VI SINGEP
ISSN: 2317-8302
Simpósio Internacional de Gestão de Projetos, Inovação e Sustentabilidade
International Symposium on Project Management, Innovation and Sustainability
V ELBE
Encontro Luso-Brasileiro de Estratégia
Iberoamerican Meeting on Strategic Management

Knowledge flow in University-Industry Relations: an analysis of established companies at Tecnopuc

GUSTAVO DALMARCO
Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS)
gustavo.dalmarco@pucrs.br

LISILENE MELLO DA SILVEIRA
Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS)
lisilene.silveira@hotmail.com

A segunda autora agradece o apoio á CAPES.

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Resumo

O objetivo deste estudo é analisar o fluxo de conhecimento em projetos conjuntos entre universidades e empresas localizadas em um parque tecnológico - um ambiente favorável a este tipo de interação. Além disso, os níveis de maturidade tecnológica foram examinados através do TRL (Nível de Preparação Tecnológica) para posterior análise de projetos estudados e seu nível de tecnologia. O método de pesquisa adotado foi o estudo de caso único, em que sete casos realizaram projetos conjuntos. Além de técnicas de observação e análise documental, foram realizadas entrevistas semiestruturadas com pesquisadores universitários responsáveis pelos projetos conjuntos e diretores de pesquisa e desenvolvimento de empresas do Parque Tecnológico TECNOPUC. As principais conclusões são: - a proximidade do parque tecnológico para a universidade tem sido uma vantagem, favorecendo a interação e incentivando a comunicação entre atores; - a maioria dos projetos são de empresas que promovem o fluxo de conhecimento, exigindo o desenvolvimento de novas tecnologias ou soluções para os problemas encontrados em seus processos de P & D.

Palavras-chave: Interação Universidade-Empresa; Parques científicos e tecnológicos; Fluxo de conhecimento; TECNOPUC.

Abstract

The objective of this study is to analyse the knowledge flow in joint projects between university and companies located in a technology park – an environment favourable to this type of interaction. Additionally, the levels of technological maturity were examined through TRL (Technology Readiness Level) for subsequent analysis of studied projects and their technology level. The research method adopted was the single case study, where seven cases conducted joint projects. Besides observation techniques and documentary analysis, semi-structured interviews were carried out with university researchers who were responsible for the joint projects and R&D (research and development) managers of the companies in the TECNOPUC tech park. The main findings are: - the proximity of the tech park to the university has been an advantage, favoring interaction and encouraging communication between actors; - most projects are of companies that foster knowledge flow by demanding the development of new technologies or solutions to problems found in their R&D processes.

Keywords: University-Industry Interaction; Science and Technology Parks; Knowledge Flow; TECNOPUC.

1 Introdução

Innovation is a key element for national and international competitiveness. A company's innovation capacity is related to its improved performance, achieved mainly through the application of new technologies. To leverage their assets, companies look for universities aiming for the application of state-of-the-art knowledge into products and processes (Dibrell, Craig & Neubaum, 2014). This movement is commonly known as university-industry (U-I) interaction, which is described by the knowledge transfer between the knowledge creation agent (here characterized by universities and research centres) and the knowledge application agent (here described by companies) (Dalmarco, Zawislak & Karawejczyk, 2012; Gubiani, Morales, Selig & Rocha, 2013). There is also a third agent – the government – who plays an important role on the establishment of policies to stimulate these partnerships aiming for innovative solutions (Etzkowitz, 2003).

The knowledge transfer between university and companies is a reality in developed countries. This interaction is one of the fundamental mechanisms to enhance competitiveness, development and dissemination of technologies, helping consolidate a modern and entrepreneurial economy (Mowery & Rosenberg, 1989). However, in emerging economies, where the development of new technologies is still incipient, the transfer of scientific knowledge from universities to industry may be one of the main instruments for the development and dissemination of new products and processes, leading to socioeconomic development and innovation (Pereira, Melo, Dalmau & Harger, 2009).

At both developed and emergent countries, one of the propositions to ease partnerships between the knowledge creation agent and the knowledge application agent is through the creation of Science and Technology Parks (Bigliardi et al., 2006). The main benefit of tech parks is the available knowledge of companies and academic laboratories that flow freely among institutions. The dynamic network-oriented environment of Science and Technology Parks stimulates not only university-firm partnerships but also firm-firm partnerships (Hansson, Husted & Vestergaard, 2005; Díez-Vial & Fernández-Olmos, 2015).

