Securing Australia's Future - Project 9 Translating research for economic and social benefit: country comparisons

Brazil

Study of measures to encourage the translation of public sector research for economic and social benefit for Brazil

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Abstract

In this report, we evaluate the overall technology management and transfer scenarios in Brazil. We present an overview of the national science, technology and innovation (STI) panorama, discuss the prevailing national STI policy framework including recent policy developments, and present the country's federal innovation law and policies for promoting technology transfer from universities and research centres to industry, including recent initiatives taken at federal and state levels. We then analyse two of the country's most important technology management offices from the two most important research universities in the country. The main findings of the report are: technology transfer is evolving in a positive manner; institutional and market obstacles hinder an acceleration of the process; TTOs need to become more professionalized and given greater autonomy; TTOs integrated with the university or research innovation framework perform better and in-depth hypothesis based studies are needed to advance future knowledge of technology transfer and commercialization in Brazil.

1. Introduction

Science, Technology and Innovation (STI) promote a web of linkages and interconnections, playing a growing and vital role in a worldwide system of production, distribution, new structures and relationships. STI can therefore significantly contribute to address the major challenges of modern societies. However, new technologies change rapidly, shortening life cycles of products and the underlying processes, and raising technology costs (Audretsch, Lehmann, & Wright, 2014).

In particular, the increasing performance of STI in emerging countries that are not members of the Organization for Economic Cooperation and Development (OECD), especially the so-called BRIICS nations – Brazil, Russia, India, Indonesia, China and South Africa – has intensified and expanded in the last decades.

BRIICS have increased their levels of R&D spending in the last decade, whilst most OECD member states have substantially cut R&D-related expenditures (Battele, 2012). In 2008, Chinese gross R&D expenditures – in real terms –was equivalent to 13.1% of all OECD countries' R&D investments, compared to 5% in 2001. United States, China and Japan have spent together half the world's $1.6 trillion R&D in 2013 (Battelle, 2013). If this current pace does not change in the near future, R&D spending as a proportion of China's GDP will surpass that of the United States in 2022.The expenditure of Russia totalled 1.5% of its GDP, which is 3/4 of the amounts spent by Canada and Italy in the same period. Brazilian R&D expenditure remained steady on 1.3% of its GDP between 2012 and 2014 (Battelle, 2013).

The BRIICS have increased investments in clean technologies as well, an area with considerable potential for expansion and application to address various global challenges. The growth of STI investments in these economies brings

about new opportunities and challenges for OECD countries as well as potential global impacts (OECD, 2010).

However, in either advanced or developing economies, companies can no longer identify and afford for all the technological and human resources they need. This inhibits their ability to foster flexible relationships with other firms as well as with other players, like universities and government research centres. As a result, one observes an increasing trend of research over the last three decades, involving technology and knowledge transfers from academic institutions to industry (Battelle, 2015; Audretsch, Lehmann, & Wright, 2014). In addition, Audretsch et al. (2014) point out a new wave of multinational firms emanating from Brazil, Russia, India and China, which are more strongly involved in the international processes of globalization and productivity increases.

Despite expressive increases in R&D efforts by developing countries – and BRIICS in particular – which have led to an increase in their share of world R&D, the commercialization efforts of the knowledge derived from R&D is still incipient in many countries with new or limited experience in Intellectual Property Rights (IPR) and Technology Transfer (TT). This problem is compound by the fact that in BRIICS most R&D is carried out by public entities. In addition, as a potential lever of technological transfer efforts, university-industry cooperation still carries several bottlenecks, being no different in Brazil (Alves, Quelhas, da Silva, & Lameira, 2015).

Therefore, over the last decade or so, BRIICS policy makers have become concerned with the sources of knowledge and their spillovers and how can intellectual property rights (IPR) be best secured by the rule of law and how ideas can best be commercialized through more efficient Technology Transfer (TT) mechanisms. Most aspects concerning IPR and TT management depends on the quality of the regional/local STI policy framework. In particular, academic and scientific institutions are the focus of policy makers and business people as the main drivers and sources of scientific and human knowledge (Colombo, D'Adda, & Piva, 2010). Thus, STI policies to promote such ecosystems in a given economy are essential. They target the development of human resources, the application and respect to the rule of law and the availability and distribution of financing to innovative firms and of incentives to user to adopt and contribute to advanced innovation (user-led innovation). In particular, they aim to assist established research universities and research centres in generating useful knowledge to firms and critical stakeholders (including leading firms) to support decision making and negotiations pertaining the commercialization of (new) knowledge. The list goes on.

Existing university-industry cooperation barriers are not the only challenges in the commercialization policy agenda of developing countries. In Brazil, in particular, cultural academic resistance and lack of regulatory frameworks in individual public universities (which have some administrative autonomy and but are constrained by central funding policies) and government research centres

and the design of proper incentives are prominent. Further, training provision to professionals in IPR and TT to researchers and university's personnel, as well as the dissemination of best practices is still incipient in the global context as well (OECD, 2010; 2013).

In order to accelerate learning and to promote more effective IPR and TT processes, many countries are introducing new laws and implementing different kinds of institutional innovations, while research institutes are simultaneously finding their own ways of advancing the partnership with industry.

Brazil is Latin America's largest country with an area of 8.5 million km² and the only member of the BRIICs group in the region. Brazil is also a founder of the Mercosur and Unasul regional trade and political blocs. Brazil's population in 2012 was 196,5m (IBGE), accounting for about 33% of Latin America's population (in 2011). Its GDP in 2012 reached €1,752b (compared to €1,607b in 2011, a growth rate of just 0.9%, further down from 7.5% in 2010 and 2.7% in 2011), the world's 7th largest, and the second largest among the BRICs, after China. Its GDP per capita in 2012 was €8,913, an insignificant growth of 0.1%. The country's average GDP growth between 2005 and 2010 was 4.23%, the lowest among the BRICs and just the 7th highest in Latin America.

In 2006, overall investment in STI represented 1.29% of GDP and in 2010 it reached 1.62%. The goal is to reach 2.2% by 2022. In 2010, R&D intensity (GERD/GDP) was 1.16%, whereas the share of private sector R&D (of GERD) was 47.3% and the share of public sector (federal and state) R&D (of GERD) was 52.7%. BERD went from 0.51% of GDP in 2006 to 0.55% in 2010. The Ministry of Science, Technology and Innovation (MCTI) executed budget in 2011 was €2,230b, posting a real growth of 1% over 2006-2010 (170% over the ten-year period 2001-2010). The National STI Strategy 2012-2015 (ENCTI, in its Portuguese acronym) main targets are: increase GERD - in 2014 GERD/GDP index will reach 1.8% of GDP compared to 1.16% in 2010; increase BERD (a goal shared with the Greater Brazil Plan) – in 2014 BERD/GDP index will reach 0.9% compared to 0.55% in 2010.

In 2010, the total number of scientists and researchers was about 234,797, of which a little over one-third held a doctorate and the majority worked in the public sector, the near totality in higher education institutions. In 2011, they published 46,933 scientific articles, representing over half of Latin America production (54.1%) and 2.28% of the world's scientific papers (Thomson/ISI).

Launched in December 2011, the Science without Borders (CsF) programme had awarded by the end of 2012 about 22,000 scholarships, with an approximate investment of € 407m. CsF programme is similar to Europe's ERASMUS, but it encompasses both undergraduate and graduate students in scientific disciplines. Students went to the United States, Canada, United Kingdom, Germany, France, Italy, Belgium, the Netherlands, Spain, Portugal, Australia and South Korea.

