & figures of the included universities

3.4. Research foci and specializations in Vienna

Life sciences

Vienna has a long and excellent tradition in biological and medical research. This provides a strong base for specializing in biotechnology as is the case today. Currently more than 400 life science companies with revenue of about 1,718 million Euro are located in Vienna. These companies employ together more than 9,000 persons (LISA Vienna 2011). The research cluster is shaped by 22 research institutions, including the five research universities that have a specialization in the life sciences, two applied universities, and fifteen other research institutions. The sector is distinguished by several ‘hot spots’ where R&D in the life

⁹ Includes University of Vienna, Medical University Vienna, Vienna University of Technology, University of Veterinary Medicine, University of Natural Resources and Life Sciences

¹⁰ Includes Ludwig Maximilian University of Munich and the Technische Universität München

sciences are concentrated, such as LIFE Science Vienna Muthgasse, the Medical University of Vienna campus, the University of Veterinary Medicine campus, and the Campus Vienna Biocenter (LISA Vienna 2011). The total life science budget was estimated in 2010 to be about 700 million Euro. Third party funds in life science research have been reported to be about 200 million Euro (LISA Vienna 2011, p. 16). The organizations with the largest research expenditures are universities followed by non-profit research institutions (see Table 3).

Table 3: Life science research in Vienna

	Universities	Applied universities	Other research institutions	Total
Employees	10,817	510	2,775	14,109
Students	33,184	2,104	-	35,288
Publications (peer reviewed)	4,430	24	728	5,182
3rd party funding, (MillionEuro)	150.0	0.6	43.5	194.1

Source: LISA Vienna 2011

Information and Communication Technologies (ICT)

The ICT research in Vienna is comprised of four universities (University of Vienna, TU Vienna, WU, Medical University Vienna), two applied universities, six research institutions, and a large number of private companies. Austria has developed its own ICT research strategy (Rundfunk- und Telekom Regulierungs-GmbH (2008) since the ICT sector has performed extremely well starting around 2005. Vienna is the largest ICT hub in Austria with an economic performance of 20 billion Euro (i.e. 15 percent of the regional GDP) and where 65,000 people are employed in this sector (ZIT 2010). The ZIT (2010) reported that 40 percent of the ICT companies in Vienna are involved in research. The development of the ICT strategy has identified a huge innovation potential in seven areas of ICT development. In terms of its innovation performance Austria as a whole is ranked as an innovation follower in the European Innovation Scoreboard (EC 2013a). The Vienna region, however, is classified as an innovation leader within Austria in the Regional Innovation Scoreboard 2012 (EC 2013b).

Environment and energy

The research field 'Environment and Energy' has future potential and its development is triggered by the European Commission via two important cornerstones – the new Environment Action Programme 2020 "Living well, within the limits of our planet"(EC 2013c) and the "Energy Strategy for Europe" (EC 2013d). This research field compared to the life

sciences and ICT is still relatively small. The most important organizations are five of the universities (University of Vienna, TU Vienna, WU, BOKU, Medical University of Vienna), ten research institutions, and nine private companies (City of Vienna 2013).

3.5. Some unique attributes of Vienna and Austria

As stated above, Vienna is Austria's capital but at the same time is one of nine federal provinces. Thus the governmental bodies are separated into a city government and a provincial government headed by the Mayor and Governor of Vienna. Vienna, as an important gate to Central and Eastern Europe, is engaged in the CENTROPE region aimed at increasing cross-border collaboration among regions in Austria, Hungary, Slovakia, and the Czech Republic. This setting brings many potential opportunities to Vienna for attracting international companies to locate in the city. In terms of quality of living Vienna was ranked as the city with the highest quality of living in the world in 2012. Vienna is also top-ranked (number four among all European capitals) in the European Green City Index which uses criteria like CO₂ emissions, energy supply, transport, water, waste, and air pollution (Stadt Wien 2012).

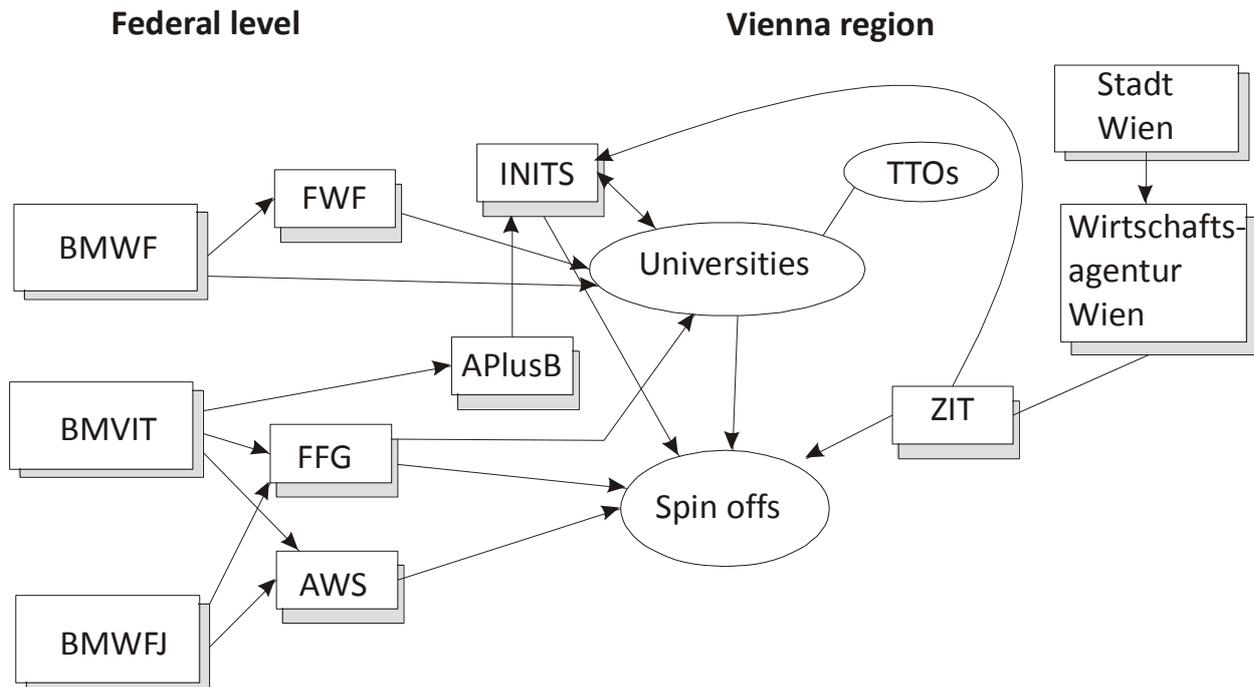
The university sector as it operates today has been shaped by the introduction of the federal Higher Education Act 2002 (UOG2002) and accompanied by a new service law. The most important impact of the new law which went into effect in 2004 was the high degree of autonomy granted to public universities after the almost complete control of the Ministry of Science. Each university was now obliged to negotiate performance agreements with the Ministry of Science and Research (Österreichischer Wissenschaftsrat 2009). The degree and type of autonomy given to universities is important in the discussion of the barriers and opportunities to increase the incidence of university spin-off generation. Austria is ranked relatively high in Europe on several dimensions of autonomy, including the recruitment of university staff. Austria, like Sweden, for example, has greater independence than many other EU countries. Financial autonomy of universities, however, is less ensured in Austria compared to other countries (Estermann et al. 2011).