Science and Technology Parks are considered as part of an innovation ecosystem that also includes other stakeholders as entrepreneurs, investors, academic researchers and technology transfer offices (Etzkowitz, Solé & Piqué, 2010; Guerrero, Cunningham & Urbano, 2015). This movement is described by the concept of Triple Helix and entrepreneurial university (Etzkowitz, 2004), which is guiding the strategic planning of most universities worldwide and is considered part of a university's innovation role (Kuhlmann & Shapiro, 2006). Universities that foster entrepreneurial activities are considered to be more efficient when it comes to the commercialization of scientific knowledge, mainly through patents and licenses, or through the development of business incubators and Science and Technology Parks (O'Shea et al., 2007; Bramwell &Wolfe, 2008).

Recent studies discusses the application of the Triple Helix approach through the roles of actors and channels of knowledge transfer (Bekkers & Freitas, 2008; D'este, Guy & Iammarino, 2012; Abreu & Grinevich, 2013; Battke et al., 2016), and the influence of Tech Parks on these partnerships (Cheng et al., 2014; Tola & Contini, 2015; Dong-min, 2015; Leh, 2016; Lin et al., 2017), but fail to address the content of knowledge – basic or applied – transferred being transferred in university-industry relations in which companies are located at the university's technology park. Adding to this, Vásquez-Urriago et al. (2014) reinforces the necessity to analyse Science and Technology Parks in emergent countries, since most studies focus on developed countries that have a similar innovation development model.

Therefore, this study aims to characterize the content of the knowledge flow between university and the companies in science and Science and Technology Parks. We argue that the flow of basic scientific knowledge is more likely to stimulate innovations (Tödtling et al., 2009), while the flow of applied knowledge is easily absorbed by companies (Østergaard, 2009).

The results obtained from scientific research tend to benefit all actors involved (Hansen et al., 2012). Thus, we chose to analyse joint projects between the university (represented by the teaching staff) and companies (usually represented by members who are research and development managers). Benefits, gains and barriers found in the interaction between academia and industry were also analysed.

2 Theoretical Framework

The establishment of university-industry relations through local networks and partnerships are mostly analysed by the role of agents and the external alternatives to companies who develop open innovation strategies (Etzkowitz, 2008; Chesbrough, 2006). However, it can be observed that the pattern of such partnerships is changing, mostly by the dynamic environment of local technological clusters and the entrepreneurial movement of universities (Etzkowitz & Leydesdorff, 2000). Universities are primarily responsible for the creation of scientific knowledge, which, although not often directly applied, can play an important role in the development of a new technology (Mowery & Rosenberg, 1989; Nelson, Rosenberg1993). Companies, in turn, are responsible for the development of new market solutions, having scientific knowledge as technological source (Fontana, Geuna & Matt, 2006). The government, for its part, is responsible for establishing a fertile environment for innovation development through policies that encourage the conduct of research activities and interaction between agents (Etzkowitz, 2003).

The relations between the university and the companies are established in mainly three ways: (i) through the interests related to basic research; (ii) through an applied research project for which academic contribution is necessary; (iii) formulating research projects that develop joint basic and applied research through multiple funding sources, called strategic research (Stokes, 2005; Etzkowitz, 2013). The main advantages of universities in such partnerships is to raise additional resources for the development of basic research, to keep qualified and updated researchers and professors into its workforce, interact with researchers from companies, to update its access to marker needs, and to raise the possibility of employment for students, among others. Companies, by its turn gain, have the advantage to develop new solutions based on high-level knowledge, knowledge exchange with academic researchers, access to laboratories and equipment, among others (Cario, Da Cunha & Simonini, 2011). Government joins the university and industry to improve the country's technological development (Dagnino, 2009).

The agglomerations of firms, universities and other knowledge-intensive organizations are beneficial for the generation and utilization of knowledge (Ponds, Van Oort & Frenken, 2011; Boschma & Frenken, 2011). For this reason, national governments have stimulated the development of science parks, technology parks, science and technology parks, technopoles, innovation centres, research parks, science-based industrial parks, university research parks, as a component of public policy to stimulate innovation (Vásquez-Urriago, Barge-Gil & Rico, 2014). These initiatives can be encompassed by the broad category of Science and Technology Parks (STPs) since they are all policy-driven and have a main common objective to promote cooperation and technology transfer, especially between firms and knowledge providers such as universities and research institutes (Hogan, 1996; Bigliardi et al., 2006).

Based on these three agents, interactions take place through different knowledge transfer channels, intended to stimulate and promote knowledge flow among university and industry (Table 01) (Zawislak & Dalmarco, 2011).