The 2008-2009 economic crises initially did not have an immediate impact on the R&D expenditure and policy, as Brazil adopted a series of macroeconomic counter-cyclical measures. However, the growth of GERD fell drastically from 15.3% in 2007 to 7.0% in 2010. In addition, whereas, over 2005-2007 it had reached 24.3%, over 2008-2010 it more than halved to 11.6%. Whereas MCTI executed budget growth rate for the period 2007-2011 was a high 25.7%, it declined significantly to 7.0% over the period 2009-2011. Furthermore, in 2011, it declined by 3.3%.

The Brazilian research system has continued to expand but the capacity of research institutions and universities to interact with firms is still lacking and the advance of innovation is slow. More importantly, Brazilian firms' commitment to innovation is still weak. Brazil's BERD/GERD index at 47.3% stands as the highest in Latin America, but it is much lower than those of China (71.7% in 2009) and South Korea (72.9% 2008). The number of industrial firms doing continuous R&D in 2010 (out of a total 106.800 firms in industry, selected services and R&D sectors) was just 3,425. The number of firms doing any R&D was also small (41,300: 17,679 industrial and 727 service firms, respectively of the total, albeit exhibiting a growth of 38.6% over the period 2006-2008). Of the 6 million formal SMEs in existence, only 15,000 performed some sort of innovation according to the 2005 Brazilian innovation survey. Although the number of innovative industrial firms has grown from 33.4% of the total in 2005 to 38.1% in 2008 and to 38.6% in 2010, only 4.1% of industrial firms launched a new product or a product substantially modified for the Brazilian market. This reflects the adaptive nature of their innovation. This adaptive behaviour is associated with the low investment of Brazilian business sector in R&D, since this kind of innovation requires less technological efforts and implies an extremely low number of researchers who carry out such activities in their context, when compared with other countries. In Brazil, most of the researchers are in higher education institutions – 80.3% of the total in 2010 – whereas only 17.6% work in firms (much less than in countries with a comparable economic performance).

In 2011 Brazil filed just 586 patents (of all types) (464 in 2008) in the USPTO; and the number of patents awarded increased from 101 in 2008 to 215 in 2011. These numbers are pale in comparison with those of South Korea (27,269 fillings / 12,262 awards), China (10,545 /3,174) and India (4,282/1,885). In 2011, the number of patents filed in the country (invention patent + utility model) and PCT reached 31,765 (a 13% growth over 2010). However, whereas the number of residents filling declined slightly to 7,764 in 2011 from all time high of 7,873 in 2008; the number of non-residents went from 18,198 to 24,001 over the same period.

Government R&D financing scope is limited. The percentage of innovative enterprises that used at least one of the different instruments of Government support for innovation in enterprises was 22.3%.

Fiscal incentives to promote private R&D investment address a very small number of firms (639 in 2010, against 460 in 2008) and are moreover, heavily skewed towards large firms located in the South and Southeastern regions. The value of R&D&I investment by those firms enjoying the fiscal incentives of the Positive Law of fiscal benefits (*Lei do Bem*) in 2010 grew by 3.5% compared to a GDP growth of 7.5%. In 2012, the overall value of fiscal incentives reached €2.2b, a 4.3% growth over 2011. Positive Law incentives accounted for 30.8% and Informatics law (includes fiscal incentives for Manaus Duty Free Zone) for 63% of this value.

Between 7,000 and 10,000 companies are responsible for Brazilian private total investment in research and development, equivalent to about 0.5% of GDP. Of these, 600-700 account for more than 90% of the total, and more than half of those are foreign.

Innovation grants' distribution by company size, which was initially also skewed in favour of large firms, has improved considerably. The last innovation survey available (covering the period 2006-2008) revealed that the percentage of innovative firms with problems or obstacles to innovation had risen to almost 50% (IBGE, 2010).

The main issues for industrial and service firms are the high cost of innovation, excessive economic risks, and a shortage of qualified personnel and of finance sources in general (British Council, 2015). Among those firms that did not innovate, the main issues were market conditions, lack of experience in doing innovation and other obstacles (IBGE, 2010). A different research study covering firms from the state of São Paulo identified as the main barriers to their private R&D investments bureaucracy in innovation project submission and accounting, as well as shortcomings in the allowable project scope (e.g., funding of value chain suppliers; hiring of foreign researchers and agreements with foreign research institution) (Alves, Quelhas, da Silva, & Lameira, 2015).

2. Background and Policy Development

In 2006, overall investment in S&T represented 1.29% of GDP and in 2010 it reached 1.62%. The goal is to reach 2.2% by 2022. In 2010, R&D intensity (GERD/GDP) was 1.16%, whereas the share of private sector R&D (of GERD) was 47.3% and the share of public sector (federal and state) R&D (of GERD) was 52.7%. BERD went from 0.51% of GDP in 2006 to 0.55% in 2010. The Ministry of Science, Technology and Innovation (MCTI) executed budget in 2011 was €2,230b, posting a real growth of 1% over 2006-2010 (170% over the ten-year period 2001-2010). But it had 3.3% decline over 2010. Although over 2007-2010 it had a real growth of 25.7%, this growth significantly declined over the last three years (2009-2011) to 7%. Over the same period (2006-2010), the share of public federal and state expenditures (including expenditures on postgraduate education, which in 2010 represented 37.8% of federal and 64.4% of state total expenditures, the latter mostly of the state of São Paulo) of GERD, went from 35.5% to 36.7% and from 14.4% to 16.0%, respectively. The National STI Strategy 2012-2015 (ENCTI) main targets are: increase GERD - in 2014 GERD/GDP index will reach 1.8% of GDP compared to 1.16% in 2010; increase BERD (a goal shared with the Greater Brazil Plan)– in 2014 BERD/GDP index will reach 0.9% compared to 0.55% in 2010.

The performance of the Brazilian research system improved considerably. In 2011, Brazil was the world's 15th largest producer of scientific literature (up from number 20 in 2000). Its scientists published almost 47 thousand scientific articles, over half of Latin America production and 2.69% of the world's scientific papers (Thomson/ISI), up from 1.8% in 2005.

However, the system innovation performance was lacking. In 2011 Brazil filed just 586 patents (of all types) (464 in 2008) in the USPTO. The number of patents awarded increased from 101 in 2008 to 215.in 2011. Further, in 2011 the number of patents filled in the country (invention patent + utility model) plus PCT reached 31,765 (a 13% growth over 2010).

The 'interlinkages' between research and innovation systems remained low. In 2010, of the 234,797 scientists and researchers a little over one-third held a doctorate and the majority worked in the public sector; the near totality in higher education institutions. However, the number of Brazilian residents filling for patents declined slightly. Finally, recent research has continued to show that Brazil has a low high tech share (PROTEC, 2012; IEDI, 2011) as well as a lowly developed business culture and a high reluctance of PROs to cooperate with the private sector.

The Brazilian innovation survey PINTEC 2008 (latest available, covering period 2005-2008) shows that the share of industrial firms developing advanced technological innovation remained quite small albeit growing from 2.7% in 2003 to 4.1%. On a positive note, the number of firms doing R&D internally, grew continuously from 2,400 in 2003 to 3,000 in 2008.

The industrial policy Greater Brazil Plan 2011-2014 (*Plano Brasil Maior* - PBM), launched in early August 2011 by President Dilma Rousseff and several then new ministries, made clear that innovation was at the centrepiece of its government-wide industrial policy: “Innovate to compete. Compete to grow.” The policy’s drive is to spur Brazil’s capability to develop innovative products and services, and prosper from exporting its technology skills rather than agricultural and mineral commodities. The policy addresses the constant complaints by Brazilian industry, including the technology sector, about the difficulty of competing with imported goods at a time when the exchange rate went as low as R$1.53 for every US$1 . The plan responds to the diagnostic that the international context has become adverse; that there is a global economic crisis; that Brazilian manufacturing exports have continued to fall and the domestic sector has not recovered from the 2008 crisis, with a few rare exceptions; that exchange rate war and predatory competition have intensified. It aims to provide a set of measures to complement government’s foreign exchange actions.