3.6. The principal institutional actors in Vienna

In the course of our research we have identified several federal and regional institutional actors supporting university spin-offs in Vienna (see figure 1). Some of them have already been mentioned in earlier sections (e.g. 3.2) but will be presented here within a network showing the relationships with other institutional actors.

The three involved ministries – BMWF (Federal Ministry of Science and Research), BMVIT (Federal Ministry for Transport, Innovation, and Technology), and BMWFJ (Federal Ministry of Economy, Family, and Youth) are the most important institutional actors at the federal level directly and indirectly supporting academic spin-offs in the Vienna region.

Figure 1: The principal actors in the generation of university spin-offs in Vienna



BMWF (Federal Ministry of Science and Research)

The ministry is responsible for Austrian tertiary education including universities and universities of applied sciences as well as other research institutes. The ministry undertakes three important activities related to technology transfer: (1) supporting universities in developing their knowledge transfer strategies including strategies for spin-off companies and these strategies are part of the performance agreement with the universities, (2) Running the National Contact Point for IPRs¹¹ which was set up together with BMVIT and BMWFJ in 2010, and (3) annual Phönix Award for academic spin-offs. The ministry negotiates the three years performance agreements with public universities including the global budget for each university. Furthermore the ministry monitors the implementation of each university's performance agreement annually. The ministry is the controlling authority of FWF (see 3.2).

¹¹ See

http://www.bmwf.gv.at/startseite/forschung/national/programme_schwerpunkte/national_contact_point_fuer_ipr_angelegenheiten/ (retrieved on 9 August 2013)

BMVIT (Federal Ministry for Transport, Innovation, and Technology)

The BMVIT fulfils a clear role within the Austrian Research, Technology, and Innovation Strategy (FTI¹²). Based on the federal strategy the ministry emphasizes six thematic foci – progression of the funding system, division of tasks between strategic standards defined by the ministry and operational tasks of FFG (see 3.2), strategic collaborations with other ministries, internationalization, controlling and monitoring, and performance agreements with research institutions. BMVIT is together with BMWFJ the controlling authority of FFG and AWS (see 3.2) both funding organizations for businesses including academic spin-offs. Additionally in its role as the funding organization of APlusB, the network of incubators in Austria, the ministry is indirectly connected to universities.

BMWFJ (Federal Ministry of Economy, Family, and Youth)

With a focus on technology and innovation, the ministry helps businesses in Austria to become more competitive. It also represents Austria's economic interests internationally. The BMWFJ, similar to BMVIT, fulfills a clear role within the Austrian Research, Technology, and Innovation Strategy (FTI) that focuses on SMEs and the enhancement of FTI in general. The BMWFJ is the second controlling authority of FFG and AWS.

APlusB (Academia plus Business)

The APlusB network is located in Vienna and functions as an umbrella organization for the eight Austrian incubator centers (accent, BCCS, build!, CAST, INiTS, SPG, tech2b, ZAT). Furthermore the network represents the incubators nationally and internationally and is funded by BMVIT. Each incubator is directly connected to academic institutions in the respective province. INiTS as the Viennese incubator is shared by the Vienna University of Technology (37%), University of Vienna (37%), and ZIT (Technologieagentur der Stadt Wien, 26%). INiTS is providing a wide range of services for start-ups, such as funding, consulting, training, networking, and providing infrastructure.

Technology Transfer Organizations (TTOs)

Each of the five included research universities is operating its own TTO with the aim of supporting university researchers to transfer their knowledge from academia to industry. The TTOs are organized as service units within the universities.

ZIT – The Technology Agency of the City of Vienna

The ZIT is a subsidiary of the Vienna Business Agency (Wirtschaftsagentur Wien GmbH) and both are owned by the City of Vienna. The ZIT provides direct financial assistance to companies, is offering technology specific infrastructure, and a broad range of accompanying

¹² See <http://www.bmvit.gv.at/innovation/forschungspolitik/index.html> (retrieved on 9 August 2013)

measures. As already mentioned, it holds 26% of the shares of the incubator INiTS. Furthermore the ZIT is representing the City of Vienna in the initiative LISAvienna the consulting and coordination center for life sciences in Vienna. LISAvienna is a joint initiative of the federal and the provincial government and funded by AWS (federal level) and ZIT (local/regional level). LISAvienna offers specific consultation for businesses in the life science industry and the overall mission includes national and international promotion of the life science cluster Vienna.

3.7. Empirical approach

The first task has been to identify an accurate listing of spin-offs founded within the 2007 to 2012 period. To do this we conducted an internet search starting with information furnished by different funding and intermediary organizations that had had contact with university faculty or other researchers who were contemplating the creation of a spin-off or had actually already done so. These organizations included:

- the Austrian network of incubators *AplusB* (Academia and Business), funded by the Federal Ministry for Science and Research (BMVIT);
- *INiTS* (innovation into business) is the AplusB program organization in Vienna;
- The *Research Studios Austria* (RSA), a program supported by FFG and manages the transfer of innovation and knowledge between universities and the market;
- *The Austria Wirtschaftsservice GmbH* (AWS) that supports companies and enterprises by providing low-interest loans; AWS runs the Pre-seed and Seed financing programs and offers market research and IPR services for entrepreneurs, SMEs, and universities;
- *ZIT-The Technology Agency of the City of Vienna* which provides direct financial assistance to companies by supporting a broad range of accompanying measures in all phases of the innovation process;

The mentioned organizations provided information on the spin-offs or start-ups that have been supported with funding. However this information covers only those supported companies that agreed to being publicly listed. The information provided on the websites of the funding and intermediary organizations comprises (generally) the name of the founded company as well as the name of the CEO. Each spin-off was then investigated further, seeking out the name of the CEO, the name of the primary scientist, the location of the scientist, the sector of the spin-off foundation, the founding year, the university origin (including department / institute), information on the product, information on patents, location of the spin-off (postal code) as well as the number of employees. To differentiate a general start-up from a university spin-off using our definition, we sought to identify the academic title of the founder(s), the source of the product idea (it has been mentioned that

the initial idea had to have grown out from research conducted at the university) as well as the relationship of the researcher / research team to the spin-off company once established. As mentioned earlier the list of university spin-offs in our eventual database is an estimate. There are several reasons why some may be missing: (i) the TTOs of the investigated universities are mainly informed about the spin-off foundation if there has been an application submitted for a patent; if this is not the case the foundation of the spin-off need not be reported to the TTO; (ii) the funding and intermediary organizations provide only information on their web pages of those spin-offs/start-ups that agreed to be publicly identified; (iii) there is not necessarily a 'paper trail' identifying a new business as a university spin-off if it did not apply for pre-seed or seed funding support from one of the public funding organizations.