The relevance of each channel used is determined by the characteristics of the knowledge itself – basic or applied – and the individual and organizational characteristics of those involved in the process (Bekkers & Freitas, 2008; Di Cagno, Fabrizi, & Meliciani, 2014). We find that participation in EU funded projects is an important channel of knowledge transfer. However, while for countries with high levels of R&D expenditure R&D spillovers contribute to the generation of new knowledge, for low R&D spenders knowledge spillovers facilitate technological imitation and catching up. Channels like consultancy and joint research, for example, can be used for both develop new technologies and to solve technical problems (Dalmarco, Zawislak & Karawejczyk, 2012). Looking at STPs, partnerships among companies and academic research labs may happen by geographical proximity, stimulating channels such as informal contacts or matchmaking workshops promoted by the university (Garcia et al., 2014). That's the reason for analysing not only the channel of knowledge transfer used, but also the knowledge content –basic or applied – being transferred.

- Conferences and workshops
- Informal meetings, talks, communications
- University graduates as employees
- Licensing of university patents
- Joint publications
- Lectures/training
- Contract research and consulting
- New firm formation by university members
- Joint R&D projects

Table 01 – Main knowledge transfer channels
Adapted from Zawislak & Dalmarco (2011)

As described, different factors may influence university-industry relations, such as technology maturity and the kind of scientific research being conducted. A scale called Technology Readiness Level (TRL), developed to improve its assessment and transfer, can describe the maturity level of technology development (Mankins, 2009; Gil, Andrade & Costa, 2014). The authors sustain that TRL is based on a 1 to 9 scale in which one describes the observation of basic principles of scientific research while nine is a technology that has already succeed when applied on market systems or products.

Observing different kinds of scientific research, Stokes (2005) discusses the spectrum between basic and applied scientific research, adapted to three categories: pure basic research, use-inspired basic research and pure applied research. Pure basic research refers to research activities originating from basic knowledge (Stokes, 2005), usually done without practical purposes in mind. However, it is the forerunner of technological progress. Some business sectors are inspired by basic research to develop their products, keeping close ties with universities (Bekkers & Freitas, 2008). Use-inspired basic research, the second category, is basic knowledge content with consideration of use (Stokes, 2005). Dalmarco, Zawislak and Karawejczyk (2012) discusses that this kind of knowledge may be observed on joint projects involving university and industry, where the first starts the research and, following some practical results, development is undertaken by the industry. The third category is described as pure applied research, which is research directed to a specific need (Stokes, 2005). This type of research requires specific solutions, such as research agreements or market consultancy (Dalmarco, Zawislak & Karawejczyk, 2012).

To expand the spectrum of possibilities in university-industry relations, it could be observed that in certain situations the type of knowledge companies are looking for is something that was already developed by the university (Perkmann & Walsh, 2009). In this case, the knowledge transferred is based on routine activities, with lower complexity and sophistication (Rapini, 2007). Consequently, the scientific knowledge available at the university is often "downgraded" to solve problems characterized by a low degree of uncertainty and technological development (Perkmann & Walsh, 2009).

Based on the theoretical review, four types of knowledge content will be used as an analytical framework (Table 2), based on the channel of knowledge transfer, technology maturity and the kind of scientific research conducted to develop the technology transferred.

Type of Knowledge	Description	References
Basic Knowledge	Observed as research activities originating from basic science. Uses channels such as papers, patents or conferences. It is based on technology maturity levels ranging from TRL 1 to 3.	Rapini, 2007; Bekkers and Freitas, 2008; Mankins, 2009; Perkmann and Walsh, 2009; Zawislak and Dalmarco, 2011; Dalmarco, Zawislak and Karawejczyk, 2012; Gil, Andrade and Costa,2014.
Strategic Knowledge	Observed on joint projects involving university and industry which tests results of basic science on certain applications. Uses channels such as joint R&D projects or publications. It is based on technology maturity levels ranging from TRL 4 to 6.	
Applied Knowledge	Observed on research projects directed to a specific need with determined results. Uses channels such as recruitment of students by the company, informal contracts and consultancy (if research is required). It is based on technology maturity levels ranging from TRL 7 to 8.	
Available Knowledge	Observed on projects that only require the rearrangement of knowledge already available at the university. Uses channels similar do applied knowledge, as contract research and consulting, but here there is no further development on knowledge available at the university. It is based on technology maturity TRL 9.	

Table 02 – Analytical framework

In order to complement the discussion on actors and channels, the knowledge flow seeks to characterize the content of the knowledge flow between university and companies that are established inside university's tech park. Thus, the research method described in the next section was adopted.

