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ljimenez@jotmi.org

Universidad Alberto Hurtado
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Closs, Lisiane; Cardozo Ferreira, Gabriela; Freitas Soria, Alessandra; Hoffmann Sampaio, Claudio;
Perin, Marcelo
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Organizational Factors that Affect the University-Industry Technology Transfer Processes of a Private University

Lisiane Closs¹, Gabriela Cardozo Ferreira², Alessandra Freitas Soria³, Claudio Hoffmann Sampaio⁴,
Marcelo Perin⁵

Abstract

This case study researched organizational factors that affect the university-industry technology transfer (UITT) processes of a private university, chosen by its success and uniqueness in the Brazilian context. Stood out as factors: innovation among pillars of management; valuing of research and intellectual property; qualified students, teachers and managers; multidisciplinary research groups; stability of governing body; performance of the TTO, Technology Management Agency and Technology Park. Difficulties highlighted were: reconciliation of time between activities of professors-researchers, bureaucracy and centralization of administrative and legal support; valuation of research results; approach and negotiation with companies. Among suggestions are: granting greater independence to the structures in charge of UITT and making them self-sustainable; training agents in technology marketing, sale, and negotiation skills.

Keywords: Technology transfer; university-industry; organizational factors; private university.

^{1,2,3,4,5} Faculdade de Administração, Contabilidade e Economia - Pontifícia Universidade Católica do Rio Grande do Sul. Address: Avenida Ipiranga, 6681, Partenon - Porto Alegre - RS - Brasil - ZipCode: 90619-900 - Phone: +55 51 3320 3547 / Fax: + 55 51 3320 3624
E-mail: lcloss@terra.com.br; gcferreira@pucrs.br; alessandra.soria@pucrs.br; csampaio@pucrs.br; mperin@pucrs.br

Introduction

Creating an environment conducive to innovation and the generation and dissemination of knowledge, essential for society's development, requires joint efforts by universities, the government, and companies. To that end, to their traditional role of generating and disseminating information, universities must add the ability to foster innovation via the transfer of technologies obtained from academic research enabling companies to manufacture innovating products carrying commercial potential. The government helps by coordinating, encouraging and supporting such relationships, performing the role of catalyst (Etzkowitz and Leydesdorff, 2000).

In such backdrop, it becomes increasingly important to understand the process of university-industry technology transfer (UITT), which represents a source of academic research resources, innovation and competitive advantages for companies, and economic development for governments (Muscio, 2010; Leydesdorff and Meyer, 2003). UITT is understood as the manner through which the knowledge developed by universities based on scientific research is transferred to one or more companies so that it may have commercial applications and benefit the public, by means of a formal mechanism that protects and licenses intellectual property (Young, 2006).

Considering that each university's organizational aspects decisively impact the UITT, to analyze such process we need to understand the context in which it takes place (Bercovitz and Feldman, 2008). Some of the factors impacting UITT performance include the policies, the institutional characteristics, and the intermediaries involved in managing this process at the universities (Landry et al., 2010; Caldera and Debande, 2010). However, few studies have been carried out on the topic in developing countries (Póvoa, 2008), especially in Brazil, looking into private universities (Closs et al., 2012).

Given the context and the theory gaps presented, the purpose of this study was to look into the organizational agents in the UITT process at a private university in southern Brazil. The institution chosen is renowned as an enterprising, innovative university in Brazil, having been

presented with the FINEP (Brazilian Financing Agency for Studies and Projects) Innovation Award in the Science and Technology Institution category – first place in the South in 2008, and a National Honorable Distinction that same year. Such choice was also motivated by the high regard the school has for research and technology transfer, an atypical case among Brazilian private universities.

This study is divided in six sections. Section two provides a review of the literature addressing UITT in the university context and the organizational factors that affect this process, section three describes the methodological procedures adopted; section four introduces the university studied; section five provides the analysis and study results; finally, this paper's concluding remarks.