After identifying and collecting contact information about each of the academic spin-offs created in the Vienna region during the time period, we then focused on collecting information from individuals representing a variety of types of actors discussed in section 2.4 above about their experiences and observations concerning the creation of university spin-offs. Semi-structured, face-to-face interviews were arranged with a selected set of individuals from among each type of actor. We conducted interviews with 39 various actors out of whom nine were faculty entrepreneurs. The length of the interviews averaged about 90 minutes. The specific questions varied among the types of actors, though most were common across all informants. The interview protocol used for faculty entrepreneurs is provided in Appendix A. In addition, we asked interviewees to complete a questionnaire about the perceived importance of a number of potential obstacles to the generation of university spin-offs (an example provided in Appendix B). Response categories were on a five-point Likert-scale ranging from 'very important' to 'not important at all'. The information provided in the interviews was interpreted to identify commonalities and differences in the views about university spin-off generation. The responses to the questionnaire were analyzed quantitatively to identify the most important obstacles (based upon the mean response) and to identify any differences in perception of obstacles across types of actor. The preliminary results of our analyses are reported below.

4. Empirical Results

The empirical investigation commenced with an internet search on the number and type of university spin-offs founded within the 2007-2012 period. This was followed by focused interviews with: (i) the TTO directors of the universities described in section 3.3; (ii) the vice-rectors of the same research universities; (iii) university faculty and other researchers who have founded a spinoff; (iv) university faculty or other researchers that conducted research which had the potential to lead to commercialization, but who did not generate a spin-off; (v) officials in policy making, R&D funding, and intermediary organizations relevant to technology development and spin-off creation; and (vi) other experts and key informants.

As mentioned above, questionnaires were administered to most interviewees as a way to obtain standardized indicators of the perceived relative importance of different barriers out to all interview partners. The following sections discuss the outcome of the empirical investigations, distinguishing between different types of actors, universities and technology fields, for deepening our understanding of the barriers and obstacles to the generation of university spin-offs.

4.1. An estimate of the incidence of university spin-offs in Vienna

The database on the number of generated spin-offs in Vienna between 2007 and 2012 has been compiled relying principally on an internet search and information forwarded by the TTOs of the Universities.

Because of data confidentiality issues, but also the likely lack of a 'paper trail' between faculty entrepreneurs and university administrators in some cases, we believe that the identified number of spin-offs is an undercount. Including the identification of spin-offs from the respective TTO offices, our 'count' of spin-offs created in the Vienna region from 2007 to 2012, using the definition discussed in section 2.2 above, comes to 113.

More than half of the spin-offs generated came from the TU Vienna (55 percent), followed by the Medical University (12 percent), the University of Vienna (10.6 percent), the University of Natural Resources and Life Sciences (BOKU) (8.8 percent), the University of Economics (6.2 percent), the University of Veterinary Medicine (2.7 percent) and the University of Applied Arts (4.7 percent). The spin-offs are highly concentrated in the two technology fields of biotechnology and ICT.

4.2. Vienna in comparison to its benchmark: Munich

For the same time period of 2007 to 2012, and using the same spin-off definition, we estimated that there between 100 and 150 spin-offs created in the benchmark region of Munich. This estimate relies heavily on information provided by the TTOs of the Ludwig Maximilian University (LMU) and the Technische Universität München (TUM). Additionally we have utilized information obtained by the FLÜGGE program in Bavaria and the EXIST program on the national level (Ministry of Economics and Technology) that support the foundation of startups. The former focuses on the support of startups in general while the latter has its focus especially on foundations out from the universities and other institutions of higher education.

The results show that the incidence of spin-off generation in Vienna compares very well to Munich, a region that is generally recognized as one of the global centers of research in biotechnology as well as other technology branches, and with two of the highest ranked universities in Europe.

4.3. Identification of the main obstacles to the generation of university spin-offs

The potential obstacles preventing a greater incidence of university spin-offs in the Vienna Region can be classified as (1) individual faculty/researcher attributes, (2) university policies and services, (3) external regional environment factors, as well as (4) national and EU policy environment factors. The results presented here come from an interpretation of the information provided in the interviews and from the responses to the questionnaire. The latter consists of 29 closed questions and was described above in section 3.6.

4.3.1. Technology transfer office directors (TTOs)

From the perspective of the TTOs, the main obstacles on the individual level of the researchers are seen in their risk-avoidance and need for security: the foundation of a spin-off often requires long-term financing as well as giving up, or at least, reducing, the time devoted to an academic career. Most of the scientists are described by the TTO officials as focused on their profession with no or little entrepreneurial know-how. Barriers related to individual attributes of the scientists are emphasized with regard to the different universities: due to their education and career models, researchers at the Medical University are between the ages of 40 and 50 when it comes to founding a spin-off. They look back on a successful academic career and have also personal restrictions which hinder them to go for the riskier option of founding a company. By comparison, the situation at the TU Vienna is different. There the scientists have the option to found a business on the Ph.D. or Post-Doc level between the ages of 25 and 30, and tend to be less risk averse, more open, and more flexible.

The returned questionnaires confirm the overall impression gained from the interviews on the individual attributes of the researchers: a) University researchers are not aware of the commercialization potential (mean 4.0), b) University researchers lack business or entrepreneurial skills (3.7), c) prestige and status within the discipline do not come from research that leads to commercialization (3.7), d) researchers have a low tolerance for risk (3.7), e) the interest in basic research outweighs the interest in research that leads to commercialization (3.3). Not being rewarded by their universities for work that leads to commercialization (2.7) and not conducting the type of research that has potential for commercialization (2.3) were not considered by TTO officials as important obstacles.

