



THE ROLE OF TU WIEN IN THE VIENNESE TECH STARTUP ECOSYSTEM

Progress Report

Student: Negoescu Alexandra

Stipendien-ID 1972

Advisor: Dr. Birgit Hofreiter

Project Details

Projekt/Stipendien-ID 1972

Title The role of TU Wien in the Viennese Tech Startup Ecosystem

Student: Mag. Negoescu Alexandra

Advisor: Mag. Dr. Birgit Hofreiter

The thesis investigates the current status of the Viennese Tech Startup Ecosystem aiming to identify and to assess the potential entrepreneurial pillars. With this in mind, we focus on the role TU Wien plays in the Viennese ecosystem. Universities per se generate new knowledge thus, universities are the source of innovation. The goal is to identify the needs and prerequisites for a strong startup/spinout activity at university level and to tag the needs in the triple helix in order to strengthen Austria's economy

The thesis will offer insights into

- TUW Entrepreneurial University activities & main commercialization challenges
- Better understanding of incentives for scientists & students to settle for an entrepreneurial life

Short description

Licenses

The report and the thesis will be published under the CC_BY or CC BY-SA license

The final report will be published at <https://www.netidee.at/role-tu-wien-viennese-startup-ecosystem> under the CC_BY or CC BY-SA license

Executive Summary

Over the past years the higher education system has been facing ‘unprecedented challenges in the definition of its purpose, role, organization and scope in society and the economy’¹ like technological progress and its embodiment in the everyday activities of universities, the shift towards information as a service along with the up and downs of the economy and funding fluctuations. These changes have had a great impact on this domain and at European level, to overcome the demands of these changes, a new concept has been embraced: ‘Entrepreneurial University’

Although historically centered on the concept of open science by means of publications and information dissemination, the interests of universities have been slowly drifting to accommodate commercialization, taking a more and more active role in bringing research from the laboratory to the market. This change directly affects one of the key actors in this scenario: the scientist. Although some scarce research do exist on how this affects their social-psychological profile, the actual impact on how the integration of research commercialization reshapes their career trajectories and professional persona in Austria has been barely tackled. Moreover, this shift has been widely criticized due to its direct affront to open science and resemblance with a firm, limiting the dissemination of science.² Understanding the cognitive aspect of technology transfer and the determinants of academic engagement can contribute to assessing the impact such a big change will have on the overall academia culture.

The important contribution to the economic development of founders is among the most important inquiries of our time³. While it is vital to understand the needs of the individual entrepreneur, we cannot oversee the fact that entrepreneurship is strongly related to the concept of ecosystems. Until recently, literature has primarily been focused on the individual entrepreneur, but it is vital to also understand their surrounding environment⁴. Focusing on the individual entrepreneur will not answer questions like: ‘Why do some places thrive with innovation while others don’t?’, ‘What are the determinants that help a startup community achieve critical startup mass?’ or ‘How does the startup community achieve critical startup mass?’⁵.

Each ecosystem is unique in its own way and surprisingly despite high real estate and living costs, some startup communities prevail. This is why it is vital to understand our startup ecosystem and discover the main inhibitors and thriving factors existing, especially now that Vienna is experiencing an increase in startup creation, thus the need to study the long-term perspective of Vienna as Austria’s main startup hub. My thesis comprises an overview of the Austrian and Viennese ecosystem, pin-pointing, its strengths, direction and support for entrepreneurial endeavors.

Technical universities are one of the main feeders to local startup ecosystems as they possess vital resources: people (students, researchers & professors), research labs, techno-entrepreneurship programmes and technology transfer offices. For some, the proximity to a research-extensive university is considered groundbreaking metric for the success potential of a startup community^{6 7}. Austrian universities among which TU Wien can have a strong hand in building today’s tech boom by deriving a comprehensive model of entrepreneurial university focused on enhancing the commercialization level of academic research output and a culture which encourages innovations. This is only possible by understanding and finding a way to overpass major challenges like how to build engagement and strengthen the entrepreneurial skillsets at university level, how to align techno-entrepreneurship-oriented activities with the core functions of teaching and research universities must fulfill and how to nurture a techno-entrepreneurial-friendly culture which supports risk taking and builds

¹ OECD. 2012. A guiding framework for entrepreneurial universities. Available online at <https://www.oecd.org/site/cfecpr/EC-OECD%20Entrepreneurial%20Universities%20Framework.pdf>

² Jain, S., George, G., Maltarich, M. 2006. Academics or entrepreneurs? Investigating role identity modification of university scientists involved in commercialization activity. *Research Policy* (2009). 38, 922-935. Available online at: <http://www.sciencedirect.com/science/article/pii/S004873330900050X>

³ Feld, B, 2012. *Startup Communities: Building an Entrepreneurial Ecosystem in Your City*. 1st ed. New Jersey: John Wiley & Sons,

⁴ Wamda. 2016. 90% of Tech Startups Fail [Infographic]. [INFOGRAPHIC] Available at: <http://www.wamda.com/2013/02/90-percent-of-tech-startups-fail-infographic>. [Accessed 06 October 2016].