Technology Transfer in the University Context

The primary UITT goal is to make it easier for academic research findings to get from the lab to the market in order to benefit the public (Berneman and Denis, 1998). According to the Association of University Technology Managers (AUTM)¹, there are four main purposes to academic technology transfer: a) facilitate the commercialization of research results for the public good; b) reward, retain and recruit academic talent; c) foster closer relationships with the manufacturing industry; d) generate revenue and foster economic growth.

UITT is inserted in the context of innovation management at universities, and it is important to analyze the organizational factors that affect its various forms and results (Caldera and Debande, 2010). At institutions that adopt a technology transfer (TT) concept based especially on the commercialization of intangible assets, institutional mechanisms called technology transfer offices (TTO) have been set up to perform the activity. TTOs can be seen as [...] organizations or parts of an organization that help public research organizations to identify and manage their intellectual assets, including the protection of intellectual property and transferring or licensing its rights to third parties aiming at further development (OECD, 2003,

¹ http://www.autm.net/Tech_Transfer.htm/ Access in May, 2011

p. 80). The particularity observed in that concept is that the focus of TTOs' work is intellectual property (IP) and all the activities deriving from identifying, protecting and commercially using it, activities which encompass from R&D projects funded by companies to patent licensing. Concepts such as the one mentioned above characterize most of the foreign TTOs. Although their precise name changes from university to university, they are all in charge of patenting inventions, licensing such patents to third parties, and even patent-free licensing (know-how transfers).

According to Siegel et al. (2004), the UITT process may encompass a series of stages, including: 1) scientific discovery; 2) scientists' disclosure of the invention to the TTO (or via commercialization and informal TT); 3) evaluation of invention for patenting by the TTO; 4) patent filing by the TTO (in case of a favorable evaluation), involving the scientists; 5) technology marketing/offer by the scientists and TTO to companies or entrepreneurs; 6) negotiation of license; 7) formal (or informal) commercialization.

At some universities, the role performed by the TTO is not restricted to activities related to IP management. That is what we have been observing in the Brazilian experience, where the scope of the office's activities usually comprises from project and consulting management all the way up to selling technologies and patents (Terra, 2001).

Although in Brazil the formal IP and TT management is becoming increasingly more important in the academia (Guarnica and Torkomian, 2009), one of the problems the country faces is the lack of legislation standardizing TTO operations. National policies encouraging university-industry (U-I) cooperation are recent and there is a wide variety of procedures and criteria for defining forms of licensing and to set prices or royalties (Santos and Solleiro, 2006; Fujino and Stal, 2007).

Aspects connected to the UITT process management impact its performance as well, and will be looked into in the next section.

Factors that Affect the UITT Process

The main UITT performance determining factors include the following aspects, which are interconnected: university policies, involving the strategy to foster research and TT, besides clear rules and procedures to disseminate information and advance cultural changes in that regard (Caldera and Debande, 2010; Amadei and Torkomian, 2009); university characteristics, including size, private nature (in the case of the US), research quality, and existence of biomedical and engineering programs (Baldini, 2006; Caldera and Debande, 2010); and intermediaries in this process, including TTOs and technology parks (Guarnica and Torkomian, 2009; Santana and Porto, 2009).

With respect to academic policies, universities that have their own patenting rules show researchers they are committed to fostering cultural change, developing an entrepreneurial environment, and legitimizing the activity (Baldini et al., 2007). However, the governmental policies that evaluate universities and advance academic research in Brazil, and which influence the policies of such universities, still tend to attribute greater value to scientific publications than to the generation of patents by researchers (Amadei and Torkomian, 2009; Corrêa, 2007).

According to Caldera and Debande (2010), rules addressing conflicts of interest between the faculty's teaching responsibilities and outside activities positively and significantly affect a university's performance in R&D and licensing agreements. In Brazil, there are cases where invention reports take a long time to be submitted, when they are submitted at all, because of the teachers' activity overload associated to the lack of rules in that regard (Santana and Porto, 2009).