There is general agreement among the TTO officials that the universities are not interested in actively supporting the foundation of spin-offs. Reasons for this are seen in the perceived lack of added value for the university (no financial value creation, no marketing effects) as well as the fact that commercialization is not seen as a principal part of the mission of the university. The institution's main interests lie within the realm of if and how the professor or post-doc involved in the spin-off continues with the research and the teaching for the University and if the know-how generated within the spin-off company is also used for teaching PhDs and Post Docs. Some TTOs mention, as a further institutional barrier, the

posing of conflicts of interest to describe the lack of a 'clean' separation by researchers/entrepreneurs between their work at the university and in the company. This can lead, for example, to a misuse of university infrastructure and facilities (lab space, etc.). The responses by the TTO officials within the questionnaires underpin the obstacles regarding the university policies: a) universities do not provide researchers with training to learn business skills needed to start a business (mean 3.7), b) insufficient 'seed capital' is provided by the Universities (3.7), c) universities do not provide sufficient rewards or incentives to faculty researchers to develop a spin-off business (3.3), d) university policies restrict start-up businesses to use university infrastructure (3.3), e) no adequate physical facilities for the location of new spin-offs are provided (3.2), f) universities do not provide sufficient help to identify, if the research has commercialization potential (3.0). The amount and quality of support provided from the university to submit patent applications (1.7), as well as the support from the university with names and contacts for external resources for assistance or advice (1.8) are not perceived by TTO officials as barriers.

From point of view of the interviewed TTOs the lack of university funding to support spin-offs in the seed stage is considered a main obstacle. The amount of funding is perceived as too small to give ongoing dynamic and flexible support. Furthermore – and this is emphasized as a special consideration of the biotech sector – a large amount of funding for a long period of time is often needed.

Concerning factors from the regional environment the questionnaire results reveal that the TTOs see the main obstacle in the lack of 'angel investors' (mean 4.0), a lack of private early stage investors in the Vienna region (3.8) as well as an inadequate number of mentors and role models of successful entrepreneurs in the Vienna region (3.7). On the level of national and EU policies the obstacles are seen in the lack of seed capital provided by national government policies and programs for university researchers to seek commercialization possibilities (3.7), as well as a lack of early and late-stage funding in national programs for start-ups to survive.

4.3.2. Faculty entrepreneurs

The most important obstacle perceived by faculty entrepreneurs related to individual attributes is the lack of entrepreneurial skills. For most of the interviewed faculty entrepreneurs it was not until an *entrepreneurially skilled* person was involved, that the foundation of the spin-off was realized. The intention towards founding differs significantly across the faculty entrepreneurs and ranges from "always considered" to "a rather spontaneous decision". For several entrepreneurs the absence of role models at their department or university was an obstacle. The loss of prestige, in the sense of a lack of collegial appreciation of entrepreneurial activities, is mentioned as an initial barrier. Those who have not yet founded a company mention as an inhibitor the fear of being overruled by some investor as well as not having an entrepreneurial role model at the university. Also

mentioned are the very different 'mind-sets' of being a researcher and being a founder of a company. The outcomes of the questionnaires indicate that the most inhibiting factors for the creation of spin-offs are: a) university researchers lack business or entrepreneurial skills (mean 4.1), b) researchers are not rewarded by their universities for work that leads to commercialization (mean 3.9), c) not enough research with potential for commercialization is conducted (mean 3.9), d) prestige and status within the discipline do not come from research that leads to commercialization (mean 3.7), e) the interest in basic research outweighs the interest in research that leads to commercialization (mean 3.7), f) university researchers are not aware of the commercialization potential (mean 3.3) and g) researchers have a low tolerance for risk (mean 3.0). With regard to the factor of risk-tolerance, interview partners from the field of IT pointed out, that the risk of founding a company differs a lot between various sectors; IT is a field where the amount of seed capital needed (for equipment, premises etc.) is rather low in comparison to the life sciences sector, for example, and thus also the level of risk that must be taken.

Concerning the institutional obstacles, the one unanimously mentioned is the low attention given to entrepreneurship within the Austrian higher education sector. The support from the university is described as low and the institution's mindset as focused on "pure, basic and ground-breaking research" with no acknowledgement for the importance of research conducted for, and with, industry. In addition to this, the strict university policies make the foundation process of spin-offs even more challenging. Other institutional barriers are seen in the organization and structure of the TTOs; they are described as "underfunded, small and not that experienced". Those who have not yet founded a company see the main barrier in the lack of support by the department as well as the university. The returned questionnaires come to the result that the main obstacle within the universities for the foundation of spinoffs is the lack of 'seed capital' provided by the universities (mean 4.3), followed by a shortage of rewards or incentives to faculty researchers to develop a spinoff business (mean 3.9) as well as a lack of training for the researchers to learn the business skills needed to start a business (mean 3.9). Furthermore the faculty entrepreneurs point out that the universities do not provide sufficient help to identify if their research has commercialization potential (mean 3.1) as well as no adequate physical facilities for the location of new spin-offs (mean 3.3). Also the restriction for start-up businesses to use university infrastructure such as laboratory equipment (mean 3.1) and the lack of supply with names and contacts of external resources for assistance or advice are pointed out (mean 3.1). On the other hand the assistance provided by the universities in submitting patent applications is not perceived as an important inhibiting factor (mean 2.3).

One of the main obstacles within the regional environment is the lack of affordable space for the location of the company. Also incubators that provide laboratories, manufacturing facilities etc. as well as qualified labor forces are lacking in the Vienna region. Additionally, difficulties in finding venture money are observed: the venture capital scene is not

considered as developed compared to other cities (e.g. Munich). The general attitude in Austria towards innovative developments is perceived as rather restrictive, an outcome of a culture related to risk avoidance and demand for security. These observations are also applicable to the financial support programs, considered by faculty entrepreneurs as too risk averse. For those who have not yet founded a company, the lack of support from national or Viennese funding organizations is one of the main obstacles.

The questionnaires underpin the experiences and knowledge regarding the obstacles within the regional environment as well as within the realm of national and EU policies. The foremost obstacle is the inadequate number of mentors and role models of successful entrepreneurs in the Vienna region (mean 3.6). This factor is followed by the lack of potential private early stage investors in the Vienna region as well as a not well developed network of actors and organizations for the support of new technology-based businesses and a lack of private late stage investors in the Vienna region (2.9). Within the area of national and EU policies a lack of early and / or late stage funding for start-ups to survive are perceived (3.9) as well as a lack of seed capital for university researchers to seek commercialization possibilities (2.9).