⁵ Feld, B, 2012. *Startup Communities: Building an Entrepreneurial Ecosystem in Your City*. 1st ed. New Jersey: John Wiley & Sons,

⁶ Feld, B, 2012. *Startup Communities: Building an Entrepreneurial Ecosystem in Your City*. 1st ed. New Jersey: John Wiley & Sons,

⁷ Graham, R. , 2014. *Creating university-based entrepreneurial ecosystems evidence from emerging world leaders*. Cambridge: MIT Skoltech Initiative.

innovation capacity within the institution. As the Ewig Marion Kauffman Foundation concluded in their Entrepreneurial Campuses⁸ report, there is no 'one-size-fits-all' method for nurturing and enabling entrepreneurial preparations within university campuses.

Undeterred by the increasing buzz and interest around the new concept of technological entrepreneurial universities, there has not yet been developed a reliable solution for developing, monitoring and evaluating the entrepreneurial performance of technical higher education institutions⁹. Such solutions prove to be of high-reaching complexities due to the fact that one must look beyond the immediate institutional output metrics and incorporate performance evaluation metrics for long term aspects as well as due to the fact that there is a considerable variation in academia's involvement across various technical disciplines by virtue of the type of knowledge prevailing and the intellectual property protection methods which can be enforced¹⁰. Furthermore, it must envisage the different views and expectations of the local stakeholders within the operational dimension of the ecosystem.

The idea that techno-entrepreneurship needs a specific development and evaluation approach is supported in the literature too by S. Shane¹¹ and Owen Smith¹² who believes that the life sciences domain is a great generator of spinouts as a consequence of the discrete nature of the invention and the long time-span of the product development. In contrast, academic involvement in the social sciences are of great interest for public sectors and usually take the form of consultancy and contract research¹³. There is also a great difference between what is considered an entrepreneurial activity in the technical domain and other domains. For example, in humanities public lectures and books targeting a certain audience are examples of the most commonly accepted forms of entrepreneurial activities¹⁴.

According to Arena and Arnaboldy¹⁵ the development of a performance measurement system for technological universities can underpin the value creation of universities in this domain and counteract the reduced public financial support for research.

The thesis defined essential metrics for the creation and assessment of the TU Wien techno-entrepreneurial ecosystem considering that a thriving start-up ecosystem is a result of multiple factors: performance, funding, talent and start-up experience¹⁶ and involves multiple stakeholders. A complete analysis focused on the above-mentioned issues provides answers to critical questions for researchers, students, entrepreneurs and investors active in the Viennese university-based technology-driven entrepreneurial ecosystem and additionally offers insights into the role TU Wien plays, has played and could play in the local ecosystem and into how to improve the campus-wide entrepreneurial experience.

⁸ W.E.F. Torrance. 2013. Entrepreneurial Campuses: Action, Impact, and Lessons Learned from the Kaufman Campus Initiative. Ewing Marion Kaufman Foundation

⁹ Wright, M., Birley, S., Mosey, S. 2004. Entrepreneurship and university technology transfer. *The Journal of Technology Transfer*. Vol. 29 Nos 3/4, pp. 235-246

¹⁰ Abreu, M, 2013. The nature of academic entrepreneurship in the UK: Widening the focus on entrepreneurial activities. *Research Policy*, 42, 408-422.

¹¹ Shane, S., 2004. *Academic Entrepreneurship: University Spinoffs and Wealth Creation*. Edward Elgar, Cheltenham, UK/Northampton, MA, USA.

¹² Owen-Smith, J., Powell, W.W., 2001. To patent or not: faculty decisions and institutional success at technology transfer. *Journal of Technology Transfer* 26, 99-114

¹³ Abreu, M, 2013. The nature of academic entrepreneurship in the UK: Widening the focus on entrepreneurial activities. *Research Policy*, 42, 408-422.