In Brazil, researchers have mentioned the lack of information on what to do to patent an invention and the need to adapt the language of their finding to the standards for writing the patent application with INPI (Instituto Nacional de Propriedade Intelectual – National Intellectual Property Institute) (Corrêa, 2007). Additionally, partnerships with companies remain underappreciated by faculty, which is a widespread aspect of the Brazilian academic culture that makes it harder to adopt technology licensing and commercialization policies (Fujino and Stal, 2007).

The university bureaucracy and inflexibility equally stand as barriers in this process, causing dissatisfactions that keep researchers and company staff away from the TTOs and leading them to set up informal and consulting relationships (Siegel et al., 2004). Much like abroad, the administrative bureaucracy, the slow-moving legal-administrative departments, and the difficulty in establishing a royalty percentage to be paid to universities, combined with the stiff regulations imposed by the Brazilian governmental agencies, at times exclude universities from the formal TT process and from sharing their results (Santana and Porto, 2009).

As for the universities' institutional characteristics, research quality is a vital element for universities to generate TT opportunities. Production of high-level research is influenced by the university's ability to recruit and retain qualified researchers working at the forefront of worldwide science progress, which is essential for innovating thinking (Park and Lee, 2011; Querido, Lage and Vasconcellos, 2011) and requires academic policies designed to achieve this goal.

Caldera and Debande (2010) highlight there is a higher number of patent and license registrations to universities that run engineering and biomedical schools. The authors also emphasize researchers respond better to financial incentives and the existence of more effective TTOs in private universities, which is likely due to their business orientation. In Brazil, most academic researchers are connected to public universities (Closs et al., 2012).

UITT intermediaries, including the TTOs, are essential for the success of this process (Querido, Lage and Vasconcellos, 2011; Guarnica and Torkomian, 2009). TTOs depend on information from researchers about their marketable findings; however, in many instances that fails to occur because researchers are unable to see such potential (Dalmarco et al., 2011). In other cases, researchers are simply unwilling to get involved in licensing for lack of interest, because they think working with the TTO is difficult, or because they do not want to share their earnings with the university (Thursby, Fuller and Thursby, 2009), therefore standing as barriers to the UITT.

One of the most important factors for the TTOs' level of participation in research, TT, and relationships with the manufacturing industry is the university's enterprising culture, highly influenced by the institution's Rector's

or senior management's attitude and level of support (Querido, Lage and Vasconcellos, 2011; Young, 2006). Some of the conditions for a TTO's good performance include its institutional independence and the experience of its team (Rahal, 2008). In Brazil, we see a lack of independence and infrastructure suitable to the operations of university TTOs which are usually in-house departments staffed by people who are underpaid and do not get royalties that would encourage them to make TT viable (Fujino and Stal, 2007).

Larger, more experienced TTOs are able to get more research contracts (Caldera and Debande, 2010; Rahal, 2008). Segatto-Mendes and Mendes (2006) showed how important TTO support is for patenting and commercializing technologies in Brazil, as they help solve bureaucratic issues. However, as we see in the country, such understaffed offices are likely to delay the patenting process (Santana and Porto, 2009).

Worldwide, researchers and companies have shown to be dissatisfied with the marketing and negotiation skills of TTO teams (Siegel et al., 2004). Selling IP can prove be difficult because new technologies usually cannot be consumed directly, are valuable to few organizations, and solely when applied. Besides, it is hard for a potential buyer to assess their worth in an embryonic stage, before studying, testing and adopting them (Rahal, 2008; Elfenbein, 2007).

According to Póvoa (2008), UITT efficacy requires deep knowledge of the technical field and its applications, as well as negotiating skills to draw up complex agreements with manufacturers. The author notes that such competencies are rare among Brazilian university administrators, though. There is also a gap between the goals of marketing policies and their actions, which pay little attention to the market's needs in the country.

Castro, Jannuzzi and Mattos (2007) highlight positive aspects of the work done by the UNICAMP TTO, considered a role model in Brazil: hiring offices specializing in trademarks and patents; patents bank available on its Internet page; its members' combined expertise; negotiation and business management practices that take self-sustainability and achievement of goals and results into account; proactive work in collaboration with researchers; and the team's blend of academic and business experience.