3 Research Method

To understand and characterize the knowledge flow between companies established at Science and Technology Parks and universities, it was conducted an exploratory study at Tecnopuc, the science and technology park of PUCRS. Tecnopuc was awarded by ANPROTEC the best technology park in Brazil for three times (2004-2009-2016), and it is recognized by its policies that stimulate local companies to establish partnerships with PUCRS. It has approximately 110 organizations established, among those 60 companies.

The research was conducted by a single case study as defined by Yin (2015). This method was used because it is a strategy that tries to examine a phenomenon in its real life context (Yin, 2015), and allows a more flexible analysis of the results (Roesch, 2005). Considering the characteristics of the knowledge content in university-industry relations is still not fully described by the current literature, we considered that an exploratory case study be more appropriate to reach our objectives.

The case selection was directed to a list of projects that companies established at Tecnopuc had with PUCRS researchers. The projects selected had the objective of developing a new technology, while projects that aimed financial support for research infrastructure or scholarships were discharged. It were identified eight projects with companies from 2010 to 2014, but only seven were analysed because both company and academic researchers were still at the technology park/university (table 03). It were interviewed the professors responsible for those research projects, who also indicated the company's researchers assigned to the project.

Project	Budget (R$)	Length (months)	Researchers involved
1	40,000.00	15	2
2	85,000.00	30	2
3	320,000.00	12	5
4	300,000.00	12	4
5	500,000.00	12	2
6	50,000.00	24	2
7	3,000,000.00	36	11

Table 03 – Profile of the projects analysed

Two data collection procedures were defined: in-depth interviews and secondary analysis. In-depth interviews were conducted with company's researchers and professor participating or having participated on each project. In total it were conducted 17 interviews in which were used semi-structures questionnaires validate by two academic experts. In addition to interviews, secondary data, such as reports and technical forms, were used as input data. All interviews were recorded and transcribed, while the reports were already on digital format (pdf or word). All information was organized by qualitative data analysis software. According to Gagnon (2010), content analysis allows different text associations that may improve the analysis, organization and integration into theoretical hypothesis.

4 Presentation and Analysis of Results

It was observed that the main difference regarding Tecnopuc and other Science and Technology Parks in Brazil is that companies established at this specific park must establish some kind of interaction with the university's scientific infrastructure. In this sense, our effort was to analyse documents that described the objective and characteristics of each established partnership, identifying those that were aligned with our analytical framework. Many companies established at Tecnopuc are ICT companies, who are beneficiary of the *Lei da Informática* (Informatics Law), but as mentions the researcher involved in project #3: *"Lei da Informática allows companies to invest in training of their own employees. Consequently they invest mostly in training, and not on research projects".* Therefore, to observe different characteristics of the knowledge flow, we looked for projects that aimed to develop new technologies, independently if it was something new for the company, the sector or the world (according to the characteristics of innovation presented by the Oslo Manual, 1997). After this previous analysis, interviews were conducted to identify motivation and barriers to joint projects university-industry and the characteristics of the knowledge flow on each research project. This information is described bellow.

Regarding the importance of universities to companies, the interviewees mentioned that the university is perceived, in most cases, as a source of new ideas for projects. It is also considered a partner to meet the demands already established by the company. Interviewee from company 7 says that: "*PUCRS has always been a partner, but I think that is true because the timing is different. Researcher have time to test new ideas, scientific concepts, and that is very important for us*". Companies also perceive the difficulties of the university, such as bureaucracy in internal processes and some criteria that hinder interaction. However, in most cases, they see the university as a great ally in joint research projects.

Analysing the importance of companies to academic researchers, interviewees highlighted that an efficient communication among partners, confidence and mutual respect are strong features of the relationship, influencing the knowledge flow. Researcher of project #1 said that: "*Communication is very fast. (...) There is no formality any longer. We were able to establish trust and a bridge thanks to the success of the project*". It could be observed that in general at the beginning of the project the company is sometimes afraid of the partnership. However, as soon as the first results are presented, the trust of the partner raises, favouring the flow of information.