¹⁴ Abreu, M, 2013. The nature of academic entrepreneurship in the UK: Widening the focus on entrepreneurial activities. *Research Policy*, 42, 408-422.

¹⁵ Arena, M., Arnaboldi, M. 2013. How dealing with spending reviews? The case of Italy. *Public Money and Management*. Vol. 33 No. 1, pp4-6

¹⁶ COMPASS. 2015. „The Global Startup Ecosystem Report 2015“, Startup Compass Inc.

Milestones Changes & Challenges encountered

The major challenge encountered which derailed the milestone plan initially set was the result of the literature review & secondary data collection stage. Not only that the literature on the topic was extensive and required more time than expected, but also caused an adjustment in the research questions and objectives of the thesis towards a better understanding of the conjunctions between environmental and internal conditions necessary for blending teaching with research and entrepreneurship and towards bringing to the forefront a model/framework which can be used to develop and measure STEM-oriented entrepreneurial universities. Therefore, the thesis is now two-folded, covering on one side the pillars necessary for developing a technical entrepreneurial universities and on the other side, a framework for evaluating technical universities. This adjustment required restructuring my entire research and the methodological approach and delayed the 'Literature Review & Secondary Data Collection' stage by almost 4 months.

Furthermore, in spite of the extensive existing literature on academic entrepreneurship, there was very scarce information focusing on techno-entrepreneurship in academia. In order to discover the specifics of a technology-driven entrepreneurial university ecosystem, additional research had to be performed in the form of interviews. The limited availability of the interviewees also contributed to the delayed development and validation of the frameworks. My efforts have been concentrated more on validating the 'Developing a techno-entrepreneurial university' framework, thus the 'Evaluating a techno-entrepreneurial university' framework still requires additional work. Supplementary I resorted to a case-study approach, analyzing the internal characteristics of worldwide technical universities and research institutes with the purpose of deriving correlations between these characteristics and the flourishing spin-off activity and I complemented the findings with other indicators used in various benchmarking surveys. The study cases considered were University Carlos III Madrid, Unternehmer TUM, Empa – The Swiss Federal Laboratories for Materials Science and Technology, Management Center Innsbruck (MCI), Dublin Technical University, Reykjavik University, Szechenyi Istvan University, Klaster LifeScience Krakow, University of Zagreb, University of Twente and Massachusetts Institute of Technology,

The decision to narrow the focus of the ecosystem assessment and concentrate my efforts on weighting the startup-ecosystem around TUW was also made. The study was conducted only at TU Wien level, a university with a profound reputation for research excellence and with a well-established technology transfer and innovation center. Even with a reputation for innovation excellence, the findings of the research might not apply equally to other universities and it is important to distinguish between general implications and case specifics.

Another challenge encountered was presenting the outcome of the research in a meaningful format. This is the part of the thesis which still requires a lot of effort. So far the frameworks derived are in a 'mind-map' format which is not comprehensive enough without the lengthy explanations included in my thesis. An easily understandable way to present the framework still needs to be derived.

Other issues which arose and caused supplementary delay were the limited availability of my advisor and the low response to the start-up ecosystem survey which was sent. In fact, the start-ups participating in the study all belong to the TUW incubator, therefore the data collected to this point alone cannot be at this point disclosed. A second iteration of the study needs to be conducted.

Findings

Understanding the entrepreneurial ecosystem in which TU Wien is operating

At European level

- Funding in Europe has been significantly increasing over the past year reaching \$68bn, followed by an even more significant increase in the first quarter of 2018 (\$24M). The number of deals reached an all time high in the 3rd quarter of 2017 (2305 deals), followed by a decrease to 1798 deals in the first quarter of 2018. A closer look at the industries funded in the past year, revealed that the Internet (40%), Mobile (14,16), Software (6.3%), Healthcare and Green Tech domains received the biggest support in this ecosystem and the focus was mostly on Seed/Angel investments (72,1% - 1464 deals between 0-1M and 1077 deals between 1-5M were disclosed) followed by Series A (16.98%), Series B (7.16%), Series C (2,66%), Series E (9,6%) and Series E (0,6%). The highest deal disclosed (a \$500+M Series B funding deal) was in the ICT domain.
- Although over half of the VC deals globally (58%) are concentrated in the US, hubs in emerging markets are becoming more and more appealing for venture capital investors who are nowadays more prominently supporting private tech companies¹⁷. This is reflected by the fact that VC investments in frontier startups have reached the highest value in 2017 since 2014 (\$600M). This is not surprising since Silicon Valley alone produced more unicorns and mega exists than any other region¹⁸.
- Based on disclosed funding stats, it is easier to raise a second round of funding in the US, but Germany is considered the next best option for raising second funding rounds, holding also the leadership with the highest exit rated country after the US. Our neighbors from Germany are also record holders for Series E funding rounds¹⁹.