Fujino and Stal (2007) suggest the following to improve Brazilian TTO performance: a) work alongside governmental agencies by providing them with technical assistance, taking part in discussions and demanding changes to the legislation so as to facilitate their partnership with companies; b) suggest internal university changes, TT guidelines, and incentives for the researchers and staff involved; c) make administrative/operating structures more capable and agile; d) train people to negotiate and sell technologies, have a highly skilled team specialized in their roles, invest in awareness-raising and valorization of TT activities; e) expand the technology flow into companies by fostering joint projects; f) promote a positive image of the university to win over business leaders and play up the value of academic research; g) encourage the creation and expansion of technology-based incubators and spin-offs; h) set up policies that foster partnerships with small innovating companies; i) prepare handbooks containing: criteria to identify the potential of licensed products, including licensing forms and agreement templates; methods for market study, technology valuation, and negotiators guidance.

University technology parks are considered important UITT intermediaries (Caldera and Debande, 2010). Playing the role of incubators, they lower the costs related to converting scientific findings into products or processes, and help sell them. The spatial proximity provided by parks located at universities makes it easier to transfer tacit knowledge between researchers and company staff, thus positively impacting the invention's commercial success (Agrawal, Kapur and Mchale, 2008). Furthermore, the local concentration of high-tech companies helps play up the value of academic research (Caldera and Debande, 2010).

Business incubators are equally conducive to U-I cooperation (Lahorgue, 2004). Connected to universities, the incubators benefit by leveraging the knowledge and technologies generated at such institutions and transferring them to their products and services. Their spatial proximity to university labs creates an important environment for innovation, thus showing the relevant role played by the incubated companies in U-I interactions in Brazil (Santos and Solleiro, 2006).

It should be noted that UITT is greatly advanced by converging actions carried out by university support structures, such as TTOs, incubators and technology parks (Lahorgue, 2004).

Methodological Procedures

The research approach adopted in this study is qualitative and of an exploratory nature, which allows us to develop, clarify, and change concepts and ideas. The method used to look into the organizational factors that affect UITT processes in the case of Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS) was the case study. It is an extreme case (Yin, 2005) involving a private university regarded as a national benchmark in research and TT, an exception among the country's private universities, usually focused solely on teaching. To meet the research goals, besides reviewing the literature we went over the university's documents, website and statutes. In addition, we interviewed members of the university and combined several sources of information to increase the reliability of results (Godoy, 2005).

We interviewed the TTO and Rede INOVAPUC managers; the Technology Management Agency director; an IP valuation and negotiation consultant; and seven researchers selected for their academic relevance and experience in the process. The researchers interviewed, who were nominated by the managers, have patent applications filed with the PUCRS TTO in the fields of Health and/or Chemistry and Biology, which together represent 61% of the university's total applications. The fields of work and number of patents requested by each researcher are described in Chart 1.

RESEARCHERS	FIELDS OF WORK	PATENTS
1	Cellular and Molecular Biology	2
2	Cellular and Molecular Biology	7
3	Aerospace Pharmacy	3
4	Cellular and Molecular Immunology	3
5	Biochemistry	2
6	Space human physiology and space biomedical engineering	6
7	Cellular and Molecular Biology, Medicine and Health Sciences	4

Chart 1. Fields of Work and Number of Patents Requested by the Researchers Interviewed

The data were collected by means of semi-structured interviews designed based on literature review. Preliminary contacts with the field assured the researchers the survey questions were suitable to the social reality of those researched (Godoy, 2005).

The interviews were recorded and later transcribed. The data were analyzed by means of content analysis. So that the answers could be better analyzed, the data were grouped into large categories defined beforehand and encompassing the policies, the university characteristics, and the UITT process intermediaries, which categories are underscored as decisive for UITT performance (Guarnica and Torkomian, 2009; Baldini, 2006).

Results: University Overview

The university studied believes innovation is a strategic process that comprises searching for, discovering, testing, developing and adopting new products, processes or organizational techniques capable of adding value to organizations. In 2006 the university set up Rede INOVAPUC, whose purpose is to foster the innovation and entrepreneurship process at the university.

