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Selling the ivory tower and regional development: Technology transfer offices as mediators of university- industry linkages

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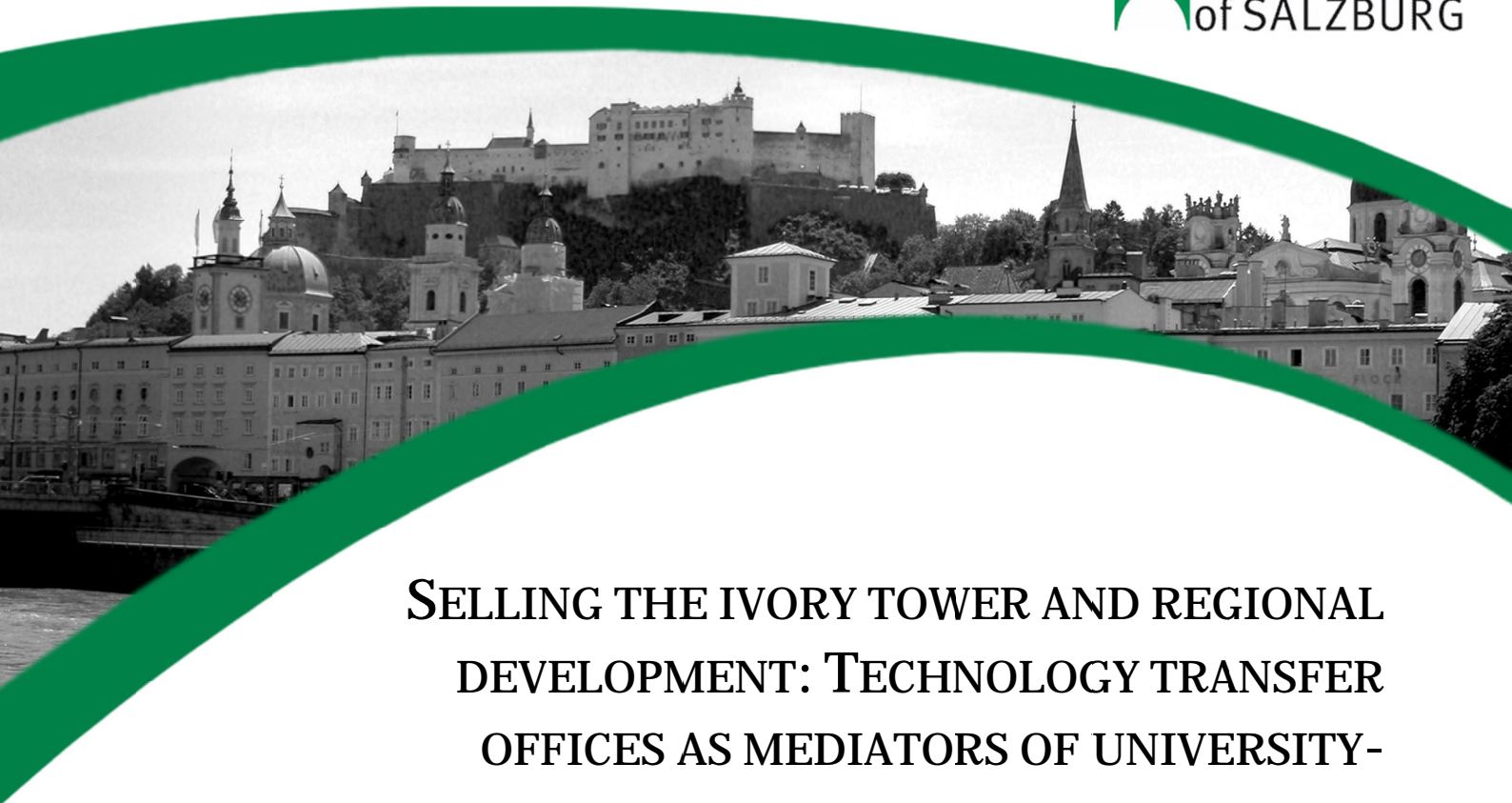
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**SELLING THE IVORY TOWER AND REGIONAL
DEVELOPMENT: TECHNOLOGY TRANSFER
OFFICES AS MEDIATORS OF UNIVERSITY-
INDUSTRY LINKAGES**

CHRISTIAN REINER

WORKING PAPER No. 2010-05

WORKING PAPERS IN
ECONOMICS AND FINANCE

Selling the ivory tower and regional development: Technology transfer offices as mediators of university-industry linkages

Christian Reiner¹

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Abstract

This article focuses on the role of Technology Transfer Offices (TTOs) in regional development in three Austrian regions that represent different types of regional economies. TTOs can be defined as “bridging institutions” between academia and business. The value added by this approach emerges due to empirical results demonstrating that the variety of TTO functions and their respective spatial-profile of activities depend heavily on the regional context. Regional economic structure and regional policy systematically shape the spatial profile of TTO activities.

The distinction between active and passive TTOs emerged as an important one regarding their potential regional economic development impact. While passive TTOs merely facilitate already existing contacts of the academic staff, active TTOs generate new university-industry linkages. These additionally created contacts are heavily biased towards the regional level. Intellectual property rights (IPR)-related TTO activities show a rather weak regional impact. This might prove problematic for policy makers that foster the patent-oriented commercialization of knowledge as a means to intensify knowledge spillovers from the universities to regional or national firms.

Keywords: universities, technology transfer offices, regional innovation systems, regional policy, Austria

JEL Classification: I23, I28, O34, O33, R11, R58

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1 Introduction

The “second academic revolution” has transformed an ever increasing number of universities into entrepreneurial universities; economic and social development emerged as a “third mission” beside the traditional university functions of teaching and research (ETZKOWITZ 2004). Perhaps one of most visible phenomena of these developments and the intensification of university-industry interactions is the founding of new institutions in universities that are more or less occupied with “selling the ivory tower”. Science parks, incubators, centers of excellence or university technology transfer offices (TTOs) are the frequently mentioned examples (MOWERY and SAMPAT 2005). This article focuses on the role of TTOs in regional development in three Austrian regions.

TTOs can be defined as “bridging institutions” between academia and business. They exercise quite diverse functions, depending inter alia on university mission and policy actions. Frequently, tasks undertaken by TTOs comprise the management of the university patent portfolio, support for spin-offs, consulting of faculty in IPR issues and contract design for cooperative research projects and information, as well as organizational support for privately and publicly externally-funded research projects (SCHIBANY 2002).

TTOs as an institution are mainly originating from US research universities. Since 1970, the bulk of US TTOs was founded and at an even faster rate after the passage of the Bayh-Dole act in 1980 which gave US universities the right to patent inventions resulting from federal funded research. In other words, TTOs are an essential element of what is denoted by KENNEY and PATTON (2009) as the “university invention ownership model”. The number of US TTOs increased from about 25 around 1980 to the current number of about 200 (SCHIBANY 2002). TTOs as internal intermediaries that appeared at European universities generally not before the mid 1990s as a result of a proliferation of Bayh-Dole like legislations in several European countries should not be mixed up with external intermediaries such as collective research centers that were already built up after the Second World War (WRIGHT et. al. 2008).

The economic rationale for TTOs as a specific institution in economic and innovation systems can be derived from three arguments. Firstly, creating a specialized organisational unit for e.g. IPR issues and business plan consulting brings about gains from specialization and economies of scale. Secondly, the market for knowledge is characterized by a number of features (e.g. high information asymmetries and high or even prohibitive transaction costs) that may lead to severe market failures (POLT et. al. 2001; DEBACHERE and VEUGELERS 2005). Hence, building up reputation is a condition sine qua non to increase the efficiency of the market for knowledge. According to MACHO-STADLER et. al. (2007), TTOs are able to pool inventions across research units and “shelve” some of these, and thereby signaling the technology buyer a positive selection towards higher quality inventions. Consequently, critical size is an important factor for TTOs in becoming efficient institutions. The third argument is somewhat related to the market failure argument but it originates from a different perspective, i.e. an innovation system perspective. Given the quite different cultures of the business sector and the university sector (MOWERY and SAMPAT 2005) and the market failure argument, a “systemic failure” is very likely to occur. Poorly connected elements deter the well-functioning of the innovation system as a whole (MAIER et. al. 2006, FRITSCH et.al. 2008)). Therefore the set-up of “bridging-institutions” that improve the efficiency of knowledge diffusion seems justified from an innovation system perspective.