At Austrian & Viennese level

- Austria benefits from its strategic geographical position: not only that it can act as a business East-West interface due to its easy access to the whole Europe within three hours of flight, but it also has more than 2000 km of highways, freeways and express rails²⁰ and a strategic position along the Danube river with various well-equipped ports capable of interfacing the North and Black Sea. More specifically, the Port of Vienna is the largest European inland container port managing 2000 container units per day. In fact, Vienna is considered the hotspot of the Austrian startup ecosystem²¹ with 63.7% of the startups being located in here²² according to the 2016 European Startup Monitor. Vienna concentrates half of the total Austrian economic output and is renowned especially for the life science and ICT domains²³ being considered one of the biggest ICT locations in Europe after London²⁴. This is not surprising considering that for natural sciences, engineering and ICT, Austria recorded the 4th highest rate of tertiary level graduates, the 5th largest rate for international scientific collaboration in the OECD area²⁵.
- Austria has a strong tradition for R&D and, with a yearly 3% increase since 2014, it is maintaining a leading position among EU countries for R&D spending. With a 3.09% of GDP in 2016 and an expected 3.14% for 2017, Austria is only exceeded by Sweden (3,36%). Vienna is the host of 30% of all research

¹⁷ W. Altman (2017, August 10). CBInsights Rise of the (global) rest – Identifying new startup and venture capital frontiers globally [Webinar]. In CBInsights webinar series

¹⁸ CBInsights. What's the easiest place to raise early startup capital?. 2017. Available online at <https://app.cbinsights.com/api/research-portal/?url=regional-vc-funnels/#head10>

¹⁹ CBInsights. What's the easiest place to raise early startup capital?. 2017. Available online at <https://app.cbinsights.com/api/research-portal/?url=regional-vc-funnels/#head10>

²⁰ Wikipedia. 2016. Autobahns of Austria – Wikipedia. Available online at https://en.wikipedia.org/wiki/Autobahns_of_Austria.

²¹ ABA invest in Austria. 2016. Austria * Opens up New Perspectives for Your Company. Available online at <https://investinaustria.at>

²² Bundesverband Deutsche Startups e.V., Berlin, Germany. 2018. ESM 2016. Available online at: <http://europeanstartupmonitor.com/>

²³ Vienna Business Agency. 2017. Vienna Region Business Atlas 2017 – Facts & Figures. Available online at <https://viennabusinessagency.at/international/location-vienna/the-business-location-vienna/>

²⁴ Vienna Business Agency. 2017. Vienna Region Business Atlas 2017 – Facts & Figures. Available online at <https://viennabusinessagency.at/international/location-vienna/the-business-location-vienna/>

²⁵ OECD Science, Technology and Industry Scoreboard. 2017. Highlights from the OECD Science, Technology and Industry Scoreboard 2017 – The Digital Transformation: Austria. Available online at <https://www.oecd.org/austria/sti-scoreboard-2017-austria.pdf>

institutions in Austria²⁶ and alone has 3.55% research quota²⁷ and a budget amounting to € 3.18 bn²⁸ for the research projects conducted at the over 1500 research institutions²⁹ existent in the city. 50% of these institutions are businesses while the rest are universities, research institutes and centers of excellence. A closer look at TU Wien revealed that it has the highest number of fully-certified Christian Doppler laboratories(16), highest number of Austrian patents recorded(75), over 4887 publications, a regular participation in the Austrian Science Fund excellence programmes, over 20 START award winners, 14 ERC grant recipients and Houska award winners, with most of the achievements under the umbrella of TU Wien's key areas of research: Computational Science and Engineering, Quantum Physics and Quantum Technologies, Materials and Matter, Information and Communication Technology, Energy and Environment.