INOVAPUC coordinates the players in the Academic Center made up of the Academic Units, Research Institutes, and the research department at its Science and Technology Museum (MCT), university units where scientific and technology research is carried out, and

the Peripheral Units, which are university mechanisms, dedicated to the interaction with society, especially with industry and various government spheres. Some of the Peripheral Units are the Technology Management Agency (AGT), Technology Transfer Office (TTO), Multi-industry Business Incubator (RAIAR), and the Science and Technology Park (TECNOPUC).

AGT was created in 1999 and focuses mainly on fostering the production of knowledge oriented to integration with society, and works as a facilitator of the U-I relationship. This Agency manages the university's Research, Development and Innovation (RD&I) projects.

The TTO is meant to establish and promote the university's IP and TT policies, besides implementing and disseminating the procedures required to protect the IP obtained from the results of research carried out at the university's various units, as well as those related to TT by means of the sale of assets, whether protected or not, belonging to the university. According to the internal resolution that sets forth the University's IP and TT Policy guidelines, all researchers must inform the TTO about their research findings whose IP could potentially be protected and transferred to society. The TTO provides support for the entire TT protection and negotiation process.

With respect to IP registration activities, TTO roles include evaluating the invention, starting by identifying the need for it, searching patent bases, and analyzing its

technical and economic viability. In the case of patents, it is supposed to ensure they are properly registered with the relevant agencies in Brazil and abroad. After filing the applications with the agencies in charge, the TTO monitors the processes to ensure proper compliance with payment deadlines and the other obligations of the university as the intangible assets' owner.

Regarding R&D carried out in collaboration with companies, the TTO's role is to take part in project negotiations, specifically those dealing with IP and confidentiality, so as to ensure the university's rights are protected. As the department promoting activities dedicated to disseminating the culture and importance of IP within the university and among companies, the TTO holds courses, seminars, workshops, and other extension activities. By so doing, the TTO seeks to train people working inside and outside the university in the specific fields related to TT and IP management.

The purposes of the university's Science and Technology Park – TECNOPUC – is to attract companies dedicated to research, development and innovation to set up partnerships with PUCRS; foster the creation and development of new technology companies; attract research and technology development companies; advance U-I interaction; generate a positive synergy between the academia and businesses; and work in a coordinated fashion with governmental spheres.

RAIAR is the university's technology business incubator set up at TECNOPUC in order to foster the development of companies dedicated to a variety of industries, especially technology. Additionally, it seeks to encourage the university's students' enterprising skills and enable the development of business networks by facilitating the operations of new companies.

Main Organizational Agents in the UITT Process

PUCRS university policies include entrepreneurship and innovation among the university's management pillars, written into its statutes, and significantly help create an academic environment conducive to UITT (Santos and Solleiro, 2006; Querido, Lage and Vasconcellos, 2011). This environment is extolled by the interviewees. The importance of university policies has also been emphasized in European countries which, like Brazil, seek to improve their performance in this process (Caldera and Debande, 2010; Baldini et al., 2007). According to the university's TTO manager

PUCRS is one of a handful of Brazilian universities whose statutes and regulations address IP protection [...] expressing the will of that group that approved those regulations, those statutes. That is now embedded in PUCRS' university policies, and without a doubt is the greatest facilitator.

Such inclusion of IP protection into the university's statutes shows the school's concern for that aspect which, according to Baldini et al. (2007), helps foster a cultural change and legitimize this activity. Unlike what takes place in most Brazilian public and private universities (Fujino and Stal, 2007), this university clearly has a high regard for research, IP and UITT, and provides incentives and actual support for researchers to generate patents.

However, researchers have had a hard time organizing their time around research, patenting processes and teaching, difficulty also discussed by Santana and Porto (2009). Nevertheless, in the rare cases where the university's professors take part in spin-off companies, their teaching performance has not suffered at all, according to the AGT manager. As pointed out by Landry et al. (2010), there are complementarities between patenting activities, spin-off formation, consulting and publications, but teaching and publication activities are substitute for each other.

