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**THE INNOVATION LAW AND ITS EFFECTS OVER THE  
MANAGEMENT OF TECHNOLOGY TRANSFER  
AT BRAZILIAN UNIVERSITIES**

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# ABSTRACT

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This study is set out to investigate the influence of federal legislation over university management practices at Brazilian Higher Education Institutions (HEI). During the last decade, Brazilian government has taken the decision to boost innovation as a key factor within its long-term developmental agenda. In general terms, innovation is related to the ability to apply knowledge in the development and production of (new or enhanced) goods and services. Innovation is then closely related to the science and technology performed by skilled individuals such as that carried out at universities. In Brazil, universities are highly recognised for the size and quality of their academic output however the translation of these results for the benefit of society at large is still considered to be weak.

As the country strives to build a sound national innovation system, a new policy framework has been introduced. Within this framework new incentives and mechanisms were created with the aim to foster innovation through various channels and at different levels. The Innovation Law (IL) is one of these mechanisms. Passed in 2004, it recognizes the pivotal role played by universities as powerful research centres and the producers of highly skilled human resources. Among other provisions, aimed at actors such as individual inventors and business enterprises, the IL directly addresses universities by allowing (and legalising) new collaborative modes and requiring the provision of support services for the promotion of technology transfer and the commercialisation of research results. For instance, public universities are mandatorily required to establish a dedicated structure (named NIT) in charge of implementing the institutional innovation policy.

Based on this ongoing process, this study aims to explore how this new policy framework is promoting a change on university management and specifically how institutions with different profiles are implementing that. For the purpose of understanding these dynamics a multiple-case study methodology was adopted. Four universities were selected aiming at showcasing four different institutional profiles. The data collection methods used included documents (such as policy documents, institutional regulations and reports, etc) and phone interviews with the target group constituted of key university managers in charge of technology transfer offices (NIT).

The findings of the study reveal that the state is having a key role in promoting innovation in the Brazil through the introduction of a favourable policy framework and funding mechanisms. Nevertheless, there is still many deficiencies identified that are preventing the institutionalisation of IL provisions. Some of these barriers are related to the gaps and conflicts in the legislation itself. More importantly, are highlighted the achievements and barriers at the institutional level that indicate how this change process is taking place and affecting university management.

A key conclusion reached is that the improvement and professionalization of university research management is a key issue if Brazil wants to fully harness academic science and technology potential for development.

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## **ABBREVIATIONS AND ACRONYMS**

BERD: Business R&D expenditure as a percentage of GDP

CAPES: Brazilian Federal Agency for the Improvement of Higher Education Personnel

CNPq: Brazilian National Council for Scientific and Technological Development

FAPESP: São Paulo State Research Foundation

FINEP: Funding Agency of MCT

FORMICT: Information Form about Intellectual Property Policy at Brazilian S&T Institutions

FORTEC: Brazilian National Forum for Technology Transfer and Innovation Managers

GDP: Gross Domestic Product

GERD: Gross R&D expenditure as a percentage of GDP

HE: Higher Education

HEI: Higher Education Institutions

IL: Innovation Law

IP: Intellectual Property

IPR: Intellectual Property Rights

IS: Innovation Systems

ISI/WoS: Thomson Reuters Institute for Scientific Information - Web of Science

MCT: Brazilian Ministry of Science and Technology

MEC: Brazilian Ministry of Education

NIS: National Innovation Systems

NIT: Núcleo de Inovação Tecnológica (Technological Innovation Nuclei)

OECD: Organisation for Economic Co-operation and Development

PACTI: Brazilian Action Plan in Science, Technology and Innovation for Development

PINTEC: Brazilian Survey of Technological Innovation

PRO: Public Research Organisations

PUCRS: Pontifical Catholic University of Rio Grande do Sul

R&D: Research and Development

S&T: Science and Technology

ST&I: Science, Technology and Innovation

TT: Technology Transfer

TTO: Technology Transfer Office

UFABC: Federal University of ABC Region

UFSCAR: Federal University of São Carlos

U-I: University-Industry relations

UNICAMP: Estate University of Campinas

US: United States

USP: University of São Paulo

WWII: World War II

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# 1. INTRODUCTION

## 1.1 Research background

Higher Education (HE) is widely acknowledged to foster socio-economic development in a variety of ways. The education of highly skilled human resources (human capital theories) (Psacharopoulos & Patrinos, 2004) and the harnessing of research results produced by universities have been traditional means by which countries are able to overcome crisis (economic, alimentary, etc) periods and further advance its developmental pathways (Becker & Lewis, 1993; Wolf & Gittleman, 1993; Stevens & Weale, 2003; Tilak, 2003).

With the rise and consolidation of the drastic changes and trends that characterize our contemporary society, Higher Education Institutions (HEI) become even more relevant actors for the development of their milieu, particularly in developing countries (WB T. F., 2000).

Cloete & Maassen (2006) explore how this period of societal and global transformation have strongly affected the HE sector and provided the basis for system reforms in several countries.

Altbach (2004) also presents arguments on how universities, from the developed to the developing world, are being affected by circumstances beyond the campus and commonly attributed to the globalisation process. These authors explain how universities traditionally have been susceptible to ongoing tensions and circumstances of both national and international nature.

Nowadays the knowledge society and the importance attached to technological innovation have reinforced the importance of universities making them subject of national developmental policies. Notorious examples are how countries like Finland, Ireland and South Korea have successfully harnessed HE potential to contribute to its socio-economic growth (Etzkowitz & Brisolla, 1999; Mowery & Sampat, 2006).

Harnessing science and technology (S&T), particularly that developed by universities, for achieving development goals is a strategy also actively promoted by international agencies (OECD, 2003; WB T. W., 2008), national and regional governments (EC, 2003). Within this paradigm, countries are faced with the challenge of promoting and maintaining growth through the permanent introduction of innovations (including product, service and marketing innovations) in the market. This is achieved through the conception of innovations, mainly of technological type, achieved through research and development (R&D) activities. The concept of Technological Innovation, as further

explored in the theoretical framework section, regards the process by which new (or improved) technologies are developed and subject to widespread use.

The described issues largely represent the actual rationale of the developmental strategy of Brazil. Technological innovation is currently at the very heart of this strategy being materialised by the development of a future “State Policy for S&T” comprising education, science and technology, a result of the cooperative work of governmental, business, academic and civil sectors of society (MCT, 2010). The main goal of this policy will be to provide a framework for implementing programmes that surpasses short term political interests.

However Brazil is facing several challenges in the pursuit of the policy’s goals. One of the main obstacles is considered to be low linkage between research universities and business counterparts (Britto Cruz, 2003). When it comes to scientific production in the form of publications Brazilian universities are considered to have a good level of performance however its operation is still very detached from business and industrial needs which is perceived to be a key factor if the country is to support its rapidly growing economy and remain a global player. Policy-makers, acknowledging this fact, have introduced in the last years legal, fiscal and funding mechanisms in order to promote these links between business and academia (Rodrigues, Dahlman, & Salmi, 2007).

This thesis aims to take a closer look and improve the understanding of how one these mechanisms created by the State, the 2004 Innovation Law, is affecting universities in Brazil (BRASIL, 2004).

Until not long ago, University-Industry (U-I) interactions were obstructed by a strong opposition from many academics based on the argument that innovation-related activities should be the focus of business enterprises and the university (mainly those supported by public money) should restrict to its mission of training highly skilled individuals (Etzkowitz, Webster, Gebhardt, & Terra, 2000; Buenstorf, 2009). This situation was further hindered by a general lack of capacity in the provision of professional support to technology transfer (TT) activities as part of a broader institutional strategy (Siegel, Waldman, & Link, 2003).

Due to the structural changes presented before though, the relationship between business and academia is notably changing. By force of law, all federal universities now have within their structures a specific unit, similar to a technology transfer office (TTO) named NIT<sup>1</sup> (Nucleous for

---

<sup>1</sup> Núcleo de Inovação Tecnológica

Technological Innovation) which is in charge of providing the academic community with innovation-related information and services.

Before the passage of the law in 2004, there were no nation-wide standards for technology transfer offices (TTO) in public research organisations (PRO). For this reason those more active universities were already equipped with technology-transfer offices designated under various denominations and displaying different maturity levels.

Some interesting studies were conducted on the role of Brazilian research universities as part of the national innovation system (Velho & Saenz, 2002; Mello, Maculan, & Renault, 2010) and more specifically on the role of TTOs (Santos, Solleiro, & Lahorgue, 2004; Lahorgue, 2005; Ritter dos Santos & Solleiro, 2006). Nevertheless, these studies were carried out previously (or shortly after) the introduction of this new framework that comprises the Innovation Law. During the last six years universities in Brazil have been working hard and on a coordinated fashion in order to comply with the Law and create structures that have the capacity to respond to its provisions. By now, as part of a larger monitoring process, there is a great need to explore how universities are implementing and institutionalising this new mandates and how this is affecting institutional management.

## **1.2 Statement of the problem**

Brazil seems to have reached the momentum where the three spheres of society (namely the academic, governmental and business sectors) are cooperatively building synergies in order to boost technological innovation as the basis for sustainable development. Within this new “social contract”, which is still in the process of development, HEI are directly addressed and required to actively engage (Cloete & Maassen, 2006; Bleiklie, 2005).

The interface between the Higher Education and the Science, Technology and Innovation systems is a new area of study in many countries including Brazil though (Cassiolato, Lastres, & Maciel, 2003). A great deal of work is needed in order to identify how this incipient system is evolving and which are the compounding mechanisms that are working effectively and which should be further improved .

With regard to HEI one of these mechanisms gained special prominence in the last years. Following the requirements of the law all federal universities have established, or are in the process of establishing, technology transfer offices named NIT. While there are some very specific functions

the NITs are required to comply with, the law leaves some room on how HEI shall institutionalise and implement technology transfer activities (Lahorgue, 2005).

As the Innovation Policy in Brazil and its mechanisms are in the process of revision and improvement it becomes essential to have feedback of how effective they actually are and how they affect academia (Oliveira & Velho, 2009). Universities, both experienced or newbies at technology transfer activities are faced with the challenge to perform well while maintaining unharmed issues related to institutional and academic missions and the public interest (Garnica & Torkomian, 2009).

The great majority of the existing analyses focus on the quantitative outputs produced by universities in connection to the law such as the number of patents granted, the revenue generated by the commercialisation of intellectual property rights (IPR) or spin-off companies created (Albuquerque, 2000; Oliveira R. , 2011). There is a lack of up-to-date literature focusing on the effects that technology transfer activities over the administration and management of Brazilian research universities (Lahorgue, 2005; Mello, Maculan, & Renault, 2010; Silva, Machado, & Lotufo, 2009). For all these reasons it is of fundamental importance to research how the administration of universities have been changed in order to promote technology transfer.

### **1.3 Research question**

The aim of this study is to analyse the effects of the Innovation Law over Brazilian research universities during the six years since its implementation.

The thesis' focus of analysis is placed on the university structure that comprises the executive staff in charge of facilitating TT activities (the NIT).

In this thesis work the term administration is broadly defined and in line with the expectation by Gumport & Sporn (1999) which accommodates university's structure and processes that implement the decisions made by academic governance. In this sense, the term management is closely related to administration but attaching a more executive nuance to the concept.

The main research question is:

Q. How has the administration of Brazilian universities been changed to promote technology transfer as an effect of the 2004 Innovation Law?

The associated sub-questions that will guide this analysis are:

Q1. How do universities assimilate and internalise the provisions of the IL into the mission, strategies and internal processes?

Q2. Is the IL having a different impact over management according to the university profile?

Q2. What are the administrative changes at the TTO level perceived as a result of the IL?

Q3. Which types of TT activities have been more reinforced as a result of the IL?

Q4. What are still the main bottlenecks for university contribution to innovations perceived by TT managers?

## **1.4 Significance**

Such an analysis is of extreme interest of different interest groups such as university managers and leaders, individual researchers and teaching staff (mainly those involved in innovation projects and courses), students, governmental representatives and policy-makers.

Another important motivation to undertake this kind of study is to add to the Higher Education knowledge stock concerning the Brazilian Higher Education System. There is an evident lack of up-to-date available literature especially with regards to Higher Education Institutions and their operation under these emerging dynamics.

## **1.5 Delimitation of the study**

This study is designed to be focused on the administrative structures in charge of technology transfer at Brazilian research universities. The analysis will be placed specifically on the impact of the 2004 Innovation Law over the institutional policy and the management structure and practices of the NITs. In order to make the analysis operational, four universities were selected to showcase four specific institutional profiles. Each profile is characterised by the following criteria: legal status (federal/state/private) and the level of maturation on the management of TT-related activities.

A theoretical framework on the factors considered critical for adequate TT at the university setting will be used to support this analysis from the theoretical standpoint.

The author is aware of the many limitations associated to a study of such nature. Although the present analysis aims to focus on the influence of a specific piece of legislation over the management of HEI, obviously the IL is only one within a myriad of factors that are simultaneously influencing factors the process of TT from university to society and the development of technological innovations. Many are beyond the control of university managers but associated with the understanding of academics (and business managers) about the pros and cons of the technology transfer process, with the importance devoted by institutional leaders to the subject and mainly the financial and human resources available to the execution of such activities.

Another potential limitation factor is the small number of institutions involved in this qualitative study (four). Although they were carefully selected in order to provide a better understanding of the situation found according to the main institutional profiles, due the diversity and number of institution in Brazil, there is a great possibility that many institutions do not see their situation and context represented in the presented case studies.

Possibly one of the most mentioned reason for the frustrations in promoting TT is the cultural differences between academia and business enterprises. As mentioned later in the theoretical framework, this aspect is not comprised in this research. The reason is that, although information asymmetries can be attenuated by the work performed by TTO managers, the question about “culture” goes beyond that being subject to personal understanding on the values and functions of the academic work. Thus, cultural differences vary greatly and are found even between researchers within the same institution and even department.

Despite the acknowledgement of such limitations, they do not prevent the consecution of the objectives proposed as the search for responding the research questions by itself bring to the forefront many interesting findings on the current situation found at Brazilian universities and existing issues for further improvement.

## **1.6 Organisation of the study**

This study is organised into five chapters. Chapter one introduces the main motivations and purposes for the development of this thesis. The research problem and associated questions are defined together with the potential significance and delimitation of the study. Chapter 2 presents the theoretical foundations used for the analysis. The main concepts, models and research orientations

borrowed from the innovation studies area are presented during the literature review. It is paid special attention to the role of universities within innovation systems and the structures deployed for the transfer of technology at the institutional level. The analytical framework that guides the data collection is explained. Chapter 3 aims to allow the reader to become acquainted with the Brazilian background and current context with regards to the consolidation of the national innovation system and the role played by universities. The fourth chapter presents the methodological approach used and the research design. The adopted criteria for case study selection and interview design are explained. Chapter 5 is devoted to present the main findings reached through the analysis of the individual universities selected. Finally, Chapter 6 closes the study by presenting an overview of the main concluding remarks grouped according to themes aimed at providing an interpretation of findings at a more general level. Some policy recommendations and ideas for future studies are included.

## **2. METHODOLOGY**

This section aims to present and justify the research strategy, methods and design used to accomplish the present study.

### **2.1 Research method**

In this section it is described what research method was selected and the issues that justify this choice.

Silverman (2010) distinguishes three different types of dissertations each of them implying the use of certain methods. The three types are: theoretical (systematic analysis for theory development); methodological (development of a new method) and empirical (analysis of a specific body of data related to real world problems). The present thesis is primarily characterised as an empirical piece of work since it searches to find empirical evidence from primary data sources in order to answer questions posed about a real and contemporary phenomenon.

Another aspect that influenced the choice of research methods for this work is the nature of the data to be collected. The research focus is placed on investigating how university management was affected by the introduction of a new legislative framework and more specifically, how do specific institutional profiles may be differently affected by it. These considerations are to a large extent concerned with data of contingent nature, dependent on the idiosyncrasies of the cases studied rather than on the bulk overall outcomes measured by statistical reports or surveys.

As the area of concern of this thesis is underexplored in the Brazilian context, this study has an exploratory nature with some descriptive features. The main purpose of such qualitative exploration is to investigate how has the administration of Brazilian universities been changed to promote technology transfer as an effect of the 2004 Innovation Law. The future findings may provide, on the one hand, insights on how other similar institutions to the ones studies may benefit from their experiences and, on the other hand, to contribute to future improvements on how to make policy-making more relevant and efficient to the university setting.

Creswell (2005) present some key factors that should be consider during the choice of a qualitative approach. The first is related to the essence of the research problem. A qualitative approach is best suited to getting a deeper understanding through exploration rather than searching for a specific trend or explanation by means of a quantitative approach. This first factor is intimately related to

the objectives of the present study as it helps to understand a complex process that is underexplored. Secondly, Creswell reinforces the importance that the potential research audience is familiarised with the research approach chosen. As this study aims to shed light on a topic that is of relevance to several stakeholder groups such as educational researchers, university managers and policy-makers it is important to clarify to the readers the basic characteristics and limitations of the study. Finally the choice between a qualitative or quantitative (or even mixed) method is to a large extent associated with the skills and experiences of the researcher conducting the study. A qualitative approach requires skills related to gathering data through observing or interviewing individuals and also on the interpretation of this material.

Given the nature of the research questions posed for this study and the reasons explained above, a qualitative research was deemed the opportune approach. The present study aims to undertake explorative research as a way to shed some light on a current underexplored situation. A qualitative approach is considered to be the appropriate one to research the topic as it permits a closer exploration of how a common factor may have different effects depending on the circumstances of the elements under analysis. As further explained in the next sections, following an initial secondary data analysis, a multiple case study design was envisaged to collect and analyse primary data through in-depth interviews and institutional documents review. The usage of multiple cases, as explained by Creswell (2005, p. 439), serves the purpose of “illuminating a particular issue” being in this case the response of different HEI to a common environmental factor (the IL).