Brazil invested € 18.2b (R$ 45.4b) in R&D in 2010, equivalent to 1.19% of GDP. The rate is considered low as it is constantly compared with the amounts applied in this area in Japan, China, and Germany. The new industrial policy also aims to boost the investments by the private sector in research and development from 0.59% of the GDP to 0.9%, and to raise the amount of Brazilian exports from 1.3% to 1.6% of worldwide exported goods. GERD will reach €14.0b (R$35b) in 2014, a major increase over the estimated €8.0b (R$ 20b) in 2010 and a doubling over the €6.2b (R$15.5b) in 2008.

The PBM policy aims to address constant complaints by Brazilian industry, including the technology sector, about the difficulty of competing with imported goods at a time when the exchange rate went as low as R$1.5359 for every US$1 or R$0.6913 for every €1. The plan’s underlying diagnostic is of an adverse international context; global economic crisis; continuing fall in Brazilian manufacturing exports; absence of domestic sector full recovery from the 2008 crisis, with a few rare exceptions; and deepening of exchange rate war and predatory competition. Therefore, its main drive is to promote Brazilian firms’ capability to develop innovative products and services, and expand technology skills rather than rely on agricultural and mineral commodities. The policy measures and programmes intend to complement government’s foreign exchange actions.

The PBM proposed significant changes in the innovation support legal framework, in particular: in the area of technological procurement; allowed technological risk clauses in contracts, as mentioned in the 2005 Innovation Law; allowed the funding of private non-profit Science and Technology Institutes (STI) in the incentives framework of the Good Law; gave permission for STI foundations to work with several STIs; and in the area of R&D investment, a new law (Lei nº 12.431) created incentives for investors in long-term financial instruments and mutual funds (*Fundos de Participação*) targeted to RDI investments by reducing the income tax rate on profits.

Innovation is part of the PBM's first set of measures (the other two are aimed at protecting domestic market and industry, and Export Promotion and Trade Defence) to promote production, investment and innovation, which comprises two groups of measures: 1- tax exemptions and 2- production, innovation and working capital financing. The second group has two working capital financing programmes for different sets of industries (PROGEREN and Revitaliza II); an extension to December 2011 of the counter-cyclical investment financing programme launched after the 2008 crisis for a total of €30.1b(R$ 75b) (Programa de Sustentação do Investimento PSI – III) for 5 sectors menaced by foreign product competition including ICT manufacturing, and technological innovation and engineering; and a €0.8b R$2b resource boost for FINEP to finance innovation in 2011 (in the first half of 2011, FINEP had already implemented €0.68b (R$1.7b of it) . FINEP additional resources will finance 80 innovation projects in priority areas of energy, health, ICT, aerospace, new materials, defence, environmental sustainability and biodiversity. Most of PSI III resources will be implemented by the National Bank for Economic and Social Development (BNDES) existing and new programmes, among others to promote new engineering training (Pró-Engenharia) to address the challenge that the share of new graduates in engineering fell from 7.0% in 2000 to 5.9% in 2010, -or 47,089-, a number deemed too low in light of the industrial and innovation needs of the growing Brazilian economy), and another finance line for Production Innovation. There has been a major increase in the volume and types of credit lines for innovation, particularly at the BNDES, the state-owned national development bank at the MDIC, tipping the balance of types of innovation support to credit finance over innovation grants. BNDES will add €0.80b (R$2b) credit line to reinforce its innovation finance portfolio and will increase resources and enlarge access to its sectorial programmes for pharmaceuticals (Profarma), aeronautics (Pro-aeronáutica) and plastics (Proplástico). Still another finance programme to be launched by BNDES is the Climate Fund to promote innovation and finance projects to reduce greenhouse gas emission. Small and midsized companies will also benefit from special credit financing lines provided by BNDES. Overall BNDES in 2011 alone will provide a total of €58.9b (R$147b) in credits. Another change in its innovation support actions is the inclusion of company multi-year innovation plans in the bank's pre-approved innovation credit line programme (Limite de Crédito Inovação).

Finally, the Greater Brazil Plan proposes significant changes in the innovation support legal framework: in the area of technological procurement, allows technological risk clauses in contracts, as mentioned in the 2005 Innovation Law; it allows the funding of private non-profit Science and Technology Institutes (STI) in the incentives framework of the Good Law; it gives permission for STI foundations to work with several STIs; and in the area of R&D investment, a law (Lei nº 12.431) creates incentives for investors in long-term financial instruments and mutual funds (Fundos de Participação) targeted to RDI investments by reducing the income tax rate on gains obtained.

The increase in the number innovation credit finance measures reflects changes in policy priorities towards the individual firm, particularly the firm that invests in technological development and innovation. Newly launched measures and refined continuing measures seek to fund or finance more discrete priority strategic areas. Fiscal incentives mechanisms were stream lined in order to reach a larger number of firms and research institutions, including R&D-focused firms. Yet, the shift in the innovation policy, induced by the emerging orientation of the Brazil Greatest Plan industrial policy, towards protectionist support through innovation fiscal incentives and credit financing to domestic sectors hit by the overvalued real and thus menaced by foreign competition sectors - automotive including auto parts, furniture, leather goods, shoes, software, IT services; wood, fruits, ornamental rocks and ceramics- and to high technology sectors with growing trade deficits - capital goods; chemicals; medical, optical and precision instruments; ICT; and pharmaceuticals – did not fully translate into new measures that could alter the current policy mix.

Some of the main challenges addressed by the new multi-year plan are sustainable investments to ensure stability and deflect inflationary pressures, the expansion of human resource training capacity and research infrastructure, as well as strengthening of innovation capacities of firms. The main future challenge for funding innovation policy is to increase the number of firms receiving support, particularly MSEs. This challenge is more severe for BNDES, but also for FINEP as the volume of its innovation loans budget grows. FINEP will also have to become more agile in disbursing grants and loans to firms.

2.1. Main actors and institutions in research governance

Brazil's research system funding comes mainly from the public sector (51.6% of GERD in 2009 – further to 52.7% in 2010, slightly up from 49.9% in 2006). Conversely, the share of the private sector decreased from 50.1% of GERD in 2006 to 48.4% of in 2009, and further to 47.3% in 2010 estimate. The federal government continues to be the main source of public funds with 69% in 2009 (71.2% in 2006). The research system has not changed much of its main institutional features and competitive funding pattern since the creation in 1951 of the main research-funding agency, the National Council for Scientific and Technological Development (CNPq). It is under to the Ministry of Science, Technology and Innovation (MCTI), created in 1985, and added "innovation" to its name in August 2011. The few changes concern a partial privatisation in the 1990s of a few public research centres in electric energy and telecommunications research.

The counterpart innovation agency under MCTI is Finep, which administers (since 1971) the main block fund for innovation funding, financing and risk financing: the National Fund for Scientific and Technological Development (FNDCT), created in 1969. After two decades of financial instability, the Executive and Legislative branches, from 1997, undertook a major reform of the FNDCT, constituting various sectorial funds to generate revenues and ensure an autonomous and continuous source of revenue for the FNDCT.