The Rede INOVAPUC manager says that the number of researchers taking part in innovation-oriented processes is still small, considering the potential for using the research results generated by the university. Silva (2007) suggests that UITT should be controlled and institutionalized by universities so that some teachers may dedicate themselves further to this process for a

while, and then reassume their regular activities later on. Caldera and Debande (2010) advocate there should be rules for handling such conflicts of interest in order to advance UITT performance.

The time and high costs to register and maintain patents (Zawislak and Dalmarco, 2011) have also compromised UITT, and so has the need to adapt the language of the finding to the standards for writing the patent application with INPI, which aspects are corroborated by Corrêa (2007).

Although assimilated into the minds of its managers, the fact that UITT is something very new at PUCRS makes it hard to run it smoothly, according to the TTO and Rede INOVAPUC managers. Most university departments have yet to fully grasp this process, which demands training for key university personnel such as the legal department members.

UITT requires the creation of new procedures; its needs require greater speed and carry specific features unlike those in the university's conventional processes. However, the university's administrative and legal support framework is bureaucratic and centralizing, which makes the flow of UITT-related processes difficult and slow. To make this process easier, some authors say TTOs should be granted independence within the university (Fujino and Stal, 2007) and a financial self-sustainability system (Castro, Jannuzzi and Mattos, 2007).

The importance of complying with university guidelines focused on entrepreneurship and innovation was highlighted by researcher 2. To follow them, this researcher attended courses provided by the university at the Business School and adjusted his work to fulfill such purposes. The interviewees talked about a cultural change that has been taking place at the university as it fosters UITT under the encouragement provided by the senior management, an important support for the process (Young, 2006).

Nevertheless, some of the interviewees mentioned barriers related to the academic culture, which largely still views applied science as "second rate"; values publications but not patents; and knows very little or is misguided about the patenting process, as observed by Corrêa (2007). According to the TTO manager, the IP system is still seen by some people as a threat to academic practices.

To break down such resistance, the TTO has been working to explain and disseminate the importance of permanently protecting IP by means of unit directors, graduate program coordinators, and research chambers. They also hold lectures in undergraduate programs and IP courses have been added to graduate programs. However, the news that a company had provided a researcher with funds for technology licensing was the best way to disseminate UITT, according to such researcher and the TTO manager, as it motivates other researchers to follow this path.

Researcher 4 summarized a few obstacles standing in the way of UITT due to the lack of communication and information, as well as to how companies behave, as they are usually averse to risks: In Brazil, we have no idea what companies need and companies have no idea what we are capable of doing. [Industries] have not been investing in patents, they are unaware of the university's potential, and universities have very talented people in their staff. [...] there is no risk-taking tradition in Brazil.

On the other hand, some researchers worry that placing an excessive value on the commercial aspects of applied science may restrict the generation of new ideas. However, Brazilian research group leaders have reported academic gains from nearly all their UITT relationships, which show the academia is not moving away from its main focus in favor of economic gains (Póvoa, 2008). Thursby and Thursby (2011) see an increase in the number of patented inventions licensed associated more to a growing inclination by teachers to register patents and by companies to outsource R&D activities through licensing, than to the trend of research shifting from basic to applied.

Chart 2 summarizes the literature review and this study's main results regarding the university's policies.

Aspect	Agent	World	Brazil	University studied
University Policies	University rules on patenting	Legitimize UITT and impact performance.	Greater valorization for publications	Defined for patenting, absent for balancing out teaching, research and UITT activities.
	Culture and Information	Cultural barriers, lack of information; lack of interest.	Lack of UITT information, underappreciated partnerships with companies.	Culture fosters innovation and entrepreneurship, encourages IP, research and UITT, support from management. Barriers: academic culture, information, U-I communication.
	Processes	Bureaucracy and inflexibility.	Bureaucracy and slow legal-administrative processes.	Bureaucratic, centralized administrative and legal support; lack of TTO independence.