- R&D is strongly supported by the public sector with 10% of the R&D funding originating from this sector. The higher education actually has the 4th highest share of expenditure in R&D according to the OECD factsheet (around 0.8% of GDP)³⁰ and the public financing share of universities is far above the EU average³¹. Still foreign enterprises continue to be the main source of financing for R&D expenditures³².
- The costs for training are significant and the request for up-skilled labor force is in high demand. Today's skilled workforce is very mobile and prefers working in highly innovative ecosystems, thus emphasizing the idea that innovation is strongly connected with social & cultural mix. With Austria holding the 4th highest rate of graduates at tertiary level (29%) for the STEM field³³ and also of the higher education expenditure in R&D globally³⁴, it is a significant player in the international mobility of the highly skilled. According to the OECD Science, Technology and Industry Scoreboard 2017³⁵, the percentage of foreign-born highly skilled individuals is slightly higher than the native-born for Austria. What's more, when it comes to scientists' mobility, the same report emphasizes a positive bilateral flow of researchers between Germany and Austria.
- Austria is ranked 3rd on CBInsight's "Top Emerging Startup Hubs", with .25% share of global disclosed VC deals. More specifically, Vienna also occupies the 3rd place among the top 10 emerging startup hub cities with .17% of the global VC deals (approx. \$ 700 M across 63 deals between 2012-2017).
- SMEs have a very important role in Austrian economy. According to the estimates produced by DIW Econ based on the Structural Business Statistics Database (Eurostat), they generated 62% of the total value added and 68% of total employment. In 2015, the 322425 SMEs employed 1 862 994 employees and generated a value added of €107 bn³⁶.
- When it comes to financing, the best financed industries in Austria over the past 2 years are in the Internet (39.58%), Mobile (17.36%), Software (2.08%), Healthcare (9.72%) and Green Tech (1.39%) domains and are mostly backed up by seed/angel investments, amounting to 86,67% of the deals (average deal size \$0.78M). Series A (7,62%), Series B (3,81%) and Series C (1.9%) are also present, but no series D and E have been disclosed in the past two years. The most active investors by the number of deals recorded in 2017 are the weXelerate Accelerator (18 deals out of which 6 in Viennese startups), startup 300 (10 deals) and Speedinvest (9 deals). The most active business angels in 2017 in Austria

²⁶ Vienna - City of Research. 2018. Vienna - City of Research. Available online at: <https://www.wien.gv.at/english/research/>

²⁷ Vienna Business Agency. 2016. Vienna Business Agency › Technology location Vienna. Available at: <https://viennabusinessagency.at/technology/technology-location-vienna/>.

²⁸ Vienna Business Agency. 2016. Vienna Business Agency › Technology location Vienna. [ONLINE] Available at: <https://viennabusinessagency.at/technology/technology-location-vienna/>.

²⁹ Vienna - City of Research. 2016. Vienna - City of Research. Available at: <https://www.wien.gv.at/english/research/>.

³⁰ OECD Science, Technology and Industry Scoreboard. 2017. Highlights from the OECD Science, Technology and Industry Scoreboard 2017 – The Digital Transformation: Austria. Available online at <https://www.oecd.org/austria/sti-scoreboard-2017-austria.pdf>

³¹ Austrian Council for Research and Technology Development. 2016. Austria as a place for research and technology. Available online at www.rat-fte.at/tl_files/uploads/Downloads/130916_Broschuere_englisch_pdf.pdf

³² STATISTIK AUSTRIA. 2018. Research and Development (R&D), Innovation. Available online at:

http://www.statistik.at/web_en/statistics/EnergyEnvironmentInnovationMobility/research_and_development_r_d_innovation/111794.html.

³³ OECD (2017), OECD Science, Technology and Industry Scoreboard 2017: The digital transformation, OECD Publishing, Paris. [ONLINE] Available at: <http://dx.doi.org/10.1787/9789264268821-en>

³⁴ OECD (2017), OECD Science, Technology and Industry Scoreboard 2017: The digital transformation, OECD Publishing, Paris. [ONLINE] Available at: <http://dx.doi.org/10.1787/9789264268821-en>

³⁵ OECD (2017), OECD Science, Technology and Industry Scoreboard 2017: The digital transformation, OECD Publishing, Paris. [ONLINE] Available at: <http://dx.doi.org/10.1787/9789264268821-en>

³⁶ European Commission. 2016. 2016 SBA Fact Sheet Austria. Available online at <https://ec.europa.eu/docsroom/documents/22382/attachments/2/translations/.../native>

were Herman Hauser (5 deals), Hans Peter Haselsteiner, Katharina Schneider, Leo Hillinger, Markus Ertler and Michael Altrichter (3 deals each).