Its revenues are generated from a variety of levies, fees and contributions and existing taxes, as for example: levies on result of the exploitation of natural resources owned by the Union, portions of the Industrialized products tax (IPI) of certain sectors and of the Contribution for Intervention in the Economic Domain (CIDE) imposed upon payments for the use or purchase of technological knowledge and/or technology transfer from abroad. In 2007, with the enactment of the Law of FNDCT (Law No. 11,540/07), the FNDCT started to be organised as an accounting fund, with own resources. This was followed by Decree No. 9,638/09 regulating its operation, detailing its management model, instituting the functioning of its Board and providing for the use of new grant instruments, which guarantee an accumulation of assets and estate. There are currently seventeen sectorial funds in operation. Fifteen of them link directly to the FNDCT and two administered by other agencies of the Federal Government – the Fund for the technological development of telecommunications (FUNTTEL) and the Audio-visual Sector Fund (FSA), to which FINEP serves as the financial agent. Of the fifteen sectorial funds which have their revenues tied up to the FNDCT, thirteen disburse resources exclusively to specific sectors and are denominated in the programmatic structure of vertical actions, while two are called transversal, since they may support projects of any sector of the economy – the Yellow Green Fund (FVA) and Infrastructure Fund (CT-Infra). Of the two transversal funds, the FVA gears to support University-business interaction, while the CT-Infra supports the improvement of infrastructure of scientific and technological institutions (ICTs).

In the last few years, the BNDES under MDIC increased and multiplied its innovation finance programmes, both horizontal and sectorial (for example, for the software and pharmaceuticals industries), re-launched a university-industry cooperation fund (Funtec), and rekindled its risk financing innovation programmes, including the launch of a seed capital programme (Criatec).

2.2. The institutional role of regions in research governance

Brazil is a federation composed of 24 federal States plus the Federal District (Distrito Federal) and 5,565 municipalities. Primary (basic) mandatory education is a shared responsibility of states and municipalities. While municipalities are responsible for pre-school (childhood) education, the states are responsible for secondary (middle school) education. The federal government is largely responsible for higher education. However, in the state of São Paulo, the state-level higher education system is much larger and important than the federal one. States are all equal in terms of overall powers and responsibilities.

In terms of research, there is no specific responsibility for the states, but all fund S&T, mainly through scholarships and research projects, via their so-called research support foundations (FAPs). Their resources for research funding come from a state constitution mandate determining a percentage of gross fiscal revenues (in the case of the oldest foundation (1960), Fapesp of the state of São Paulo, which also receives additional revenues from a state endowment, the share is 1%). The 24 FAPs in 24 states and in the Federal District (only the

two states of Roraima and Rondônia do not yet have a FAP) are usually under the state secretariat of S&T, development or planning. In recent years, several FAPs have also supported thematic network-based projects and even more recently, innovation projects in cooperation with universities and research organisations, or in the form of direct grants to firms. Up to March 2012, 16 states had promulgated a state Innovation Law, three had drafted a project and the Federal District is in the process of approving its law. A handful of those states established innovation funds to provide competitive grants to firms. FAPs' research distributes funds through competitive calls. For Fapesp, for example, the distribution is: 42% to research projects, including thematic projects; followed by 36% for scholarships; and special programmes for strategic areas and support to technological innovation with 11% each (percentages for 2009). There have been strong efforts by the 27 units of the federation to increase R&D funding, thus their share of GERD increased from 14.4% in 2006 (or 30.4% of public expenditures to 16.0% in 2009 (same in 2010 estimate; again 30.4% of public expenditures). However, this growth was skewed, for in these states' expenditures the share of expenditures with graduate education grew considerably from 58.4%% to 61.5% over the period (reaching 64.4% in 2010 estimate). That is, their actual expenditures on R&D are declining. In 2010, the share of states GERD of total GERD was 16% (or 0.19% of GDP; down from 16.26% in 2007 or 0.18% of GDP), but without expenditures with postgraduate education it was 5.70% (5.89 in 2007). Total state GERD as share of total states receipts fell from 1.72 in 2001 to 1.37% in 2010 (1.38% in 2007). The four states with the largest shares in relation to their total receipts were: São Paulo, Southeast region (3.36% versus 4.90 in 2001), Paraná, South region (1.86%), Santa Catarina (1.59%) and Rio de Janeiro, Southeast region (0.96%). In the last few years there has been an effort on the part of the federal government to decentralise research (and more recently innovation) policy by transferring research programmes to state agencies, which run the programme locally.

2.3. Main research performer groups

The shares of actual R&D performed by HEIs, PRO and Business Enterprise sectors (% of GERD) are not available. Universities execute the majority of the research, followed far by public research institutes, among which the public agricultural research company Brazilian Enterprise of Agricultural and Husbandry Research (EMBRAPA), under the Ministry of Agriculture, Husbandry and Supply (MAPA), has a major role. It maintains research centres spread around the country. Another major centre is the Oswaldo Cruz Foundation (FIOCRUZ) under the Ministry of Health (MS), and headquartered in the city of Rio de Janeiro.

The research system developed into an effective system over the past decade - in spite of its still unbalanced geographic productivity and low-network based research execution. By contrast, the innovation system, which began to be structured in earnest from 2005 with the passing of the federal innovation law, still presents key structural holes such as a small number of networks involving

industry, regional and local authorities, weak private sector research in terms of number of firms, own expenditures and government incentives with limited scope and reach.

In spite of recent efforts towards research decentralisation, the research performance is still centralised in the Southeast, and to a lesser extent, South regions. In fact, research performance is concentrated mainly in two states: São Paulo and, to a lesser extent, Rio de Janeiro.

Until the mid-1990s, research policies in Brazil geared mainly to public research, particularly individual researchers in universities and, to a lesser extent, public research organisations (PROs). They often faced the problem of a lack of financial resource continuity, mainly due to cyclical budgetary constraints and a generally fragmented allocation linked to a highly segmented allocation policy with a multiplicity of disconnected target areas. Universities employ 57% of researchers and research institutes 6% (2008). In 2010 (last year available), higher education expenditures (graduate education expenditures in public federal and state budgets plus private) reached €2,631m (R$5,835m), accounting for 26.1% of GERD. Total public (federal and state) expenditures on graduate education accounted for 50% of total public expenditures on R&D.

In 2010, according to MCTI, of the 234,460 individual researchers (R&D) in Brazil, 87% worked in higher education institutions, and 83,270 had a doctorate. In 2009 (last year available) HRST as a share of economically active population (equivalent HRST as share of total Economic Active Population, based on author's elaboration from MCTI data) was 18.6%.

The exceptions in the domination of public universities in the research university landscape are a few denominational universities such as catholic universities, particularly the Pontifical Catholic University of Rio de Janeiro, PUC Rio, the country's most important private research university (the main others are PUC-RS, PUC-MG, PUC-PR and PUC-SP). The two main research universities are the University of São Paulo USP and the University of Campinas UNICAMP, which his part of the first-tier higher education system of the state of São Paulo. They are particularly strong in basic sciences and engineering. In São Paulo, a strong biomedical research university is the Federal University of São Paulo / *Escola Paulista de Medicina* UNIFESP/EPM. Another is the Federal University of Rio de Janeiro UFRJ, with a very strong graduate programme in engineering (COPPE, and a few other federal universities: UFRGS (Rio Grande do Sul state); UFSC (Santa Catarina state); UFMG (Minas Gerais State) and University of Brasilia UnB (Federal District). No other state has a higher education system comparable in terms of quality and size to that of the state of São Paulo.

HERD represented 46.1% of GERD in 2010, mainly in public federal and state institutions. Altogether universities account for about 60% of R&D performance in Brazil, funded mainly by public resources, although private sector funding has been growing in recent years, albeit from a relatively small volume and source base.