## **2.2 Research Design**

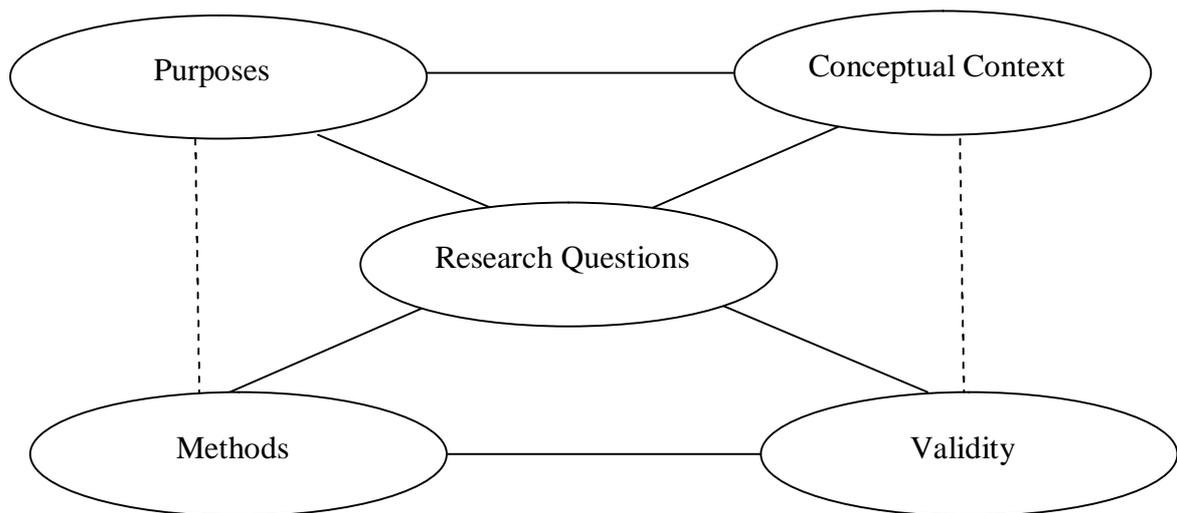
Maxwell (1996) proposes a flexible interactive model for qualitative research design. This model differs from traditional ones because it refuses the idea of research being a “linear process” constituted of sequential stages from problem definition to the formulation of conclusions. Maxwell’s highlights that sequential models are not adapted for qualitative research since its components frequently need to be reformulated in response to new developments or changes. According to Hammersley & Atkinson (1983,p.28) “research design should be a reflexive process operating at every stage of a process” (Maxwell, 1996, p. 2).

The reason why such a model is considered by the author to be “flexible” and “interactive” is mainly due to the fact that the activities within the research process, such as data gathering and

analysis, theory development and definition of research questions, are continuously carried out in an interconnected and mutually influencing way.

Maxwell's model is composed of five elements wherein the core one (research questions) underpins the development of the study. The other four elements can be appraised in the figure 7:

**Figure 1.** Maxwell's interactive model of research design



Source: Maxwell (1996)

The Research Questions feature at the central of this model influencing (and being influenced) by the development of the other elements namely: Purposes (goals of the study), Conceptual Context (theories and frameworks), Methods (strategies and approaches) and Validity (reliability of results). These elements were taken into consideration during the development of the present thesis work. During the thesis work this rationale was often perceived as the research question remained fixed whereas other aspects were developing in mutually transformable ways.

### **2.2.1 Case study design**

Some aspects are deemed important in order to contextualise the choice of a case study methodology as especially for the choice of the selected institutions to be studied.

The IL introduces a new framework for the technology transfer activities performed by public research institutions, establishing several duties to be carried out and opening up new avenues for collaboration with the private sector. Nevertheless, from the text of the law it is possible to observe that its operationalisation and implementation is left to a large extent to the discretion of each institution. The establishment of an internal administrative instance though, the NIT, is a common

compulsory requirement, something that was also complied with by some private institutions in a spontaneous manner. It is important to highlight that there is an enormous variability on the maturation level of TT activities found amongst Brazilian universities. While some have a long track record featuring as top patenting organisations in national rankings, others are starting to create an institutional capacity in order to respond to the requirements of the IL.

As the present study focuses on the effects of the IL over universities from a managerial standpoint, changes and reforms at the institutional level introduced in connection with the IL will be investigated. The diversity of university profiles found at the Brazilian university system provides a strong indication that the IL may have been operationalised and impacted institutions in very different ways. On this basis and in line with the results of the initial investigation explained in section 4.3.3, the present analysis is structured around four specific institutional profiles considered to represent the great majority of research universities in the country. Each institutional profile category will be explored by means of an empirical analysis of a specific showcase institution. All the four universities have one common characteristic though: they were selected for displaying an outstanding performance within its category with regards to the promotion of TT as a strategic institutional function.

The case study methodology is considered to be suitable for holistic and in-depth investigations (Feagin, Orum, & Sjoberg, 1991). It enables the collection and presentation of detailed information about a particular entity in a particular context. The purpose is to try to identify causal relations associated to the underlying circumstances that can produce some conclusions or answers to the research questions.

Yin (1994) provides an extensive work regarding the case study methodology. The author presents five ways to undertake social science research, as exposed in the table, experiment, survey, archival analysis, history and case study.

**Table 1** - Relevance situations for different research strategies

Strategy	Form of research question	Requires control over behavioural events?	Focus on contemporary events?
Experiment	how, why	yes	yes
Survey	who, what, where, how many, how much	no	yes
Archival analysis	who, what, where, how many, how much	no	yes/no
History	how, why	no	no
Case study	how, why	no	yes

Source: Yin (1994, p. 6)

As the present study focuses on contemporary events that are underexplored the case study methodology is a suitable choice. Additionally, there is an attempt to search for explanations for context-bound causal relationships best approached via case studies.

Yin also provides a categorisation for case studies design that is of particular relevance for the present thesis. There are four main types of case studies: (1) single-holistic case, (2) single-embedded case, (3) multiple-holistic case and (4) multiple-embedded case. This categorisation is done according to the number of cases analysed in combination with the number of units analysed within the case studies.

**Table 2.** Types of case studies designs

	<b>Single-case design</b>	<b>Multiple-case design</b>
<b>Holistic</b>	Single-holistic	Multiple-holistic
<b>Embedded</b>	Single-embedded	Multiple-embedded

Source: Yin (1994)

For the present work is based on a multiple-holistic case study approach focused on the understanding of the possible different dynamics of contemporary events in which the researcher lacks control over the variables under analysis (Yin, 1994).

### **2.2.2 Stages of data collection**

The research design is organised in two stages of data collection and interpretation: Stage 1 consisted on an exploratory investigation aimed at identifying the relevant university profiles and respective showcase universities to be studied. Stage 2 consisted in a qualitative analysis of collected secondary data from the selected NITs in order to present an updated account of the institutional background that serves a second function of providing an overview of the type of universities it represents. Additionally, a qualitative study based on in-depth interviews of key managers from the NITs selected was performed with the aim to clarify the ways by which the Innovation Law had an impact over university TT management. It is believed that this design can produce the necessary data to answer the research questions posed and to draw related conclusions. The next sections present more details about each of these phases.

### **2.2.3 Initial investigation**

After setting the main research question, purposes of the study and related conceptual frameworks an exploratory investigation was undertaken in order appraise the optimal ways to study the issues at stake. The main purpose of this exploratory investigation was to check how suitable a case study methodology would prove to be considering the variation of institutional profiles found in Brazilian higher education institutions. For this reason a multiple and holistic case study design was preferred. There are, obviously, several ways to create a systematic categorisation for university profiles.

For the purpose of this thesis, and according to the literature identified during this exploratory stage, two factors were identified to influence this differentiation in the Brazilian context of technology transfer activities at universities (Lotufo, 2009; Garnica & Torkomian, 2009): (1) the legal status of the university (public or private) together with the territorial jurisdiction (federal or state) as these factors provide different contexts in terms of funding and regulations, and (2) the maturity of each institution in the management of TT. These two conditions were taken into consideration when designing the criteria for the number and profile of cases to be selected.

Thus, the categorisation created for the selection of the multiple case studies aims to cover the conditions under which the key universities, in the TT context, are operating in the moment.

After defining the categorisation considered to respond to the study aims, the selection of the showcase institution was purposive (Silverman, 2010, p. 141) meaning that apart from attending the

criteria established the institution was selected amongst those considered to be the most dynamic in the country in fostering the cooperation with business counterparts.

The following table provides an overview of the categorisation created:

**Table 3.** Criteria for the selection of showcase institutions

<b>Label</b>	<b>Legal Status</b>	<b>TT Maturation</b>	<b>Showcase institution</b>
Type 1	Public State	Consolidated	UNICAMP
Type 2	Public Federal	Consolidated	UFSCAR
Type 3	Private	Consolidated	PUCRS
Type 4	Public Federal	Starter	UFABC

The four selected institutions were contacted and invited to participate in the analysis. Favourably, all the four institutions were very interested in the purposes of the study and in participating as a showcase institution.

#### **2.2.4 Secondary data collection**

Up-to-date background material was collected in order to present a first overview of the current state of the NITs existing in Brazilian universities. This type of information was mainly collected from institutional documents concerning the TTO, scientific literature published by Brazilian researchers, official reports published by the Ministry based on data facilitated by each institution and other quantitative data. Other sources of data were scientific articles published by researchers studying the academic technology transfer field.

In addition, and in order to present the profile of the analysed institutions, more specific background material was collected. The institutions were asked to provide some related documents and archives. This information helped not only in introducing the case profile but also in defining the areas for further in-depth focus during the interviews and how to shape them according to the framework of analysis.

### **2.2.5 Interview design**

The first stages permitted to gain insight on the background and context of the selected institutions with special emphasis over the TT perspective. Based on this foundation, four in-depth interviews with key managers from the selected TTOs were foreseen with the purpose to acquire a deep the understanding on the core issue of the thesis: how the innovation law promoted changes over university administration considering the circumstances enjoyed by each institutional profile.

The interviews undertaken follow a semi-structured format (Maxwell, 1996). The choice of a semi-structured format is justified since the interview is not highly structured as in the case of closed-ended questions nor it is totally unstructured incurring in the risk of losing focus on the issues of interest. A semi-structured approach then, offers the possibility to guide the interview based on the proposed theoretical framework in use.

After an extensive contact via e-mail, they were carried out by telephone calls over the internet and lasted in average 60 minutes. Face-to-face interviews were initially considered however the geographical dispersion of the case studies and associated mobility costs hindered this possibility. One “best informant” from each institution was selected (Creswell, Educational research : planning, conducting, and evaluating quantitative and qualitative research, 2005) according to the criteria explained further on in this section.

A semi-structured approach to the interviews was considered the most appropriate since it enables interviewees to respond in an open-ended way making it easier to identify different interpretations and opinions amongst the participants over the same issues. The semi-structured approach is perceived to be more effective since it combines the structure of the issues under analysis blended with the flexibility needed to explore different patterns. It also permits that the interviewer (researcher) to react promptly over emerging important issues. In order to extract the desired information, an interview guide containing open-ended, theory-driven questions was used in the exact same version for the four institutions.

The rationale guiding the designing of questions was two-fold: first it aimed to identify the main idiosyncrasies particular to each institution in order to establish its profile and context and support (or dismiss) the categorisation criteria used. Secondly, and more importantly, the questions are aimed to measure the extent to which the Innovation Law has been an element that fostered the process of change in the management of TT at universities.

The choice of interviewees was based mainly over two factors: the longevity within the NIT (preferably linked to it since its establishment) and holding a position that enables a comprehensive overview of all its dimensions. These two criteria naturally led to the necessity to interview one of the NIT officers with a coordinating role.

### **2.2.6 Constraints and strengths**

Some constraints apply to the feasibility of this study. The first and main one is the short period occurred since the passage of the IL (six years). So far, there was no official evaluation carried out on the effectiveness of such policy nor any improvements or amendments.

Moreover, since university TT is still a novel function within most HEI in Brazil, the great majority of universities in the country are still in the process of building the basic institutional structure needed. A strategy deployed to avoid a situation where no clearer results were perceived was the selection of three out of the four case studies with sufficient experience in the subject.

The size, heterogeneity and geographical dispersion of the university system in Brazil were another barrier to the feasibility and design of this study. However it is important to remember that its primary aim is not to produce generalisations to the whole university system but rather to provide insights on how the process is being perceived in some specific institutions with marked profiles.

Finally, the time available for carrying out the thesis research work (four months) was another limiting factor for a broader or more comprehensive production of results.

### **2.2.7 Reliability**

Although reliability and validity are two concepts derived from quantitative research, a brief discussion about these issues is considered to be valid within a qualitative study since it permits to evaluate the quality of research by third parties.

According to Flick (2006) reliability regards to the need of clarification to the reader on the extent of the author's interpretation of the acquired data. In this work, in order to strengthen reliability of used data, all interviews were recorded in digital quality which made transcription and interpretation easier and not reliant on hand-written notes. Moreover, the interviews were structured in order to ensure similar information modules for the three case studies. This was tackled through the use of identical interview guides (see Appendix 1).

For Hammersley (1992, p. 67) reliability refers to “the degree of consistency with which instances are assigned to the same category by different observers or by the same observer on different occasions”.

Regarding the representativeness of the selected case studies, it is important to say that the theory-driven selection aims to provide a fair reflection of the situation found at institutions with similar profiles. It is considered that the findings can be generalised with a minimum of reliability as far as the reader can identify the criteria for the cases selection to match a certain target context. Moreover the findings are not intended to reflect directly the actual situation found at every HEI nevertheless, for a matter of practical usefulness, they may be insightful for future institutional reforms as a way to avoid potential problematic areas or borrow from other successful experiences.

One of the most challenging and important aspects of interviewing is to get more accurate information. In order to reinforce reliability, neutral probing of answers was used as a way to minimize misunderstandings on behalf of the interviewer and interviewee.

### **2.2.8 Validity**

Although it is very hard to talk about validity within a qualitative study it remains a crucial issue to be dealt with. Creswell & Miller (2000) define validity as “how accurately the account represents participants’ realities of the social phenomena and is credible to them”. In this sense, in studies such as the present one, validity is more related to the inferences drawn from data than on the data itself. The views of enquired persons are then analysed through the lens of the theoretical framework used. A more constructivist approach is taken since a pluralistic and sensitive to the context interpretation is considered necessary for the analysis to be relevant to HE practitioners and policy-makers.

In a research project there are several types of validity that should be sought, for instance: construct, internal and external validity (Hoyle et al. 2002). Construct validity means that the theoretical constructs of cause and effect properly represent the real situation it attempts to model.

During this work this issue was considered by modelling the empirical tools used on theoretical issues that have been extensively discussed and produced consensus amongst several researchers. Although a precise measurement is hard to achieve in a qualitative study, it is important to emphasize that the primordial aim is to explore current trends and specificities to each type of institutional profile. The very assessment of the suitability of the methodology used (constructs) is also a valuable output of the study.

Internal validity is concerned with the causal relationships between the variables being studied. It is possible to say that the core research question of this thesis searches for the relationship between two dimensions: the policy context and administrative changes or improvements at the institutional level. Although these dimensions are not properly considered as “variables” it is possible to say that this is the internal validity sought after within this work.

Finally, external validity occurs when the causal relationship discovered can be generalized to other elements or contexts. One of the objectives of the categorisation created is that the findings could be organised on a relevant way to institutions characterised by similar features. Nevertheless, external validity is limited due to the resources and time frame available for this work. Differences in perceptions on behalf of institutional leaders and academic community on the missions of the university also affect the generalisation even in the case of extrapolating results to similar institutions.

In general terms, as properly noted by Silverman (2010), all attempts to analyse collected data, including those of quantitative nature, involve the act and risks of interpretation. As a strategy to avoid these risks, during the present study it is attempted to provide the reader not only with hard facts and interpretations over findings but also with a rich description of the settings and situations found. These descriptions were deemed necessary in order to enable the different readers to be also able to draw (or relocate) the findings reached.

Moreover, it is believed that the usage of multiple sources of evidence can increase validity. In this sense, each of the case studies was established based not only on the primary data obtained from the interviews but also from other published sources (academic, official, institutional).

Finally, the coherence between the findings and the concepts borrowed from the analytical framework was verified systematically in order to avoid a biased interpretation.

### 3. CONCEPTS AND ANALYTICAL FRAMEWORK

This chapter examines the literature relevant to the study of the role of university research in the innovation process and introduces the recurring themes and concepts relevant for the analysis to follow.

#### 3.1 Technological innovation

It is widely accepted that technological change and other types of innovations are the main drivers to socio-economic growth and development (Fagerberg, Mowery, & Nelson, 2006).

The OECD (2005) provides the following encompassing definition for the innovation concept:

*“An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method or a new organisational method in business practices, workplace organisation or external relations”*

Thus, more than just an invention, an innovation involves the requirement that it is successfully implemented in society.

In this thesis, and in line with Lundvall (2010), the term Innovation is used to make reference to the phenomenon that is part of our modern economy which comprises learning, searching and exploring, and eventually achieving results such as new products, new techniques, new forms of organisation and even new markets that become widely used in society. Nowadays, Innovation has become particularly crucial for the long-term competitiveness of firms and to developmental policy-making (Lundvall, 1997).

A more formal definition for the term is provided below:

<p><b>Definition of Innovation:</b> “In an essential sense, innovation concerns the search for, and the discovery, experimentation, development, imitation, and adoption of new products, new production processes and new organisational set-ups” (Dosi, 1988, p.222)</p>
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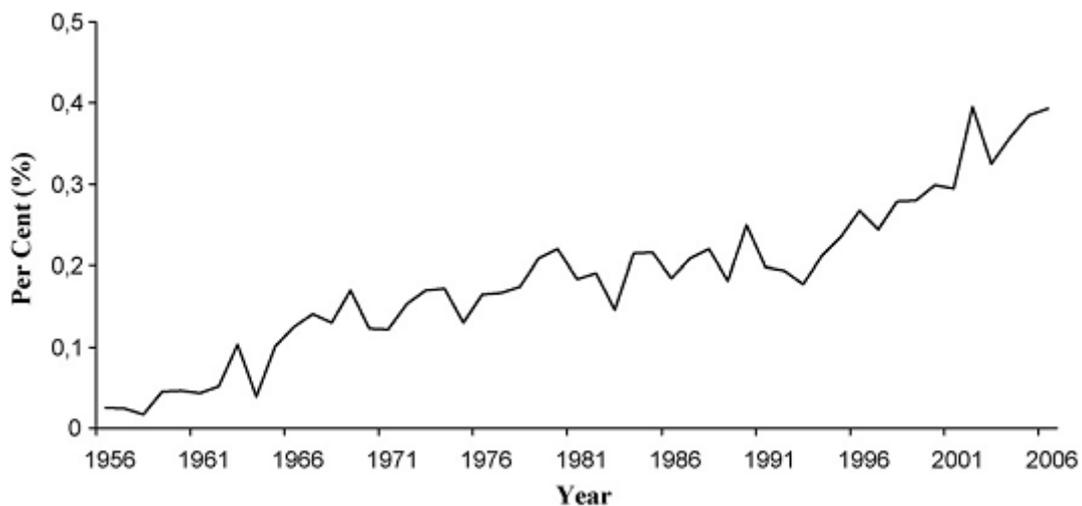
In a narrower sense, Technological Innovation is a term used to refer to the process through which new or improved technologies are developed and subsequently widely adopted in society. It is widely recognised that two of the main types of activities that lead to the implementation of innovations are the ones of scientific and technological nature (OECD, 2000). This is especially true nowadays due to the fact that most radical innovations are rooted in science such as information and

communication technologies, biotechnology and material sciences. In addition, new technologies are characterised by an increasing complexity and multidisciplinary which obliges firms to more links with science and often recur to external knowledge providers such as universities (Gibbons, Limoges, Nowotny, Schwartzman, Scott, & Trow, 1994).