4.3.3. Vice-Rectors

The vice-rectors of the five research universities identified several obstacles and problems which became effective after universities' became autonomous in Austria, effective in 2004. The process of becoming independent entities includes also budgetary changes. The Ministry of Science is allocating a global budget for universities (see Table 1 in section 3.3) on the basis of negotiated performance agreements. Almost two-thirds of the global budget is used for personnel costs in order to fulfill teaching and research goals which results in a lack of budget for all remaining goals and has been identified as one major obstacle. Universities do not have a designated line item in their budgets dedicated to supporting spin-off activities. This has led to the underfunding of TTOs and thus for support of IP activities as well as a lack of financial resources for spin-offs in their seed and early stages. As the outcome of the questionnaire reveals, the lack of adequate physical facilities for the location of new spin-off businesses is one of the prevailing barriers (mean 4.0). This goes hand in hand with the limited existence of private investments for high-tech activities in Austria (which has been mentioned by almost all respondents across every type of actor in our sample). This is distinct from the issue of whether there are sufficient public funds for spin-offs available in the very early pre-seed and seed funding stages.

Besides these pure pecuniary limitations the vice-rectors reported about organizational barriers which occur because of two co-existing systems of staff contracts, the 'old' public contracts ('Beamtenverträge' and the 'new' private contracts ('ASVG')). This has led to a 'generation gap' due to the fact that staff members in the two different systems have different career horizons, different salaries, and different obligations that partly affect the

individuals' attitudes towards entrepreneurial activities. The paucity of role models as well as the absence of entrepreneurial skills of the faculty hinder the generation of spin-off businesses. From the returned questionnaires the following individual researcher attributes are mentioned that obstruct the generation of university spin-offs: a) university researchers lack business or entrepreneurial skills (mean 4.3), b) the interest in basic research outweighs the interest in research that leads to commercialization (4.0), c) not enough research with potential for commercialization is conducted (3.3) and d) researchers have a low tolerance for risk (3.3). The factors *not* having much of an impact on the incidence of university spin-offs are similar to those mentioned by the TTOs: prestige and status within the discipline do not come from research that leads to commercialization (mean 3.0), researchers are not rewarded by their universities for work that leads to commercialization (2.7) and a lack of awareness for the commercialization potential of the research (2.3).

On the other hand, the questionnaire responses indicate (surprise, surprise!) that the vice-rectors do not see that many factors in the area of university policies and services that prevent a greater number of university spinoffs; none of the factors mentioned are seen as important obstacles (training for researchers to learn business skills, provision of 'seed capital', rewards to faculty researchers to develop spinoffs etc.).

Nevertheless, there seem to be differences among the universities in terms of the perception that internal university policies and practices hamper the generation of spin-offs. In some universities there is a lack of developed strategies for innovation and technology transfer, inconsistent rules and regulations for IP sharing, little or no funding to support the preparation of patent applications, and restrictive rules about the use of laboratories, other university infrastructure, and university personnel for spin-offs, while in others this is not the case.

With regard to the regional environment, vice-rectors agree with other actors that there is an inadequate amount of public funding for the foundation of spin-offs. Furthermore, Vienna is characterized as having 'structural weaknesses' for technology-based entrepreneurship and innovation generally, indicated by a lack of critical mass in R&D, a lack of culture for risk taking, and a lack of implementation ("defensive strategies" only on the paper). The completed questionnaires confirm the impression about the external regional environment as well as on the national and EU policy environment. As main obstacles in the regional environment the lack of a 'culture' of entrepreneurship in the region of Vienna (mean = 4.0), a lack of potential private early stage investors (4.0), a lack of potential private late stage investors in the Vienna region (4.0) as well as a lack of 'angel investors' for spinoff businesses (3.7) are pointed out. Within the category of national and/or EU policies, a shortage of early and /or late stage funding for start-ups are mentioned (4.3) as well as a lack of seed capital for university researchers to seek commercialization possibilities (4.0).

4.3.4. Actors in funding, policy, and intermediary organizations and other experts

Obstacles identified by officials in funding, policy and intermediary organizations, as well as other knowledgeable experts, are not substantially different from those mentioned by faculty entrepreneurs and university officials. They do, however, address several broader and perhaps more 'holistic' factors, such as the legal framework, for example. From the point of view of some experts, Austria has not a long tradition of university spin-off activities due to the fact that it was not until 2002 that federal law gave universities considerable autonomy. Most experts interviewed acknowledge that since then there has been movement favoring a more entrepreneurial environment in Vienna and Austria as a whole. Yet the entrepreneurial environment not only in Austria but in almost all of Europe has been assessed to be still much lower when compared to the U.S. In general, researchers seem to be more risk averse in Europe within societies having a low tolerance for failure. The lack of business and entrepreneurial skill of university researchers is also underscored in the questionnaire responses (mean 4.2). Interest by academics in acquiring these skills has been increasing, however, and there is now greater opportunity for faculty and graduate students in several of the universities to take short courses to acquire business and entrepreneurial skills.

It is generally understood that scholarly publications and then patenting are assessed as more valuable, or worthy, activities by university researchers compared to generating spin-offs. The results from the questionnaire substantiate the lack of reward towards university researchers for work that leads to commercialization (mean 4.2). Publications still matter the most, by far, in terms of reward and prestige in almost all disciplines. Within the domain of commercialization of research, patents have gained in value for advancing scientific careers, but the creation of spin-offs is still seen as having little value within research communities. Another point that has been introduced is that academic CVs are evaluated differently in Europe compared to the U.S. There, professors have greater mobility to move back and forth between the university and industry without harming their careers. That mobility has helped to embed an entrepreneurial attitude within departments in universities in terms of the types of questions investigated and the rewards given for different forms of research output. In Europe, including Austria, faculty careers would be harmed by spending periods working in industry since their work is evaluated almost entirely by publications in highly ranked scholarly journals.

Experts have also identified that expectations of academics in terms of commercialization are often unrealistic. They tend to underestimate the time, costs, and skills required for their businesses to become successful. Scientists who want to become entrepreneurs need sufficient knowledge about the potential market ('researching the market').

In terms of financial issues, there is a consensus among our expert respondents that Austria suffers from a lack of private venture capital. This has been identified as a European-wide phenomenon which has improved somewhat over the last ten years or so

, but is still a major problem. There was general agreement that there ample opportunities for spin-offs to receive public pre-seed and seed funds, but experts agree that private equity is needed for late-stage funding, often covering a horizon of ten years. The dearth of private equity investors has been identified as one of the most important obstacles.

Another factor that prevents a higher incidence of university spin-offs is the lack of inter-university cooperation. Universities in Austria are basically separated entities with specific know-how and expertise, often lacking certain knowledge for a successful commercialization. Pooling and sharing some resources and expertise across universities may be a way to provide more support for faculty entrepreneurs in an environment of scarce resources for higher education institutions.