The view of actors allows us to identify the existence of barriers and facilitators faced by both agents. Characteristics such as the prestige of the university; involvement of academic researcher with market issues; open relationship between university and company; and easy access to research laboratories, are seen as favourable. The proximity of the company was highlighted as one of the most important facilitators, i.e., being in the TECNOPUC tech park, inside the university (PUCRS), facilitates the interaction between actors. Interviewee from company 4 says "*The fact that we are located in the technology park of the university makes interaction a lot easier. Nothing is far away, everything is close by, and many companies do not have this culture of interaction with the university*". Agrawal, Kapur & McHale (2008) and Garcia et al. (2014) refers that geographical proximity enables the transfer of knowledge between researchers and the industry, generating a positive impact on the success of a product launch. For instance, the advantage of being located at a STP is stressed by limitations on company's technology development process. Location incentive relies on the type of ownership and corporate control the firm features, since partnerships are determined/limited by the sole headquarters. If the local unit has responsibilities on the initial stage of product development, then it will focus on innovation creation (Leh, 2016). In this case, the firm may come up with product variation fostered by partnerships with the university.

Analysing the barriers face by the agents on establishing partnerships, bureaucracy was de most relevant factor described by the interviewees. Interviewee of company 6 mentions that *"it is very annoying, the paperwork to fill out, we need a simpler system, able to multitask, a system that unites the group that will work"*. Siegel et al. (2004) corroborate this view, arguing that the university's bureaucracy and inflexibility are barriers in the interaction process, creating dissatisfaction among researchers and company members, often having informal and consultancy interactions. Adding to bureaucracy, other barriers were also described as the usual gap between academic interests and company's result-oriented goals; research time difference for each agent – companies requires agility while university works on academic schedule; frequent changes of company's R&D managers, as well as research objectives were also mentioned as an specific issue of companies.

It is interesting to point out that even though communication is highlighted as a facilitator between actors, bureaucracy as a major barrier seems to relate to communication processes. Thus, it is understood that communication for alignment and formalization of processes that involve their relationship could be more transparent and better communicated. Project developed is also penalized by the different deliveries that each agent expects, also demanding better time management.

Describing the content of knowledge presented on the knowledge flow between the university and the companies established at the technology park, we were able to identify different types of knowledge according to project analysed.

Describing the projects that are characterized by content of Basic Knowledge, projects #1, #3 and #4 are in line with basic research activities, since they are mostly guided by theoretical and experimental research. As mentions the researcher involved in project #4: "*We cannot say that we generated a product, they were prototypes. Plus, our goal was not development, it was research*". The researcher involved in project #3 adds that "*we get the whole scientific development part. They gave us some ideas, but the results were scientific, such as papers"*. Interviewee of company #1 complement saying that: "*We've been in this partnership for three years. In the first year we managed to register a patent on a technology"*.

Project #2 and #6 were identified by a knowledge flow based on Strategic Knowledge, since these projects were based on basic knowledge but with consideration to be explored for a specific use. The researcher involved in project #2 mentions that: ""*He will add value to an internal process and will enhance the value of his company in the market. He is developing a methodology to optimize his service*". Interviewee of company 2 says that "*This project was part of my Master thesis. We are discussing the application of a certain concept to justify a process optimization".* Describing project #6, the academic researcher mention that *"We were able to show the efficiency of the research, we validated tests, had good results, and the company was able to sell the product [for which] we developed the technology".*

The category Applied Knowledge was observed on projects #5 and #7, as they are characterized as projects directed to a specific need, with the purpose of obtaining new knowledge. The interviewee of company #5: "*During the project we needed to conduct a study to evaluate whether this technology worked as well as other similar equipment on the market. We didn't have expertise to develop such a study, so people from the university were involved to determine the evaluation methods*". Describing project #7, the academic researcher interviewed mentions that "*For me the best result is the opportunity to apply in practice. To carry out the applied research and apply the results of what I do*".

Describing the category Available Knowledge, surprisingly none of the projects were based on something that was already available. This category was only mentioned by the interviewee of company #1 as possibility of also using the results of project #1 into other applications than those previously foreseen: "We are planning to *develop new products using the technology that has already been developed for project #1*". This is also one of the possibilities of companies when interacting with universities. The development of joint research projects may result in secondary technologies that can be used into other applications or even portfolio products.

Summing up, even though the company is more geared towards the market and the university to academia, it is crucial to understand how this interaction takes place. Various authors present university-industry interaction as a stimulus to innovation (Gubiani et al., 2013; Dalmarco, Zawislak & Karawejczyk, 2012; Etzkowitz & Leydesdorff, 2000; Pereira et al., 2009; Silva, Rocha & Silva, 2014; Noveli & Sagatto, 2012), what could also be observed as the main objective of the projects analysed since most of them were based on basic and strategic knowledge. Both actors and some channels of knowledge transfer are recognized by the university as a way to facilitate this interaction. The fact that there is a technological park with companies willing to promote innovation facilitates the access of university researchers.