### 3.2 Innovation and economic development

Research on the role of Innovation within socio-economic development has shown a tremendous growth in recent decades. It is characterised by a highly cross-disciplinary of various fields (Economics, Sociology, Organisational theory, Psychology, Marketing, etc) that provide different insights on the topic (Fagerberg & Verspagen, Innovation studies - The emerging structure of a new scientific field, 2009). This led the Innovation studies field to take several theoretical strands and provoke an explosion of related publications (see figure below).

**Figure 2:** Science articles with ‘innovation’ in the title 1956–2006 (in percent of all social science articles)



Source: ISI Web of Science extracted from Fagerberg & Verspagen (2009)

The link between innovation, knowledge and economic development has been acknowledged for a long time. Howells (2005) states that since the 1890’s there is the understanding that both knowledge and economic activity directly and indirectly affects each other in cycles of change. The same author continues analysing how the rationale underpinning this perceived phenomena has evolved through time: following Schumpeter’s seminal work (1934) many scholars have gave their contribution on how new innovations, human capital and technological progress affect economic growth (Temple, 1999; Fagerberg J. , 1987).

These issues together gave rise to Innovation policy, considered a more complex and different field than Science policy, with a specific economic underlying rationale.

Lundvall (1997, p. 37), one of the key scholars investigation the links between innovation and development, provides the following definition for Innovation policy:

*“Innovation policy refers to elements of science, technology and industrial policy that explicitly aim at promoting the development, spread and efficient use of new products, services and processes in markets or inside private and public organisations. The main focus is on the impact on economic performance and social cohesion. Innovation policy has wider objectives than those of science policy and technology policy.”*

One aspect which is frequently highlighted in the literature is that there is an apparent shift of focus from “science and technology” to an “innovation” policy-making, which must be dealt with care since science and technology has broader effects and objectives than solely economic ones (Lundvall, 1997). It becomes thus clear that S&T has a great potential to contribute to economic development by being harnessed by an adequate innovation policy, nevertheless, it is in the hands of policy-makers to design policy frameworks that reflect the a balanced concern for scientific, social and economic rationales.

Within the context of an innovation policy-making with broader socio-economic goals, one concept that gains special impetus is that of Learning Economy (Lundvall, 1997; Peters & Olssen, 2005). The idea behind this concept is associated with the growing importance attached to the ability to learn as a crucial element for the economic success of individuals, firms, regions and national economies as a whole. Reinforcing the idea behind the knowledge-society, knowledge is the main resource and learning is the main process. In this sense, learning has a broad connotation and refers to the acquisition of knowledge and skills through formal education but also by means of practical experience and training.

As knowledge and learning capacity become crucial competitiveness factors, the access to the sources of knowledge acquire importance. Universities and research centres gain a prominent role, as traditional loci in society for knowledge creation and dissemination, scientific discovery and technology (Lundvall, National systems of innovation: Toward a theory of innovation and interactive learning, 2010). In this context, universities become one of the main actors (but certainly not the only one) in charge of knowledge creation and the training of highly skilled individuals.

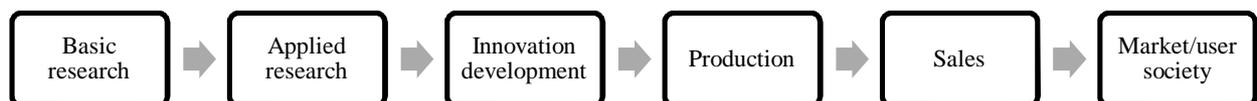
It is easily observed that universities are increasingly recognising the trends described above and responding in the form of lifelong learning initiatives, offering support for technology protection and exploitation, providing training modules and services for external companies, etc as ways to contribute with the learning capability of individuals and firms.

### 3.3 Models of technological innovation and the role of basic research in innovation

#### 3.3.1 The linear model of innovation

A previously widespread assumption (specially after the Second World War) was that the innovation was a result of a sequential linear process (Nelson, 1959; Arrow, 1962) composed by consecutive stages starting from research, then development, production and finally marketing, which largely characterises applied science. However, (Kline & Rosenberg, 1986) were very influential in changing this paradigm. Their counter argumentation to this model was based on the recognition that Innovation is the result of a complex interactive process. The authors highlight three main flaws of the linear model: first, it claims that research is the main driver of innovation while it is acknowledged today that users, both inside or outside firms, are the main source of needs that lead to innovations. Secondly, the process is characterised by several feedback loops between the stages of the process that often lead to unforeseen outcomes. Thirdly, the linear model underestimates the importance of incremental changes when very few innovations are of radical and disruptive nature.

**Figure 3.** The linear model of innovation



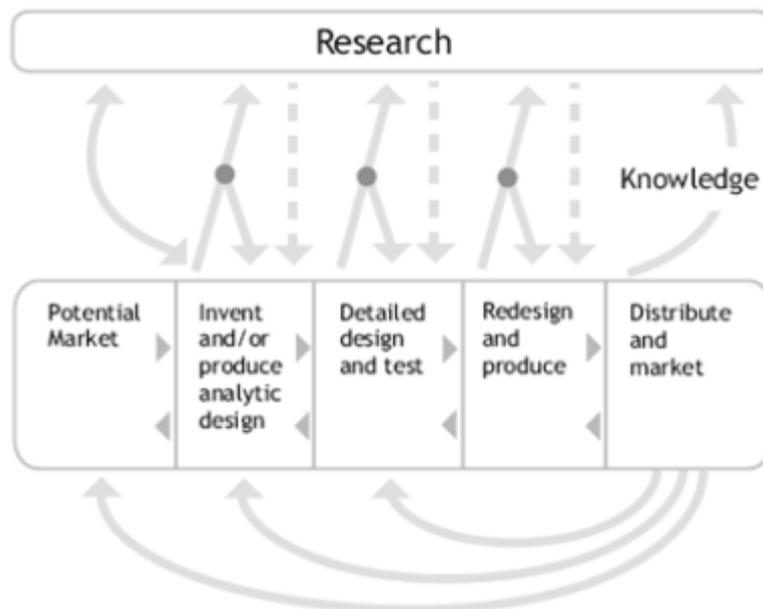
Source: **Gulbrandsen (2008)**

The linear model places a great deal of importance on basic research while ignoring the role of the other components of the chain. This importance is transformed into high expectations on the relevance and applicability of research results. It is appropriate to say, however, that even though this model is considered outdated it is still valid for a minority of cases and scientific fields such as Biotechnology where “linear” characteristics apply to its innovation process (Gulbrandsen, 2008).

### 3.3.2 The chain-linked model of innovation

The current prevailing model that is deemed to better explain reality is the so-called Chain-linked Model (Kline & Rosenberg, 1986). In the figure used to depict this model (see below) it is possible to observe that research and accumulated scientific knowledge continue to play a key role in the process, however, the numerous feedback loops indicate that other actors, skills and relationships may be crucial to overcome bottlenecks and transform research into widespread adopted innovations (Cohen & Levinthal, 1990).

**Figure 4.** The chain-linked model of innovation



Source: Kline & Rosenberg (1986)

### **3.4 Frameworks on the configuration of actors within innovation processes**

As the field of innovation studies grows, it becomes available a considerable offer of frameworks for the identification of the relevant actors and the analysis of the interactions amongst them. For the specific aims of this thesis, two frameworks are presented: the Triple Helix model and the Innovation Systems approach. Both frameworks are equally relevant for the analysis of the Brazilian experience however it is important to highlight some basic differences between them. The Innovation Systems approach considers the firms as the innovation engine with other organisations acting as support structures. The Triple Helix focuses on the interactions between university, industry and government and how these three spheres facilitate the emergence of hybrid organisations (such as incubators) as catalysts for the innovation process.

The reason behind the selection of these two frameworks is the impact that they had (and still have) over the development of the current innovation policy and on the emergence and dissemination of new arrangements (i.e. science parks, technology clusters, incubators, etc) at national and regional levels in Brazil.

#### **3.4.1 Mode 2 of knowledge production**

The discussion about scientific knowledge production modes has also an important impact on the emergence of Innovation studies and policies. Gibbons et al (1994) were very influential in disseminating the idea that science, from the mid 20<sup>th</sup> century onwards, had become substantially transdisciplinary and knowledge being produced in different contexts (closer to application milieus) than the traditional ones. Additional characteristics of this novel framework were problem-orientation, less-hierarchically organisation and more socially accountable. The Mode 2 label was used in order to distinguish this new paradigm from the old one (Mode 1) where the traditional research values and disciplinary norms applied.

Despite the popularity and huge outreach gained by the book published by Gibbons and colleagues, reviews on its propositions were not always supportive. Some scholars argued that it is more a political ideology than a real theory (Godin, 1998). Others criticised the supposed novelty of Mode 2 arguing that it reflects the very same organisation of science before its academic institutionalisation in the 19<sup>th</sup> century. This last argumentation was put forward especially by (Etzkowitz & Leydesdorff, 2000) two scholars that were also influential in the innovation studies by introducing the Triple Helix model.

### 3.4.2 The Triple Helix model

A triple helix of university-industry-government dynamic interactions constitute the core element of this theory put forward by Etzkowitz & Leydesdorff (2000) with the purpose to transcend the understanding of previous models of institutional relationships (e.g. *laissez-faire* or socialist).

This model brings to the forefront the new configuration of the three institutional spheres that shape innovation systems (both internally and between spheres), with the associate decentralisation of power from the state, the openness of the business enterprise and the increased role to be played by universities in the knowledge society. A key feature of the Triple Helix model is that it is a more university-centred approach, contrasting with others in which the business enterprise role is accentuated (Edquist C. , 2005).

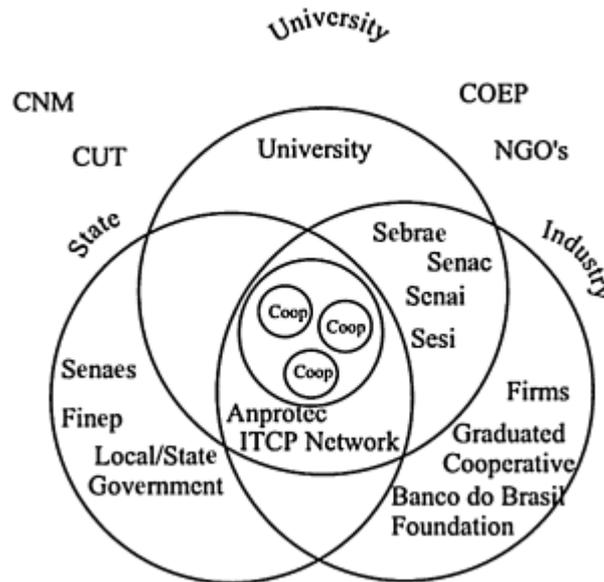
From its inception, in 1996, the model has fast gained momentum and the interest from academics and policy-makers across the world, especially in developing countries. This gave rise to the Triple Helix Association and the organisation of the Triple Helix International Conferences Series, having its 9<sup>th</sup> edition in 2011. The third edition of the Conference took place in Rio de Janeiro (Brazil) in 2000 after the first in 1996 Amsterdam and the second, 1998, in New York.

#### The Triple Helix in Brazil

Brazilian scholars state that the Triple Helix model had an important impact in the country policy-making (Dagnino, 2003). It initiated a shift by becoming the prevailing theoretical model which in turn affected the design of the current science and technology policy framework of the country. It is considered that the Triple Helix model not only influenced the actual innovation policy in place (such as the focus of this thesis the 2004 Innovation Law) but also contributed to the spread of institutional arrangements like technological business incubators, science parks and technology clusters. It also helped in promoting the understanding that the Brazilian universities shall to be more responsive to business needs in a sustainable way, an idea that was not very popular in the Latin American public university few decades ago (Arocena & Sutz, 2002).

One of the authors of the Triple Helix concept himself states that the developments in the Brazilian scenario and the convergence of interests from institutions of different spheres enabled the country to achieve a Triple Helix III configuration, something that has been serving as a model to other Latin American countries (Etzkowitz, Mello, & Almeida, 2005).

**Figure 5.** Triple Helix III in Brazil



Source: Etzkowitz, Mello, & Almeida(2005)

### 3.4.3 The Innovation Systems approach

It is widely acknowledged that no entity (either firm or knowledge institution) can innovate in isolation. For this reason, another key theoretical framework used to understand the intricacies of the innovation process at the macro level is provided by the Innovation Systems (IS) approach (Freeman, 1987; Lundvall, National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning, 1992; Nelson, 1993; Edquist C. , 1997) For the scholars from this tradition, innovation is the result of continuous interactions amongst the systems' main components: firms, universities, governmental organisations, users and other competing or collaborating firms (suppliers or customers). The Systems of Innovation is a dynamic approach that places the focus on the interplay of these institutions operating at different spheres (economic, social and political) and on their specific roles on promoting or precluding the innovation process (Edquist C. , 2005).

A general definition of IS is provided by Edquist C. (1997, p. 14) which states that it “includes all important economic, social, political, organisational, institutional and other factors that influence the development, diffusion and use of innovations.”

The broad definition of IS has derivate lines of study that focus narrowly on the national level (National Innovation Systems - NIS), on a certain technological area (Sectoral Innovation Systems)

or geographical region (Regional Innovation Systems) (Carlsson, Jacobsson, Holmén, & Rickne, 2002).

Earlier predictions that national governments would eventually become irrelevant alongside the globalisation process proved to be quite exaggerated (Lundvall, *The globalising learning economy: Implications for innovation policy*, 1997). Despite the fact that many elements of the innovation process are transnational or global (being science an example) in many instances, national governments still play an important role. National governments have the power to introduce standards and regulations, channel funds and create incentive systems. They are also generally in charge of the supervision of the higher education system and the research system. All this possibilities enable governments to design and implement specific innovation strategies and policies at the national level.

### **3.5 The role of universities in Innovation Systems**

Lundvall (1997) states that the innovation process is highly interactive and that the main types of interactions take place at the level of the different organisations involved in it. Collaboration with knowledge production centres (such as universities and research centres) are a central part for these interactions as scientific knowledge is fundamental in most cases for new technological advances. Thus the role of research universities is considered of uttermost importance as these institutions are sources of fundamental knowledge and also technological knowledge with industrial application.

The potential that universities have to offer for the strengthening of the NIS is frequently actively promoted by governments. Since the 1970's numerous governments worldwide have initiated coordinated efforts at the national level in order to exploit universities role and bridge the gap between universities and the productive sector. These endeavours led to the creation and proliferation of new arrangements such as science parks, incubators and bridging institutions which are perceived to be environments that facilitate innovations.

As far as legislation is concerned, the US Bayh-Dole Act of 1980 becomes a landmark as it is widely credited for improving University-Industry technology transfer in the United States by promoting university patenting and licensing of technologies to private firms (Henderson, Jaffe, & Trajtenberg, 1998). One of the main novelties introduced by the Act was that the ownership and control of the intellectual property resulting from federally funded research should be granted to the

performing institution and no longer to the sponsoring agency. This enabled institutions the chance to exploit research results commercially. Another key aspect was the requirement for the establishment of institutional IP policies and new organisational structures in charge of managing TT activities and protecting IP. According to (Nelson, 2001) the number of TTOs increased from 25 in 1980 to 200 in 1990 to the extent that nowadays they have become an integral part of nearly all US universities.

Despite the fact that between 1988 and 2003 US patents awarded to university faculty increased fourfold, the Act's real direct influence over these achievements is still questioned and subject of controversies. More strikingly, it has been serving as a model for several countries (Mowery & Sampat, 2005) which, as it will be seen later on, is the case of Brazil.

The recognition that universities are key institutional actors within the innovation process brings about several issues related to this closer relationship expected from academia and business counterparts. Some of these issues and the main theoretical strands that have emerged in the last decades connected with the role of universities are considered below.

### **3.5.1 The academic perspective**

Modern universities and higher education systems as a whole are strongly affected by structural trends that attach a broader and more utilitarian perspective to academic knowledge. In this context Bleiklie (2005) identifies two emerging groups of knowledge regimes: *academic capitalist regimes* and *public managerialist regimes*. Academic capitalist regimes are associated with university-industry alliances, economic drivers and the commercial rationale involved. Public managerialist regimes are driven by university-state alliances, political-administrative interests and a semi-competitive logic that make incentive policies a function of institutional performance.

Within the scope of academic capitalist regimes lie two conceptual frameworks that are extremely relevant for any analysis on the role played by universities: "entrepreneurial universities" (Clark, 1998) and "academic capitalism" (Slaughter & Leslie, 1997).