4.3.5. Summary of the identified obstacles

The rank-order importance of factors as obstacles to the generation of university spin-offs, combining respondents across all of the types of actors is shown in Table 4.

Table 4: Rank order of obstacles to the generation of spin-offs (the obstacles have been differentiated into four different fields: i = individual faculty / researcher attributes, u = University policies and services, r = external regional environmental factors, n = national and EU policy environments)

Rank order	Factor	Type of factor	Mean value
1	Lack of business or entrepreneurial skills	i	4,08
2	Interest in basic science outweighs interest in research that leads to commercialization	i	3,78
3	Reward from the university for research that leads to commercialization is not sufficient	i	3,67
3	Prestige and status within the discipline do not come from research that leads to commercialization	i	3,67
4	Early stage and / or late stage funding for start-ups is not enough	n	3,62
4	Awareness for commercialization potential of the research is missing	i	3,62
5	Universities do not provide sufficient 'seed capital'	u	3,57
6	Lack of 'angel investors' for spinoff businesses in the Vienna region	r	3,49
7	Training opportunities to develop business skills are missing	u	3,44
8	Inadequate concentration of private industry R&D activity within key technology areas in the Vienna region	r	3,39
9	Lack of potential private early stage investors in the Vienna region	r	3,26
9	Low tolerance for risk in the professional work and career	i	3,26
10	Lack of sufficient rewards to faculty researchers do develop spinoff businesses	u	3,24
11	Not enough research that has commercialization potential is conducted	i	3,22
12	Not enough seed capital for university researchers is provided to seek commercialization possibilities	n	3,20

13	Lack of potential private late stage investors in the Vienna region	r	3,15
14	Inadequate number of mentors and role models of successful entrepreneurs in the Vienna region	r	3,06
15	The network of actors and organizations for the support of new technology-based businesses in Vienna is not well developed	r	2,89
16	The region of Vienna does not have a 'culture' of entrepreneurship	r	2,80
17	Not enough physical facilities for the location of new spinoff businesses are provided	u	2,76
17	Not sufficient help is provided to identify the commercialization potential of faculty research	u	2,76
18	EU Policies and funding programs do not adequately support or encourage commercialization of university research	n	2,68
19	The generation of university spin-offs is not supported or encouraged by City and Federal government	r	2,58
20	University policies restrict start-ups from freely using university infrastructure	u	2,47
21	Universities do not support researchers with contacts or external resources for assistance or advice	u	2,22
22	Federal government does not provide sufficient autonomy and flexibility to individual public universities to support spinoff activities	n	2,15
23	Lack of assistance in submitting patent applications	u	2,03
23	National laws and conflict of interest make it too expensive for spinoff businesses to utilize university infrastructure	n	2,03
24	Austria does not have adequate intellectual property protection	n	1,40

There is a broad consensus both within and among the different types of actors about what are the main obstacles that inhibit a higher incidence of university spin-offs. On the level of the individual attributes, the first and foremost obstacles are seen in the lack of business and entrepreneurial skills of the researchers and the low tolerance for risk. Only regarding the factor of lack of sufficient rewards by their universities for work that leads to commercialization is there a statistically significant difference in the means of responses among the different actors (see Tables 5, 6, 7 and 8). While the university officials do not see this factor as an inhibiting one for the generation of spin-offs, the faculty entrepreneurs as well as intermediaries/experts perceive it as significant.

Table 5: Difference of means (ANOVA) “University researchers are not rewarded sufficiently by their universities for work that leads to commercialization”

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	11,747	2	5,874	4,548	,022*
Within Groups	28,413	22	1,291		
Total	40,160	24			

N = 25, *p>0,05

Table 6: Post-hoc Tukey HSD Test for the variable “University researchers are not rewarded sufficiently by their universities for work that leads to commercialization”

Actors	N	Subset for alpha = 0.05	
		1	2
University	9	2,67	
Faculty Entrepreneur	7	3,86	3,86
Intermediary/ Expert	9		4,22
Sig.		,108	,794

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 8,217.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Table 7: Difference of means (ANOVA) “Universities do not supply researchers with names and contacts of external resources for assistance or advice”

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	10,921	2	5,460	3,865	,036*
Within Groups	31,079	22	1,413		
Total	42,000	24			

N = 25, *p>0,05

Table 8: Post-hoc Tukey HSD Test for the variable “Universities do not supply researchers with names and contacts of external resources for assistance or advice”

Actors	N	Subset for alpha = 0.05	
		1	2
University	9	1,56	
Intermediary/ Expert	9	2,67	2,67
Faculty Entrepreneur	7		3,14
Sig.		,164	,700

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 8,217.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Among university policies and services, the main inhibiting factors are seen in the lack of physical facilities, the insufficient supply of seed funding, as well as a lack of training opportunities for researchers to learn business skills. On the level of the region of Vienna the impression of the most important obstacles is very consistent: it is a lack of 'angel investors', a lack of early and/or late stage investors, as well as an inadequate number of mentors and role models of successful entrepreneurs. Also on the national and EU level the various actors identify the same factors inhibiting university spin-off generation: the lack of seed capital from the national government and programs as well as the lack of early and / or late stage funding from federal government programs for start-ups.

The paucity of 'angel investors' and other sources of venture capital in the Vienna region is seen by all types of actors as a major barrier to generating a higher number of spin-offs. At the same time they share the perception that the Austrians intellectual property protection as well as national laws and conflict of interests regarding the utilization of university infrastructure are not major barriers.

All of the types of actors agreed on the lack of business and entrepreneurial skills of the researcher as one of the main factors in preventing a greater incidence of university spin-offs in the Vienna region.

5. Conclusions, Policy Recommendations, and Suggestions for Further Research

The empirical results indicate that the generation of university spin-offs is a complex process with different obstacles becoming more or less important in the different stages of spin-off development. Institutional norms and practices are often not compatible with the ambitions of faculty entrepreneurs and hence universities do not provide the support that is deemed important by would-be entrepreneurs at the very early stages. The larger milieu of Vienna is also not equipped with particular resources such as a concentration of role models and of private investors important for success at the later stages of spin-off development.

Our investigation of the perceived barriers to spin-off generation suggest a range of possible actions and changes that, if implemented, could and should increase the incidence of university spin-offs and contribute to the building of Vienna as a knowledge region. With a few exceptions and caveats, what we have learned about the situation in Vienna can apply to many other regions within Europe.