- Vienna recorded a +36.23% funding growth in 2017, reaching \$ 23M in funding last year for 27 deals. An average 6 deals per quarter were disclosed entailing an average \$4.99M per quarter. Equally noticeable to the general Austrian direction, the Viennese ecosystem deals are centered on the Internet (60.71%), Mobile (only 7.14%) and Healthcare (7.14%) domains. In contrast, the financing stages of the deals disclosed over the past 2 years are for the seed/angel stage (85.71% with an average deal size of \$0.87M) and Series A (14.29% with an average deal size of \$2.4 M), leaving aside completely later stages.
- Since 2017 when the private equity investment reached an all-times high, it decreased overall reaching a value of € 87.23M as of 2016³⁷ and focused primarily on business products and services, ICT, construction, consumer goods and services, Financial and insurance activities, biotech and healthcare and transportation³⁸. Moreover, according to the Statistics Austria R&D Survey (2013)³⁹ and the Austrian Research and Technology Report 2016⁴⁰ a 16% R&D spending surge up to year 2016 with the business domain registering the highest increase, followed by the higher education domain, which is also the main provider of basic research, was revealed.
- Austria encountered in 2017 a +119.23% exit growth, with 58 exits registered last year. Still, the biggest quarter for exits was 2018 Q1 where a whopping 18 M&As have been recorded in Austria. By refining the search, the M&A activity in Vienna has increased significantly in 2017 (+400% exit growth) with 5 M&As in 2017.
- VC deals in Vienna have had an upward trend between 2012 and 2015, with spikes generated by a series of mega-rounds (\$100M+) from Biotech companies and with a slight downturn in 2016 followed by an increase in 2017. Still, later stage investments are almost inexistent in Austria respectively in Vienna. Business angels are one of the most active source of equity in the ecosystem and try to compensate for the shortage of VC funding through various angel collaboration programs (Super Angel Funds/ Angel Platforms) which pool together their funds and invest them into promising start-ups/spin-offs.
- Even with its excellent strategic position, great support for public funding and early stage startups and spin-offs, its proximity to other important European Startup Hubs can also act to Vienna's disadvantage. Stronger Start-up Hubs like Berlin and Budapest are putting Vienna in a cone of shadow.

Academic Entrepreneurial Ecosystem

- Historically, academia was driven by the norm of open science. Through publications and discoveries, information has been disseminated, emphasizing the social aspect of such a practice. In the past decade, a shift towards bringing research from the laboratory to the market has been starting to emerge. Therefore it is vital to understand where the university stands on the commercialization path. For this purpose it is critically to understand the involvement of students and more importantly scientists.
- What is the context and what are the circumstances in which the university is activating? What are its strengths and weaknesses? How is the university positioned within the ecosystem and which are the areas of strategic importance? Which are the existing processes and supporting mechanisms? The biggest mistake universities make when starting their transition towards an entrepreneurial university is not taking the time to understand exactly the context and culture of the university and jump directly to integrating successful examples from other renowned universities. The first step before embarking on a process of change is to clearly understand where the university stands. The outcome of this research can be then used as a pillar to assess the potential direction, opportunities and drive the

³⁷ Statista. 2018. • Private equity investment in Austria 2007-2016 | Statistic. Available online at: <https://www.statista.com/statistics/411302/total-investment-private-equity-markets-austria/>

³⁸ Statista. 2018. Private equity investment by sector in Austria 2016 | Statistic . Available online at: <https://www.statista.com/statistics/428174/investment-by-sector-private-equity-markets-austria/>

³⁹ STATISTIK AUSTRIA. 2017. Research and Development (R&D), Innovation. Available at: http://www.statistik.at/web_en/statistics/EnergyEnvironmentInnovationMobility/research_and_development_r_d_innovation/index.html.

⁴⁰ ERA - ERA Portal Austria. 2017. Austrian Research and Technology Report 2016 // ERA. Available online at: <https://era.gv.at/object/document/2876>.

change process forward in a direction which best suits the institution by openly discussing these aspects with various stakeholders from the knowledge, enterprise, government and various interest groups.