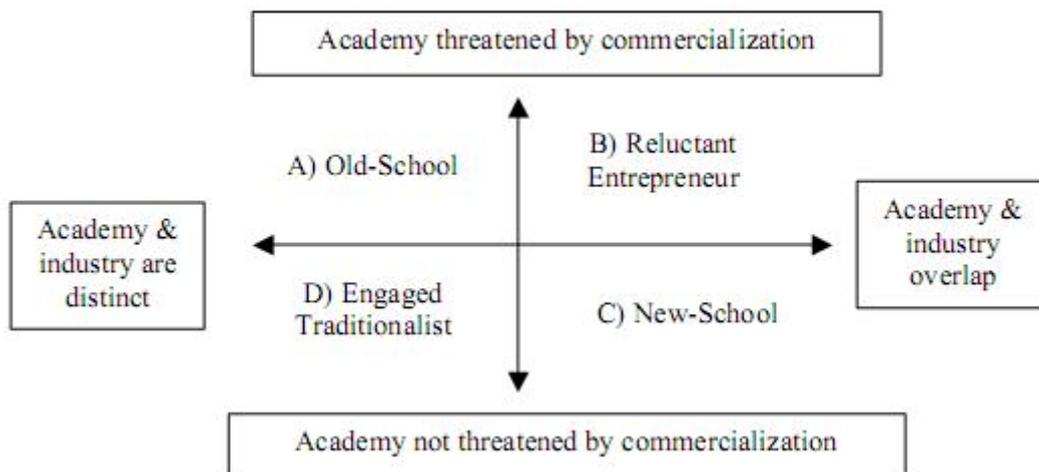
Burton Clark provides a comprehensive overview of what entrepreneurial universities are by exploring five European institutions' pathways on how they have responded to a complex change scenario of increasing societal demands and decreasing governmental support. Of especially relevance to the present thesis is the author's analysis of how a strengthened steering core should blend traditional academic values with stronger managerial perspectives and how the enhanced

development periphery can be based on a symbiosis of traditional academic departments with structures that manage their interface with the external world.

Sheila Slaughter and Larry Leslie, *op. cit.*, explore the factors and evidence on the increasing degree that higher education is subordinate to an extra-academic market. The neologism “academic capitalism” is used to represent the perceived threats that may accompany the transition from an idealistic model of research (mainly curiosity-driven and government-funded) to one heavily influenced by the dynamics of the global economy.

Despite some scepticism and criticising, the academic community is increasingly acknowledging the importance of the role universities can play by means of technology transfer for the prosperity of the societies where they are included. This leads to the development of new “social contracts” involving HE and the nation’s belief that it is one of the resources that will contribute to wealth creation and economic development for the country (Metlay, 2006). This social pact is largely discussed in the light of the social returns of science (Pavitt, 1998) and on the ways of protecting the public interest in technology transfer activities, especially those involving intellectual property rights (Boyle, 2008).

**Figure 6.** Typology of academic views on U-I relations through commercialisation



Source: Owen-Smith & Powell (2001)

These new pacts require long-term commitment of key players (government, political parties, firms, universities, trade unions) in a way that this shared understanding enables the creation of real initiatives. As far as universities are concerned, even though research and innovation-related activities may not be their main reason for existence, their performance in this area enhances their

social role and creates opportunities for more institutional autonomy and sustainability when adequately dealt with. The recent publication of the report “Managing University Intellectual Property in the Public Interest” on behalf of the US National Academy of Sciences provides a great deal of evidence on the basis of the large (positive and negative) experiences of North American universities in technology transfer (NAS, 2010).

### 3.5.2 University technology transfer

Within the context of knowledge-intensive societies, national systems of higher education are seen as strategic instruments for economic development and change. In order to accelerate the process by which academic research results are transferred and ultimately exploited by the productive sector and/or society at large, many measures and mechanisms are introduced and generally referred to as university Technology Transfer (TT) or University-Industry (U-I) linkages.

Despite the more favourable climate existent nowadays, bringing the scientific and the business worlds together is not necessarily an easy task. Both sides are strongly marked by distinct sets of values and missions which sometimes hamper the prospects of collaboration. For this reason part of the literature on U-I collaboration is concerned with the possible negative effects of it over the core values and functions of academic work (Dasgupta & David, 1994; NAS, 2010). Although part of this preoccupation is legitimate, the literature also presents various arguments showing that leveraging synergies through adequate mechanisms may lead to substantial benefits for both sides as it is discussed hereinafter.

Siegel *et al* (2004) consider that there are several stakeholders related with the University-Industry technology transfer process, nevertheless the key ones and their main functions are the ones below:

**Table 4.** Key stakeholders within the U-I technology transfer process

<b>Key stakeholders</b>	<b>Core function</b>
University scientists	Discovery of new technologies
University technology managers and administrators	Liaison between academic scientists and industry Management of university’s intellectual property
Firms/Entrepreneurs	Commercialisation of university-based technologies
Government/Funding agencies	Policies/Funding

Source: (Siegel *et al*, 2004)

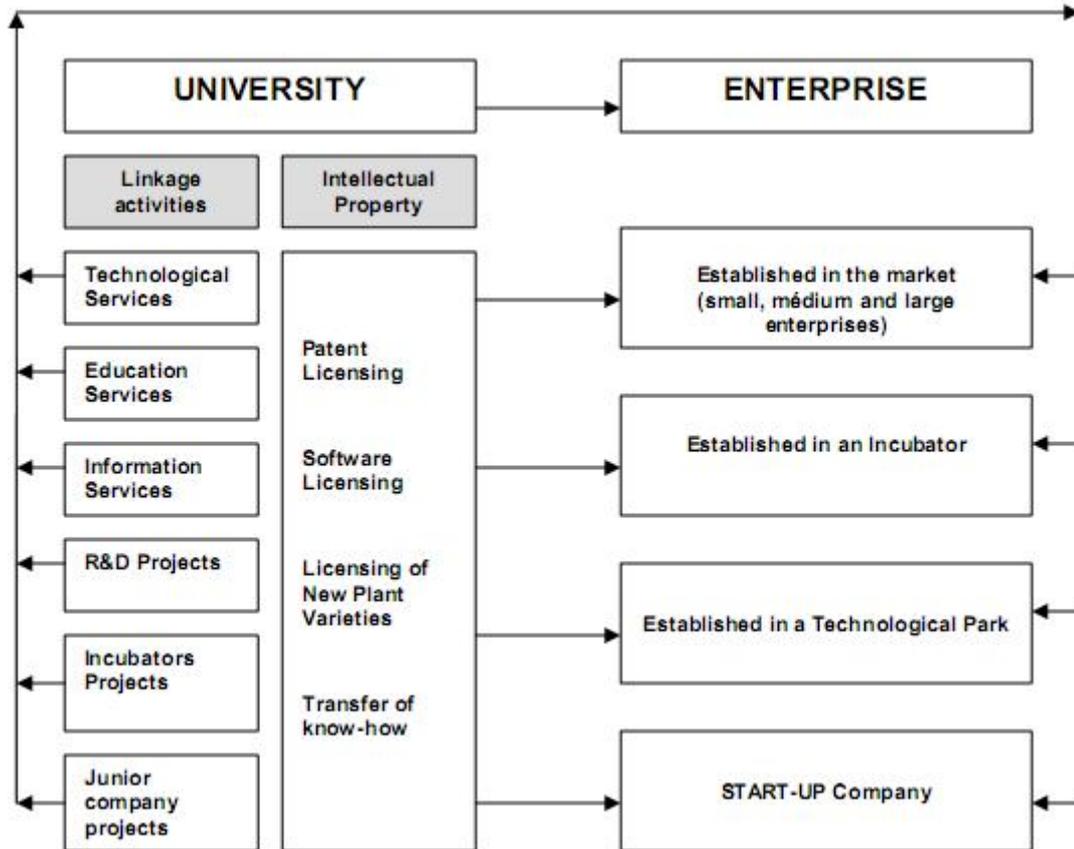
The transfer of technology between universities and third parties is often measured in terms of patents, licenses and contracts established with industrial partners (which are more easily quantified

than other types). Nevertheless, the process of knowledge and technology transfer originating from universities to the private sector is much broader and takes numerous forms (Foray, 1997). The main types of mechanisms are the following (Schartinger, Rammer, Fisher, & Frölich, 2001) (NAS, 2010):

- The movement of highly skilled students to public and private employment;
- The publication of research results in the open academic literature (including joint publications);
- Personal networking between producers and users of new knowledge through professional meetings, conferences, etc;
- Collaborative research projects, joint research programmes;
- Tailor-made vocational training;
- Contract research;
- Faculty consulting services;
- External entrepreneurial activity of academic staff;
- Licensing of intellectual property to firms or spin-off companies;

The following figure offers another perspective for the understanding of the ways (commercial or not) universities transfer technologies to the enterprise sector:

**Figure 7.** University-enterprise technology transfer processes



Source: Ritter dos Santos & Solleiro (2006)

Drawing from this set of mechanisms it is possible to observe that technology transfer may occur through both commercial and non-commercial arrangements although all of them have the potential to contribute to national and regional economic growth.

### 3.5.3 Benefits and costs of TT

Evidently, the cooperation between universities and business counterparts only happens when the matching of synergies from both sides will potentially produce mutually beneficial outcomes.

In this section we explore the main benefits or incentives that foster the participation of universities with industry but also the drawbacks of such collaborations.

U-I collaborations enable academic institutions to tap into new sources of complementary expertise, equipment and research problems. These possibilities reinforce the experience offered to students, by exposing them to private research problems and eventually enhancing future prospects of job

placement. Collaboration with industrial partners, especially those at the surrounding environment, fulfils social demands for relevance to regional development (Arbo & Benneworth, 2006) while at the same time providing extra sources of funding (CPB/CHEPS, 2001). Since universities are not profit maximisers, funding shall not be considered as a primary incentive for them to undertake U-I activities. Moreover, as further explored in the next section, TT financial gains taken solely rarely constitute a worthwhile reason for universities to cooperate with private counterparts. Although the funding generated may not constitute a substantial source of revenue for the institution, it does help financing related administrative costs and financially rewarding research groups involved.

Possible drawbacks or costs associated to these activities involve potential distortions of academic research and training agenda from “basic” towards “applied” research, diversion of energy and commitment of faculty from the core university missions and a weakening of researchers’ commitment to “open science” due to secrecy requirements (Dasgupta & David, 1994; Mowery & Sampat, 2006).

Although there is a substantial body of literature concerned with the negative effects attributable to commercially oriented research and its potential to undermine the traditional missions of the universities, recent comprehensive research reviews (NAS, 2010) have found little evidence on this sense. Moreover, some studies stress the fact that some kinds of technology transfer activities not only don’t hamper basic functions but have a complementary effect (Meyer, 2006; Buenstorf, 2009). A recent study (Oliveira R. , 2011) conducted with Brazilian researchers explored the underlying reasons that motivate these academics to get involved in technology transfer through the protection and commercialisation of research results and the types of impact on traditional academic activities. Although commercialisation of academic results is a recent phenomenon in Brazil, and quite often criticised, the study results have showed that the interviewees experienced several positive impacts such as the increased quality over teaching activities, increased prestige and better funding possibilities while potentially negative effects were easily handled by the researcher intervention.

As U-I interactions grow in number and in complexity, universities are increasingly urged by governmental authorities (BRASIL, 2004; EC, 2008) to set up structures in charge of facilitating this process and offering professional support to the academic community. Commonly known as Technology Transfer Offices (TTO) these internal units act as intermediaries, bridging the academic offer to external matching opportunities. Other types of intermediaries are technology and

innovation consultants, technology and science parks, incubators, information systems and contact platforms, etc (Polt, Rammer, Schartinger, Gassler, & Schibany, 2001).

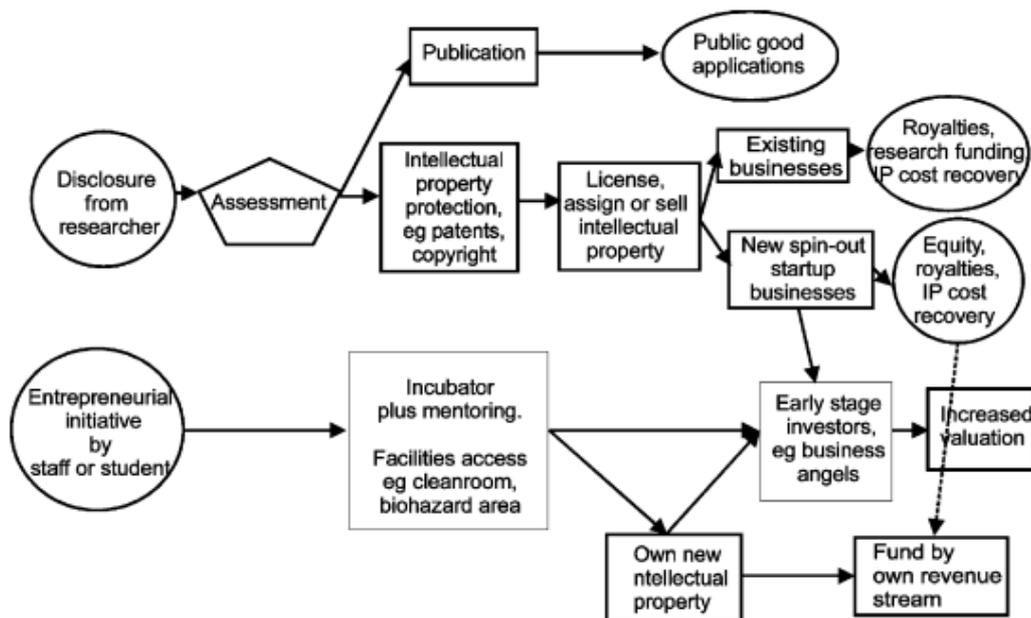
### 3.5.4 The Technology Transfer Office (TTO)

The transfer of ownership of intellectual property from governments or researchers to institutions, which occurred in most countries during the last decades, encouraged universities to establish specific structures (TTOs) dedicated to the promotion and management of technology transfer (OECD, 2003).

The basic functions of the TTO are related with providing in-house research groups with the complementary assets needed to engage in joint collaborations with industry. For instance at the internal level they provide information and raise awareness on TT activities, perform research auditing in order to map the institutional portfolio, offer support on legal issues such as contracts, intellectual property management, spin-off companies creation and on the design of incentive schemes. Outside the institutional limits they enhance networking with potential partners, search for additional sources of funding and participate in thematic networks.

The following figure provides an overview of the main commercialisation channels of university research. Each of these steps are generally supported by the professional assistance of TT officers as they involve a great deal of legal and administrative effort.

**Figure 8.** Commercialisation mechanisms for public sector research



Source: Hindle & Yencken (2004)

All OECD countries have been struggling to guarantee that public research organisations make a contribution to development by protecting the intellectual property and commercially exploiting the ownership of research results (OECD, 2003). The objective is to transform universities and research centres into engines for technology-based innovation. This trend has been followed by emerging economies as is the case of Brazil. The 2004 Innovation Law requires all Brazilian public research universities to establish a dedicated technology transfer office referred to as NIT (*Núcleo de Inovação Tecnológica*).

### **3.5.5 Technology Transfer and Funding**

Another recurrent reason used as an argument in favour of university TT activities (especially research commercialisation) is that it promotes income generation and funding diversification (EUA, 2010). From several perspectives, funding has become a critical and controversial issue affecting higher education governance both at the system and institutional levels. A scenario of greater public financial stringency perceived in most OECD countries in the last decades has considerable decreased public funding levels for the core tasks of universities. Adding to this situation is the fact that as modern research activities increase in complexity they also become extremely expensive.

These drivers, in combination with targeted policies aimed at promoting university TT, have yielded some universities to generate large amounts of funds from the licensing of patents (AUTM, 2008). Although these achievements are highly publicised in the media and by universities themselves as a key indicator for TT performance, some scholars highlight other important issues associated to income generation that are generally not deserved attention. Kordal & Guice (2008) claim that statistical data on university patenting and licensing activities should be interpreted with caution. Impressive data may be misleading since a large annual income figure may be the result of a one relatively rare license agreement. Additionally, most technologies have a very low rate of exploitation success requiring institutions to rely on an extensive portfolio and considerable time and effort to actively promote it.

This type of analysis provide important evidence supporting the case that TT and commercialisation of research results should not be viewed solely on the basis of income generation as usually universities' overall expenditures in intellectual property protection and management surpass net income generated by licensing and royalties (NAS, 2010). On the other hand, there is a growing

consensus that greater emphasis should be placed on the potential of other forms of TT such as the movement of students and researchers to the productive sector and collaborative research.

### **3.6 Analytical Framework**

The primary objective of this analysis is not to assess the effects of Innovation Law over the innovation-related outputs of universities but, rather, to explore how the passage of this new legislation promoted positive administrative changes for the university's structures in charge of (or recently put in place for) the management of TT activities.

With this purpose in mind, a literature review was performed in order to gain some insight on what factors are considered to influence the most the performance of university-based technology transfer organisations. The existing literature in the topic has come to the conclusion that university technology transfer outcomes may substantially depend on organisational practices (Siegel, Waldman, & Link, 2003). This review raised my awareness on the importance of the topic and fostered the search for specific elements that are considered by academics and practitioners to be critical factors behind the effectiveness of TT activities.

In this regard, the works of Debackere (2005) and Siegel (2004) are of particular relevance. Both scholars' research perform an in-depth analysis of the organisational and managerial factors that are identified as central behind successful U-I collaborations.

Siegel's makes use of a qualitative inductive approach based on interviews with three stakeholder groups: academics, administrators and entrepreneurs from North American institutions to explore the role of organisational practices within the U-I collaboration process. His study permits to appraise what are the main underlying motives to undertake this type of cooperation, identifies the main channels and how each group's perceptions vary in several aspects. One of the main results achieved is that all these discrepancies reinforce the importance of organisational and managerial factors as a strategy to overcome barriers and bottlenecks for the U-I cooperation.

Debackere's offers a comprehensive overview of the latest studies on the effectiveness of TT mechanisms. With the aim of shedding light on how to increase effectiveness of U-I practices he provides a methodological framework based on several factors related to the organisational structure, processes in place and context present within and surrounding the university.

The conclusions reached by Siegel's reinforce the importance of certain factors for the successful promotion of TT. The set up of "reward systems", or incentive systems, is considered an effective strategy to reinforce and praise the behaviour of TT-active researchers. Financial incentives are commonly used but also some more academic-oriented practices can be used such as the consideration of TT activities within tenure track systems. With relation to the selection of personnel in charge of running the TTO, certain "staffing practices" that are based on a match of the necessary technical and soft skills as pre-requisite for U-I interface tasks are positively related with the good TT management. Another critical issue is the design of flexible "institutional policies" that enable university researchers to be more interested in engaging in TT through the institutional pathway instead of succumbing to informal relationships with external partners. It is necessary to ensure the provision of the necessary "resources" to comply with the institutional mission regarding TT and, finally, the commitment to eliminate "cultural and informational" barriers that hamper TT process.