Therefore, innovation and the idea to make this process of technology transfer happen often arise from a chance encounter between researcher and the company manager. Actors must then be attentive as the flow of knowledge generation can be stimulated anytime, anywhere.

5 Conclusion

Science and technology parks are considered the locus of innovation in emergent and developed countries, since the geographical proximity between companies and universities (who in most cases host the STP) may stimulate the knowledge flow among institutions. However, in emergent countries like Brazil, where companies are not used to interact with universities, it is necessary to establish specific policies to promote such partnerships. At Tecnopuc, companies who want to move into the STP must interact with the university, being the partnership established prior to the company's address change. In this scenario, our objective is to characterize the content of the knowledge flow between university and the companies established at the science and technology parks. We wanted to observe if companies were doing the bare minimum to be established there, or if they were taking advantage of the geographical proximity to develop high tech products. Apparently the last one is the main objective on the observed cases.

Regarding facilitators and barriers observed in university-industry relations, the geographical proximity to the STP was considered the main facilitator to the partnerships. The companies see in the university, including researchers and students, a highly qualified and easy to access team available to attend the company's needs. On the other hand, the bureaucracy to meet demands, whether to begin a project or purchase materials and equipment, was identified as a barrier. The gap between the company's view (result-oriented) and the university's (research-oriented) apparently affects the interaction between the actors. Companies consider that being established in the STP is an strategic advantage since it provides both relevant joint research and qualification of company employees.

With respect to the knowledge content transferred by the flow, basic knowledge is the most common content observed on the cases, mostly due to the incentives provided by the *Lei de Informática*. Strategic knowledge and applied knowledge were less frequent, usually associated with basic knowledge. Current technology was found in two projects that used a technology previously developed in partnership with the university. This is an important finding since the transfer of current technology is associated to partnerships that doesn't look for the development of new technologies. In this case, however, it is based on a previous technology developed with the same company, who foresaw a new application for it.

Restricting to TECNOPUC companies, considering that few of them have joint projects with the university, was one of the limitations of this study. Many companies have in-house R&D units and, because they have an innovative profile, they go to the university only to be inside the campus and more connected to the information and technologies that academia can provide. What often happens is that these companies do in-house research and do not disclose its content for several reasons. This factor restrain interaction between agents, who could take advantage of the fact of having companies looking for innovation and researchers wanting to work in partnership with these companies as a factor that adds to the proximity of TECNOPUC to the university.

In the future, the analyses developed in this study could be expanded and deepened by including other companies and researchers in order to analyse this research in different types of Science and Technology Parks, as well as analyse joint projects with university researchers and companies outside the park. Finally, this study gave inputs to the identification of facilitators and barriers found in the interaction between university and the industry. It also contributed to the identification of the level of knowledge transferred, determining the types of knowledge and identifying the levels of technological maturity of each project studied.

References

Abreu, M., & Grinevich, V. (2013). The nature of academic entrepreneurship in the UK: Widening the focus on entrepreneurial activities. *Research Policy*, 42(2), 408-422.

Agrawal, A., Kapur, D., & McHale, J. (2008). How do spatial and social proximity influence knowledge flows? Evidence from patent data. *Journal of Urban Economics*, 64(2), 258-269.

Battke, B., Schmidt, T. S., Stollenwerk, S., & Hoffmann, V. H. (2016). Internal or external spillovers: Which kind of knowledge is more likely to flow within or across technologies. *Research Policy*, 45(1), 27-41

Bekkers, R., & Freitas, I. M. B. (2008). Analysing knowledge transfer channels between universities and industry: To what degree do sectors also matter?. *Research Policy*, 37(10), 1837-1853.

Bigliardi, B., Dormio, A. I., Nosella, A., & Petroni, G. (2006). Assessing science parks' performances: directions from selected Italian case studies. *Technovation*, 26(4), 489-505.

Boschma, R., & Frenken, K. (2011). The emerging empirics of evolutionary economic geography. *Journal of Economic Geography*, 11(2), 295-307.

Bramwell, A., & Wolfe, D. A. (2008). Universities and regional economic development: The entrepreneurial University of Waterloo. *Research Policy*, 37(8), 1175-1187.

Cario, S. A. F., da Cunha Lemos, D., & Simonini, A. (2011). Avaliação da interação universidade-empresa em Santa Catarina por intensidade tecnológica. *Revista de Economia*, 37(4).

Cheng, F., van Oort, F., Geertman, S., & Hooimeijer, P. (2014). Science Parks and the Co-location of High-tech Small-and Medium-sized Firms in China's Shenzhen. *Urban studies*, 51(5), 1073-1089.