Very few of these research universities have embraced the third way that is to become more entrepreneurial and geared towards innovation. In some universities some departments and areas have developed stronger linkages with industry. An example is the case of oil and gas exploration, where the leading state company Petrobrás has developed very strong ties with both the federal university UFRJ (particularly its engineering graduate programme COPPE in ocean and platform engineering, among many other areas), as well as with PUC Rio (e.g. in the area of computer graphics, among other areas). Over the last few years, the number of research universities adding the third way to their activities has increased. This is due to government university-industry research promotion programmes, the formidable expansion of Petrobrás university cooperative programme and to the entry of several other large, national and multinational firms (Vale, CSN, Braskem, Oxiteno and Natura among others) and government incentives for universities to become more innovation-oriented.

Between 2007 and 2010 (latest year available) BERD, which comprises expenditures by state companies such as Petrobrás (the country's corporate leader in R&D expenditures, both in terms of internal R&D and external acquisition of R&D increased (after a drop in 2008), going from €6,739m to €9,328m. However, as share of GDP, BERD initially grew and then experimented a slight decline: 0.52% in 2007 to 0.59% in 2009, and then 0.51% in 2010; still quite lower than the target goal for 2010 set in the previous industrial policy PDP of 0.65%.

Whereas the rise in absolute terms in BERD appears to reflect the impact of public funding programmes aimed at leveraging greater private sector investments, such as the Economic Subsidy programme and the fiscal incentives provisions in the Positive Law, both launched in 2006; the 2010 decline as the share of GDP is partly due to the fact that in 2009 the GDP fell by 0.33%. Moreover, BERD as a share of GERD fell slightly from 47.9% in 2007 to 47.3% in 2010, after a high 48.4% in 2009.

2.4. Innovation performance

The Brazilian innovation survey PINTEC 2008 (latest available, covering period 2005-2008) shows that although in relation to the 2005 survey results (covering the period 2003-2005) the number of innovative firms increased from 30,377 to 38,299 in a universe of over 100,000). The share of industrial firms developing advanced technological innovation remained quite small albeit growing from 2.7% in 2003 to 4.1%. While the number of firms doing R&D fell from about 5,000 in both 2003 and 2005, to 4,300 in 2008, the number of those doing R&D internally continuously grew from 2,400 in 2003 to 3,000 in 2008.

In 2011, FINEP registered a finance demand from innovative companies on the order of €2.71b (R$9.56b). In the face of this, FINEP committed its full budget and will contract €970b (R$2.5b) in innovation finance loans with enterprises; an increase of 52.6% compared to the prior year. The actual disbursement to enterprises totalled €721m (R$1.86b) until the end of 2011, a growth of 52.7%

compared to 2010. In 2011, in order to meet in a timely manner growing corporate demand for project finance, FINEP reduced by 58.8% the average time required for project selection.

Overall, between 2006 and 2010 (although 2010 data for some programmes are not yet available and for others, the last call was in 2008) the government mobilised €5.58b for business innovations distributed as follows: economic subsidies (grants) and fiscal incentives (34.4%); financing, which includes a small share for FINEP and BNDES public venture capital programmes (61.1%) and structuring programmes (tech transfer, incubators and technological parks, etc.) (4.5%). The government innovation policy main programmes (in terms of volume of resource allocation) are Finep's corporate grants (Subvenção Econômica), fiscal incentives (Positive Law provisions) and financing (Finep's Pro-Inova / Inova Brasil programme, as well as BNDES multiple corporate financing programmes.

The number of firms that made use of the Positive Law fiscal incentives reached 524 in 2009, a 317% growth compared to 2006. Their R&D investments over the same period grew from €814m (R$2.1b) to €3.22b (R$8.3b). Similarly, counterpart investments made by beneficiary ICT-producing firms of fiscal incentives under the Informatics Law increased considerably. In 2009, 519 firms benefited; a 147% growth over 2007. Over the period 2007-2009, their investments in R&D projects totalled €853 (R$2.2b).

2.5. STI plans

As the national plan PACTI 2007-2010 expired at the end of 2010, a new one did not see the light until one year later in December 2011: the National STI Strategy 2012-2015 (*Estratégia Nacional de Ciência, Tecnologia e Inovação 2012-2015* - ENCTI). The overarching strategic goal is to achieve a sustainable development with S&T&I as its main driver. The strategy addresses five challenges: reduce the scientific and technological gap that still separates Brazil from developed nations; expand and consolidate Brazilian leadership in the natural knowledge economy; enlarge the basis for environmental sustainability and the development of a low carbon economy; consolidate a new pattern of international insertion for Brazil; and overcome poverty and reduce social and regional inequalities. In order to address these issues, the strategy's three main drivers are: promotion of innovation, human resources training and capacity-building, and strengthening of S&T research and infrastructure. The related improvements in ST&I policy are aimed at refining the innovation regulatory framework, refining and enlarging S&T funding structure and strengthening the National Science, Technology and Innovation System (Sistema Nacional de Ciência, Tecnologia e Inovação - SNCTI).

The ENCTI main targets are: increase GERD - in 2014 GERD/GDP index will reach 1.8 compared to 1.16 in 2010; increase BERD (a goal shared with the Greater Brazil Plan)– in 2014 BERD/GDP index will reach 0.9 compared to 0.56 in 2010; increase the innovation rate (share of industrial firms involved in innovation) in 2014 to 48.6%, compared to 38.6 in 2008 (latest year available

from national innovation survey PINTEC); increase the number of firms doing continuous R&D to 5,000 from 3,425 in 2008 (excludes state firms. PINTEC); double to 12,260 by 2014 the number of innovating firms making use of the Good Law incentives, from 630 in 2009-2010; and increase the percentage of innovating firms that make use of at least one of the government innovation support measures to 30% in 2014 compared to 22.3% in 2010.

ENCTI priority programmes are (in bold sectors common to the Greater Brazil Plan): ICT, Pharmaceuticals and the Health Industry Complex, Oil and Gas, Defence Industrial Complex, Aerospace, Nuclear, Innovation Borders (biotechnology and nanotechnology), Promotion of Green Economy (renewable energy, climate change, biodiversity, and oceans and coastal zones) and Science, and Technology and Innovation for Social Development (ST&I diffusion and improvements in science education, productive inclusion and social technology, and technologies for sustainable cities). The STI long-term policy ENCTI for the period 2011-2014 aims to raise the R&D intensity from 1.5% in 2010 to 2.5% in 2020, reaching 1.53% in 2014.

ENCTI planned public expenditures (comprises expenditures of federal and state governments – state research support foundations FAPs, and state companies) over the period 2012-2015 totals €28.8b (R$74.6b). The distribution according to the main sources is: MCTI (39.1%), Ministry of Education MEC/Capes, higher education promotion agency (16.8%), FAPs (13.7%), Ministry of Development and Foreign Trade MDIC/BNDES, national state bank for economic and social development + Inmetro, national institute of standards and metrology (9.7%); MME/Petrobrás, oil and gas, and Eletrobrás, electricity generation and transmission state companies (8.9%), Ministry of Defence MD (5.3%), Ministry of Health MS (2.8%), Ministry of Agriculture, Husbandry and Supply MAPA/ Embrapa, state agricultural research enterprise (2.6%).

ENCTI's aim is to raise the R&D intensity (GERD/GDP) from 1.19% in 2010 to 1.80% in 2015. Some of the challenges addressed by the new multi-year strategy are sustainable investments to ensure stability and deflect inflationary pressures, the expansion of human resource training capacity and research infrastructure, as well as strengthening innovation capacities of firms. Accordingly, BERD is planned to grow from 0.50% of GDP in 2010, to 0.90% in 2014 (€8.031b or R$20.710b). In order to achieve this target, BERD annual growth rate will have to increase from 15% (2000-2010) to 27% (2010-2014).