Notwithstanding the economic rationale for TTOs, some empirical and policy oriented studies refute the efficacy of TTOs in creating and even facilitating UIL (KENNEY and PATTON 2009). On the contrary, following some scholars they may even inhibit a closer interaction of academic and corporate researchers. For example, a policy paper from the Kauffman Foundation (2007) argues that the centralization of commercialization activities at

universities due to a TTO leads to all the problems typically associated with monopolies. Hence, they suggest either the abolishing or the implementation of competition between TTOs. FRITSCH et. al. (2008) report empirical research about how faculty from Eastern German universities views their TTOs. Especially the acquisition of contract-research projects, frequently regarded as an important function of TTOs, emerged as rather unhelpful. TTOs lack the necessary trust and the engagement in subject-specific networks to initiate relevant contacts. Sometimes their engagement was even perceived as a perturbation in creating and maintaining UIL. In fact, WRIGHT et. al. (2008) report that small informal contract research projects between academia and business have almost disappeared at the K.U. Leuven because they have to be formalized since the implementation of the TTO. Noteworthy, the related revenue abatement was not offset by better regulated contracts with large firms because of the competencies of the TTO. Last but not least, KENNEY and PATTON (2009, p.1407) stress that TTOs have an attenuating effect on knowledge flows from university to industry for institutional arrangements force TTO officers to act as revenue maximizers for the university instead of “facilitators of technology dissemination for the good of the entire society”.

In spite of this criticism, TTOs are interesting from a policy as well as from an economic geography perspective. The policy relevance stems from the potential beneficial effects resulting from close UIL and the associated knowledge flows from academia to private sector firms for the competitiveness and innovativeness of firms and regions (FRITSCH and SLAVTCHEV 2007; OECD 2007). Alas, the linkages between the university and the business sector are perceived as relatively weak in Europe (AUDRETSCH and LEHMANN 2005; CONTI and GAULE 2009). A current Communication from the Commission (2009, p. 5) emphasizes what is known as the “European Paradox”: “Europe is productive when it comes to the generation of knowledge. [But] the level of lasting strategic cooperation between the two sectors remains too low.” Additional interest from policy makers on TTOs and related institutions stems from successful examples of university-based regional development that are based on close UIL and from potential revenues resulting from commercialization activities of universities (ETZKOWITZ and DZISAH 2008; SCHIBANY 2002). As a consequence, bridging institutions such as TTOs have become one of the policy instruments supported by the EU, national and regional governments and development agencies to foster knowledge exchange between academics and business.

Research on the spatiality of TTO activities might contribute to at least two bodies of regional economic research. Firstly, studies on spatially mediated knowledge spillovers still lack empirical evidence regarding the exact mechanisms that contribute to the geographically bounded spillovers from university to industries (D’ESTE and IAMMARINO 2009). TTOs may have a direct impact on the spatial-profiles of KT-channels; understanding their role and activities in KT has the potential to improve our knowledge on the means that cause the spatiality of UIL. Secondly, research on regional innovation systems (RIS) can be enriched by focusing on the role of TTOs as technology mediating organizations in connecting the knowledge generation with the knowledge application and exploitation subsystem (FRITSCH et. al. 2008, MAIER et. al. 2006).

Two research gaps are identified. Firstly, European and even Austrian TTOs have not been researched very thoroughly up to now. Secondly, little is known about the spatial-profile of TTO activities and the influence of policy actions and regional context upon it. Accordingly, based on regional policy research and a RIS approach, two research questions are investigated: What is the potential influence of TTOs to contribute to regional development, especially the development of regional clusters? How does regional policy and regional economic context influence the spatial range of TTO activities?

This paper is structured as follows. The following chapter reviews the literature. Section 3 develops a framework for the analysis of TTOs in RIS and delineates the study design. Section 4 gives a short overview on UIL in Austria and the main policy programs behind the set up of TTOs in Austria. Sections 5 and 6 report and analyze the main empirical findings. Finally, in section 7, some conclusions are drawn and policy implications discussed.

2 Literature Overview

TTOs and their role in the transfer of academic knowledge into the business sector figures prominently in the innovation-related literature in the US. Indeed, a current encompassing literature overview on university entrepreneurship by ROTHARMEL et. al. (2007) demonstrates that TTOs are one of the key research areas in the emerging research field of university entrepreneurship. Given the absence of TTOs in the majority of European countries until recently, it may be no wonder that European contributions are rather minor. As a result, the effects of European TTOs on UIL and the commercialization of academic knowledge remain largely unknown (BERGMAN 2009). However, the research interest is soaring as may be indicated by a current survey of European TTOs to gain a more comprehensive picture of the “European Paradox” (CONTI and GAULE 2008; CONTI and GAULE 2009).

The majority of research on TTOs has focused on issues such as incentive systems for scientists to disclose their inventions and collaborate with the TTO and the licensing firm even after the licensing agreement was negotiated (e.g. due to royalty distribution) as well as on governance structures inside TTO-augmented universities (JENSEN and THURSBY 2001; DEBACKERE and VEUGELERS 2005). The general aim of this stream of literature is the identification of the main independent variables determining the productivity of TTOs, usually proxied by variables such as licensing revenues or the number of granted patents. However, given our research focus on the spatiality of TTO activities, such papers are not reviewed here in detail (for an overview see e.g. PHAN and SIEGEL 2006; LEDEBUR 2008; ROTHARMEL et. al. 2007). To my knowledge, only three papers on TTOs exist that explicitly adopt a TTO perspective and take spatial factors into account. In the first, FRIEDMAN and SILBERMAN (2003) apply regression analysis on data from 83 US research universities to investigate the effects of a favorable economic environment (a relatively high concentration of technology-oriented firms and industry-research as well as an entrepreneurial climate) on license income and other output related variables of TTO activities. The results strongly confirm the expected positive effects of a favorable economic environment on KT outcomes. In the second paper, BELENZON and SCHANKERMAN (2007) investigate the impact of various university objectives on KT activities by TTOs. Especially interesting for our purpose is their attempt to gauge the implicit costs of a dominant local economic development objective of TTOs. Based on a simple agency model in which the TTO pursues either the maximization of license income or local development objectives, their regression-analysis indicates relatively high opportunity costs of a local development engagement of US TTOs: Universities with strong local development objectives (they are more likely to license to an in-state rather than an out-of-the state company) generate about 30 percent less income per license than comparable universities after controlling inter alia for the technological orientation of the university and the regional economic structure. In the third, WRIGHT et. al. provide evidence on the role of different KT-channels of universities and how the transferred tacit and codified academic knowledge contributes to industrial change in four different European countries. One of their investigated KT-channels was the TTO-channel. Relevant findings on TTOs are the following: TTOs mainly transfer codified knowledge; successful collaborations take time

to develop and are commonly rather bottom-up phenomena; professional IP management is needed to attract company investment in embedded laboratories on a campus.

Some conceptual conclusions on the role of TTOs in regional development can be derived by analysing the typical activity portfolio of a TTO more closely. Firstly, it encompasses all “direct knowledge transfer” channels, i.e. spin-offs, cooperative research projects and intellectual property rights (IPR) emanating from academic research, instead of “indirect knowledge transfer” such as publications or student mobility. Secondly, regarding the distinction between “formal knowledge transfer” (KT) and “informal KT”, TTOs are clearly pre-occupied with formal KT activities. Thirdly, an additional differentiation that emerges as important for the contributions of TTOs for regional development is between “active TTOs” and “passive TTOs”. While the former ones pursue the generation of contacts the latter ones simply act as facilitators of already existing contacts. Herein lies a further fundamental disagreement in research about what the appropriate role of TTOs is in “bridging the gap” (ROTHAERMEL et. al. 2007, p. 58): “Here, some argue that a TTOs role includes establishing a link between the university and industry (...), while others suggest that scientists in universities and industry are embedded in the same formal and informal networks thus limiting the TTOs role in facilitating these relationships (...).”

Three consequences from these characteristics for regional development implications of TTOs can be identified: firstly, if TTOs concentrate on the facilitation of formal KT activities the respective channels might increase in relative importance compared to informal knowledge transfer channels. If the latter ones are more regionalized than the former ones because e.g. of the need for face-to-face contacts, TTOs may decrease the regional development impact of universities. Furthermore, a sectoral effect is also likely to occur since different industries rely on different types of UIL (KENNEY and PATTON 2009). For example, patents are much more important in biotechnology than in say engineering or IT industries. If TTOs concentrate and facilitate only formal KT via patents, regions with industries that rely on these channels benefit from the presence of a TTO while other regions might even be worse off because traditional KT-channels are reduced in their relative importance. Secondly, if TTOs are primarily responsible to foster direct KT, this might be an advantage for regional development policies. According to FRITSCH et. al. (2008), direct knowledge transfer activities should be at the core of policies that tried to propel a university-based regional development. Thirdly, concerning the geography of different KT channels managed by TTOs, FROMHOLD-EISEBITH (2006) suggests a low degree of localization for the two main activities of TTOs, i.e. support and management of cooperative research projects and of patents and licences. University spin-offs supported by TTOs are almost naturally highly localized. A conclusion about the net-effects of TTOs on the spatial-profile of TTOs remains an empirical question. The study demonstrates that especially “active TTOs” are highly oriented towards the regional level alleviating potential deregionalization effects of TTOs due to a concentration on formal KT activities such as IPR marketing.