Of course, in an environment of fiscal restraint there are insufficient resources to enact everything that could increase spin-off generation. There are also some measures that would not pass the political feasibility test, resources aside. Finally, it is important to consider the tradeoffs of investing resources for a strategy aimed at innovation and entrepreneurship generally, and university spin-off generation specifically, versus other

paths to creating economically sustainable economies. Within the scope of this study and paper offer a set of recommendations that would be considered advice – a wish list if you will. The third issue of whether the pursuit of a spin-off strategy would be more effective at building a knowledge region is one that is also beyond the scope of this paper, but that we will pursue in the near future.

Table 9: Possible actions to increase the generation of spin-offs

	City and/or regional level	Federal (ministerial) level	University policy level
Funding and investments			
Vienna should focus its resources (marketing and otherwise) on a more limited set of technology areas that are seen as offering the greatest competitive advantages	X		
Foster the supply of incubators in the Vienna Region	X		
Provide additional, affordable lab space within existing but underutilized structures	X		
Universities be given dedicated funding to support pre-seed and seed funding of faculty research with high promise		X	
Incentives in the form of a ‘funding bonus’ be provided to universities for every spin-off generated		X	
Provide greater opportunities and incentives for universities to cooperate and share resources regarding support for academic entrepreneurship generally and spin-off generation specifically		X	
Address the disparity in funding between basic research and applied research and a lack of funding for more risky projects. Funding for basic science is only 20 percent; it should be increased		X	
Commit a pool of public money for early stage capital for spin-offs with high promise		X	

Invest in more professional TTOs and collaborate across universities in the sharing of knowledge and expertise			X
Many institutes are too small and underfunded (e.g., cannot afford lab space or post-docs). Inter-institutional collaboration and sharing can be a rational solution			X
Offer affordable space for early start-ups in university facilities			X
Training / education/ attitudinal and cultural change			
Provide incentives and paths for faculty to be able move back and forth between universities and industry over one's career		X	
Change in the primary and secondary educational system – 'innovative kids will lead to innovative universities and innovative universities will lead to an innovative economy'		X	
Speed job dating as very successful instrument for Ph.D.s and other graduates to get to know the job market as well as meet the right people			X
Getting exposed to the culture and the role models of entrepreneurs should be part of the scientific training of Ph.D. students			X
Eliminate the misunderstanding that the university will earn revenue from spin-offs from the very start. Revenue enhancement should not a primary objective in supporting spin-off creation			X
The mindset of the university should encourage and support curiosity and also more risky research and business ideas			X
Work to change the culture of failure: rather than blaming someone for not succeeding, establish attitudes to accept and then learn from failure			X

Marketing			
Work to make the Vienna region more visible to providers of venture capital and to identify potential angel investors	X		
Organize Scouting Days			X
Networking and Capacity Building			
Form a network of experienced entrepreneurs who would 'volunteer' their time to provide guidance and advice to would-be faculty entrepreneurs	X		
Build a shared database, in conjunction with partners such as the Chamber of Commerce, of resources available for the support of new technology-based businesses.	X		
Invest in more professional TTOs and collaborate across universities in the sharing of knowledge and expertise			X

Further research

To the extent we know that academic entrepreneurship generally, and spin-offs specifically, are influenced by not only individual attributes and attitudes, but also by factors in the institutional, regional and global environment, then it would be highly valuable to enlarge the study to include cases of other European regions of similar size, but which vary in the ecological conditions in the regional economy and in how university systems operate including their culture. This extension would allow the use of a comparative case study design to be able to isolate the effect of different factors that vary among the regions.

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Appendix A

Interview Guidelines for Faculty Entrepreneurs

The main purpose of our meeting with you is to help us identify, based upon your own personal experience as both a university researcher and entrepreneur, what are the most important barriers or obstacles to the creation of university spin-offs here in the Vienna region.

1. Could we start with giving us a brief history of your academic career including your main research interests?
 - a. In what year did you complete your Ph.D. (if not a Ph.D., then the highest degree earned)?
 - b. At what university did you receive your Ph.D.?
 - c. If you have completed your habilitation, in what year was that?
 - d. When did you begin the research that eventually led to the formation of a business?
 - e. What was your initial role in this research (i.e., were you always the project director)?
 - f. At what time when you were conducting this research did you begin to think about starting a company based upon the research?
 - g. At what time did you decide to start a business?

2. Had you any previous entrepreneurial experience before this?
 - a. Had you previously started a business?
 - b. Had you previously ever received and/or applied for a patent?

3. Did you have any entrepreneurial role models in your department or institute? Did you have any entrepreneurial role models elsewhere in your university? Did you have any role models in your discipline or research area located at other universities?

4. What were the most important factors or reasons for deciding to start a business based upon your university research?
 - a. Increase research funding opportunities
 - b. Increase personal compensation and financial rewards
 - c. Challenge of successfully starting and growing a business
 - d. Increase the quality of your basic, scientific research
 - e. To be better able to attract the most talented research staff to your lab
 - f. Increased prestige and status within your discipline
 - g. Greater independence and autonomy from university administration
 - h. Incentives from the university to start up a business
 - i. Other?

5. Now we would like to ask you about the principal barriers you experienced in starting up your company Prompts:
 - a. Finding investors
 - b. Lack of experience in knowing how to start a business
 - c. Lack of a role model
 - d. Personal financial risk
 - e. Insufficient time while working full-time as a university faculty member
 - f. Restrictive university policies and rules
 - g. Lack of help/support from the university TTO

- h. Absence of an entrepreneurial culture in your institute/university
- i. Absence of an entrepreneurial culture in the Vienna region/Austria
- j. Federal laws restricting faculty in state universities from starting businesses
- k. Other?

6. Do you have anything that we have not covered that you wish to add?

Thank you very much for your time and cooperation!

Appendix B

Barriers to Generating University Spin-off Companies in the Vienna Region

Faculty Entrepreneurs

Name _____

Title _____

University _____

Please complete the questionnaire and return it via e-mail to harvey.goldstein@modul.ac.at or verena.peer@boku.ac.at, or by fax to Prof. Harvey Goldstein: (+ 43) 1 320 3555 903

In several of the questions below, we refer to seed capital, angel investors, early stage investment, and late stage investment. We define these terms as follows:

Seed capital here refers to funding to support further R&D leading to an invention or prototype, but before the new business is actually formed. **Angel investors** are individuals who may be one source of seed capital.

Early stage investment refers to sources of capital needed for product development *after* a new business is formed.

Late-stage investment refers to sources capital needed for production to finance the operations of the business up to the point of selling publicly-traded stock in the business.