Chart 2. University UITT policies

Research quality (Park and Lee, 2011) and the existence of biomedical schools (Caldera and Debande, 2010), which in this university represent the fields with the highest number of patent applications, are factors that influence UITT. The response to financial incentives and the existence of more effective TTOs in private universities are also highlighted by the same authors.

Because it is a private university, this institution enjoys management continuity, unlike the lack thereof seen in public universities whose strategies suffer interferences. Researcher 2 further emphasized the different attitudes displayed by public and private university scientists. At the latter, such as PUCRS, researchers are under greater pressure to adhere to the university's policies and goals. The researchers also mentioned the knowledge built by consolidated research groups. The integration of viewpoints from different departments in multidisciplinary research groups has been conducive to the generation of new knowledge leading to patents. The access to information, especially that available in international academic bases – the main initial source of research, lab

structure, and the university's dedication to attracting high quality teachers and students have been highly extolled by the researchers. Chart 3 summarizes the results connected to PUCRS' characteristics.

Aspect	Agent	World	Brazil	University studied
University characteristics	Research quality	Generates UITT; encompasses attracting and retaining researchers.	-	Efforts to attract qualified researchers and students
	Departments	Engineering and biomedical.	-	Biomedical schools; multidisciplinary groups
	Sector	Private: response to incentives, more effective TTOs.	Public: stronger research.	Private: need to raise funds, management continuity.

Chart 3. PUCRS' UITT-related characteristics

With respect to UITT agents, the researchers highly extolled specific structures like the TTO, for its support to patenting processes, and AGT, for its help in drawing up and managing contracts, in addition to the support of the outside consultants hired.

According to the consultant interviewed, the university managed to enlist one of the leading Brazilian IP advocates to coordinate its TTO, a possible decisive factor for the latter's success (Rahal, 2008; Young, 2006). The university's TTO is capable of performing all types of technology transfers, although it has not done so via spin-offs yet. To do that, the TTO manager has suggested setting a legal guideline to induce such transfers, a standpoint corroborated by Baldini et al. (2007).

There is a gap in terms of selling academic technologies, as pointed out by researcher 6: "the TTO does the paperwork, we do the development. Then we need to sell it; we need to create the effort." The Rede INOVAPUC manager also points out this same TTO need:

The TTO today – even for the time it has been around, a matter of going through stages – is primarily dedicated to protection [...] it is basically a source of costs for the university because patents need to be maintained, they need to be paid for. And the TTO should be a source of new funds for research.

The TTO manager mentioned actions developed in that regard: keeping a portfolio of technologies available

for licensing on the website; handing out technology catalogs to company R&D managers; taking part in fairs to get closer to companies; advertising on the university's communication outlets; actions by researchers, who know the companies working in their fields of research and therefore represent one of the main points of contact for companies. Such actions have drawn the interest of companies, especially regarding technologies at an advanced stage of development.

The TTO manager credits some of the difficulty in advertising the technologies to the concern for keeping their confidential aspects secret. The AGT manager highlighted the need to create a channel that identifies the competencies developed by university researchers, based on a view of the market. Such reading would make it possible to raise funds to foster projects capable of generating spin-offs that can be made viable by means of the university's incubator, a practice he says should be regulated.

Besides the difficulty in identifying and approaching business partners, most of the interviewees reported having trouble valuing research results and negotiating their licenses/patents with companies. Unsuccessful negotiations are likely to frustrate teachers and discourage new UITT attempts, a risk that can be lowered by having educated negotiators with well defined degree of autonomy. To do that, the TTO has hired a specialized company, although that makes the process less agile than it would be had they had such expertise internally.

According to the consultant interviewed, Brazil lacks skilled people to manage intangible academic assets, a problem also found in more developed markets (Siegel et al., 2004; Elfenbein, 2007). Such management involves not only patents, which do not seem to be the first option when protecting new technologies in Brazil (Zawislak and Dalmarco, 2011), but also the transfer of know-how and other information that may not be necessarily patentable or sellable. Advertising that an academic invention capable of benefiting society has been licensed, for instance, may help boost the university's image and add value to the institution. As stated by the TTO manager, showing the social relevance of research developed by the university is the major goal of TT, more important than obtaining economic gains.