3 Data and method

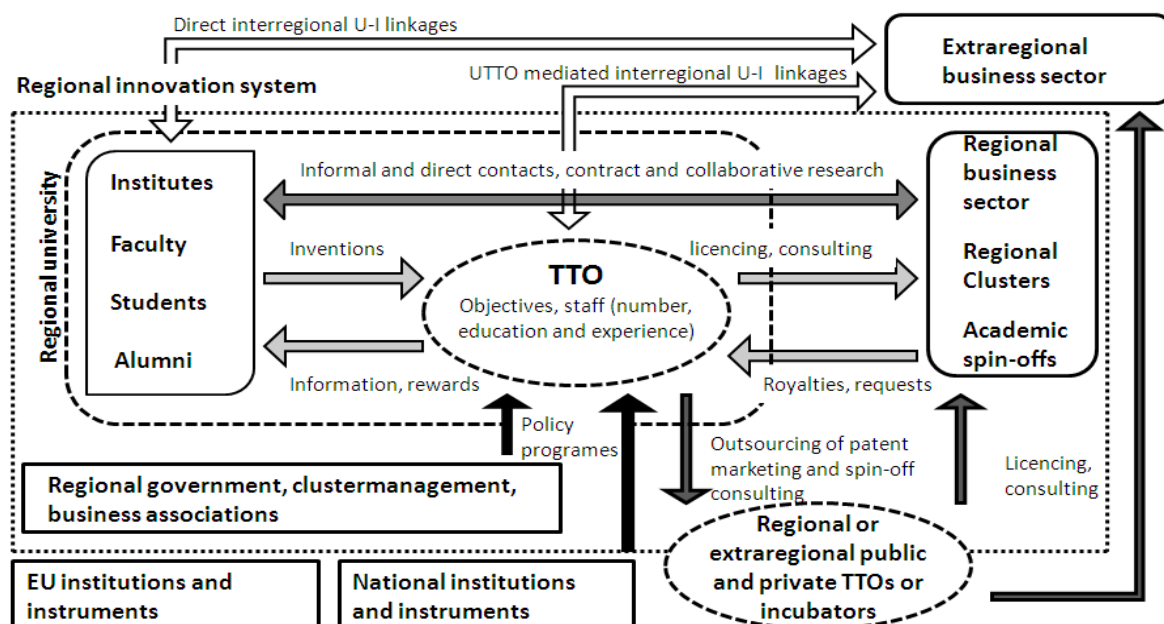
The methodology of empirical studies on TTOs can be grouped into two categories: very detailed case studies and formal microeconomic models (e.g. JENSEN and THURSBY 2001), on the one hand (e.g. DEBACKERE and VEUGELERS 2005 investigated just one TTO), and quantitative econometric approaches the other hand (e.g. CONTI and GAULE 2009). The study which is most akin to the applied methodology in this paper is WRIGHT et. al. (2008). They researched several transfer channels and institutions including TTOs in six universities each located in a different region belonging to four European countries. However, their regions were selected by the principle of similarity, i.e. they chose regions that represent average

European regions regarding several regional economic indicators. Contrary to WRIGHT et. al. (2008) we selected regions along the lines of dissimilarity to capture the influence of different regional economic and political contexts on TTO activities. The value added by this approach emerges due to empirical results demonstrating that the variety of TTO functions and their respective spatial-profile of activities depend also on the regional context.

A total of 14 TTOs from 11 universities in three Austrian regions were interviewed via semi-structured interviews (Table 3). Three different university types are part of the survey: technical, medical and general universities. These include only public universities. The interview partner was either the head or the expert for KT-activities of the TTO. This results from the organizational peculiarities of the organisation of KT-activities in different universities. Some universities have set up more than one TTO to realize gains from specialization or merely because of path-dependent organizational development. The study included all TTOs from all public universities in the three respective regions. Hence, the entire population in the three regions was surveyed. Regarding the representativeness of the sample for Austria as a whole, only the universities of Salzburg, Klagenfurt and Linz were not included in the survey. However, since two of them possess no TTO, only one Austrian TTO was not included. As a result, the data may even give a good overall picture for the TTO activities in Austria.

The study design and the questionnaire were built upon a framework depicted in Figure 1. The aim of this framework is to highlight the main knowledge links of a TTO in a RIS. Following a regional policy perspective, the TTO augmented RIS framework emphasizes the difference between intra-regional and extra-regional knowledge links. The arrows are colored in five different shades of grey, each representing a distinctive functional relationship. While the questionnaire includes questions on all kinds of relationships of a TTO, this paper focuses on the contact of TTOs with the regional and extra-regional business sector and the policy programs implemented by national or regional governments and business associations. The relations of the TTOs with faculty are not addressed (for an empirical analysis on this relation see AUDRETSCH et. al. 2006).

Figure 1: U-I interfaces and the role of TTOs in intra-regional and extra-regional knowledge transfer



In order to capture regional differences and the influence of different RISs, TTOs of universities from three Austrian regions were investigated. Table 1 provides an overview on the three regions of Styria, Tyrol and Vienna including the national level.

Table 1: Regional economic structure and performance

Region	Population in million ¹	GDP p.c. ²	GERD ³ as % of GDP	Professors (full time equivalents) ⁴	Employment in high-tech sectors as % of total employment ⁵	High-tech patent applications to the EPO ⁶
Styria	1.20	26 900	3.47	346.6	3.91	20
Tyrol	0.70	32 500	2.45	206.8	2.41	13
Vienna	1.67	41 500	3.54	714.6	5.87	49
Austria	8.31	31 100	2.46	1565.3	4,10 ⁷	24

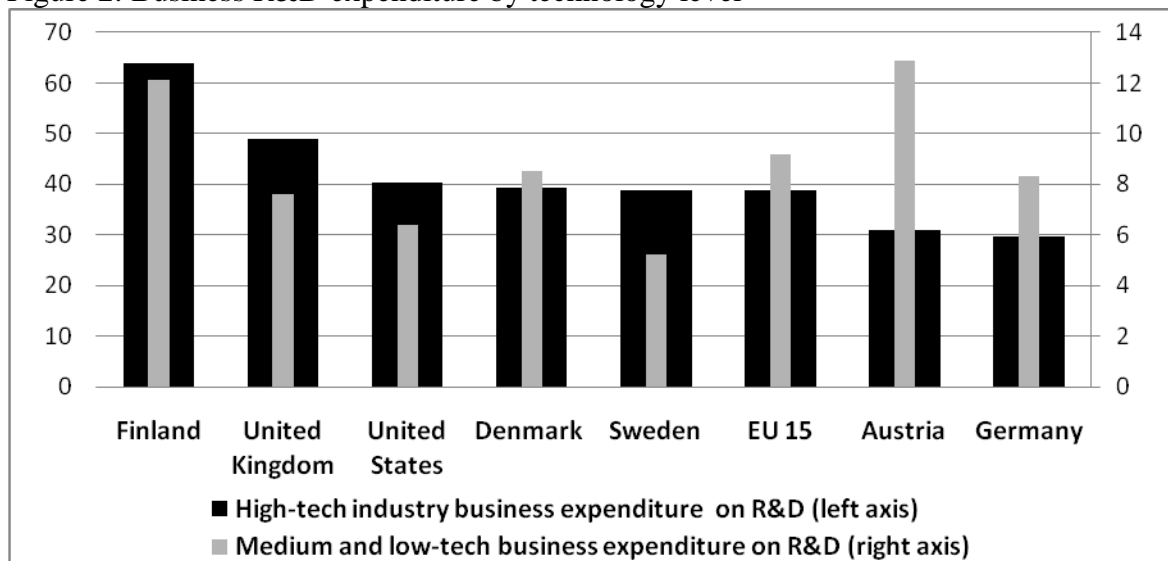
Data: Eurostat, Yearbook of Statistics Austria 2009, Hochschulstatistik; ¹2007, ²2006 current prices, ³Gross expenditures on R&D 2006, ⁴ Excluded are universities for business and arts, private universities and the university of Krems, ⁵2007: high-tech manufacturing and high-tech knowledge-intensive services, ⁶ average number of applications per million inhabitants 2000-2005, ⁷2005

The Austrian capital, Vienna, performs best on all cited innovation and GDP indicators. Conversely, Tyrol seems to have the most unfavorable regional economic context, at least from a knowledge economy's perspective. The employment in high-tech sectors is an important proxy for the absorptive capacity of the regional business sector. Whereas Styria's figures almost match the national average, Tyrol is far beneath this. A classification of the three regions may portray Vienna as a metropolitan region, Styria as an old industrial region and Tyrol as a "normal" region without clear specialization patterns or economic trajectories. In table 1, Vienna is seen to possess the highest potential for dense UIL, while Tyrol points to the opposite.