Debackere raises the attention to similar issues and, in addition, highlights other important factors such as the importance of the "configuration" of the TTO within the organisational structure. The centralisation or decentralisation of TT support structures are considered having an important impact over the results achieved. A more centralised approach is considered common in most universities, however with time and experience, decentralisation has been acknowledged for improving TT efficiency. Another critical issue mentioned by Debackere is the important role played by external "contextual factors". In the present study, the IL itself is seen as a major contextual factor for the present analysis.

Together these two frameworks serve as analytical lens to explore how Brazilian NITs are organised and what types of administrative changes were sparked by the Innovation Law with regard to these aspects. Table 2 summarises these critical factors.

**Table 5.** Critical factors for TT effectiveness at the university setting

<b>Factor category</b>	<b>Related issues</b>
Organisational structure	Autonomy from government Internal autonomy Institutional TT policy Specialised structure Centralisation: TTO centralises all functions Decentralisation: matrix structure – TTO only offers central basic support services with extensions within research groups
Incentive mechanisms	Engagement of researchers to exploit results Ownership and management of IPR, researcher’s rewards Evaluation system that also acknowledge market-relevant research Promotion and tenure schemes in science & engineering
Specialised resources	Staffing practices, needed skills, financial resources allocated
Supportive context	Institutional and policy environment, culture and history of the academic institution. Organisational emphasis on UITT.

Although cultural differences are frequently considered to be one of the main barriers for U-I collaborations, they are not explored in the present analysis. The underlying reason is that, as noted by Siegel et al. (2004), cultural differences do not only occur between the academic and business worlds. There are also marked differences amongst scientists themselves belonging to different disciplines and traditions (Becher, 1989). Additionally, there are also considerable cultural differences within the university setting between academics and administrative staff from the TTO.

The Innovation Law features as one of the factors within “Context” heading. In effect, the Innovation Law becomes a key factor due to its compulsory nature and potential influence over all other factors. The extent of the impact of this factor is the focus of this thesis.

The present framework will be used to guide the collection of primary and secondary data on the selected universities to be studied. Furthermore it serves as the theoretical basis to conduct the analysis of whether the IL fostered a positive impact over university technology management.

## **4. BRAZILIAN BACKGROUND AND CONTEXT**

### **4.1 Historic overview**

Brazil was one of the last countries in Latin America to create a Higher Education System (HES). This happened less than 100 years ago, being the first comprehensive university established by the Federal government in 1920 (although some of the first higher learning institutions originated during the XIX century). According to Laus & Morosini (2005) the evolution of the Brazilian HES can be categorised in four periods that were marked by issues such as a military dictatorship period, a first reformation underpinned by administrative efficiency principles (and the introduction of the department replacing the chair), the reinforcement of the three fundamental missions and the adoption of the Humboldtian model based on research. The fourth and last period started from the 1990's with the introduction of a new regulatory framework<sup>2</sup> that laid down the legal foundations for the actual educational system at all levels. From the 50's onwards, the creation of both public and private institutions intensified in number and geographical coverage. In a period of 30 years 22 new federal universities were created.

Oliven (2002) states that in 1981 there were 65 universities (7 of them with more than 20.000 students enrolled). Nowadays according to the latest census<sup>3</sup>, the Brazilian higher education institutional snapshot is the following: there are 2.314 HEI in the country, about 90% of them are private and the great majority are faculties (85%). About 8% of all HEI are universities (190) wherein 104 are public (59 federal, 38 state, 7 municipal) and 86 are private. Complementary, there are 35 federal institutions offering technological programmes of higher learning (IF/CEFET).

### **4.2 The creation of Brazil's research system**

In Brazil, as is the case for many other countries in the world, WWII marked a watershed in terms of research development. Before that the country was essentially agricultural and counted with a very small scientific pool and a weak institutional research infrastructure. The academic profession was not adequately institutionalised nor rewarded (Machado Rezende, 2010). In 1951 takes place the first governmental action to build capacity with the establishment of the National Research Council (CNPq) and the Commission for the Improvement of Personnel in Higher Education (CAPES). From the 1970's onwards, though, some key events marked the building of a research

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<sup>2</sup> Law on Regulations and Norms for National Education LDB (9394/96)

<sup>3</sup> Source: INEP 2009 - Censo da Educação Superior de 2009

system that led to the creation of the Ministry of Science and Technology (MCT) in 1985. Since this period, the federal government has been largely stimulating the training of highly qualified human resources through the financing of fellowships and research grants (to individuals and groups) for undergraduate and graduate programmes and the training of academics in foreign institutions (Schwartzman, 1991). These measures enabled the scientific training of thousands of researchers permitting the expansion of the human resources base.

This brief historical introduction shows that although research is a relatively recent endeavour in Brazil, the country has developed in the last decades a strong S&T system, which enabled the training of around 10.000 doctors per year<sup>4</sup> and an increasingly prominent role.

### **4.3 The industrialisation process**

In order to discuss the actual innovation policy in Brazil it is relevant to present some of the issues that shaped the genesis of its industrialisation process. According to (Mello, Maculan, & Renault, 2010) the industrialisation process started in the 1950's based on three pillars: firstly the multinational corporations, in charge of introducing capital and technology in the country; secondly the State in charge of attracting international funds and complement the scarce national availability and thirdly the embryonic national investment employed to develop the domestic technological market.

The 1980's in turn are considered to be the "lost decade" due to the extremely high external debt and the permanent hyperinflation (which reached 2500%/year in 1993 and was not controlled until 1994<sup>5</sup>) that mobilised all sectors in the country. Following that, the 1990's were characterised by a strong influence of neo-liberal political ideology that facilitated a widespread opening of the economy to foreign investment, the privatisation of public companies and a reformulation of organisational structures under a modernisation justification.

Brazil displayed a rapid industrialisation however marked by a great dependency on foreign technology. This can be attributed by the strategic choice made by the government at that time to follow an "import substitution" model (Shikida, 2005) where the most technological advanced industrial sectors were left to the multinational companies while state-owned companies were

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<sup>4</sup> Source: CAPES/MEC

<sup>5</sup> Source: IBGE, Instituto Brasileiro de Geografia e Estatística

dedicated to the primary sectors such as electricity, telecommunications, mining, steel and petrochemicals.

Despite this initial rapid growth during the first decades, industrial productivity stagnated especially when compared to some Asian countries, such as South Korea and Taiwan, which are also late-industrialising economies like Brazil (Viotti, 2002).

More recently, in spite of Brazil's macroeconomic stability and growth, the country is still considered to lag behind in the proportion of goods traded internationally of medium-high technology content (Rodrigues, Dahlman, & Salmi, 2007). In addition, Brazilian companies are considered to be very little innovative. The national technological innovation survey (PINTEC) provides indicators on the evolution of the innovative behaviour of business enterprises. In 2005 only 5.6% of the companies stated to develop internal R&D activities. This percentage has even declined in the latest edition of the survey (PINTEC 2008) to 4.2%. Although some indicators have displayed some considerable improvement (38.6% have reported to have introduced some kind of product/process innovation contrasting to 33.4% in 2005), only 4.1% of the surveyed companies have implemented a new or substantially improved product. In terms of human resources, a very small portion of scientists work for the industry, less than 25%.

Since 2003, with the governmental recognition of innovation as a strategic priority, the country is searching for new ways to catch up with other countries and transform this situation. With this goal in mind, the current industrial policy widely acknowledges the importance of S&T role and the necessity to promote the cooperation between business enterprises and universities or research centres is seen as crucial in order to exploit the country's full potential.

#### **4.4 National R&D snapshot**

The actual Brazilian Science, Technology & Innovation (ST&I) system presents a rather comprehensive and multifaceted architecture. To the point that Neves (2002) refers to it as a "complex" instead of a "system" due to the diversity of its actors (placed in several levels) and the variety of relationships established amongst them. The Ministry of Science and Technology (MCT) and the Ministry of Education (MEC), in conjunction with other ministries, feature at the highest level being in charge of providing strategic guidelines in the form of policies and implementing them with the support of funding agencies (FINEP, CNPq, CAPES). At the provincial level, the states also have specific departments and foundations in charge of implementing local and federal S&T policies.

A greater level of coordination between these actors can be observed in the last years. Four National Conferences on Science and Technology took place between the years 1985 to 2010. The main goal is to gather the representatives from all sectors connected to S&T in order to receive input for long-term policy-making. The latest conference, that took place in 2010, was called by presidential decree and gathered 4.000 participants with the objective to discuss a state policy for science, technology and innovation for the promotion of sustainable development. The main output of this consultation process was released in December 2010: the “Blue Book” (MCT, 2010) synthesizes the main recommendations achieved and proposes an agenda with priority action areas. These initiatives were developed within in the scope of the Plan of Action in Science, Technology and Innovation for Brazilian development (PACTI) for the period 2007-2010 which is articulated with the industrial framework that will be further explored in section 3.5.

Another important data source for an updated contextualisation are innovation-related indicators. The actual stage of S&T in Brazil displays some promising indicators and others that despite low levels have lately shown a considerable evolution.

**Table 6.** Selection of Brazilian innovation-related indicators

Gross R&D expenditure as a percentage of GDP (GERD)	1.1% <sup>6</sup>
Business R&D expenditure as a percentage of GDP (BERD)	0.5% <sup>7</sup>
Patents per million population	0.3 <sup>8</sup>
Scientific publications in 1998	7.860 <sup>9</sup>
Scientific publications in 2008	26.482 <sup>10</sup>
Share of world’s scientific articles	2.7% <sup>11</sup>
Share of 25-64 age cohort holding a tertiary education degree	11% <sup>12</sup>
Doctorates awarded per year	10.000 <sup>13</sup>

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<sup>6</sup> 2008 OECD (Science and Innovation country notes)

<sup>7</sup> 2008 OECD

<sup>8</sup> 2008 OECD

<sup>9</sup> Thomson Reuters SCI

<sup>10</sup> Thomson Reuters SCI

<sup>11</sup> Thomson Reuters SCI

<sup>12</sup> Ministry of Education

<sup>13</sup> (RYCIT, 2010)

Brazil's expenditure in R&D accounts for 63.5% of Latin America's total being higher than in Russia, India and Mexico, but still below China and the OECD average and similar to that of Spain and Italy in absolute value. According to the OECD, between 1998 and 2008 publications have been increasing on average by 12.2% on an annual basis. It is worth noting that the number of doctorates awarded per year (5.2 per 100.000 population) is higher than the OECD average although the portion of engineers is still relatively low. In order to enlarge HE coverage and access opportunities, the number of private institutions have widely expanded.

In terms of funding, the public sector is still the main sponsor of Brazilian R&D being responsible for 54.5% of GERD, a feature shared by most developing nations. Another characteristic considered as one the main weaknesses of the system is the great majority of the researchers in the country are academics<sup>14</sup>. Only 37% of them work for the business sector. This proportion is exactly opposite to that found in developed nations. Analysts consider this particularly problematic since a closer dialogue and relationship with industrial counterparts is hampered due to the scarcity of scientists in the productive sector (Brito Cruz & Chaimovich, 2010). This also contributes to the low number of patents granted to the Brazilian industry.

The number of scientific articles published by authors affiliated to Brazilian institutions has more than tripled in the last ten years. Research output is considered to be relatively high (both qualitatively and quantitatively) and steadily growing for a developing country: Brazilian scientific publications in indexed journals account for 2.63% of the world production (reaching almost 5% in the agricultural sciences) and 54.56% of Latin America's<sup>15</sup>. It is important to highlight that most scientific production in the country comes from public universities, mainly federal ones (with few exceptions such as the private PUC universities and state universities such as UNICAMP). Brito Cruz & Chaimovich (2010) state that just seven universities accounted for 60% of the articles published at international journals in 2009. A geographical imbalance also marks the scientific production as most of it is concentrated at the southeast and south regions.

The academic sector is thus considered to be the most dynamic actor with great potential to influence the innovation process. Nevertheless the productive sector is not able to tap into the knowledge produced due to an apparent mismatch between offer and demand and a lack of innovative behaviour by not identifying potential R&D needs.

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<sup>14</sup> Source: MCT 2010 database

<sup>15</sup> Source: 2008 Incites, Thomson Reuters. Published at the website of the Brazilian Ministry of Science and Technology.

## **4.5 Legal framework for Science, Technology and Innovation**

Despite the recent global economic recession, Brazil enjoys structural conditions that promote a favourable environment for the strengthening of its R&D system as a way to improve its competitiveness. Brito Cruz & Chaimovich (2010) mention as some of these conditions “several years of stability, both in economic terms and in the democratic process; an expanding domestic market; an energy demand that is under control and a significant role as an international commodities’ provider”. Taking advantage of this situation of stability, the country has decided to reshape its developmental pathways and undergo a series of development policies restructuring.

Within this rationale, in 2004 the government established a new framework, the Industrial, Technology and External Trade Policy (PITCE) having under its scope a set of measures (funding, fiscal incentives, regulatory mechanisms, technical support, etc) targeted at boosting the productive development. The actual framework, the Productive Development Policy (PDP) is a continuation of PITCE and intends that the growth results attained so far can be maintained and improved in a sustainable way in the future.

One of its main axis aims at stimulating R&D in the private sector as a way to spur innovation and growth. As a result a new legal framework was introduced including:

- the Innovation Law (10.973/2004);
- the Good Law (11.196/2005);
- the Bio-security Law (11.105/2005) and
- the Policy for Biotechnology Development (6.041/2007).

This framework, in articulation with the S&T one (PACTI), aims to provide the basic conditions for fostering innovation in the country.

### **4.5.1 The Innovation Law (IL)**

Passed in the end of 2004, the Innovation Law (Law 10.973) facilitated the creation of important instruments to support industrial R&D, instruments that largely address universities and their relations with business enterprises. Its provisions foresee that, for the first time, federal universities are entitled to undertake joint R&D projects with industrial partners and share the eventual intellectual property generated. This act also promotes the cooperation between business and academia by the permission for the use of public laboratories by private parts, the exchange of staff,

support for the creation of spin-off companies by faculty members and enabling universities to provide consultancy services and market patents' rights on the exclusivity mode.

Another key element of the IL (and the focus of analysis of this thesis) is that it mandates federal universities to organise an institutional support structure in charge of handling issues related to technology transfer, referred to as "Nucleus of Technological Innovation" (NIT).

Those few institutions that were active in technology transfer already had such units within their structures well before the passage of the law. Such universities were particularly influenced to create these offices due to the passage of the 1996 Industrial Property Law (9.279) that deals with the ownership of intellectual property rights. On the other hand, since 2004 the great majority of universities have been in the process of building new institutional capacity in order to comply with the Innovation Law.

In 2006, mostly as a reaction to these new demands, the representatives of research institutions joined in a coordinated effort and created FORTEC<sup>16</sup> (National Forum for Innovation and Technology Transfer Managers). FORTEC is the leading association of TT offices in Brazil and has the aim to represent TT managers (from both public and private universities), disseminate the innovation culture and provide support to those institutions in the process of establishing NITs.

By now Brazil is considered to rely on the basic institutions, legal framework and resources needed to promote the growth of its industry and of innovation levels. The main challenge though is to assure that these mechanisms work properly and deliver the desired outcomes.

#### **4.5.2 The NIT**

The 2004 Innovation Law, amongst its various provisions, mandates that all public Science and Technology Institutions (STI) in the country must comprise an instance referred to as NIT (Núcleo de Inovação Tecnológica) in charge of managing the innovation policy of the institution. The Law describes as the basic responsibilities of the NIT the following:

- i. to manage the institutional policy regarding the protection of inventions, licensing activity, innovation and other forms of technology transfer (implying the existence of such a policy);

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<sup>16</sup> <http://www.fortec-br.org>

- ii. to assess and classify research results in order to attain the dispositions of the Innovation Law;
- iii. to support independent inventors requests;
- iv. to appraise and provide input on the adequacy of publication or protection of scientific discoveries arising from the institution;
- v. to perform the request and maintenance of intellectual property rights arising from its research outputs;
- vi. to provide the Ministry with yearly reports on institutional performance indicators.

Before presenting the findings that were gathered through this thesis work six years after the introduction of the IL, it is interesting to have an overview of what was the situation three years ago. A short mid-term analysis may help in understanding the impact of the IL on the evolution to the current panorama to be presented.

An analysis undertaken in 2007 by FORTEC amongst its members showed that the great majority of NITs in operation belonged to universities (74%) and the rest belonged to research centres or other technological institutions. In this analysis it was possible to observe that only two years after the introduction of the IL the number of institutions with NITs tripled, passing from 26 to 86 (FORTEC, 2007). At that time, 50 percent of them were still in the incipient process of self-structuring or initial operation.

It was possible to appraise a great geographical concentration (66%) of NITs at the southeast and southern regions of Brazil (a natural consequence of the concentration of research institutions present in these regions). That universities with longer tradition in TT activities had already established such a unit prior to the introduction of the Law however many institutions created or are creating this structure in order to respond to it.

With regards to the location within the institutional structure, most NITs were under the scope of the Vice-Rectorate of Research and/or Graduate Programmes. Only 22 percent were directly linked to the Rectorate. A striking evidence, though, is that the great majority of universities started to respond to the IL immediately after to its introduction, at least in creating the basic legal infrastructure for the NIT creation at the institutional level. The actual operation and performance of the NITs, however, was and still is subject to several obstacles for many universities as will be seen later on.

When analysing the institutionalisation process of NITs within Brazilian universities, Lotufo (2009) considers that good performance is still a function of the experience of the institution (through the NIT staff) in managing TT activities. Since innovation-related activities are relatively recent in Brazilian academic institutions, there is a scarcity of experienced and specialised staff and thus the best performing universities in this area are the ones that started earlier.

Another characteristic quite peculiar to Brazilian research universities is that for many decades they make use of institutional foundations as a way to decrease bureaucracy and facilitate the administration of contracts and financial resources. Lahorgue (2005) notes that the creation of NITs does not aim to substitute the foundations in any sense, in fact they are complementary, since universities are still prohibited to undertake several legal and contractual actions due to existing regulations. The same author affirms that NITs have actually transformed a “prior individual-to-business” relationship into a genuine “university-business” interaction.