In order to meet the challenge 'Promotion of Innovation in Firms', the ENCTI, has set the objective to 'Expand the business participation in the country's technological efforts, with a view to improving the national and international competitiveness. Among the many strategic activities and orientations associated with this objective, one can call attention to a few. First, to give priority to the strengthening of partnership with SEBRAE, inview of fostering RD&I in micro and small enterprises. Second, to it will aim to improve the regulatory framework and incentives to innovate, expanding the reach of these policies and reinforcing the integration between the different instruments of

support to innovation. Third, it will expand the use of government procurement power as a mechanism of strengthened demand for products of innovative companies. Fourth,it will stimulate training of researchers (masters and PhD) with focus on innovation and its related enterprises. Finally, it will reward innovation and technological extension activities in academic professor career evaluations.

Next, in order to meet the challenge of establishing 'New pattern of public finance for the development of national scientific and technological innovation' ENCTI has set the objective 'Expand the resources for the development of national scientific base and for technological innovation.' Some of the main strategic goals and activities to be pursued include expansion of investment capacity in promoting research and training human resources of CNPq; creation of a an risk capital organisation 'FINEP-Par' for direct equity investment in companies; and improvement of the legal framework of innovation, with special attention to RD&I incentives to micro, small and medium-sized enterprises.

Until July 2012, FINEP had financed 334 projects, totalling € 4.7b. Since 2011, the FNDCT had ceased to be the main source of resources for the FINEP budget. In that year it contributed with just € 294.1m, in comparison, € 1.369b contributed by BNDES . Over 2011 and 2012, Finep received two resource injections from PSI, for a total € 1.480m. At the end of 2012, it was authorized to receive a further € 1.1b. The PSI programme Innovation at BNDES has € 1.923b for investment in two lines: 1- general innovation projects and 2-Pro-engineering programme, focused on engineering process improvement. Another programme is the PSI Transformative Projects with a € 3.0b budget to roll out innovative green field plants. BNDES further operates in conjunction with FINEP two other innovation finance programmes: the PAISS programme for the alcohol and sugar industries, with € 740m, and the Inova Petro for the oil and gas industry with resources of € 1.1b.

Until recently, access to business R&D support has been complex and fragmented, dispersed through multiple programmes in several public grant funding, credit financing and equity investment institutions. Funding for SMEs is sketchy and small. In general, the process is time-consuming, bureaucratic and the selection criteria although transparent, far from straightforward. Moreover, no funding scheme has been regularly evaluated and benchmarked against comparable schemes in other countries.

2.6. Knowledge Production

In 2010, the total number of scientists and researchers was about 234,797, of which a little over one-third held a doctorate and the majority worked in the public sector, the near totality in higher education institutions. In 2011, they published 46,933 scientific articles, representing over half of Latin America production (54.1%) and 2.28% of the world's scientific papers (Thomson/ISI), up from 1.8% in 2005, ranking as the 15th largest producer of scientific literature (up from number 20 in 2000).

In 2009, according to Thomson/ISI database, the top three scientific areas in Brazil with the highest share in world production were: agricultural sciences (9.89%); animal and plant science (7.04%), and pharmacology and toxicology (3.96%).

According to the Unesco, between 2002 and 2007 the number of scientific publications grew from 12,573 to 26,482; an absolute growth of 110%. The area with the highest absolute number of publications is medicine (8,799 in 2008), whereas mathematics had the lowest with 708 in 2007, despite having had a considerable increase from 2002 with 398 papers.

Over 90% of Brazil's scientific production comes from the 4,099 graduate programmes. The country has roughly 85,500 Ph.D. holders, equalling 1.4 Ph.Ds. per thousand inhabitants, against 8.4 in the United States and 13.6 in Germany. Over 80% of the Ph.Ds. is working in universities. There are 253 universities employing 77.463 Ph.Ds. and 113 public and non-profit scientific and R&D centres employing 8,099 PhDs. Between 2007 and 2011, the number of students enrolled in doctoral programmes and of doctorates awarded, went from 49,667 to 71,387 and from 9,915 to 12,217, respectively. In 2007, the top three scientific areas in these categories were Human Sciences (8,949), Health Sciences (7,644) and Engineering (6,908), and Health Sciences (1,798), Human Sciences (1,698), and Agricultural Sciences (1,217), respectively. In 2011, the rankings were, again for both, Human Sciences (11,134), Health Sciences (10,247) and Engineering (8,722), and Health Sciences (2,132), Human Sciences (2,007), and Agricultural Sciences (1,468), respectively.

2.7. Innovation Production

In 2011 Brazil filed 586 patents (of all types) (464 in 2008) in the USPTO; and number of patents awarded increased from 101 in 2008 to 215 in 2011. These numbers are pale in comparison with those of South Korea (27,269 fillings / 12,262 awards), China (10,545 /3,174) and India (4,282/1,885). In 2011 the number of patents filled in the country (invention patent + utility model) plus PCT reached 31,765 (a 13% growth over 2010). However, whereas the number of residents filling declined slightly to 7,764 in 2011 from all time high of 7,873 in 2008; the number of non-residents went from 18,196 to 24,001 over the same period.

The number of Brazilian patents filled at the USPTO grew from 375 in 2007 to 568 in 2010 (Mexico 295 and India 3,789); and patents awarded from 118 to 219 (Mexico 115 and India 1,137). In 2008, Brazil had 0.2% of triadic patents (WIPO). The number of patents filed at the Brazilian intellectual property office (*Instituto Nacional de Propriedade Industrial* INPI) rose from 25,406 in 2006 to 28,052 in 2010. Non-residents accounted for 72.6% and 74.1%, respectively. PCT filings accounted for 63.7% and 64.4%, respectively, the near totality in both years by non-residents. Between 2006 and 2010, the number of patent filings by micro enterprises increased from 199 to 288: a 44% growth.

A research policy partnership between the MCTI and the states, the Regional Scientific Development programme established 519 agreements with FAPs for a total value of €33m (R$84m) to support projects in regional ROs with a lack of qualified researchers.

2.8. Recent Developments

In spite of federal government efforts to increase R&D expenditures, the 2008 global economic crisis affected public R&D&I investments in the coming years, when budget cuts became deeper. Between 2007 (when it hit a high) and 2011, the share of 'MCTI Treasury-originated' budget line -the most important budget line, as budgetary resources originated from Other Sources / 'Own Resources' budget line, represented just 7.6% of total executed budget in 2011- over the 'Executed Budget' budget line in the Congressional Budget Proposal (*Lei de Orçamento Anual* LOA) declined from 82.9% to 71.8%. The equivalent share for the most important block fund in MCTI's budget, the FNDCT, the drop was even more severe. It dipped from 93.4% to 65%. Between 2007 and 2011, the shares of FNDCT and of the other main block fund (CNPq) in MCTI executed budget fell from 33.4% to 33.5% and from 16.3% to 15.6%, respectively. Over the 2008-2011 period the growth winners were the Nuclear Programme, from 10.1% to 15.2%; and Personnel expenditures, from 26.7% to 30.4%. Further, MCTI's 2012 congressional budget proposal suffered from 22% cuts by the Executive, amounting to €600m.

Demand-side innovation policy although still emergent is becoming increasingly relevant as a policy thematic strategy. To date there has been no implementation as legal and regulatory hurdles have yet to be issued. Already at the PACTI (2007-2010), priority II Promotion of Technological Innovation in Firms had in one its actions an activity to develop public procurement framework to promote national technology firms technological development. At the end of 2010, the extant industrial policy PDP Executive Committee on Public Procurement succeeded in that the Presidency issued an Executive Order (MP 495/2010) that significantly improved the regulatory framework for public procurement on several measures. First, by establishing preferential margins for public procurement to goods and services produced domestically or provided by national firms, and by firms investing in R&D in the country. Next, it modified clauses in the Public Calls Law (Law 8.666, of 21 June 1993) to exempt from the law's obligatory public calls, themes of interest to the Innovation Law. Third, it allowed public purchases within a period of 120 months, and improved the relationship between funding agencies and support foundations linked to scientific and technological institutions, including public federal universities.