4 University-Industry linkages and university policy

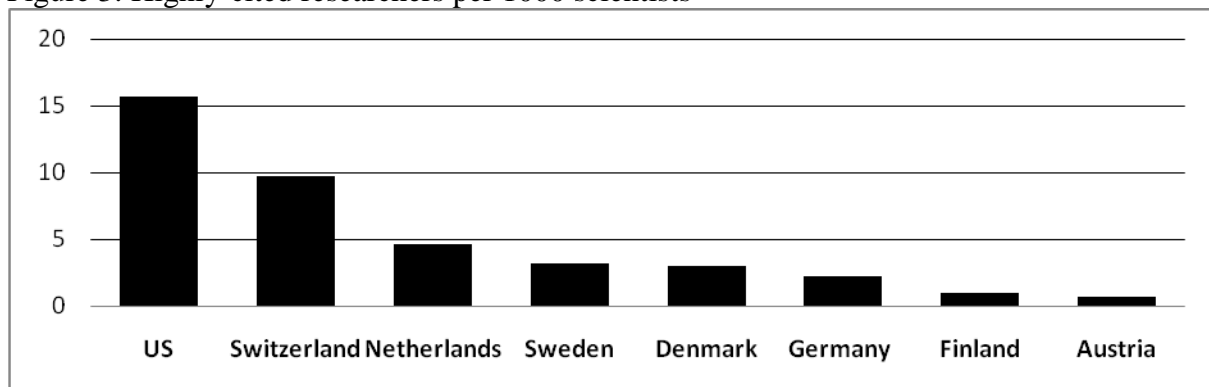
Country and regional specific UIL are shaped by several factors. Very important ones are the structure and performance of the business and the university sector (POLT et. al. 2001; FROMHOLD-EISEBITH 2006). The situation in Austria reveals a rather low potential for intense UIL. To start with the business sector several factors point to a relatively low absorptive capacity of and demand for scientific knowledge (JANGER and WAGNER 2004): specialization in industries with an advanced medium-tech level and a lack of high-tech firms (Figure 2); a strongly skewed firm-size distribution towards SMEs; reliance on incremental innovations; industrial core with a synthetic knowledge base. On the other hand, Austrian universities generally perform little cutting-edge research compared to the leading countries with a similar GDP level (Figure 3). The distance to the research frontier in several fields demonstrates a further evidence for rather unfavorable conditions for dense university-industry interactions (Österreichischer Forschungs- und Technologiebericht 2009).

Figure 2: Business R&D expenditure by technology level



Data: OECD 2008

Figure 3: Highly-cited researchers per 1000 scientists



Data: Österreichischer Forschungs- und Technologiebericht 2009

In accordance with the structural conditions outlined above, several studies on UIL in Austria confirmed the fact of relatively low interaction-intensity among universities and private sector firms (SCHARTINGER et. al. 2001; POLT et. al. 2001; FISCHER AND VARGA 2003). By applying spatial econometric techniques to test for spatial knowledge spillovers from university research in Austria, FISCHER and VARGA (2003, p. 315) deduce the need for “policy strategies to facilitate flows of knowledge within Austrian regional systems of innovation”. Perhaps TTOs can contribute to meet this goal.

Recent studies, however, demonstrate that a change is underway, pushing Austrian universities closer to the needs of an embryonic but growing high-tech sector. TRIPPL and TÖDTLING (2008) demonstrate that the interaction between Austrian biotechnology-clusters and universities has increased and more direct and interactive forms of knowledge links have been established. Taken together, Austrian UIL can be characterized as relatively weak but developing towards higher intensity (European Innovation Scoreboard 2008). What is important for our study is the high degree to which this development is policy driven in nature. This observation also applies to the implementation of TTOs in Austrian universities.

Triggered by policy spillovers from the US, Austria introduced Bayh-Dole-like legislations in 2002, giving universities the right to exploit research results from academics. Academics, in turn, are obliged to disclose their inventions to the TTO. This change in regulation was part of an encompassing university reform giving universities autonomy on issues such as staff decisions or resource allocation. Since universities lacked the competencies for managing IPR issues, a policy program called “uni-invent” was set up to support universities in implementing the new law (Table 2). The majority of universities established some sort of TTO; most of the interviewed TTOs were built with the financial support of uni-invent. The program phased-out at the end of 2009. Even though some TTOs reported a number of problems due to decreasing financial support, most TTOs will be maintained.

However, as is shown in Table 1, the activities and design of TTOs depend on several policy programs implemented at different spatial scales. For example, the EU founded Proton as a European association for European TTOs to foster best practice strategies and training facilities for TTO managers. Several Austrian TTOs are members of Proton. At the national level, “AplusB” is a relevant program for the design of TTOs which finances the foundation of incubators for university spin-offs. Each federal state in Austria has founded one incubator and hence most TTOs have outsourced parts of their spin-off assistance to these incubators.

Table 2: Policy actions regarding TTO-activities in Austria

Spatial level	Policy actions and programs	Description
EU	Proton (European knowledge transfer organization)	Founding of Proton as a European support organization for TTOs
	Guidelines and standard setting for IPR-issues, collaborative research and knowledge transfer	Development and commission of studies on standards and best practice examples in TT-activities
National level	Uni-invent I (2004-2006) Uni-invent II (2007-2009)	Support for universities to establish institutions (TTOs) for the commercialization of university produced knowledge
	Tecma	Assistance for inventors in the commercialization of research results
	A plus B	Supports university spin-offs by funding incubators (AplusB-centers) located in every federal state in Austria
	Styria: “Science fit”: University of Graz , University of Technology, Montan University Leoben, Joanneum Research	Networking initiative to proactively connect regional SMEs with universities or other “problem solvers” financed by the city of Graz, the regional government and the EU
Regional level	Tyrol: Support for TTOs	Financial support and integration into regional development strategies of two out of three TTOs
	Vienna: “Expertinnen der TU Wien beraten Wiener Unternehmen” (Advice by experts from the technical university of Vienna for Viennese companies): Technical University of Vienna	Advice for Viennese SMEs from researchers from the technical university of Vienna financed by the Viennese chamber of commerce

Regarding regional policy influence on TTOs, it has to be stressed that academia and is generally beyond the scope of regional policy-makers in most countries (e.g. Germany as a prominent exception). A study on university governance in Europe shows that public-private partnerships are hardly influenced by regional governments but very strongly by institutional management and academics, i.e. universities have a significant degree of freedom in decisions concerning quantity and quality of public-private partnerships (CHEPS 2006).

Austria has a centralized university system and TTOs as part of the universities are generally subject to the national level university policy. Nevertheless, regional policy agents have also tried to utilize TTOs for the sake of regional economies. The approach of the programs differs greatly. On the one hand, the Styrian program “Science fit” aims to create new contacts between SMEs and all Styrian universities (excepting the Medical University of Graz) through TTO officers who pro-actively contact and visit SMEs to network them with the university for problem-solving research co-operations. On the other hand, the Viennese program (financed by the regional chamber of commerce) finances a TTO-mediated consultancy of firms which contact the Technical University of Vienna for technological advice. Hence, the Styrian program is based on an “active TTO” model, while the Viennese program builds on a “passive TTO” model. The closest integration of TTOs into regional policy strategies might be present in Tyrol, as the two largest TTOs are financially supported by the regional development agency and integrated into regional development strategies. On the other hand, two interviewed TTOs stated that their requests for support from regional institutions for the financing of regional-oriented services of the TTO were denied. For example, one TTO manager tried to get funding for a SME consultancy regarding cooperation with university researchers from the regional development agency. In his words: “The development agency declared that it cannot be a university task to counsel firms on university-industry cooperation possibilities. However, this was 2002. At that time another ideology still prevailed.”

5 Organizational structure and objectives of TTOs

TTOs differ widely between universities and regions. Table 3 presents some of the important organizational characteristics of the interviewed TTOs. The second column depicts the size of the TTOs proxied by the full time equivalents of TTO officers preoccupied with KT in a narrow sense, i.e. excluding administrative tasks or support for EU projects etc. This restriction is vital in distinguishing TTOs of general universities from those of technical universities. The units of general universities that carry out KT activities are generally larger than those from technical universities but their staff dedicated to what is usually understood by KT is very minor compared to that of TTOs at technical universities. For example, the University of Vienna and the University of Graz, the two biggest Austrian universities employ just 2.25 FTEs of TTO officers whereas the Montan University of Leoben, a minor technical university, employs 11 FTE TTO officers. Summing up the number of FTEs per region reveals that Styria has by far the highest number of TTO officers (21.5); Tyrol (15) and Vienna (16.5) have approximately the same number. Given the fact that Vienna has twice as many university professors as Styria and about three times more than Tyrol, a very different picture concerning regional TTO activities emerges.