Based upon your own *personal and professional experience*, as well as *knowledge of other colleagues* who have attempted to start up a business based upon their university research, what is the relative importance of the following factors in *preventing* a greater incidence of university spin-offs in the Vienna region, on a scale of 1-5, where 5 means a very important factor, and 1 means not a factor at all (please highlight).

Individual faculty/researcher attributes	Importance				
	High				Low
University researchers are not conducting enough research that has commercialization potential.	5	4	3	2	1
University researchers are much more interested in basic science and not interested in research that leads to commercialization.	5	4	3	2	1
University researchers are not rewarded sufficiently by their universities for work that leads to commercialization.	5	4	3	2	1
University researchers are not aware of the commercialization potential of their research.	5	4	3	2	1
University researchers may be interested in research that leads to commercialization, but lack business or entrepreneurial skills.	5	4	3	2	1

University researchers have low tolerance for risk in their professional work and their careers. 5 4 3 2 1

Prestige and status within their disciplines do not come from research that leads to commercialization. 5 4 3 2 1

University Policies and Services

Universities do not provide sufficient rewards or incentives to faculty researchers to develop spin-off businesses. 5 4 3 2 1

Universities do not provide researchers with training to learn the business skills needed to start a business. 5 4 3 2 1

Universities do not provide sufficient 'seed capital' 5 4 3 2 1

Universities do not provide adequate physical facilities for the location of new spin-off businesses. 5 4 3 2 1

University policies restrict start-up businesses from freely using university infrastructure, such as laboratory equipment. 5 4 3 2 1

Universities do not provide sufficient help to identify if faculty research has commercialization potential. 5 4 3 2 1

Universities do not provide enough assistance in submitting patent applications. 5 4 3 2 1

Universities do not supply researchers with names and contacts of external resources for assistance or advice. 5 4 3 2 1

External Regional Environment Factors

The region of Vienna does not have a 'culture' of entrepreneurship. 5 4 3 2 1

There is an inadequate concentration of private industry R&D activity within key technology areas in the Vienna region. 5 4 3 2 1

There are a lack of 'angel investors' for spin-off businesses in the Vienna region. 5 4 3 2 1

There is a lack of potential private early stage investors in the Vienna region. 5 4 3 2 1

There is a lack of potential private late stage investors in the Vienna region. 5 4 3 2 1

There is an inadequate number of mentors and role models of successful entrepreneurs in the Vienna region. 5 4 3 2 1

A network of actors and organizations for the support of new technology-based businesses in Vienna is not well developed. 5 4 3 2 1

City and Länder government policies do not support and encourage the generation of university spin-offs. 5 4 3 2 1

National and EU Policy Environments

National government policies and programs do not provide enough seed capital for university researchers to seek commercialization possibilities 5 4 3 2 1

National policies and programs do not provide enough early stage and/or late stage funding for start-ups to survive 5 4 3 2 1

Austria does not have adequate intellectual property protection. 5 4 3 2 1

National laws on conflict of interest make it too expensive for spin-off businesses to utilize university infrastructure. 5 4 3 2 1

The federal government does not provide sufficient autonomy and flexibility to individual public universities for supporting or encouraging spin-off activity. 5 4 3 2 1

EU policies and funding programs do not adequately support or encourage commercialization of university research 5 4 3 2 1

Additional comments or observations you might have:

Appendix C

List of Persons interviewed (alphabetic order)

Dr. Andy Bailey (CEO and operational director, Virusure)

Dr. Eva Bartlmä (TTO, Vienna University of Technology)

Ao. Univ. Prof.Dr. Reginald Bittner (Head of the Department of Applied Anatomy, Medical University Vienna)

Dr. Andreas Chwatal (CEO, Destion)

Mag. Eva Czernohorsky (ZIT)

Ao. Univ. Prof. Dr. Otto Doblhoff Dier (Vice Rector for Research and International Relations, University of Veterinary Medicine Vienna)

Dr. Thomas Felzmann (CEO and founder, Activartis Biotech GmbH)

Dr. Irene Fialka (CEO, INITS)

Dr. Martin Paul Frenz (Frenz Cross Cultural Consulting GmbH)

Univ. Prof. DI Dr Johannes Fröhlich (Vice Rector for Research, Vienna University of Technology)

Dr. Thomas Funke (Institute for Entrepreneurship and Innovation, Vienna University of Economics and Business)

Mag. Herbert Gasser (Drittmittelkoordination, University Vienna)

Mag. Helmut Gassler (Joanneum Research)

O. Univ. Prof Dr Josef Glöbl (Vice Rector for Research and international Research Collaboration, University of Natural Resources and Life Sciences)

Prof. Dr. Johannes Grillari (CSO, Evercyte)

Prof. Dr. Michael Hess (Head of the Clinic and Head of the Clinical Unit for Poultry Medicine, University of Veterinary Medicine Vienna)

Mag. Michael Hoffmann (TTO, Medical University of Vienna)

DI Stefan Kreppel (Head of Program, FFG)

DI Mag. Florian Kruse (Co-founder, PhonicScore)

Dr. Karl-Heinz Leitner (Austrian Institute of Technology)

MMag Rudolf Lichtmanegger (WKO, Economy Policy Department)

Fabien Martins, MBA MSc (CEO, Max F. Perutz Laboratories)

Mag. Sabine Matzinger (BMWFJ, Innovation und Transfer)

Mag. Simone Mesner (BMW, RTD Strategy and Knowledge Transfer)

Prof. Dr. Markus Müller (Vice Rector for Research, Medical University of Vienna)

Dr. Ruppert Pichler (BMVIT, Research and Technology Funding)

Dr. Sandro Pirkwieser (CTO, Destion)

Prof. Helmut Pottmann (Co-founder and Scientific Advisor, Evolute)

Ao. Univ. Prof. DI Florian Rueker (BOKU, co-founder F-STAR)

Mag. Christine Ruckenbauer (TTO, University of Veterinary Medicine Vienna)

DI Dr. Gerald Ruppert (Head of Department, AWS)

Dipl-Geophys. Thilo Schmalz (TTO, University of Natural Resources and Life Sciences)

Dr. Elisabeth Schludermann (TTO, Vienna University of Technology)

Dr. Joachim Seipelt (Founder and Vice-President of AVIR Green Hills Biotechnology AG)

Mag. Edeltraud Stiftinger (CEO, AWS)

Prof. Dr. Franz Tödting (WU Wien)

Roman Tolic (Entrepreneur, Tolikas Media Company)

Prof. Dr. Susanne Weigelin-Schwiedrzik (Vice Rector for Research and Career Development, University of Vienna)

Dr. Lucas Zinner (TTO, University of Vienna)