Chesbrough, H. W. (2006). *Open innovation: The new imperative for creating and profiting from technology*. Harvard Business Press.

Dagnino, R. (2009). A Relação Universidade-Empresa no Brasil e o" Argumento da Hélice Tripla". *Revista Brasileira de Inovação*, 2(2 jul/dez), 267-307.

Dalmarco, G., Zawislak, P. A., & Karawejczyk, T. C. (2012). Fluxo de conhecimento na interação universidade-empresa: uma abordagem complementar. *XXXVI Encontro da ANPAD. Anais*… Rio de Janeiro.

De Oslo, M. (1997). Manual de Oslo. http://gestiona. com. br/wpcontent/uploads/2013/06/Manual-de-OSLO-2005. pdf. [Accessed June, 25 2017]

D'Este, P., Guy, F., & Iammarino, S. (2012). Shaping the formation of university–industry research collaborations: what type of proximity does really matter? *Journal of Economic Geography*, 13(4), 537-558. DOI: https://doi.org/10.1093/jeg/lbs010

Di Cagno, D., Fabrizi, A., & Meliciani, V. (2014). The impact of participation in European joint research projects on knowledge creation and economic growth. *The Journal of Technology Transfer*, 39(6), 836-858.

Dibrell, C., Craig, J. B., & Neubaum, D. O. (2014). Linking the formal strategic planning process, planning flexibility, and innovativeness to firm performance. *Journal of Business Research*, 67(9), 2000-2007.

Díez-Vial, I., & Fernández-Olmos, M. (2015). Knowledge spillovers in science and technology parks: how can firms benefit most?. *The Journal of Technology Transfer*, 40(1), 70-84.

Dong-min, L. I. N. (2015). Exploring the Developing Mechanism and Upgrading Strategy of University Science Park. *Journal of Qiqihar University* (Philosophy & Social Science Edition), 3, 053.

Etzkowitz, H. (2003). Innovation in innovation: The triple helix of university-industry-government relations. *Social Science Information*, 42(3), 293-337.

Etzkowitz, H. (2008). *The triple helix: university-industry-government innovation in action*. Routledge.

Etzkowitz, H. (2013). Hélice Tríplice: Universidade-Indústria-Governo-Inovação em Movimento. *Porto Alegre: EDIPUCRS*.

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. *Research Policy*, 29(2), 109-123.

Etzkowitz, H., Solé, F., & Piqué, J. M. (2010). The creation of born global companies within the science cities: an approach from triple helix. *Engevista*, 9(2), 149-165.

Fontana, R., Geuna, A., & Matt, M. (2006). Factors affecting university–industry R&D projects: The importance of searching, screening and signalling. **Research Policy**, 35(2), 309-323.

Gagnon, Y.C. (2010). *The Case Study as Research Method: A Practical Handbook.* Presses de l'Université du Québec.

Garcia, R., Araujo, V. D. C., Mascarini, S., & Santos, E. G. (2014). Efeitos da qualidade da pesquisa acadêmica sobre a distância geográfica das interações universidade-empresa. *Estudos Econômicos* (São Paulo), 44(1), 105-132.

Gil, L., Andrade, M. H., & Costa, M. D. C. (2014). Os TRL (Technology Readiness Levels) como ferramenta na avaliação tecnológica. *Revista Ingenium*, 139, 94-96.

Gubiani, J. S., Morales, A. B. T., Selig, P. M., & da Rocha, F. B. (2013). A transferência para o mercado do conhecimento produzido na pesquisa acadêmica. *Navus-Revista de Gestão e Tecnologia*, 3(2), 114-124.

Guerrero, M., Cunningham, J. A., & Urbano, D. (2015). Economic impact of entrepreneurial universities' a ctivities: An exploratory study of the United Kingdom. *Research Policy*, 44(3), 748-764.

Hansen, P. B., Becker, G. V., Neff, H. B., & De Mello, N. C. (2012). Contribuição do parque tecnológico para a competitividade das empresas instaladas: análise do caso do TECNOPUC-RS. *Revista Gestão Organizacional*, 5(2), 192-213.

Hansson, F., Husted, K., & Vestergaard, J. (2005). Second generation science parks: from structural holes jockeys to social capital catalysts of the knowledge society. *Technovation*, 25, 1039–1049.

Hogan, B. (1996). Evaluation of science and technology parks: the measurement of success. *The Science Park Evaluation Handbook*, 86-97.