The majority of TTOs was founded in 2004 as an outcome of the uni-invent program. Characteristically, the technical universities already started with the implementation of TTOs in the 1980s. Regarding the regional embeddedness the context of the foundation of the TTO has to be considered. A particular interesting history is displayed by the foundation of the Industrial Liaison Office of the Montan University Leoben, the biggest Austrian TTO. The year of foundation was characterized by the heydays of the crisis of the old industrial region where the university is located. It became clear that only new innovations would improve the declining competitiveness of the regional industry; looking for the innovative potential in the region, the university emerged as the main institution that should provide the needed knowledge for a new technological trajectory. To develop this new role of the university and to accelerate the knowledge link between regional firms and the university, the Industrial Liaison Office was founded. Another TTO that was founded before 2004 is the TTO of the

University of Innsbruck, Transidee. The foundation was part of a regional development strategy for IT industries called “Informatikoffensive Tirol”. To supplement the newly founded institute for IT with close UIL at the regional level, Transidee was founded with financial support from the regional development agency of Tyrol. Contrary to these two TTOs, the bulk of TTO foundations around 2004 were not linked to regional needs or regional policy actions.

TTOs cooperate with a number of cooperation partners, especially in the field of IPR and spin-offs. Remarkably, the only TTO that relies entirely on internal expertise is the already mentioned Industrial Liaison Office. One explanation may be that this TTO has already achieved the critical mass and experience needed for effective KT activities. Only three out of fourteen TTOs maintain their own spin-off facilities and do not co-operate with the AplusB centers for academic spin-offs. The cooperation with international firms and associations specialized in the marketing of patents can contribute to the delocalization of UIL. For example, one TTO manager is member of an international organization for IPR issues which brings together supplier and buyers for technologies on a global level. As a consequence, the intensity of informal contacts of that TTO is higher with international than with regional or national-based private sector firms.

Table 3: UTTOs and co-operation partners

Region	University	TTO (TTO Officers FTE) ¹	Year of foundation	Co-operation partners (location)
Styria	University of Graz	Office of Research Management and Service (1.0)	2004 ²	AWS (Vienna), Science Park (Graz) ³
	Medical University of Graz	Research Management and Research Funding (2.0)	2004	BDC (CH), Science Park (Graz) ³
	Graz University of Technology	Technology Exploitation Office (5.0)	2004	AWS (Vienna), BDC (CH), IPB (DE), Steinbeis (DE), Ocean Tomo (US), LES (global network), Science Park (Graz) ³
		Technology Transfer (2.5)	1986	
	Montan University Leoben	Industrial Liaison Department (11.0)	1987	
Tyrol	University of Innsbruck	Projekt.Service.Büro (2.5)	2004 ²	Cast (Tyrol) ³ , BDC (CH)
	Innsbruck medical university	Center for Academic Spin-offs Tyrol (Cast) (7.5)	2002	
Vienna	University of Vienna	Research Services and International Relations (1.25)	2004	AWS (Vienna), TTO (DK), INITS (Vienna) ³
	Medical University of Vienna	Research Support Unit (Technology Transfer) (3.5)	2004	BDC (CH), Technology Exploitation Office (University of Graz)
	Technical University of Vienna	Extension Center (Technology Transfer) (7.4)	1985/ 2004	BDC (CH), TTO (DK), INITS (Vienna) ³
	University of Veterinary Medicine	VetWidi (1.5)	2004	BDC (CH)
		Office of Technology Transfer and Research Management (1.0)	2003	
	University of Natural Resources and Applied Life Sciences	Research Service (1.5)	2004	AWS (Vienna), Tecnet (Lower Austria), BDC (CH), INITS (Vienna) ³

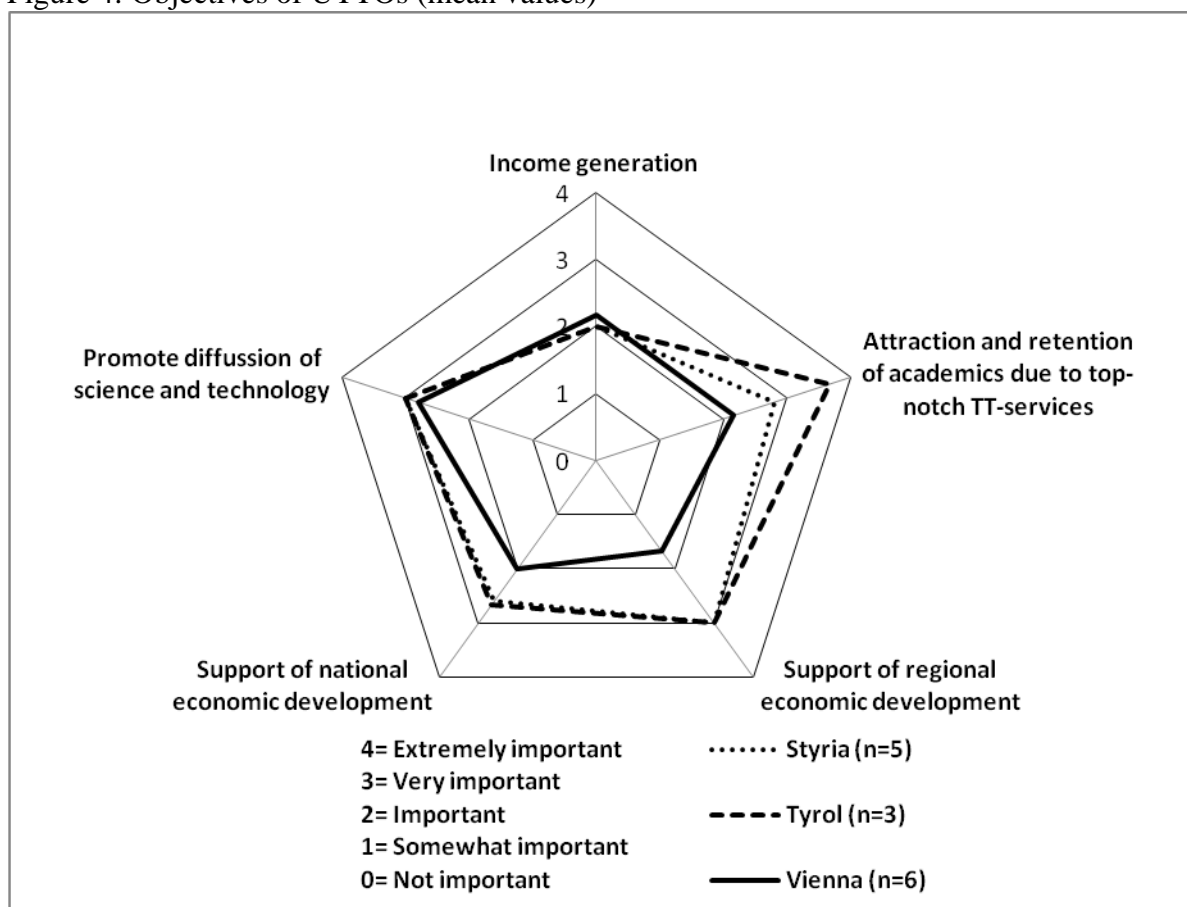
¹Excluding administrative and organisational staff; ²Both TTOs were established around 2000 but they had not started with TT-activities until 2004, ³AplusB centers for academic spin-offs

Originally, the newly founded TTOs were thought to co-operate in the marketing of patents with the national development bank (AWS) that also manages the uni-invent program. Similar to the German situation, where one unit for patent marketing was established in each region, the Austrian TTOs should co-operate with one national centralized patent marketing unit that had already accumulated know-how in this task. Yet, most of the TTOs started to market IPRs on their own or cooperated with foreign partners specialized in the respective field of technology because they were rather unsatisfied with the AWS. Perhaps, this is a manifestation of the monopoly problem of TTOs (Kauffman Foundation 2007). Judging this situation from the perspective of economic rationalities for TTOs, whether or not each TTO

reaches the critical mass and economies of scale necessary to provide effective KT services, might be questionable.

The aims of TTOs are illustrated by Figure 4. Apparently there are substantial differentials between the different regions. However, there are also some similarities: Almost naturally, the diffusion of science and technology is perceived by all TTOs as one of the most important goals. On the other hand and probably in contrast to what would be expected from a university policy perspective, income generation is the least important goal in Tyrol and Styria. Even though this might represent a realistic assessment of the potential for revenue generation, universities already stripped of public funding per student have to finance an additional service unit which actually works at a loss. Hence, the criticism of KENNEY and PATTON (2009) that TTOs act as revenue maximizers rather than as facilitators of technology dissemination does not apply for the Austrian TTOs.