Researchers get a financial incentive in the amount of one third of the gains obtained from the sale of technologies, but the consultant interviewed pointed out a lack of staff, resources, valorization and motivation for the TTO team, who carry out this process. Rapini and Righi (2006) suggest that UITT profits should be shared among researchers and support staff.

The location of the university's technology park, TECNO-PUC, at the university campus, has created an unparalleled environment of innovation for its implementation, as it brings industry and academic researchers closer together. Interacting with firms is especially relevant because technology development requires great tacit knowledge from researchers (Agrawal, Kapur and McHale, 2008). The visibility, the external recognition, and the resources generated via the interaction with industry set up there benefit researchers and their units, advancing UITT at PUCRS. A prerequisite for companies to operate in that science and technology park is that they have some sort of interaction with the university, whose main purpose is to encourage research by means of collaboration with companies and other institutions.

The RAIAR Business Incubator helps turn research results into innovation. However, the Rede INOVAPUC manager points out the need to improve that mechanism in order to make the most of the research results produced at the university. That could be achieved by integrating the RAIAR TTO work to create highly innovative companies. Chart 4 summarizes the results related to UITT intermediaries.

Aspect	Agent	World	Brazil	University studied
Intermediaries	TTOs	Culture and management support; independence and experience; lack of business skills.	Lack of independence and infrastructure; solve bureaucratic issues; work role model: Unicamp TTO.	Work importance recognized, problems: valuing research results, approaching and negotiating with companies.
				AGT: experience in project design and management
	Technology Parks	U-I cooperation; research; sale and transfer of tacit knowledge.		Brings researchers and industry together; fosters innovation.
	Incubators	University-industry cooperation.	Spatial proximity creates an environment of innovation.	Innovation potential; lack of development.

Chart 4. UITT agents

Concluding Remarks

In PUCRS' case, we see that the main organizational factors that affect UITT are similar to those found in other Brazilian and international universities. That is possibly due to the fact that universities from many countries mimetically duplicate the pioneering model created by the US (Golish, Besterfield-Sacre and Shuman, 2008), which creates similar hardships and advantages in different contexts. Systematizing such data is one of this paper's contributions to the theory.

The literature review and the research carried out point to the need of setting clear academic policies for the university's relationship with firms (Fujino and Stal, 2007; Costa and Torkomian, 2008). Such policies should include incentives that foster such relationship, such as sharing TT profits among researchers and support staff (Rapini and Righi, 2006).

An important suggestion for improving UITT is to create mechanisms that systematize the prospection of all technologies developed by universities so as to identify and evaluate those capable of generating innovation. We also suggest setting up channels to contact companies and clear procedures for attracting investors and fostering UITT via the creation of new companies.

Some of the UITT hindrances we found include: valuing research results and identifying, contacting, and negotiating with business partners. To overcome such professional needs, which are found in companies as well, we recommend that universities develop courses that train agents to work in the fields of technology marketing, sale, and negotiation.

To implement university-industry contacts, we suggest holding business rounds that bring together manufacturers and researchers whose market expertise and research results are essential for UITT. Considering the contribution provided by researchers in all phases from advertising to selling inventions (Thursby, Fuller and Thursby, 2009), we recommend including them in training programs that develop their relationship and business skills. We also suggest that universities set up institutional structures and mechanisms making it possible for researchers to better balance out the time they dedicate to UITT and their other activities.

To deal with the bureaucracy and centralization of the university's administrative and legal support, we suggest granting greater independence to the structures in charge of UITT and binding them to the generation of results, thereby making them self-sustainable. We further recommend disseminating information and the strategic importance of IP and UITT to the support departments, in order to streamline the inside work flow and the creation of new procedures, when need be.

One of this study's limitations was the impossibility to interview other agents and representatives from companies involved in this university's UITT processes due to time constraints for carrying out our research. Therefore, to consolidate the results obtained in this study, we suggest surveying other players connected to the process and other Brazilian universities, especially private ones, where there is a greater need for empirical studies.

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