Kuhlmann, S., & Shapir, P. (2006). How is Innovation Influenced by Science and Technology Policy Governance? Transatlantic Comparisons. In: J. Hage, & M. Meeus, *Innovation, Science, and Institutional Change* (p. 592). Oxford: Oxford University Press.

Leh, F. C. (2016). Trends and policy implications of the location selection of electric and electronic firms in Malaysia: A case study of the Penang and Kulim High-Tech Parks. *Malaysian Journal of Society and Space*, 12(7), 119-132.

Lin, H. E., McDonough, E. F., Yang, J., & Wang, C. (2017). Aligning Knowledge Assets for Exploitation, Exploration, and Ambidexterity: A Study of Companies in High-Tech Parks in China. *Journal of Product Innovation Management*, 34(2), 122-140.

Mankins, J. C. (2009). Technology readiness assessments: A retrospective. *Acta Astronautica*, 65(9), 1216-1223.

Mowery, D., Rosenberg, N. (1989). *Technology and the pursuit of economic growth*. Cambridge University Press.

Nelson, R.R., & Rosenberg, N. (1993) Technological Innovation and National Systems. In Nelson, RR. (Ed). *National Innovation Systems*: a Comparative Study. Oxford Univ. Press, New York.

Noveli, M., & Segatto, A. P. (2012). Processo de Cooperação Universidade-Empresa para a Inovação Tecnológica em um Parque Tecnológico: Evidências Empíricas e Proposição de um Modelo Conceitual. 610. *RAI: Revista de Administração e Inovação*, 9(1), 81-105. DOI: 10.5773/rai. v1i1.

O'Shea, R. P., Allen, T. J., Morse, K. P., O'Gorman, C., & Roche, F. (2007). Delineating the anatomy of an entrepreneurial university: the Massachusetts Institute of Technology experience. *R&D Management*, 37(1), 1-16

Østergaard, C. R. (2009). Knowledge flows through social networks in a cluster: Comparing university and industry links. *Structural Change and Economic Dynamics*, 20(3), 196-210.

Pereira, M. F., de Melo, P. A., Dalmau, M. B., & Harger, C. A. (2009). Transferência de Conhecimentos Científicos e Tecnológicos da Universidade para o Segmento Empresarial. *RAI: Revista de Administração e Inovação*, 6(3), 128-144.

Perkmann, M., & Walsh, K. (2009). The two faces of collaboration: impacts of university-industry relations on public research. *Industrial and Corporate Change*, 18(6), 1033-1065.

Ponds, R., Van Oort, F., & Frenken, K. (2011). Innovation, spillovers and university-industry collaboration: An extended knowledge production function approach. *Journal of Economic Geography*, 10(2), 231–255.

Rapini, M. S. (2007). Interação universidade-empresa no Brasil: evidências do Diretório dos Grupos de Pesquisa do CNPq. *Estudos Econômicos* (São Paulo), 37(1), 211-233.

Roesch, S. M. A. (2005). *Projetos de estágio e de pesquisa em administração: guia para estágios, trabalhos de conclusão, dissertações e estudos de caso*. Editora Atlas SA.

Siegel, D. S., Waldman, D. A., Atwater, L. E., & Link, A. N. (2004). Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: qualitative evidence from the commercialization of university technologies. *Journal of Engineering and Technology Management*, 21(1), 115-142.

Silva, H. D. S. S., Rocha, E. S., & da Silva, W. M. C. (2014). Inovar para desenvolver: Relação entre os atores Universidade, Empresa e Governo. *Examãpaku*, 6(2).

Stokes, D. E. (2005). *O quadrante de Pasteur: a ciência básica e a inovação tecnológica*. Campinas, SP: Unicamp.

Tödtling, F., Lehner, P., & Kaufmann, A. (2009). Do different types of innovation rely on specific kinds of knowledge interactions?. *Technovation*, 29(1), 59-71.

Tola, A., & Contini, M. V. (2015). From the diffusion of innovation to tech parks, business incubators as a model of economic development: the case of "Sardegna Ricerche". *Procedia-Social and Behavioral Sciences*, 176, 494-503.

Vásquez-Urriago, Á. R., Barge-Gil, A., Rico, A. M., & Paraskevopoulou, E. (2014). The impact of science and technology parks on firms' product innovation: empirical evidence from Spain. *Journal of Evolutionary Economics*, 24(4), 835-873.

Yin, R. K. (2015). *Estudo de Caso-: Planejamento e Métodos*. Bookman editora.

Zawislak, P., & Dalmarco, G. (2011). The silent run: new issues and outcomes for university-industry relations in Brazil. *Journal of Technology Management & Innovation*, 6(2), 66-82.