In April 2011, BNDES launched the first demand-side innovation programme: the *BNDES PSI BK TICs Tecnologia Nacional*. The programme offers low interest financing (5% against 8.7% for large enterprises and 6.5% for MSEs in the previous programme BNDES PSI BK) for the acquisition of ICT equipment produced with the Basic Production Process requirements (PPB, which requires

high local content) and with technology locally developed in accordance to MCT requirements (*MCT Portaria 950/06*). By contrast, BNDES PSI BK programme only requires the PPB.

In January 2012, BNDES (under MDIC) and FINEP (under MCTI) announced that in 2012 they would commit € 455 million (in subsidised credit, grants and equity) to fund corporate research and development of cellulosic ethanol to the pilot project phase towards the development of second-generation ethanol biofuel. At the time, 14 business plans were already under review, including proposals by foreign multinational companies that had acquired Brazilian companies in the sugar and alcohol sectors.

In August 2012, FINEP, BNDES and Petrobrás launched the €1.1b (R$3bn) Inova Petro programme to develop a supply chain for the oil and gas industry and thus improve the local content industry. The programme, which features all the technical support of Petrobrás, represents the first time the FINEP will combine different financing instruments, such as credit, Economic Subsidy grants and cooperative grants between technological and scientific institutions and companies. BNDES will provide resources in the forms of loans, equity participation and through the FUNTEC research grants programme. The Inova Petro will run until 2017, offering resources for the development of technologies related to the following themes: surface processing - technologies applicable in the processes that happen on platforms and vessels; subsea installations – technologies applicable to various equipment and ducts that are below the water; and wells facilities – technologies applicable to the well at the see bottom.

On the institutional front, in January 2012, a new Minister of Science, Technology and Innovation MCTI, Marco Antonio Raupp, took over, replacing Aluízio Mercadante who became Minister of Education. Raupp is a physicist and former president of Brazil's Space Agency (AEB) under the MCTI, where he designed a space policy in 2011 in partnership with the then recently re-created state company Telebrás (charged with the development of the backbone infrastructure of the country's ambitious National Broadband Plan) to build the Brazilian Geostationary Satellite (SGB). He signalled the strategic importance of such institutional partnerships to spur developments in the area. He promised to increase ties between the generation of knowledge in the scientific community and the development of research in private companies. "An imperative is the construction of a model that links scientific knowledge and the economy." He expressed the need to give continuity to the work of his predecessor by augmenting research and technological innovation as stated in the government industrial policy programme - Great Brazil, and the high-level human resources capacity-building programme - Science Without Frontier, launched in President's Dilma Roussef first year in government (2011).

Further, in order to stimulate the participation of private capital in innovation, Minister Raupp promised to increase public-private partnerships such as the development of the new Industrial Research (Embrapii) programme, created by

Mercadante in partnership with the peak industrial trade association National Confederation of Industry (*Confederação Nacional da Indústria* CNI). Embrapii programme aims to make available to industrial companies public laboratories infrastructure and skills, such as those of the Instituto de Pesquisas Tecnológicas (IPT), connected to the University of São Paulo (USP), the National Institute of Metrology, Standardization and Industrial Quality (Inmetro), linked to MDIC and high-performance centres of National Service of Industrial learning (Senai).

In effort to increase funding and improve access to business R&D support, the federal Government launched on March 14, 2013 the Inova Company Plan. The plan aims at making Brazilian companies more internationally competitive through technological innovation and increased productivity. The €12.2bn (R$32.9bn) resources for 2013 and 2014 will target organizations of all sizes of industrial sectors, agriculture and services. Of the total, €7.7bn (R$20.9bn) will be given through credit for companies, with subsidized interest rates of 2.5% to 5% per year, grace period of four years and 12 years for payment. Economic subsidy grants to companies will account for €444m (R $ 1.2bn), while the support for research institution and business partnerships' research projects will have €1.6bn (R$ 4.2bn). The Plan will also invest €814m (R$ 2.2bn) in equity participation in knowledge-based enterprises. BNDES and the Finep/MCTI mange these credit lines. The plan's Steering Committee will be formed by the Civil Cabinet of the Presidency and by the ministries of science, technology and innovation; Development, industry and foreign trade and finance, in addition to the Department of Micro and small business.

3. Brazil's Innovation Law

In several countries, the definition of a legal framework to stimulate innovation was decisive. In the United States, the approval of the Bayh-Dole Act in 1980 raised the annual rate of patents granted to US universities by over tenfold. This has increased the number of Technology Transfer Offices (TTO) in the United States in the last two decades and produced legal spill over effects to other economies, which adapted their legal and institutional framework towards more responsive universities in the IPR and TT contexts. This first involved developed countries and, more recently, developing countries as well including Brazil.

With the economic stagnation of the 1980's in Brazil, a large part of the support initiatives for Science, Technology and Innovation (S,T&I) entered a period of hibernation, and some initiatives were even interrupted by the privatisation process of state-run companies. However, from the second half of the 1990's, S,T&I re-emerged in Brazilian public spotlights with a greater focus on the need to increase the competitive capacity of national industry in the wider context of economic opening, and by doing so, making use of the scientific and technical skills that were being developed by top local universities. Since then, among the many numerous institutional achievements the following stand out for their competitive nature: a) the Sector Funds (*Fundos Setoriais*), b) the Innovation Law and c) local incentive laws and d) an overall industrial policy framework known as The Production Development Plan (PDP).

Box 1: Brazil's Federal Innovation Law[1]

Brazil's Innovation Law sets the legal framework needed to improve the country's capacity to generate and commercialize technology. The Law deals with incentives to increase cooperative R&D between federal institutes of research and higher education (Science and Technology Institution-STI) and firms. It also regulates the use and the negotiation of IP generated from collaborative R&D activities between STI and firms.

The current legal framework regulating STIs compels them, among other things, to undertake a public bidding process for the licensing of technologies. According to the Innovation Law, STIs are requested to publish a previous "request for licencees" for the purposes of transferring or licensing their technologies.

In addition, the Law allows STIs to negotiate the use of their laboratories with Small and Medium Enterprises-SMEs. This aims to facilitate higher levels of R&D among small companies that otherwise would not have the conditions (equipment, tools, lab materials, etc.) to develop and implement innovative projects.

For the majority of Brazilian researchers who are affiliated with or employed by Brazilian federal institutions of research and higher education, the Innovation Law expects to serve as an incentive to establish partnerships for developing new technologies. Researchers will have the possibility to work in other STIs for the time necessary to conclude joint-projects and will continue to receive their regular

[1] Adapted from the World Intellectual Property Organization. Available at < http://www.wipo.int/sme/en/documents/brazil_innovation_fulltext.html >. Accessed on 9th July, 2015.

salaries. Researchers will also be able to request special leave without pay if they decide to become involved with a start-up company in order to further develop their new technologies. In both cases, benefits from the commercialization of intellectual property are expected to be shared among researchers, STIs, and private firms. This more flexible scenario aims to expand and deepen the experience and expertise already present in federal Brazilian STIs, stimulating the links between academic institutions and industry.

It is important to mention that the Innovation Law requires STIs to create "Offices of Technological Innovation" (Núcleos de Inovação Tecnológica-NITs) which, among other duties, will be responsible for the management of the technology generated by researchers, with special attention to decisions regarding intellectual property and licensing.