- Entrepreneurial activities originating in academia can be very complex ranging from 'limited interaction through extensive research collaboration at formal and informal levels, to scientists as fully-fledged entrepreneurial founders'⁴¹. Certain activities undergone by academic entrepreneurs are not easily measurable. The technology transfer offices usually only disclose data related to IP protection which only reveal university performance related to institutional entrepreneurship & innovation capacity. To this we can add Fini et. al.⁴² & Link et. al.⁴³ discovery that a substantial fraction of the business ventures founded by scientists are not based on disclosed/patentable research, thus informal in nature and usually undisclosed to the TTOs. Measuring the commitment of a university to entrepreneurship and innovation, its culture for facilitating disruptive innovations or the ecosystem in which these entities operate are hard to measure and rarely considered together. While the resources needed for driving infrastructural capacity are of extreme importance for the growth of the University 3.0, without entrepreneur and innovation commitment and a culture fostering such mentality, one cannot guarantee a sustainable regional & national growth⁴⁴.
- As main actors, scientists are the ones directly affected by these broad changes in the institutional framework. Embracing commercialization means a shift in their role, activities, workload and even priorities which in turn affect their perception of and participation to technology transfer. The normal academic career path implies norms which encourage information sharing for the common good, lack of emotional and financial attachments, 'organized skepticism', impartiality and an academic prestige based on publications and similar such articles. These norms are in contradiction with the entrepreneurial role identity which promotes technology as private property, passion and optimism. This new composite identity where university researchers overlay commercial orientation on top of academia is known in the literature as 'Hybrid role identity'⁴⁵.
- The biggest concern expressed by researchers is the interference with their academic pursuit of open research, basic science and publication⁴⁶. This is because they most of the time do not know what to expect and what is required of them in order to commercialize their research. These aspects can significantly affect individuals and result in their psychological strain⁴⁷. Tenured scientists who bygone the pressure of producing academically oriented output are more likely to get involved in commercialization movements.
- According to Jain et.al researchers also took on a hybrid role on an experimental basis: sabbaticals/ used their free time to work on their spinouts which helped them refine their comfort zone. Some researchers see their academic role identity as prevalent, therefore some of them feel more satisfied if the university would handle or help them find a suitable person with technical business management skills to handle their business. The researcher itself can assume the desired role within the business without the pressure associated by being labeled an entrepreneur and lead decision maker. They see universities as being the perfect custodian (to the detriment of private companies) for disruptive technologies as TTO possesses both the financial means to file & protect the technologies and the business knowledge and negotiation skillsets.
- By encouraging entrepreneurship at university level, both for students and researchers, access to new career paths can be opened. Although concerns have been raised on the possibility that legitimizing entrepreneurship at university level can lure away students and researchers from academia (especially researchers), the latest study done on encouraging entrepreneurship in university labs⁴⁸ reveals that supporting entrepreneurship does not undermine academic research nor does it affect researcher's

⁴¹ Murray, F., 2004. The role of academic inventors in entrepreneurial firms: sharing the laboratory life. *Research Policy* 33, 643–659

⁴² Fini, R., Lacetera, N., Shane, S., 2010. Inside or outside the IP system? Business creation in academia. *Research Policy* 39, 1060–1069.

⁴³ Link, A.N., Siegel, D.S., Bozeman, B., 2007. An empirical analysis of the propensity of academics to engage in informal university technology transfer. *Industrial and Corporate Change* 16, 641–655.

⁴⁴ R. Graham, 2014. Creating university-based entrepreneurial ecosystems – evidence from emerging world leaders. MIT Skoltech Initiative.

⁴⁵ Jain, S., George, G., Maltarich, M. 2006. Academics or entrepreneurs? Investigating role identity modification of university scientists involved in commercialization activity. *Research Policy* (2009). 38, 922-935. Available online at: <http://www.sciencedirect.com/science/article/pii/S004873330900050X>

⁴⁶ Merton, R.K., 1968. *Social Theory and Social Structure*. The Free Press, New York

⁴⁷ Thoits, P.A., 1983. Multiple identities and psychological well being- a reformulation and test of the social-isolation hypothesis. *American Sociological Review* 48, 174-187

⁴⁸ Roach M. 2017. Encouraging entrepreneurship in university labs: Research Activities, research outputs, and early doctorate careers. *PLoS ONE*12(2)

interests in pursuing an academic career. For this purpose it is recommendable to evaluate the entrepreneurial interest, the invention disclosure activity the role of management in the encouragement of an alternative entrepreneurial career as well as the invention disclosure activity and the individual interest in entrepreneurial endeavors.