Figure 4: Objectives of UTTOs (mean values)

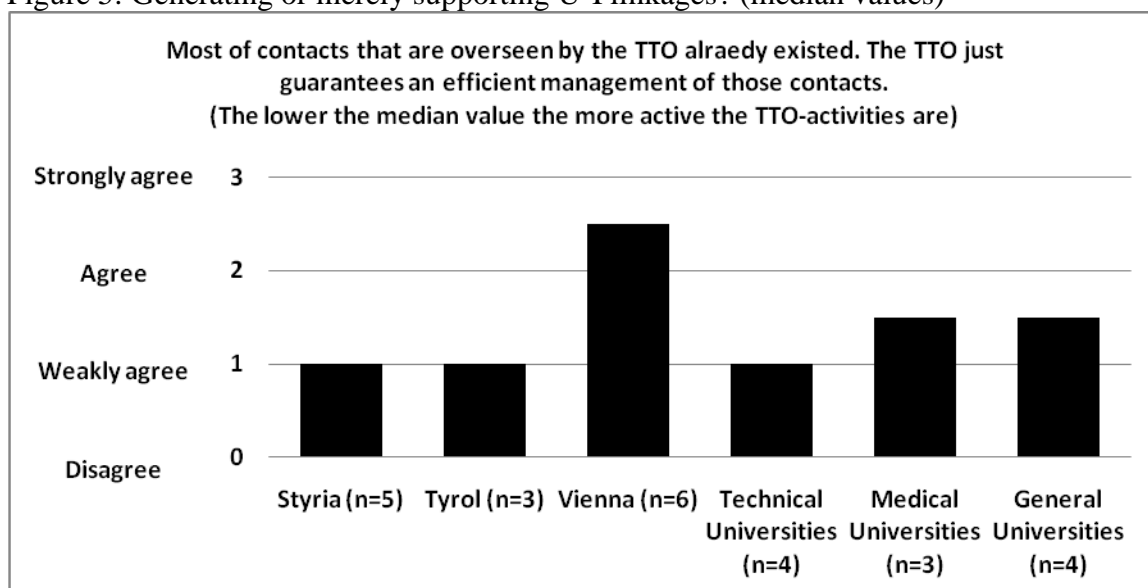


The main differences between Vienna and the other two regions concern the support for regional economic development. While the average Tirolean and Styrian TTO perceives this aim as “very important”, the average Viennese TTO judges this engagement in regional development issues between “somewhat important” and “important”. Interestingly, income generation is somewhat more important for TTOs in Vienna than regional economic development. Regarding support for national economic development, the differences are lower with the same rank-order remaining. These results modify the non-regionally differentiated results of the European TTO survey by CONTI and GAULE (2008) that claim a uniform priority of the local economic development goal relative to income generation. The

biggest divergence between the regional TTOs occurs on the relevance of TTO activities for the attraction and retention of academic talent. Tyrolean TTOs perceive this to be the most important goal and of extreme importance, conversely though, TTOs in Styria judge this to be as important as the support for regional development. Taken together, a clear difference on regional development objectives of TTOs in Vienna and in the two other regions investigated can be observed. As will be demonstrated below, similar patterns of other variables suggest a systemically different role of TTOs in different regions.

Following FRITSCH et.al. (2008), TTOs should concentrate on the facilitation of contacts established by academics themselves. Figure 5 documents the degree to which TTOs restrict their mission to this “passive role” as opposed to a more active role in establishing additional contacts. TTO officers were asked if most of their contacts that they manage have already existed. The spatial-profile of UIL of universities with a passive TTO are shaped by the contacts of faculty and the TTO contacts mirror these contacts in a one-to-one way. However, even in this case TTOs might have an influence by changing the relative transaction costs between different types of UILs. For example, AUDRETSCH et. al. (2006) report that researches with an effective functioning TTO in place tend to chose licensing as the main way commercialization, whereas, in the presence of a inefficient TTO they are more geared towards founding spin-offs as a commercialization strategy, which in turn, clearly has a higher degree of regional impact. Contrary to passive TTOs, active TTOs naturally influence the geography of UIL.

Figure 5: Generating or merely supporting U-I linkages? (median values)



The TTOs from Vienna show a median of 2.5, i.e. they are more or less passive TTOs. Quite the opposite is observed in TTOs in Styria and Tyrol which weakly agreed and argued that their role and activities are heavily shaped by the aim of contact creation instead of just contact facilitation. Analyzing the distribution of “passive versus active” TTOs by type of university, technical universities are the most active ones. Two partly related explanations for this are possible: the first of which, may be that technical universities have older and larger TTOs that may have already reached a critical level of trust and reputation to play a more active role in innovation networks between academics and private sector firms; the second, that university policy may be biased towards fostering KT from technical universities because

they are perceived as the proper agents for the promotion of academic knowledge spillovers (AUDRETSCH and LEHMANN 2005). The highly active character of the TTOs in Tyrol is underlined by the fact that Tyrol possess one general and one medical university, both belong to the type with rather passive TTOs. Rank-correlation between the degree of “activeness” of TTOs and regional informal contacts with firms as well as with an index variable “regional embeddedness” results in a positive correlation of about 0.5 at a significance level of 0.10. Accordingly, the more active a TTO the higher is the orientation towards the regional level. As a result, TTOs in Styria and Tyrol are more integrated in the RIS and play a more active role in connecting the different elements of the RIS. In both regions regional policy actions are an important explanatory factor for these patterns. The policy program in Styria “Science fit” was already mentioned above; Transidee, one of the two TTOs for the University of Innsbruck is an integral part of the regional development strategy and hence concentrated on connecting the regional business sector with the university.

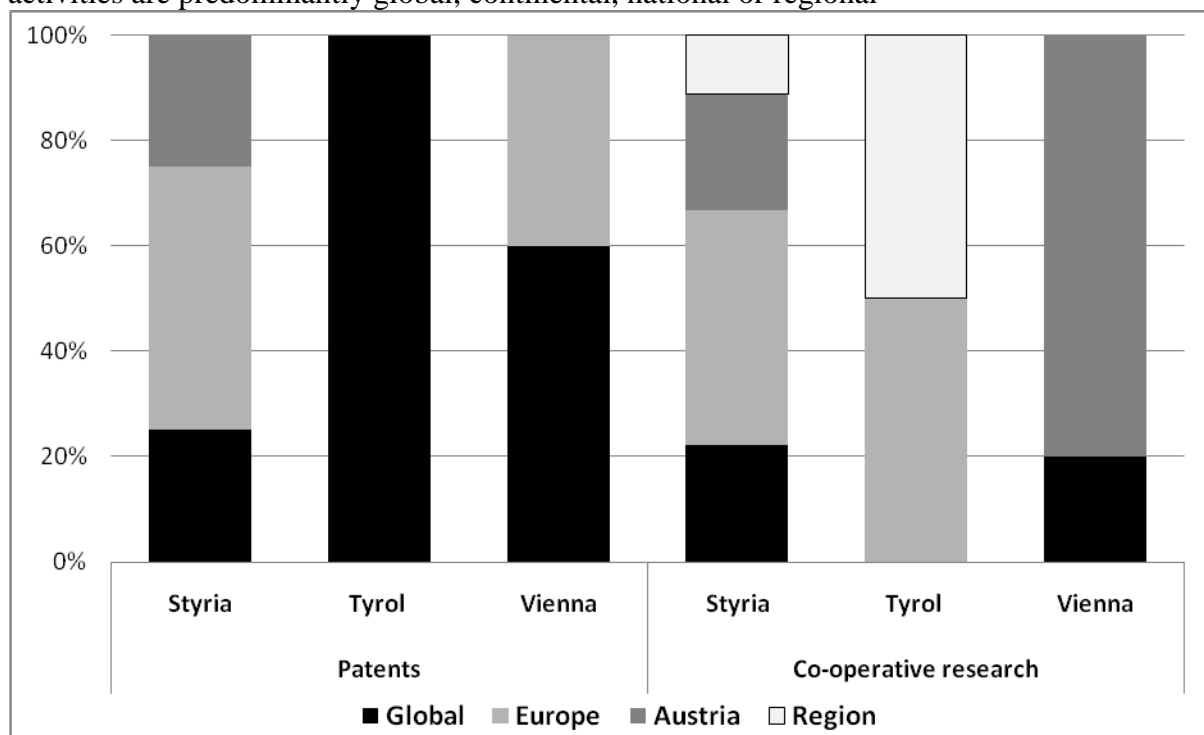
Concerning the criticism of FRITSCH et. al. (2008) on an active role of TTOs, an additional insight can be reported. SCHARTINGER et. al. (2001) found that a lack of information on what expertise and problem-solving competencies are available at the university is one the main barriers for UIL in Austria. Attenuating this lack of information is one of the main goals of active TTOs. In the best case, TTO officers possess the tacit knowledge of “know-who”: who is the appropriate academic for a specific problem or research task? Hence, TTOs need to maintain very close linkages with faculty on order to function as effective boundary spanners in an active manner. One way to secure this proximity between the TTO and faculty is to hire researchers for the TTO. For example, the TTO Transidee of the University of Innsbruck is managed by a physicist with a habilitation. On the other hand, one might question whether connecting SMEs with the university, which is often the core activity of active TTOs, meets the needs of academics. While this might be perfectly reasonable from the perspective of regional development, a TTO officer reports that academics are not unequivocally satisfied about the various, but insignificant, contacts. A TTO manager stated that one of the main tasks of active TTOs is to function as a “filter” between the demands from SMEs and the capacities and interests of the scientists, i.e. to “shelve” some of the potential cooperation projects between university and SMEs (MACHO-STADLER et. al. 2007). Refusing inapt demands is very important to maintain effective linkages between SMEs and the university. An additional explanatory factor behind the relatively high number of SME requests regarding university cooperation beside TTO activities as such lies in a policy program (“Innovationsscheck”) that supports SMEs financially for starting co-operation with the university.