As a final remark, it is important to highlight that the NIT materialises the strategy followed by the federal government meaning that this obligation upon institutions to manage and protect intellectual property rights aims to promote and reinforce the relationship between public research organisations and business actors.

## 5. EMPIRICAL FINDINGS

In the following chapters all the empirical findings will be presented, analysed and interpreted in the light of the theoretical framework adopted. First a brief overview of the current panorama of the NITs in Brazil is presented.

### 5.1 Overview of the NITs operation in Brazil

Article 17 of the Innovation Law requires all public research institutions to provide the Ministry of Science and Technology (MCT) with an annual report concerning the actual status of institutional policy and performance on innovation-related activities. All individual reports are blended together into a report (named FORMICT) and published by the MCT (BRASIL, 2010). Four annual national reports were released so far based on the years 2006, 2007, 2008 and 2009. This section aims to put some basic data into perspective in order to permit an appraisal of the evolution of NITs since the passage of the Innovation Law.

#### 5.1.1 Revenue

According to the MCT, in 2006 the revenue generated by universities and research centres through the engagement in joint projects, licensing and the provision of other innovation-related services was approximately 810.000 Reais. Three years after the introduction of the IL, this figure ascended to 13.1 million Reais (about 6 million Euros). Much of this evolution is attributed to the expansion of NITs within Brazilian institutions of science and technology. The table below provides some figures on this evolution and comprising both public and private institutions outcomes.

**Table 7.** NITs evolution in Brazil from 2006 to 2009

	2006	2007	2008	2009
Number of operational NITs	19	54	75	80
Revenue generation from royalties (in Brazilian Reais <sup>17</sup> )	810.000	4.952.199	13.163.989 <sup>18</sup>	67.460.257

Source: data compilation from FORMICT reports 2006-2009

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<sup>17</sup> Exchange rate: 1 Euro = 2,3 Reais (in May 2011)

<sup>18</sup> R\$12.044.934 generated by public institutions and R\$1.119.055 by private institutions.

There is a clear quantitative evolution of NITs showing that the great majority of research universities in the country are devoting substantial efforts to attend to the requirements of the IL. Private universities, even though not officially required to comply, are responsible for a considerable share of operational NITs: ten out of the eighty operational NITs belong to private institutions. This may be partly due to the fact that private universities in Brazil have been traditionally more open to the market, especially since the introduction of neo-liberal policies in the 90's. These issues indicate the interest of those high-level private research universities in becoming as prestigious and competitive as their public counterparts in cooperating with business counterparts.

It is possible to say that there is already a critical mass of NITs established in the country. In total there are 156 NITs from which 80 are fully operational. The 2006 FORMICT report accounted for only 23 NITs in operation. This evolution was associated to various factors such as the institutional support, governmental support and funding through Finep for instance and the work developed within projects (such as Inova NIT, PRONIT/SC, Pro-NIT SP, REDETEC initiatives, etc) aiming at sharing good practices for NIT creation and technology management practices.

**Table 8.** Actual stage of implementation of NITs

Operational	Under implementation	Not implemented	TOTAL
80	60	16	156

Source (BRASIL, 2010)

### 5.1.2 Human resources

The issue about the human resources working within the NITs is very important for an analysis of managerial nature. Currently, it is hard to establish the number of employees associated to an average NIT as there are clearly different profiles of NITs operating at different conditions. Table 8 provides an overview of the distribution of Brazilian NITs according to the number of human resources devoted to running the NIT.

**Table 9.** NITs' distribution according to number of employees

1-7 employees	8-16 employees	17-72 employees
32%	35%	33%

Source: (Pimentel, 2010)

While a big share of NITs operate with very small teams of 1-4 employees there are also exceptionally large NITs that can count with 72 employees (at USP for example) and 48 employees such is the situation found at Unicamp, one of the analysed NITs in the following sections. According to the data of FORMICT 2009, teams are generally composed in two proportional shares: half of the NIT staff is made of permanent administrative staff and the other half of temporary staff working under traineeships or scholarship schemes.

This basic introduction was aimed at presenting the reader with the overall picture of the NITs operating in Brazil. The next sections will present and analyse the data collected from the selected showcase universities. Some tables are included to present the basic figures of each university. Unfortunately, due to restrictions such as confidentiality issues or lack of updated data the contents are not exactly the same. The main axis for analysis presented in the theoretical framework, and summed up on Table 2, served as the basis for guiding the collection of data through the interviews and institutional documents. Findings related to how the IL promoted changes related to the categories of analytical framework used, namely, the organisational structure, the use of incentive structures, the deployment of specific resources and other supportive elements within the institutional context were searched. Some of the findings are presented within each case study and additionally they are further discussed and refashioned according to thematic issues in the Conclusions chapter.

## **5.2 Case 1 – UNICAMP, University of Campinas**

The State University of Campinas was founded in 1966 with the original goal to offer quality science education as a way to respond to the growing demand for qualified personnel and thus contribute to the development of the industrial pole of the non-metropolitan region of the state of São Paulo. This comprehensive university is characterised by a research-intensive orientation through its 700 research groups making it the top Brazilian institution in the ISI/WoS-indexed scientific output on a per capita basis and accounting for eight percent of the total Brazilian output in 2009.

Unicamp has had a pioneering role in Brazil in terms of setting standards for policies on interdisciplinary and multidisciplinary work and for the establishment of collaborative mechanisms of U-I relations. These strong and long-standing collaborations with private partners have led to the

development of a solid management structure for handling the technology transfer of the intellectual property developed within the university.

**Table 10.** Basic data about UNICAMP

Legal status	Public state
Year of creation	1966
Students	32.772
Faculty	2.070
TT maturation	consolidated

### 5.2.1 UNICAMP – Technology transfer profile

Unicamp is a highly reputed university in terms of research and technology transfer. Probably the most reputed one in the whole Latin America in this area. This prominence was gained and is maintained as a consequence of the very dynamic nature of its post-graduate programmes and the high level of its research activities. Interestingly, the number of graduate students is practically the same of undergraduate ones. Nowadays, Unicamp is well-known for being a high quality public research university with close ties to industry.

Silva, Machado & Lotufo (2009) state that at Unicamp the technology transfer culture and the concern about IP protection policy dates back to the 1980's. In 1978, it became the first Brazilian academic institution to launch an incubator project (CODETEC) aimed at fostering the translation of research results into commercial products or processes. In 1984 the institution created the first institutional instance in charge of providing support to faculty, the Permanent Commission for Industrial Property (CPPI). The first TTO (named *Escritório de Transferência de Tecnologia*) was established in 1989. The growing quantitative and qualitative demand for services has led to some organisational readjustments and name changes. In 2003 all technology transfer and intellectual property support services were aggregated under the current denomination: Unicamp Innovation Agency (Inova). Inova is placed directly under the authority of the Rectorate. This extensive managerial experience and the wide research portfolio have led to the consolidation of a comprehensive and detailed institutional policy for the management and protection of intellectual property. Inova is considered a strategic asset for the institution as it contributes to fulfilling the mission of quality research and the transference of its results to society.

**Table 11.** UNICAMP's NIT key figures

Name	Agência de Inovação - Inova Unicamp
Web site	<a href="http://www.inovacao.unicamp.br">www.inovacao.unicamp.br</a>
Year of creation	2003
Employees	40
Patents granted (2000-2010)	66
Licenses	54
Revenue through royalties (2005-2010)	R\$ 1.258.854,00

Inova's main mission is "to extend the impact of Unicamp's education, research and extension through the development of partnerships and initiatives that stimulate innovation in the benefit of society".<sup>19</sup> According to the coordinators, its main function is to provide Unicamp's researchers with professional support aiming at encouraging the protection and exploitation of commercially promising and/or socially relevant research results.

Another institutional arrangement that shows the level of specialisation reached by the institution is a network called Unicamp Ventures<sup>20</sup> which unites all active entrepreneurs that were originated in the university. Up to now there are 2.000 affiliated companies (totalising 7.000 employees) that were created by faculty and former students.

The seminal experience of Unicamp through the developments that led to the creation of Inova is still of extreme relevance, serving as a role-model for several universities in Brazil that are initiating the process of NIT establishment.

### **5.2.2 Unicamp findings**

The opportunity to analyse the Inova case study proved to be an enriching experience. The institution has such a large track record on technology transfer and commercialisation that one entire thesis could be devoted to it. With the objective to ensure a fair equilibrium amongst all case studies, the some of the main findings more closely related to the guiding aspects of the theoretical framework are presented.

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<sup>19</sup> Source: Official statement of Inova's creation (GR n°51/2003)

<sup>20</sup> <http://unicampventures.ning.com>

### *Organisational structure*

Since TT structures within Unicamp were created a long time before the introduction of the current federal policy framework, the IL had a modest impact over its activities. In reality, the debate over the São Paulo state innovation law in the year 2000 preceded the discussion at the federal level. In this sense, Inova was more affected by the regional policy context that took place five years before the IL.

One fact that can be considered as an effect of the IL was the consolidation of an institutional policy for intellectual property. Although internal regulations and processes were already in place, the creation of Inova in conjunction with the passage of the IL provided the momentum for the consolidation of a comprehensive institutional IP policy<sup>21</sup> in 2009. This policy was created with the participation of all sectors of the academic community and addresses issues of particular importance to Unicamp's idiosyncrasies. Some examples are specific provisions about the IPRs at different stages of clinical trials and author's rights for software creation allowing the inventor to choose between protection of rights or the availability to the public domain. Other important changes regarding research management at the university were the introduction of specific guidelines and procedures on the co-ownership of research results produced within joint collaborative projects and the creation of mechanisms that allow the proactive offer of university technologies to be commercialised.

The last central issue regarding the organisational structure for TT and innovation is that Unicamp, similarly to other public institutions studied in this thesis, makes use of a private law non-profit foundation (FUNCAMP). Within this approach the foundation acts as a complementary mechanism that facilitates the administrative and financial procedures associated to the management of research projects. The usage of foundations is reinforced by the IL and depends on the previous authorisation of the Ministry of Science and Technology.

### *Incentive mechanisms*

The institution has incorporated two types of incentives to those academics interested in technology transfer. Following the directives of the IL, Unicamp grants one-third of royalties to the individual inventor. Another way to attach academic prestige to innovation-related activities performed by

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<sup>21</sup> Consu A 08-2009 and A 016-2010

faculty members is the annual “Inventors Awards” ceremony. There is no recognition though of TT results into institutional assessments of faculty performance.

### *Resources*

Inova is one of the NITs in Brazil with the largest number of employees (40). It was identified that the human resources hiring policy (staffing practices) praises for a balanced combination of individuals with the following skills: technical, communication and project management. From the technical (or scientific) areas most employees have a background in law, biology and engineering with a complementary training or experience on intellectual property rights. As the interviewee pointed out:

*A combination of technical, communication and project management skills became indispensable. As for technical competences, lawyers, biologists and engineers counting with IP knowledge are mainly needed to develop the NIT's functions.*

There are three main modalities for staff hiring: public competition procedures and CLT contracts (based on the private law) for permanent staff. There are also temporary posts assigned by means of internships.

In terms of financial resources, Inova budget relies primarily on governmental (state and federal) funds originating from FAPESP, FINEP and CNPq. The funds generated by the institution through technology transfer come mainly from licensing contracts. Currently, some members of the team are receiving specific training in order to promote in the future the creation of technology-based companies belonging to the university.

### *Supportive context*

During the study it was possible to observe that the pervasiveness of the innovation culture amongst its departments and faculty members, being almost a trademark of this institution. In this sense there is a strong supportive context also perceived by the importance devoted to TT and links with society within the institutional mission and values. Thus, the IL gave a further impetus to something that was already largely established and with the total support of faculty members and university leaders.

It was highlighted that the successful achievements attained so far in terms of financial indicators motivate the pursue of further TT opportunities however the main benefit sought after is not based on financial compensations but rather on academic excellence that this type of collaborations can provide to the university. This is especially relevant because most of the research funds come from public sources. The self-assessment of this NIT is positive in the sense that the institution considers that it is attaining its missions. The interviewee stated that:

*The NIT (Inova) is successfully promoting technological innovation, meaning that the product or process developed be absorbed by the market or further implemented by a company. Royalties' income is not our main goal but it can be considered as an indicator for assessing our performance in promoting innovation.*

Another key success factor is attributed to the sustainable and strong support received from the university's central administration.

From this interview it was possible to identify that one of the main barriers faced by Inova NIT managers is to deal with the different sets of interests and motivations when making the interface between the academic and business worlds. These university managers have to develop the necessary communication and technical skills in order to promote joint collaborations that bring benefits to both sides. The following interview extract supports this situation:

*Many business firms are focused on its competitiveness and financial sustainability, and thus, search for a fast return of investments. On the other side, the University is focused on the dissemination and advancement of knowledge through interesting projects that can complement the training of students. The NIT challenge is to act as a mediator bringing valuable opportunities so the university can develop its missions and at the same time business enterprises can benefit from this cooperation.*

When questioned about how the IL could be enhanced in order to boost the performance of universities with a similar profile of Unicamp, it was mentioned that the law needs to comprise mechanisms that facilitate the contract of services from companies and grant universities with the possibility to own minority shares of spin-off companies.

### 5.3 Case 2 – UFSCAR, Federal University of São Carlos

In the beginning of 2011 the Ministry of Education has released the outcomes of the national evaluation of undergraduate and graduate courses of Brazilian universities known as IGC<sup>22</sup>. According to this official index, UFSCar is amongst the nine best universities having scored the maximum grade five, something that was achieved by only five percent of the assessed universities. This comprehensive university is highly research-oriented and its excellence is also due to the high academic credentials of its faculty members wherein 99.9% hold postgraduate degrees, the great majority PhDs. Another peculiar characteristic of UFSCar is the creation of new programmes providing academic training at rising and multidisciplinary research areas in innovative ways.

**Table 12.** Basic data about UFSCAR

Legal status	Public federal
Year of creation	1968
Students	10.242
Faculty	775
TT maturation	consolidated

#### 5.3.1 UFSCAR – Technology transfer profile

The institutional concern about the protection of intellectual property within technology transfer activities with the productive sector started during the 1990's and was materialised by the creation of the Nucleus for Outreach UFSCar-Enterprises (Nuemp). Similarly to what happened in other universities in this study, the university continued in improving the services provided what led to some reconfigurations and renaming of the TT support structures. Since the year 2000, UFSCar has been managing and facilitating TT involving intangible assets through its S&T Support Foundation (FAI). In 2002 it was created a dedicated unit ("*Setor de Projetos*") in charge of managing patents request processes arising from institutional projects. In the following year it was introduced a set of institutional guidelines on the rights and obligations associated to intellectual property generated within the institution. These regulations were introduced simultaneously to an increased dynamics

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<sup>22</sup> Source: Índice Geral de Cursos available at [www.inep.gov.br/areaigc](http://www.inep.gov.br/areaigc)

in commercially exploitable research and the necessity for support with intellectual property protection mechanisms.

Since the beginning, the activities of this NIT are under the direct responsibility of the university's Rectorate and the administrative procedures are operationalised through the institutional foundation (FAI).

**Table 13.** UFSCAR's NIT key figures

Name	Agência de Inovação (AI)
Web site	www.inovacao.ufscar.br
Year of creation	NUEMP: 1996 AI: 2007
Employees	10
Patents requested	55
Patents granted	7
Licenses	7
Revenue in 2010	R\$ 350.000,00

### 5.3.2 UFSCar findings

#### *Organisational structure*

Following the Innovation Law, in 2007 UFSCar introduces a comprehensive institutional innovation policy and creates its Innovation Agency (Agência de Inovação - AI) under the hierarchic subordination of the Rectorate. AI's main functions are related to the implementation of UFSCar's innovation policy and the follow-up and support for IPR issues and TT activities. The formulation and development of the Finep<sup>23</sup>-funded project named "Creation and implementation of UFSCar Nucleus for Technology Management" enabled the institution to facilitate the NIT creation and strengthening its operation by means of the establishment of legal instruments, managerial tools and human resources development. These measures were also to a large extent envisaged to help the university to respond to the Innovation Law requirements.

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<sup>23</sup> Funding agency of the Brazilian Ministry of Science and Technology

A simple search on the research portfolio database<sup>24</sup> returns over forty technologies either available for further development or ready for immediate exploitation. One of the strategies deployed by this NIT to keep up with this dynamic TT is to audit the institution constantly in order to draw an institutional “map” of existing research capabilities. This auditing process aims to identify the academic offer and match with potential industrial needs or existing demands. Several collaborative projects are established through this way with the intermediation of the NIT and eventually result in new technologies or services exploitable by the university.

Throughout the analysis of this case it was possible to observe that UFSCar had an institutional capacity established, already before the introduction of the IL, with functions and support services similar to those required from the actual NITs. In this sense, the passage of the law attached a more formal character and legitimacy to the TTO functioning within the institution. Another indication of the anticipation of UFSCar in relation to the new legislative framework is the approval of an institutional policy<sup>25</sup> introducing academic staff rights and duties with regards to TT and intellectual property. The income distribution rule adopted foresees one-third of the revenue to each of the parties: the University, the researcher(s) involved and the department.

Finally, with regards to the support structure used for facilitating administrative and financial procedures within TT activities, UFSCar also makes use of a research support foundation. The intermediate role played by foundations was often considered as a crucial mechanism for reducing bureaucracy and provide the necessary agility for activities under the IL.

#### *Incentive mechanisms*

In terms of financial incentives, UFSCar follows the recommendations of the law and assigns one-third of revenues arising from research results to the individual researcher or group. The existing incentive mechanism for NIT staff is made on the basis of financing specific training and human resources development activities in line with the functions of each member.

#### *Resources*

*With regards to funding for its operation, this NIT is largely dependent on the financial support provided by the university foundation mentioned before. The unit budget is complemented by specific funding lines from governmental agencies such as FINEP and FAPESP. Notably, this NIT*

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<sup>24</sup> Electronic version of “Carteira de Patentes”

<sup>25</sup> Portaria GR n° 627/03, 24/10/2003

*has reported to also rely on self-financing alternatives by means of services' provision to external organisations.*

### *Supportive context*

The existence of two academic representations, the Innovation Council and the Special Commission for Intellectual Property (COEPI) both composed by academic staff members. These instances have the function to provide an academic input within decision-making processes regarding TT and research commercialisation within the institution.