- The aspect as alternative career generator is of big importance especially considering that research shows PhD students prefer to join the workforce as employees in startups to actually founding a company themselves⁴⁹. Preparing PhD students for an entrepreneurial career path can add additional flexibility and can act as eye opener for starting a business or ensure highly skilled scientific workforce for the ones interested in entrepreneurship without losing their focus on research.
- University-business collaboration is a constant discussion and metric for entrepreneurial universities as it has a multi-facet importance: bridging the gap between the contrasting cultural and social aspects of universities and the corporate world, acquiring skills and competences suitable for the constantly changing labor market, retaining Austrian talent and attracting international talent in the region, strong research institutions combined with skilled workforce generate a positive image of the region and is a source of attraction for foreign investments interested in relocating or expanding, changing economic conditions have a lower impact on HEIs
- Austrian universities focus their university-business cooperation activities around 'collaboration in R&D' and 'commercialization of the R&D results', efforts clearly reflected by the above EU average score which revealed these 2 categories at the most developed forms of UBC in the 'The State of University-Business Cooperation in Austria'⁵⁰.
- Even in the face of a constantly changing ecosystem centered on the need for cooperation, maintaining its independence and its ability to cater to societal problems needs to be supported by the academia though the appropriate ethical roadmap.
- Consultancy activities are a great source for empowering entrepreneurial activities at university level. On one side these endeavors contribute to the prestige of the department and institution, on the other side it allows direct collaboration with industry and activities which can be considered entrepreneurial in the sense that allow researchers to focus their attention on developing new products and services for the market together with the industry partner under certain basic elements of risk: costs & research time.
- Universities can make use of mediators, individuals employed at the university which do not take part directly in research, but are facilitating relationships between organizations. Their overall goal is to increase research cooperation between their university and local industrial partners. This approach is already employed by the majority of European businesses (a great example in this regard is the Siemen's Center of Knowledge Interchange programme), but at university level, the study on 'State of European University-Business Cooperation' conducted by the European Commission reveals that academics see themselves as main initiators of university-business-cooperation as a result of participating in open forums, workshops, industry conferences or other networking functions at their disposal⁵¹. This approach is one of the top barriers perceived by businesses when considering a collaboration with universities as they do not gasp with whom and what is the procedure for initiating a collaboration⁵².
- At TU Wien level, the entrepreneurial mindset still needs to be promoted among researchers. 61% of the participants in the study never considered to assess the business potential of their research while 9% have considered this option, but did not know whom to contact and what support the university offers for this purpose. Researchers also perceive the lack of capital funds as the main barrier to commercializing their idea. This is not surprising since most of the participants have been able to conduct their research with the support of public governmental, European or third party funding and it is common knowledge that conducting 0.5-1 year pilot studies and further prototyping is cost intensive. Other barriers TUW researchers expect to encounter are insufficient time commitment from academic

⁴⁹ Roach M. Sauermann H. Founder or Joiner? The role of Preferences and Context in Shaping Different Entrepreneurial interests. *Management of Science*. 2015; 61 (9): 2160-84

⁵⁰ T. Davey, A. Altmann, B. Ebersberger, A. Meerman, V. Galan-Muros. 2013. *The State of University-business Cooperation in Austria*. Science-to-Business Marketing Research Cnetur, apprimo UG and UIIN.

⁵¹ T. Davey, C. Plewa, A. Dreier. 2017. European academics see themselves as the main initiator of UBC. *University Engagement*. No. 5, 10-11

⁵² M. Melonari. 2017. Clear path for cooperating with universities- Overcoming the top three barriers. *University Engagement*. No. 5, 12-13

staff, lack of business expertise and market research, workload volume and bureaucracy. The study also set to discover what would TUW researchers consider as being a commercialization incentive for them. According to the outcome of the study, help with the development of a spin-off strategy and non-engineering issues, taking over patenting costs, financial support for feasibility & market studies and prototyping, recognition as well as providing access to TU Wien's network, lab and office space and intermediating collaboration and networking among like-minded people would be great incentives for research commercialization

- TUV Spin-off & Start-up Profile:

Venture profile	
Legal Form	GmbH (61,5%)
Main Focus	B2B (100%) with 15% focusing on both B2B and B2C
Average number of products	1
Languages of products	English & German
Average number of employees (both part-time & full-time and excluding founders)	2
Age of Company	Less than e years
Average no. of founders	4

Founder Profile	
Age	20-50
Gender	24% female, 76% male
Nationality	89,5% Austrian, 10,5% foreigners (Swedish, Czech, Slovakian and Romanian)
Level of Education	76,4% Post-Graduate 21% Graduate 2,6% Undergraduate
Background	Engineering, Biotech, Architecture and a combination of Engineering with Business
Previous Startup experience	92% No, 8% Yes
Average Salary	EUR 0-50k

- The main result of my thesis are the two frameworks derived which due to their complexity could not be included directly in the report, but are available online in the form of a mind map:
Techno-Entrepreneurial University Development Framework - <https://bit.ly/2IZ5pSZ>
Techno-Entrepreneurial University Evaluation Framework - <https://bit.ly/2HsvL2J>