6 TTOs and regional economic development

Three relevant factors for the relationship between TTO activities and regional development are discussed and analyzed: firstly, the spatial-profile of different TTO activities; secondly, TTO mediated cluster-university linkages; and thirdly, matching the supply and demand of technology in the three regions is compared in order to assess the degree of regionalization of TTO activities.

Different KT-activities of TTOs are characterized by specific spatial profiles (FROMHOLD-EISEBITH 2006). The highest degree of localization arises due to spin-off support by TTOs: all consulted spin-offs founded their firm inside the region of the university. The other two classical tasks of TTOs, patent marketing and the management of co-operative research projects, show a much different geography. Figure 6 shows the regionally differentiated TTO activities and their predominant spatial range.

Figure 6: % of UTTOs whose spatial range of patent and co-operative research related activities are predominantly global, continental, national or regional



As expected, no TTO has a majority of their contacts in patent marketing inside the region, and only a few in Styria have their main focus in Austria. The TTOs in Tyrol that show the highest degree of regionalization in other variables are mainly oriented towards the global level in patent-related activities. Accordingly, the potential of patent-related KT to contribute to the regional and even national development seems to be relatively small. Patenting as one of the politically most enthusiastically supported transfer mechanism appears to be the least spatially constrained one. Taking into account that most of the TTOs were founded to explicitly support the marketing of IPRs, a higher concentration of researchers on this transfer channel risk a decrease in the regional development impact of universities. It has to be stressed that the majority of IPR-marketing activities are shaped by research projects between academia and business. The IPRs for the results of the project are defined in contracts ex ante, and the main task of the TTO is to secure that the university receives a “fair” share of royalties without any influence on the spatiality of these contacts. Furthermore, the discrimination of foreign firms (e.g. by selling the patent more cheaply to national or regional firms) because of regional development objectives, is prohibited by EU law. Nevertheless, even if the TTO has the task to proactively search for a buyer of university IPRs, the strategy of TTOs as described by a TTO officer demonstrates a systematic de-regionalization: “The higher the rated novelty of a patent, the larger the area of spatial search for firms as buyers of the IPR is. The greater the scope of spatial search activities, the higher the costs. The higher costs are, in turn, justified by higher expected returns from a patent because of the high novelty.” This procedure points to a trade-off between the goal of regional development and the maximisation of income for the university (BELENZON and SCHANKERMAN 2007).

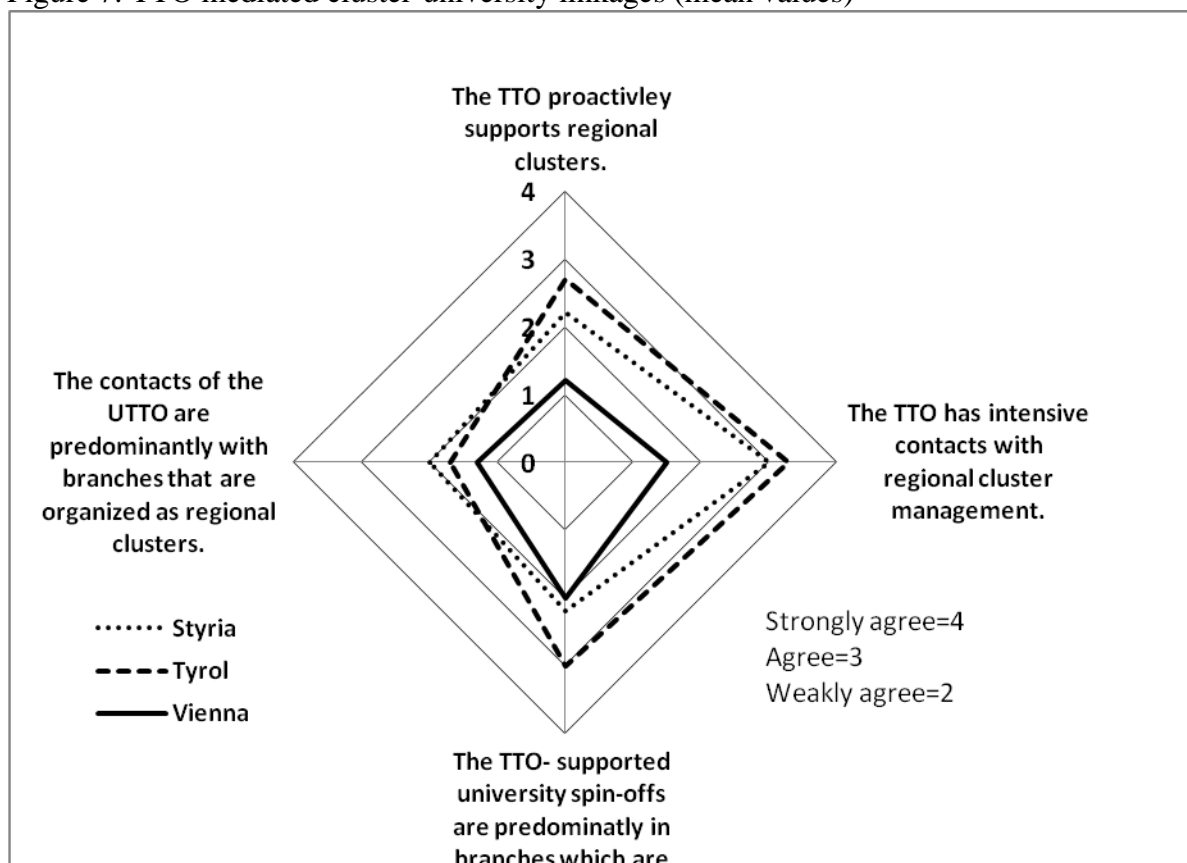
The spatial-profile of co-operative research projects is quite different to that of patents. In line with the literature, co-operative research projects are much more spatially bounded. In contrast to IPR issues, active TTOs are much more active in influencing co-operative research projects. Again, the already observed differences between the regions emerge: the

TTOs in Tyrol display the highest degree of regionalization regarding co-operative research projects, whereas, no Viennese TTO is predominantly occupied with managing regional research co-operations.

Cluster strategies are often at the core of regional economic policy in Austria. The competencies for clusters and partly also for innovation policy reside at the regional level. On the other hand, Austria has a centralized university system. Accordingly, the co-operation between national universities and regional development strategies cannot be guaranteed by a single political body.

Looking at the contributions of the TTOs in the three regions on regional cluster strategies, a pattern of high regional differentiation emerges. Figure 7 shows several dimensions regarding the interaction between TTOs and clusters. The higher the mean value, the higher the intensity or support of these interactions. The most striking feature is the very distinctive role of the Viennese TTOs in the support for regional cluster initiatives. The TTOs in Vienna are more or less unconnected with regional clusters, while the TTOs in Tyrol and Styria have a rather close relationship with cluster projects. The intensity of contacts to regional cluster management is very high in Tyrol and Styria and very low in Vienna. However, the intensity of contacts does not translate into a very high overall support for clusters. As may be apparent, the TTO contacts with branches correspond rather weakly with the branches that are organized as regional clusters. Additionally, the active support of regional clusters is no aim, as such, at most, only an unimportant one for Styrian and Viennese TTOs. When asked if the existence of regional clusters influences the KT-activities of the TTO, the vast majority of TTO officers reported that there was none. One TTO officer, who affirmed some influence, cited an example of this, stating that the decision of whether to support a university spin-off depends, inter alia, on the compatibility of the spin-off with regional clusters.