One of the drawbacks associated to the IL, an issue also found in other universities studied, is the requirement to publish a public tender for the licensing of technology on an exclusive basis. This requirement is considered to hinder the commercialisation process. Another formality, the establishment of a specific contract tackling IP issues, at the begging of the collaboration between the university research group and the private partner is also seen as an obstacle. From the side of the university it may seem a protection mechanism nevertheless the other partner is often afraid to incur into such formality at an early stage of the cooperation as a great deal of uncertainty and risks are at stake.

During the interview it was possible to identify that one of the main functions of the NIT is diminish information asymmetries and cultural barriers between the academic and business worlds. The following extract highlights the importance of this aspect:

*USFCar's NIT intervenes at trying to minimize problems associated to cultural difference between the two worlds by training its staff on negotiation and communication issues so they are able to "speak the language of entrepreneurs". The negotiations are always carried out by NIT staff with the technical support and approval of the involved researchers. However researchers are practically never directly involved with the negotiation burden.*

In general terms, although the IL was not essential in raising the awareness about TT and on the creation of institutional structures it is deemed to have had a positive impact on the strengthening of existing capabilities and the influence upon the official recognition of the NIT within the institutional structure. The TT procedures and bureaucratic steps are also considered to be done in a faster way. Researchers, in their turn, are more aware and active in undertaking the necessary measures to protect their research results. Apart from the associated advances and drawbacks

associated to the IL one issue is deemed of utmost importance: the follow-up of the IL provisions in order to fill in the existing “legal gaps” and provide universities with specific guidelines on implementing mechanisms.

*The IL was very important in promoting a critical mass over the TT theme however there are several legal gaps that generate uncertainties and prevent the establishment of joint projects. For instance the IL urges universities to share labs and equipments with private partners nevertheless there is no clear guidelines on how this can be operationalised in practice.*

It was acknowledged that much of the impact still expected to come from the IL would be achieved if HEI were insulated from the uncertainties and risks that these “legal gaps” promote.

#### **5.4 Case 3 – UFABC, Federal University of ABC**

The Federal University of the ABC is located in the ABC region which stands for the name of the three cities Santo André, São Bernardo and São Caetano. This region is a well-known for being one of the most dynamic industrial poles in Latin America due to the existence of national and international companies mainly automobile manufacturers. UFABC is a brand new and innovative educational project within the Brazilian Higher Education context. Created in 2005 from scratch and under the motto “Technology University for the 21st Century”, it encompasses several differentiating aspects: first it relies completely on an academic staff holding PhD degrees. Its interdisciplinary institutional project, considered to be one of the most advanced in the world, was conceived by 25 prestigious Brazilian scientists and spins around three main disciplinary axes: (i) Natural and Human Sciences, (ii) Mathematics, Computing and Engineering and (iii) Modelling and Applied Social Sciences. Initially, the incoming students are not associated to any of these axes. The basic common workload involves only 47 percent of compulsory subjects, the rest being subject to the individual interests of each student. After completing this stage, the student may opt to have a basic bachelor degree in Science & Technology or further continuing to follow studies into a specific concentration degree or graduate programme.

**Table 14.** Basic data about UFABC

Legal status	Public federal
Year of creation	2005
Students	2.000
Faculty	402
TT maturation	initiating

In such a short time of operation, UFABC research is already considered to be of high quality, being its programmes and research groups recognised by ministerial evaluations and funding agencies. Another characteristic is its commitment to respond to those needs and problems arising from industry (especially local) that are in line with the institutional research priorities and interests.

#### **5.4.1 UFABC – Technology transfer profile**

The inclusion of UFABC's NIT as a case study was based on a strategic choice of analysing how the Innovation Law affected the design and implementation of a brand new NIT within such a singular institutional context that is intimately tied to innovation through science and technology. Thus, it is important to highlight that this NIT was established by institutional regulation less than one year ago (in July 2010) and it is still under the stage of consolidation, a two years-period foreseen for adaptation and creation of internal regulations.

**Table 15.** UFABC's NIT key figures

Name	Núcleo de Inovação Tecnológica
Web site	<a href="http://nit.ufabc.edu.br">http://nit.ufabc.edu.br</a>
Year of creation	2010
Employees	9

#### **5.4.2 UFABC findings**

##### *Organisational structure*

Due to the institutional mission and with the boos of the IL Technology transfer is a central part of the institutional regulations. This is already implemented through the creation of the NIT (directly linked to the Rectorate) which main goals are to promote technological innovation through the

adequate exploitation of institutional research assets. Despite the extremely short operational period that has not yet allowed the establishment of a constant flow of activities and the accomplishment of a critical mass of results, the case of UFABC is very interesting to consider since it enabled to analyse a NIT being conceived and structured taking into consideration the current innovation legal framework. For instance, it was possible to observe that it is already organised into three specific units: the Division of Technology Transfer, Division of Intellectual Property and Division of Technological Information. This separation of functions was considered to be the most appropriated given the specific demands of the IL and the necessary managerial and technical skills within each division.

University management at UFABC is also being changed in order to comply with the legal provisions concerning the use of public procurement for the commercialisation of those institutional assets generated through the dispositions of the Innovation Law. UFABC NIT is also dealing with the creation of an institutional framework concerning faculty that aim to participate in the creation of innovation-related businesses. All this managerial tools are considered to be critical since the NIT aims to be the access gate between the university, embedded in a powerful and diverse industrial regional, and its business partners.

When touching the aspect of decentralisation, considered an important aspect by the theoretical framework in use, it was possible to observe that although this NIT does not count with representatives working within the departmental levels there is a commission named “NIT Research Group”, composed by five faculty members, that is in charge of providing guidance and input to the NIT decisions from an academic perspective.

#### *Incentive mechanisms*

The issue related to incentive schemes to the participation of researchers with TT activities is still under implementation. It was highlighted that the remuneration for extra activities within the academic setting is still a controversial subject in many Brazilian public universities. The traditional principal of wages’ isonomy is considered to hamper some attempts to foster TT through financial incentives. Academic incentives are currently under consideration for future adoption.

### *Resources*

During the analysis it was verified that the NIT was constituted of nine workers: two full-time employees (general coordinator and deputy coordinator), three part-time heads of division, two full-time administrative staff and two part-time interns.

In the interim between UFABC foundation and the creation of its NIT, five years have passed without any TT support unit within the institution. This means that during this time either researchers were prohibited to undertake TT commercial activities or they had to do so in alliance with other institutions in specific justified cases. The IL fostered the creation of the NIT which in turn facilitated the deployment and generation of resources in a legal way and according to institutional regulations.

During the interview it was also highlighted that UFABC NIT intends to accomplish a pedagogical dimension and this is contributing to shape its internal structure. The university wants students to develop entrepreneurial skills through the access to a business incubator and the NIT will be in charge of facilitating that.

*UFABC NIT is being conceived within a broader institutional pedagogical project wherein it facilitates the students' access to company incubators and other mechanisms that stimulate an entrepreneurial behaviour. This NIT has a crucial function to play for a university located in such a dynamic and important industrial region.*

### *Supportive context*

Although this institution is still under the implementation period of its NIT, the importance of the external context is expected to be a crucial element for its operation. The university is placed within one of the most active industrial poles of Latin America and with the increasing strength of the Brazilian productive sector it is considered to receive a major influence from the outside. In terms of internal context, the situation found cannot be more promising: the institution has been recently conceived and relies on a leadership that is committed with boosting its societal function while preserving academic values by means of an innovative institutional project.

When questioning about the current obstacles that are hampering the attainment of the goals in responding to the IL it was possible to identify that the lack of specialised human resources is still a big problem. One additional area for improvement is related to another key aspect within the

theoretical framework used: the need for the introduction of incentive schemes and regulations for researchers performing innovation-related activities and NIT staff holding coordinating roles.

## 5.5 Case 4 – PUCRS, Pontifical Catholic University of Rio Grande do Sul

In 2009 PUCRS was awarded as the best private university of Brazil<sup>26</sup> due to the overall quality of its undergraduate programmes according to the established criteria. The institution offers currently 23 Masters and 19 PhD programmes. In terms of research and technology, PUCRS is a reference centre for excellence in research and innovation in South America. INOVAPUC<sup>27</sup> is a network that gathers all institutional actors, initiatives and projects related to entrepreneurship and innovation within the university. Its main function is to articulate the academic centres and TT-related offices in strong joint ventures with companies for the development of applied research.

**Table 16.** Basic data about PUCRS

Legal status	Private non-profit, religious affiliated
Year of creation	1948
Students	31.473
Faculty	1.678
TT maturation	consolidated

### 5.5.1 PUCRS – Technology transfer profile

Technology transfer is within the heart of PUCRS’ mission as it is stated in its regulating statute paragraph 7: “To stimulate innovation by means of protection and transference of the knowledge generated within the University”<sup>28</sup>. This commitment is translated in the comprehensive system of support structures and investments in technology transfer activities.

The combination of high level research capabilities and professional support management services have enabled, in 2009, PUCRS’ to publish a compendium with about 60 technologies available for

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<sup>26</sup> Student Guide and “Banco Real – Grupo Santander” 2009 Awards. Source: [www.melhoresuniversidades.com.br](http://www.melhoresuniversidades.com.br)

<sup>27</sup> [www.pucrs.br/inovapuc](http://www.pucrs.br/inovapuc)

<sup>28</sup> Free translation of the author.

licensing that were developed by the institutional researchers in six different research fields from biotechnology to software engineering.

PUCRS' science and technology park – TECNOPUC – is the biggest one in Brazil and one of the largest in Latin America, has the mission of creating an environment of innovation and research involving the interaction between academia, the government and industry. Created in 2003 with 5.4 hectares located within the university campus, it hosts 66 organisations: 48 companies, 8 representative entities and 10 research centres. TECNOPUC hosts CEITEC a chip prototype and production centre.

It is important to highlight that the innovation process within PUCRS is complex and functions and services are well distributed amongst several institutional support units:

- **ETT** (Escritório de Transferência de Tecnologia): technology assessment, protection and transference;
- **AGT** (Agência de Gestão Tecnológica): joint R&D projects management;
- **CI** (Centro de Inovação): in cooperation with Microsoft promotes innovation through the usage of new information technologies;
- **IDÉIA**: Institute for R&D that offers R&D projects incubation and high-level research infrastructures;
- **LABELO**: Laboratory specialised in electro-electronics;
- **NE** (Núcleo Empreendedor): Entrepreneurship support and training programmes;
- **RAIAR**: Business incubator hosting 77 start-up companies;
- **TECNOPUC**: Science and Technology Park.

From this list, ETT is the unit that performs the role relevant for this thesis analysis. PUCRS's NIT is named ETT (Intellectual Property and Technology Transfer Office).

**Table 17.** PUCRS's NIT key figures

NIT Name	Escritório de Transferência de Tecnologia - ETT
Website	<a href="http://www.pucrs.br/prppg/ett">www.pucrs.br/prppg/ett</a>
Year of creation	AGTPI: 1999 ETT: 2005
Employees	8
Patents granted	73
Licenses	8

## 5.5.2 PUCRS findings

### *Organisational structure*

PUCRS' NIT has been located under the authority of the Vice-Rectorate for Research and Post-Graduate Studies. Created in order to respond to the new dynamics in the university management of research results, it is responsible for the protection and management of the institution's intellectual portfolio and the promotion of technology transfer as a way to foster PUCRS integration into society.

It is very important to clarify that this university already counted with a well-established and comprehensive structure for dealing with innovation and TT activities. The stimulus to innovation through the transference of knowledge generated within the university is even part of the institutional statute.

### *Incentive mechanisms*

Similarly to the public institutions and in line with the IL, PUCRS has established the one-third rule for the sharing of TT revenue. There are no financial incentives in place as the institution considers that most researchers' that are currently not involved in TT would not have their behaviour changed for such kind of encouragement. On the other hand, the NIT works heavily over other strategies aimed at raising awareness and increasing participation such as constant visits to labs, organisation of information days and events, technological fairs and publications.

### *Resources*

This institution has perceived an increase of funding available for R&D in innovation-related initiatives since the passage of the IL, which is considered to be a positive factor by the academic community. Nevertheless, as a private institution it can rely more heavily over funds originating from the institutional budget and the cooperation with private companies.

In terms of staffing practices, there is no explicit hiring policy however there is a preference for professionals with previous experience on intellectual property and research management. The NIT of this private university is relatively small when compared to other public institutions at the same maturity level however it is important to highlight that there are several other instances within the university in charge of specific aspects of TT, R&D collaboration with business enterprises and the commercialisation of research results.

### *Supportive context*

From the interviews with university representative it was observed that the institution was committed with creating innovation favourable environments well before the introduction of the IL. This can be verified by the creation of the several support structures and the science park. Thus although the IL was not a decisive factor that influenced the creation of the NIT it is positively supporting its functions. The following interview extract demonstrates that:

*From all the new mechanisms introduced by the federal government, the IL is the one that has been contributing the most for the technological innovation development in the country. (...)The requirement that all universities must have a NIT in charge of managing innovation was the starting point for a change in the university setting.”*

Some of the existing conditions that were reported by the interviewed technology manager to hamper the TT process are associated to the incipient state of protected technologies that require further development for viable commercialisation. Such an investment is generally not desired by potentially interested firms. There is still a need to further align research and innovation policies in a way that researchers become interested not only in publishing but also in patenting.

It was mentioned that the new avenues for cooperation between universities and business partners have multiplied joint collaborations and led to an increased interest on the usage of intellectual property mechanisms by researchers. An issue that is currently under the consideration of the NIT and the university central administration is the design of a policy to foster and govern the spin-off company creation by faculty members.

*Before the IL the sole preoccupation of the researcher was to comply with the existing institutional policy by generating the maximum amount of scientific publications. There was very little concern with the possibility to protect the intellectual property generated, partly due to the lack of support from the side of the institution but also because this kind of academic production was not taken into account within academic assessment systems.*

As a concluding remark concerning the analysis of the PUCRS case it was interesting to observe how a private university, which is moderately subjected to federal legislation, considers the IL to be a key milestone in turning the university into a more fertile environment for innovation. The IL is considered to foster universities to offer academics with the tools and support services needed to increase the interest over commercial exploitation of research results. It enhances the security of both sides (academic and business) on pursuing joint collaborations. The governmental commitment

displayed through the passage of the law has also enabled ministerial agencies (CNPq and FINEP) to create new and more focused funding mechanisms including financial support for the reinforcement of university capacity through training for NIT management staff.

## 6 CONCLUSIONS

### 6.1 General overview

During the development of this work it was possible to appraise that science and technology policy in Brazil has been consolidated over the last fifty years by means of heavy and sustained investments in terms of the training of high level human resources and the modernisation of research infrastructures both at universities and research centres. This push has enabled the impressive improvement of indicators on the research outputs produced by Brazilian researchers, as seen previously in this work, the numbers of MSc/PhD graduates, researchers and published scientific articles have risen dramatically.

More recently, possibly during the last six years, the innovation policy has gained momentum in Brazil. Concomitantly to a period of robust economic prosperity, Brazilian leaders see innovation as a key concept within long-term policies. National plans for S,T&I reinforce the importance of its science base and of technological autonomy on the overall development of the country. A greater intertwining between the industrial and scientific policies is currently seen by the government as key strategy. Following this rationale, it was possible to witness a substantial expansion on public spending on science, technology, research and development. As innovation is not a product of academia or business enterprises in operating in isolation, the interaction amongst the actors of the national system of innovation (mainly between the public research system and the productive sector) and the promotion of favourable environment for innovation were fostered by the government through various mechanisms. These dynamics perceived nowadays in Brazil are in line with the theoretical frameworks presented in the beginning of this work (Etzkowitz & Leydesdorff, 2000; Edquist C. , 2005) .

Some specialists point to the fact that the innovation policy in Brazil is still extremely focused on the role played by academic R&D actors and on the promotion of U-I cooperation and less concerned with the business firms (Britto Cruz, 2003). This is considered to be one of the key fragilities of the Brazilian innovation system as the business firm is eventually the chain component that is able to transform science results into wealth for the country. In addition to this there is a need to evaluate the effectiveness of the policy programmes in place (Cassiolato, Lastres, & Maciel, 2003). Anyhow, universities, especially the public ones, are increasingly subject to greater

requirements to be more responsive to socio-economic needs and priorities and to enhance their cooperation with business counterparts. According to the latest data from the Ministry of Science & Technology, researchers based at universities account for 57 percent<sup>29</sup> of the total researchers in the country. This fact together with the low tradition of university-industry cooperation has led the government to create mechanisms to foster this cooperation expecting that the high-quality academic research performed at universities may have spill-over effects and support business enterprises to acquire a more innovative behaviour.

## **6.2 Suitability of the theoretical framework used**

In the Brazilian literature, there is a lack of academic works analysing the issues related to the transfer of technology from higher education institutions to the business sector and especially with a managerial point of view. The present work was placed over these issues with special concern over the implications of 2004 Innovation Law over TT management within academic institutions.

For this aim a theoretical framework based on the works of Siegel (2004) and Debackere (2005) was used. When revising the latest academic literature on the topic, this framework was considered appropriate for the analysis to be undertaken as it provides concrete factors that after several studies are considered to be critical for the effective management of university technology transfer. The main objective then was to verify whether the introduction of the IL had promoted substantial changes related to these critical factors.

Among the findings reached by this study it was possible to conclude that the theoretical framework adopted to guide the analysis proved to be satisfactory for the purposes established. Although the framework was developed based on the realities found at more developed countries, it proved to be very useful in addressing the Brazilian university context in a suitable way. The main reason for that is that it focuses on issues that are at the very heart of academic institutions and to current managerial practices and problems. Possibly one of the axes of the framework that is still less evident at the Brazilian context is the existence of more elaborate incentive schemes to both academics and TT managers, something that is very common in the US for instance.

The following concluding remarks are devoted to summarise the main findings that have emerged during the analysis of the case studies. The usage of the categorisations provided by the theoretical framework were very useful to guide the data collection and analysis however at this concluding

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<sup>29</sup> Source: MCT 2008 report.

section of the thesis, an organisation of results according to a categorisation emerged from the empirical data is considered a context-bound manner to present the findings.

### **6.3 Impact of the Innovation Law over specific university management issues**

Although Brazilian academic institutions are generally considered to be lagging behind other more developed countries in about twenty years in terms of using technology transfer mechanisms, there is a clear atmosphere of change felt at several levels. From the feedback received, it is possible to say that the IL had a positive influence on promoting this trend but, evidently, within such a complex process as the role of academic research in technological innovation, there are several factors at play to be considered.

When it comes to the effects of the IL over university management, the impact is more visible. Although three of the four institutions analysed in this work had already a long experience on the management of technology, the answers received were many times comprehensive putting into perspective the institutional experience in comparison with other universities in the country.

With no doubt the IL has promoted several changes. Many of them will be highlighted in the following pages with the associated shortcomings perceived. Nevertheless, it is central to say that possibly its main direct contribution was to promote a nation-wide debate on the role of universities within the national innovation system and how each of them should conceive ways to develop TT according to the law but also in line with the institutional mission and academic values. This subject remained highly controversial in Brazil for several decades and due to the IL it is slowly changing. During the interviews it was mentioned by NIT managers that in the “old” normative vision those innovation-led researchers quite often were considered as “mercenaries” or “capitalists”, accused of betraying academic values. Even institutions as a whole were used to be questioned when undertaking joint collaborations with business counterparts as a way to promote innovation. Nowadays, although necessary precautions are taken, there is a growing understanding of the role of science and research within innovation and, eventually, in socio-economic development. The IL, as part of this trend, had the virtue of attaching legitimacy to the interactions between research institutions (mainly public ones) and providing the legal basis for the practical measures to be taken at the institutional level. The obligation for the creation of the NIT being the main one. The creation of FORTEC as a national forum for technology managers was also repeatedly mentioned as an important landmark in supporting capacity building.

In this sense, it becomes clear that Brazilian universities have already taken substantial steps towards building the managerial capacity necessary to deal with technology transfer in a more professional way. To a large extent, these improvements are a result of a long process influenced by several actors and that has culminated, among other results, into the creation of an innovation policy framework that includes the Innovation Law. Among other provisions, the act lays down important rules for U-I relations that are enabling universities to have a closer relationship with business firms through the usage of public R&D infrastructure, exchanges of staff, creation of spin-off companies by faculty, the commercialisation of patents including ownership issues, tax incentives for joint collaborations and the support for small technology-based firms. In terms of institutional management, the IL clearly addresses university leaders to take the necessary administrative measures for handling with revenue and expenses related to TT activities.

All studied universities agree in the point that the IL has an important role in filling the legal vacuum that existed before and hampered the operation of universities. If before, the great majority of universities did not feel the need for actively promoting innovation, nowadays the IL is a legally binding instrument by which the public institutions are required to have an innovation and intellectual property policy plus a dedicated structure to manage its implementation (the NIT).

The following issues have recurrently being associated to the impact after the introduction of the new policy framework over university management. They are organised according to themes in order to facilitate the presentation of the conclusions over the findings reached.

Regional impact: the Innovation Law has had so far a strong impact at the regional level by provoking the creation of new state innovation legislation. So far, fourteen states have approved state innovation laws and five others are under the process. These laws will also have an impact over those higher education institutions and research centres operating under the state authority. For instance, the State of São Paulo Innovation Laws also requires institutions to create their own NITs.

Institutional legitimacy: there is a consensus amongst all interviewees that the IL has provided technology transfer offices of universities with the necessary institutional legitimacy, something that was not evident before within many institutions. Although some of these structures have been developing similar functions for years, they were mostly seen as offering “extra” support services to those more entrepreneurial faculty members. After the IL the NIT has a clearer and even mandatory

role to develop. This is considered to be a very important effect of the law over university TT management. When contrasting to the conclusions reached by previous studies on the same subject, the lack of consensus on the scope and tasks to be carried out by the TTO was perceived as a great barrier to the performance of NITs in Brazil (Brisolla, Corder, Gomes, & Mello, 1998; Ritter dos Santos & Solleiro, 2006). The Law also promoted increasing uniformity in TTO denomination (NIT) similarly to the case for other countries such as the United States (TTO) or Spain (OTRI). Although much have been accomplished in this sense, something that was verified in the studied institutions, there are plenty of other universities that are still underway in defining NITs scope of functions and duties in order to avoid governance conflicts.

Internal procedures: it was repeatedly reported that one of the very initial effects of the IL was the design and approval of internal procedures and routines for dealing with TT in the light of the new legal framework. Universities had also to establish internal databases for matching the institutional portfolio of research results with potential industrial partners. Moreover, the analysis and development of commercialisation schemes to be put in practice by the institution, including royalties' shares, prices, costs and guidelines for the negotiation of contracts.

Ownership of results: following the requirement of the IL many universities are shifting the institutional ownership rights to the individual inventor/researcher. The majority of studied universities are under the process of establishing policies that govern the transfer of rights to the inventor. Governmental agencies (such as the CNPq) have also yield the transfer of ownership from previously granted (or being processed) of intellectual property rights to the universities in charge of such research projects. This new situation led to an increment on the number of projects carried out by the NITs reinforcing the need for their existence.

Royalties' distribution: the IL determines that academic researchers are entitled to receive a minimum of five percent a maximum of one-third of the royalties generated from the commercialisation of research<sup>30</sup>. In this sense most universities are in the process of defining international regulations that shall be applied to future TT contracts. Through the studied universities, it was possible to identify that this issue is often dealt with on a case-by-case basis as it touches a sensitive issue that is determinant for the successful transference of many technologies.

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<sup>30</sup> Law 9.279 of 1996 - Industrial Property Law established that the ownership of research results belong to the institution the researcher belongs to.

Financial incentives: there are now three mechanisms of financial retribution that universities have created after the new regulations introduced by the IL: researchers may receive a innovation stipend, the participation on the financial returns generated by the commercialisation of IPRs (from five percent to one third) and also the payment for faculty involved in the provision of technological services related to innovation further explained below. Some of the studied universities already have such mechanisms in place however the findings have demonstrated that there are insufficient rewards for faculty involved with TT. The issue of incentives is largely considered to remain a weakness at the Brazilian universities as academics continue to be rewarded majoritarily on the basis of publications and other types of academic achievements not TT productivity.

Provision of services: A new possibility introduced by the IL is that public universities may provide technological services for companies and charge for that. Some of these services that are currently being implemented by the case studies include certification for technical compliance, technology watch for competitive intelligence, training courses within continuing education programmes and consulting services.

Revenues and Expenses: the IL determines that universities are in charge of taking the necessary measures for the management of its innovation policy and the new possibility of administrating the revenues and costs related to TT and commercialisation activities. This issue remains a big barrier for many universities in Brazil that have difficulties in reaching and administrating with funds generated by TT activities. Traditionally, once money is deposited in the general university account there are several difficulties in dealing with it. A practical solution that is currently adopted by many universities is the usage of a foundation exclusively linked to the institution (or in association with other universities) after the official approval of the Ministry. Through this way universities reported to gain in flexibility and efficiency in dealing with funds.

Extinction of public procurement: before the IL public universities were obliged to commercialise their technologies through the mandatory use of public procurement. This situation was considered to harm the “novelty” attached to the patent, a critical condition for the competitive advantage for the licensee. After the introduction of IL, public procurement is only used when the licence is commercialised on an exclusive basis which requires a simplified version of public procurement. Some interviewed managers have pointed to the fact that the necessity of using public procurement

(although the simplification of the administrative procedure was welcomed) is still a barrier due to some legal contradictions that arise. On the one hand, some IPR are granted on the basis of co-inventorship (permitted by the very same IL) leading to patents shared by universities and private actors. For this reason, a public procurement process on a license that is co-owned by a private firm is a matter of questioning by some managers. Another issue that remains is that public procurement fails to guarantee novelty and secrecy, what leads to missing some good opportunities to generate funds through commercialisation.

Sabbatical leave: Universities are now allowed to grant sabbatical leaves for researchers on the grounds of establishment of an innovation-related firm. Some managers interviewed have point to some shortcomings in this regard. Although the legislation introduces the sabbatical leave possibility, the civil servant legislation is still not adapted hampering its usage. Another issue is that as soon as the researcher becomes the head of a firm he/she is no longer able to file forthcoming research results via the academic institution.

## **6.4 Bottlenecks and challenges**

This section is devoted to gather those issues that were highlighted for remaining as barriers that need to be overcome so universities are able to better respond to the objectives of the Innovation Law.

Some technology managers consulted still consider the dissemination of the intellectual property culture to be a considerable challenge within Brazilian universities. It was mentioned that a possible way of attenuating this aversion of some researchers could be the inclusion of TT-indicators within the criteria of academic assessment and progression systems. At the moment, the main strategies used to address this problem at the institutional level, is the organisation of information meetings, conferences and publicity materials for spreading successful TT initiatives.

The lack of professionally trained and skilled staff is considered to be one of the barriers for a more efficient performance of the NITs in supporting TT. A related barrier is the extremely bureaucratic and difficult process for hiring new staff for the NIT especially that managerial staff specialised on

the valorisation of technology and intangible assets, on the protection of intellectual property and on interface for the commercialisation of technologies to industrial partners.

Some managers consider financial sustainability to be a potential weak point of the NIT since in most cases it has a major reliance on governmental funds for covering costs associated to personnel, training of human resources, etc. Additionally, it has been pointed out that the assignment of temporary staff hinders the possibility of retaining trained staff and induces discontinuity in capacity building efforts.

In order to improve technology management and the recognition of researchers, there is a general perceived need that institutions should have a better follow-up system of those research activities carried out within the university that have a TT dimension. This would enable future academic and financial recognition of faculty efforts and a better provision of support services. This issue is sometimes subject to the awareness of researchers in informing the NIT about such activities.

The centralisation versus decentralisation of support structures to TT is another critical aspect. In opposition to the theoretical framework used, most studied universities opt for the centralisation of TT management activities due to the perceived advantages that this approach may offer regarding to more internal autonomy and power. Moreover, the possibility of having a general follow-up of all U-I projects carried by university research groups is considered a plus.

Something that was curiously considered as a bottleneck by university managers is the excess of freedom enjoyed by academics in Brazil. They claim that this independence sometimes leads to informalities in the sense that some academic inventors “by-pass” the institutional channels, ignoring the commitment of commercialising via the official procedure wherein the institution detains the ownership rights that can be shared or even transferred to the inventor. In this regard, the IL is perceived to have a positive influence by deterring such behaviours.

The question concerning financial incentives within public institutions in Brazil is deemed of utmost importance since some managers convey that this issue is even dealt with as a “heresy” or “taboo” within some universities. This is possibly due to the salary isonomy, a principle used in the Brazilian law that regards to the equal pay of civil servants. It is proposed that academic faculty should be adequately rewarded for this type of activities both financially and also within tenure

systems. It is necessary to boost professional ascension paths for academics (also known as Y-careers) if universities aim to retain the best professionals and not lose them for companies or universities in other countries.

Some universities still struggle with the operationalisation of the management concerning the appropriation and usage of funds generated by TT activities. While facing difficulties to pay individual researchers royalties, the partner firm is sometimes asked to forward to the researchers due earnings. Another difficulty concerns the payment for the transference of know-how when there is no IPR involved. In this case one of the possible solutions identified was the registry of the contract at the National Institute for Industrial Property (INPI) attaching an official backup for the arrangement.

These outcomes point to two important facts: on the one hand universities must remain focused in complying with the existing legislation and managing technology transfer in those ways that strategically reinforce the missions and priorities of the institution. On the other hand, although the introduction of a new legislative framework is by itself considered to be a considerable achievement, the ST&I is a highly dynamic field that demands constant re-evaluation and improvement of existing policies and mechanisms. So far, it was possible to observe through the case studies that universities, from the managerial perspective, are making their best to make the IL operational even though this sometimes means the creation of internal regulations and practices that respond to their circumstances and needs but are not totally “in line” with the available legal framework. This is sometimes inevitable since these legal frameworks present contradictions and are still in need for further fine-tuning. In this regards, the next section presents some of the issues that arouse during the analysis which could be tackled in future policy-making.

## **6.5 Policy recommendations**

All interviewed institutions acknowledge the positive achievements facilitated by the introduction of the IL but also agree in the need of transforming the law by means of more practically-oriented and specific provisions. For instance, it was mentioned that the law could directly address the support to young graduates interested in establishing technology-based business. Another issue discussed was that the innovation policy framework in Brazil is still very concerned with the big enterprises that generate large revenues while a critical mass of small and technology-based firms would potentially display better results within the large innovation context.

In general it is frequently mentioned that the federal government, through the IL or other legal provisions, should establish specific indications of how universities shall shape the existing mechanisms in order to operate “within the law”. Otherwise the current situation is leading to situations like the launch of public procurement for the license of a technology shared with a private partner. There were also some clashes with other legislations that define the university prosecutor’s office to be the only one dealing with juridical affairs something that is also supposed to be under the NIT jurisdiction.

High federal instances such as the AGU (Advocacy General of the Union) and CGU (Office of the Comptroller General), bodies in charge of the juridical actions and responsibilities of the federal government and the defence of the public interest, should take measures to remove practical conflicts arising from the interpretation of the IL and promote a better adaptability of the legal mechanisms in place concerning universities. It was also claimed that these bodies should help in diminishing the risk (from the juridical point of view) associated to innovation-related activities so both universities, researchers and firms become less risk-averse.

During this study it was possible to observe a certain discredit on the current generation of established entrepreneurs. Some technology managers consider that most of them do not invest in research and innovation activities because, unfortunately, they still do not believe in the returns that this kind of investment can bring. However they consider that the next generation will be more equipped to harness R&D potential within a business enterprise. For this end some managers consider that the improvement of entrepreneurship skills should be more promoted within the academic curricula of scientists and engineers and through initiatives such as Junior Enterprises.

One important challenge considered to being met is that the NIT is now the official interlocutor facilitating the interface between the university and the productive sector. In addition to that, the NIT acts as an interlocutor within the university itself facilitating the connection between the central administration authorities (Rectorate, vice-Rectorates and juridical services), administrative offices and research groups. This trust relationship is still to be under construction.

## **6.6 Ideas for future studies**

Something that is still to be further analysed is whether the centralisation of technology management is suitable for the universities in the Brazilian context. Some studies addressing the reality found in other more advanced countries in this subject have highlighted that decentralisation has increased the effectiveness at the university setting (Etzkowitz, Webster, Gebhardt, & Terra, 2000; Siegel, Waldman, Atwater, & Link, 2004; Debackere, 2005). The very theoretical framework used for this thesis addresses the issue of centralisation versus decentralisation of technology transfer management. Although a centralised structure is considered to be effective at an initial stage in the management of technology transfer, with time and volume of activities, its effectiveness is considered to be negatively affected. It is possible that a central NIT supported by further decentralised sub-NITs within specific thematic scientific fields or university departments may prove to be more effective but this verification depends on further practical developments within institutions and the production of further evidence through research.

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# APPENDIX

## Appendix 1: In-Depth Interview Guide

<b>Part I – Establishing the NIT’s profile</b>
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### Supporting material for presenting the institution:

- Documents explaining the university background with regards to Technology Transfer and collaboration with business partners.
- Numbers of patents requested and granted per year so far.
- Yearly report submitted to the Ministry of Science and Technology (MCT FORMICT)
- Year of university creation.
- Year of NIT creation. Previous similar denomination?
- Is TT/U-I a central part of the University mission? If so, which kinds of support are provided by the institution to foster it?
- Number and profile of employees (scientists, lawyers, engineers, administrators, etc)?
- What are the criteria for staff hiring within the TTO?

### Questions:

1. How would you characterize the primary research scope of your university? (basic, technological, comprehensive)
2. How were TT activities conducted prior to the establishment of the NIT?
3. Was there any professional support to the management of TT activities prior to the creation of the NIT?
4. What were the main drivers that motivated the creation of the NIT? Was the IL the driver?
5. What is the institution’s strategy and policy for TT? What are the underlying motives/rationale for TT in your university? Are there any specific priorities?
6. Where is located the NIT within the institutional structure of your university (central administration or middle management level)? Do you consider having enough autonomy to develop your activities?
7. What is the research funding per year?
8. What is the TT and commercialisation activities total revenue?
9. Please describe the main TT mechanisms used in your institution? (licensing, consultancy services, spin-off companies, joint collaborative projects with business partners)
10. What are the main types of tasks performed? (Information dissemination, training, networking, R&D management, TT contracts)
11. Are there any incentives schemes (monetary or others) in your institutions for faculty to engage in TT activities? How about incentives directed to NIT staff? Do you consider them to be effective?
12. Are TT-related activities considered within evaluation system of researchers in your university?
13. How do you assess the effectiveness of TT in your institution?

14. Is your office responsible for all TT activities managements or are there other structures simultaneously in place?
15. Do you have any sort of decentralisation approach in order to guarantee a closer relationship with the different research groups? Do you have representatives within research groups?
16. Please describe the most serious barriers that inhibit the formation of specific types of TT activities.
17. Which mechanisms are in place in order to minimise cultural and information barriers?
18. Which strategies you use in order to engage researchers in TT activities?

<b>Part II – Assessing the impact of the Innovation Law (IL) at the institutional level</b>
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1. The IL is considered to be inspired by other similar initiatives in developed countries such as the US Bayh-Dole Act of 1980. Differently to other countries, Brazilian researchers are traditionally considered to display very low levels of interaction with the productive sector through TT. Do you consider this situation to be changing as a result of the passage of the IL? Are there other factors at play?
  
2. What are the perceived effects of the IL with regards to:
  - a. Improving TT administrative structure (creation or reinforcement of the NIT)
  - b. Hiring of research groups by business enterprises for innovation-related consultancy services:
  - c. Stimulating faculty to create spin-off companies:
  - d. Sharing and renting of academic facilities (labs, equipment) for the usage of private companies:
  - e. Institutional policy related to TT:
  - f. Academic publishing patterns:
  - g. Number of patents filed and granted:
  - h. Changes in the internal regulations and process in order to cope with the financial management of revenues and expenditures of TT activities (administrative day-to-day operations, payments for IP protection, inventors, assisting staff)
  - i. Concession of more research funding (from public and private sources)
3. What are the perceived barriers at the institutional level? How could future policy-making help that?
4. What are the main strategies to establish contact with firms?
5. What are the main benefits of TT activities to your institution?
  
6. As a final concluding remark, please give you personal point of view on how effective has been the Law so far in promoting university technology transfer for strengthening innovation in Brazil and which are the areas perceived as bottlenecks that may be potentially be improved by future legislation?