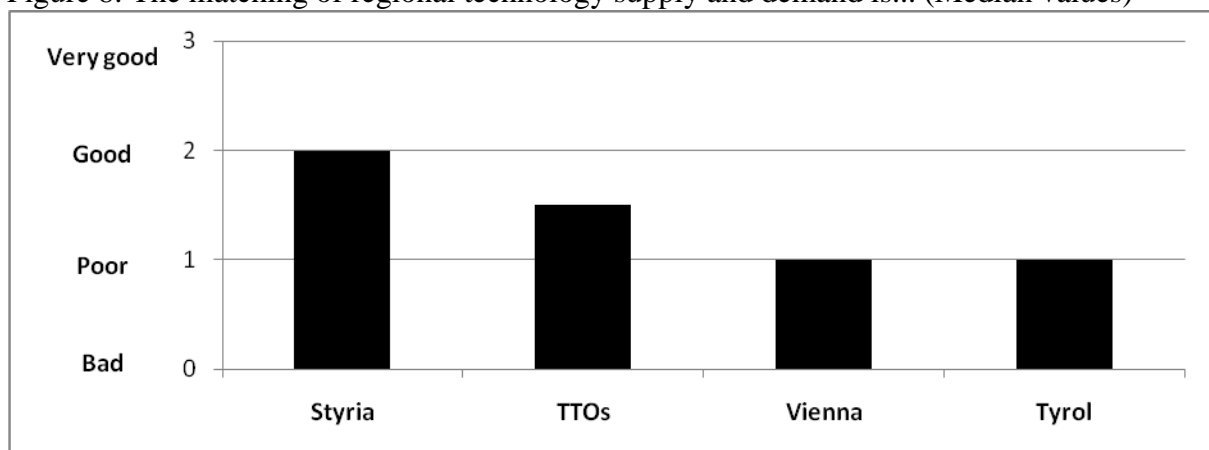
Figure 7: TTO mediated cluster-university linkages (mean values)



However, the mean values in figure 7 may underestimate the actual contribution of TTOs to cluster development. Some qualitative examples complement the picture. The most active TTO in the support of clusters is the Industrial Liaison Office of the Montan University Leoben. It has been the promoter and the provider for a regional cluster based on material technology. It is not surprising that this cluster fits the knowledge produced at the university very well. A further example may be given by the comparison of the TTOs of the Medical University of Vienna and the Medical University of Graz and their linkages with the human technology cluster in Styria and the life-science cluster in Vienna, respectively. The Styrian TTO is a shareholder of the human technology cluster and the interviewed TTO officer is well integrated into the social network surrounding cluster activities. The support of the cluster figures is high on the agenda of the TTO activities. In opposition to this, the TTO of the Medical University of Vienna does not have any contact with the life-science cluster and the aim to support the cluster is irrelevant. Since the fit between the university knowledge and the regional cluster is more or less equal in the two regions, the differences have to be explained by other factors (see below).

FROMHOLD-EISEBITH and SCHARTINGER (2002) convincingly argue that KT outcomes have to be evaluated against the background of several indicators. One indicator of crucial importance for the assessment of UIL in RISs concerns the matching of university produced knowledge and regional knowledge demand or firms' receptiveness. However, an encompassing empirical estimation of this relationship might be very complex. Yet, what also counts as actual KT activities of TTOs is not so much the objective matching as a result from the analysis of university structure and industry structure, but rather, the perceived matching between regional technology supply and demand. Figure 8 shows that there are remarkable disparities between the regions.

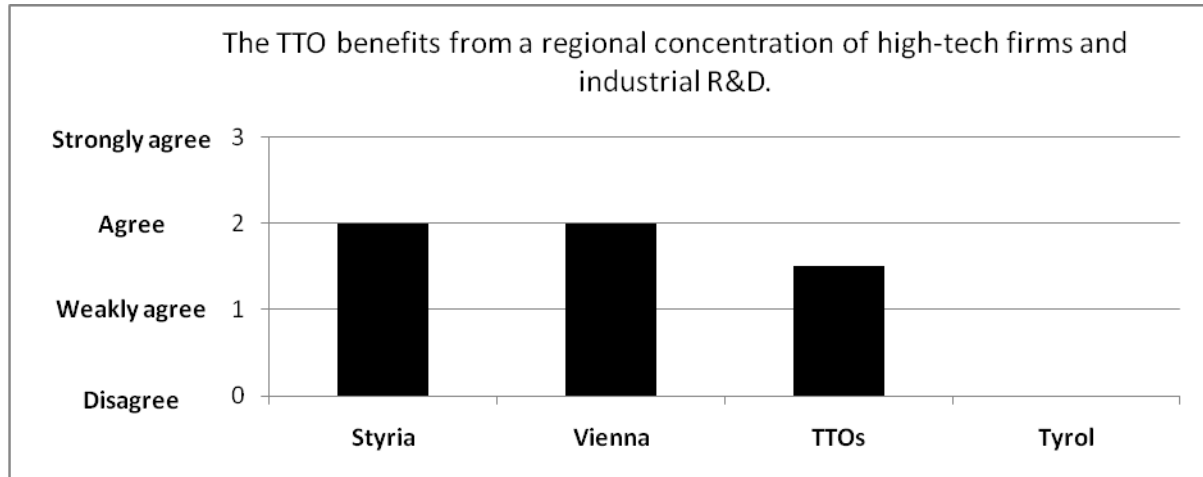
Figure 8: The matching of regional technology supply and demand is... (Median values)



Contrary to what might be expected from the regional indicators presented in table 2, Viennese TTOs perceive the regional matching of university produced technology supply and demand as poor. More in line with the indicators is the result for Tyrol, and perhaps a somewhat surprising result is the “good” matching in Styria. Whereas Styria has a matching quality above the average of the 14 TTOs, the respective median values are below the average for Vienna and Tyrol. However, this result should be interpreted carefully because Viennese TTOs also responded that they benefit from a regional concentration of high-tech firms and industrial R&D (Figure 9). On the contrary, all three TTOs in Tyrol stated that there is no benefit for their KT activities emanating from a regional high-tech industry. The

implications of these results for the spatial-profile of the TTO activities in the different regions as well as an explanation are provided in the following final chapter.

Figure 9: TTO views on the advantages for KT activities arising from the regional business sector



7 Discussion and policy implications

Two research questions were asked: What is the potential influence of TTOs to contribute to regional development, especially the development of regional clusters? How does regional policy and regional economic context influence the spatial range of TTO activities? On the whole, the empirical results show that TTOs perform very differently in the three investigated regions. TTOs in Vienna are relatively weakly oriented to and connected with the regional business environment. The opposite holds true for the TTOs in Styria and Tyrol. And by comparing these patterns with the regional economic context, which is an important variable for explaining regional KT from university to the business sector, the results shed light on very diverse patterns of collaboration shaped by additional factors than the demand by the industry.

Styria seems to provide the clearest case. The TTOs are heavily engaged in the RIS due to: policy actions that support the regional orientation of the TTOs; very good matching between university knowledge production and industry demand; and universities' strong regional mission. Hence, the activities of the TTOs contribute to, and reflect, the already dense-networked RIS.

A comparison of Styria and Tyrol reveals very similar spatial orientation with a strong focus towards supporting the regional firms and connecting them with the university, but under very different regional contexts. The receptiveness of the regional business sector in Tyrol is by far the worst among the three investigated regions. A TTO manager mentioned that the university lack the institutes of relevance for traditional industries with a synthetic knowledge base such as engineering. Furthermore, even the business sector is characterized by a rather low level of technology compared to Styria. Taking this into account, the concentration of the TTOs on regional KT-activities appears to be somewhat problematic, at least from the viewpoint of national efficiency and from the perspective of a university policy that tries to maximize income and reputation from transferring cutting-edge knowledge to the business sector. Contrary to the case of Styria, the main drivers behind this orientation are regional policy initiatives and a regional oriented university mission.

In sum, comparing Vienna with Styria delivers similar results as the study from FROMHOLD-EISEBITH and SCHARTINGER (2002). Despite a relatively encompassing endowment with high-tech industries in Vienna, the TTOs at the universities in Vienna are comparatively weakly oriented towards the own region. One explanation for this might be a disadvantage in knowledge-matching as reported by TTO officers. In addition, Viennese universities might perceive themselves as universities for Austria or Europe and not for Vienna, a judgement stated by several TTO officers. Furthermore, there might also be a general lack of attention on the part of the regional policy makers regarding the connection of universities with regional firms. For example, a TTO officer stated that he tried to get some support from regional agencies for regional KT activities but they were not interested in it. More, the only regional program for TTOs that supports the consultancy of Viennese firms by the Technical University, is based on the concept of a passive TTO. Additionally, there seems to be the problem of how to create “order from noise”: Nearly every TTO manager in Vienna mentioned that there are such a lot of institutions that there is no need to contribute in a specific way to regional development goals. All this would not be a problem for the economic development of Vienna if the RIS functioned in an effective manner. Alas, this is not the case. TÖDTLING and TRIPPL (2009) assert that the RIS of Vienna suffers of fragmentation between the various elements of the innovation system. Enhancing the interaction between industry and universities might be an important strategy for the regional innovation policy. In conclusion, judging the TTO activities against this background, shows that they mirror and reproduce the fragmentation of the RIS. Hence, they are evidently ineffective agents for impelling regional economic growth by improving the knowledge linkages of the Viennese RIS.

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