Chapter IV of the Innovation Law also introduces important new incentives to promote innovative activities within enterprises. For example, by recognizing the role of the private sector in the development of new technologies, the law makes it possible for public funding agencies to transfer non-refundable resources to private companies, which prohibited until the Law was decreed. It is worth noting that the allocation of public funds is contingent upon the firm investing a determined amount of its own resources in the research project.

The Sector Funds are an important link in the financing of STI in Brazil in various fields such as agriculture, health, biotechnology, oil and gas, aerospace, among others. These funds are under the Brazilian Innovation Agency (FINEP) with resources from the National Scientific and Technological Development Fund (FNDCT). Since the Sector Funds have innovation as a desired outcome, a substantial part of the projects they finance embody some aspect of technology transfer and commercialization of products or services derived from the projects. In general, the FINEP does not have IPR in projects funded by the Sector Funds. By doing this, FINEP expects to shorten the already high bureaucracy involved in multi-partner projects in which there is typically, on the one hand, public agents such as universities and research centres and, on the other, private companies. The challenges ahead are still high, given the resource contention context due to tight federal budgetary constraints. Cumulatively by 2013, the retentions in fund releases from the Sector Funds summed R$ 9.87 billion at current values, compared to R$ 9.3 billion actually disbursed in that period. Funds disbursements are as sunk cost or on a reimbursable basis.

The Innovation Law (Law No. 10.973, as of December 2, 2004) provides the legal status for stimulating innovation in Brazil (Box 1). As regards tax incentives, by Law No. 11,196 (as of November 21, 2005), known as Law of Fiscal Benefits (*Lei do Bem*, in Portuguese). The spirit of the former, in short, is to propose several measures to stimulate the interaction between government, academia and the business sector, promote scientific and technological entrepreneurship. The latter law aims to extend the benefits of the former to any manufacturing firm willing to carry R&D. Between 2009 and 2013 the number of firms receiving fiscal incentives under the law went from 635 to 1,158 (Milioni, 2015).

The measures within Brazil's STI policy framework entails a set of strategies aimed to establish a favourable ecosystem conducive to effective IPR management and to the dissemination of TT best practices. The two laws mentioned earlier are expected to contribute to it, along with: i) the legal framework on IPR brought to life in the country since 1996; ii) a group of sector-based funds (*Fundos Setoriais*) financing innovative projects in many areas of knowledge.

In addition to these measures, there are also initiatives promoted by state governments with the creation of their own innovation laws and specific instances to foster STI at state and regional levels. As the Innovation Law only set the legal basis for university-industry cooperation among industry and federal universities, the other vast set of universities whose research and personnel budgets financed by each federation's state government is still available only in a few states.

On the other hand, private universities IPR and TT are free to devise their own guidelines to determine how their researchers interact with industry, and how the university can benefit from it. However, with a few exceptions, including some Catholic and other vocational institutions, most private universities in Brazil do not carry substantial R&D, and thus there is little cooperation among private universities and industry.

A novel aspect brought to life by the Innovation Law was the creation of Technological Innovation Centres (or NIT, the Brazilian Portuguese acronym) in Brazilian federal universities and research labs dealing with IPR and TT. Because of this Law, federal research institutions have therefore engaged in the preparation of internal policies and management strategies concerning the treatment of both their intellectual properties and the licensing of the knowledge produced by researchers within their facilities. All this demanded significant efforts in the establishment of administrative bodies and procedures for transfer, negotiation and licensing of technologies produced within national federal universities and research labs.

There are 20 thousand researchers in the Lattes platform registry with at least one IP claim. The number of patents registered by researchers registered in the Lattes platform roughly tripled between 2000 and 2010 from under 2,000 to about 6,000 (Andrade, Rafael L. P. de, 2015). There

4. Knowledge Transfer Policies

4.1. Intellectual Property (IP) Policies

Compared to North America, the average university in Brazil generates far fewer inventions and patents. This is largely due to a less systematic and professional management of knowledge and intellectual property (IP) by them. Additionally, a range of factor hinders the efficient knowledge transfer in Brazilian research institutions: cultural differences between the business and science communities, lack of adequate incentives, legal barriers as well as

underdeveloped and fragmented markets for the commercialization of knowledge and technologies.

At most public federal universities, which have established sharing rules on revenues of IP ownership of research results and associated IP rights, the inventors receive 1/3 and the university 2/3. The latter portion is further split: half in order to finance the IP processing and administrative costs and the other half goes to the department of the inventing research unit.

The 2005 Innovation Law and subsequent modifications supported the creation of Knowledge Transfer Office (KTO) at universities (*Núcleo de Transferência de Tecnologia* - NIT) and created the possibility for federal public academic researchers to establish a start-up firm without losing institutional tie and public employee retirement benefits. In 2006, MCTI supported the creation of the National Forum of KTO Managers (*Fórum Nacional de Gestores de Inovação e Transferência de Tecnologia* - FORTEC). Then, MCTI established the Working Group on IP (*Grupo de Assessoramento Interno de Propriedade Intelectual* - GTA-PI) to promote a uniform institutional IP culture in articulation with the Inter-Ministerial IP Group (*Grupo Interministerial de Propriedade Intelectual* - GIPI) and the Inter-Ministerial Commission on the Innovation Law Framework. Further, the PACTI Pro-Inova programme reinforced the commitment to the expansion and strengthening of KTOs.

Table 1: Brazilian Patents Filed – 2013

	Public	%	Private	%	Total	%
Brazil	1560	92,1	184	88,5	1744	91,7
Abroad	128	7,6	24	11,5	152	8
Brazil & abroad	5	0,3	0	0	5	0,3
TOTAL	**1693**	**100**	**208**	**100**	**1901**	**100**

Source: Ministry for Science, Technology and Innovation.
< http://www.mct.gov.br/upd_blob/0235/235841.pdf>

MCTI monitors and reports Knowledge Transfer activities. Public research institutions with KTOs have the legal obligation to provide information to the MCTI on their patenting and licensing activities annually. For the few private ones, which receive support this is voluntary. In 2008, of the 101 institutions that provided patenting information (82 public and 19 private) to MCTI, 67 had filed for patents (1,021 patents filled in Brazil (INPI) – versus 767 in 2007- and 112 patents filed abroad (not specified where) – versus 93 in 2007) and 31 had been granted patents (146 in Brazil – versus 122 in 2007 - and 21 abroad – versus 10 in 2007). Table 1 provides information on the amount of patents filed from Brazilian public and private institutions of research and higher education in 2013. Table 2 provides the number of patents granted.

Brazil still reports a significant gap in the number of patents it generates compared to leading nations. In 2013, 85% of the worldwide 205,300 Patent Cooperation Treaty (PCT) applications were filed by firms,[2] and over 75 per

[2] http://www3.weforum.org/docs/WEF_Competitiveness_Lab_Latin_America_15.pdf

cent of these came from the United States, Japan, China, Germany and the Republic of Korea. By contrast, Brazil filed only 271 applications, or 0.004% of the total (British Council, 2015).

Table 2: Brazilian Patents Granted

	Public	%	Private	%	Total	%
Brazil	162	94,2	84	84,8	246	90,8
Abroad	9	5,2	15	15,2	24	8,8
Brazil & abroad	1	0,6	0	0	1	0,4
TOTAL	**172**	**100**	**99**	**100**	**271**	**100**

Source: Ministry for Science, Technology and Innovation.
< http://www.mct.gov.br/upd_blob/0235/235841.pdf>

In March 2009, FINEP made a €4.0m (R$10m) call to support Technological Innovation Nuclei (ILO/TTO or NIT in Portuguese) at public universities/research centres funding 8 projects involving 73 institutions. In 2008, a €4.0m(R$10m) call for the implementation, structuring and consolidation of regional and state-level NITs approved 8 projects involving 64 institutions. In that year, there were 81 NITs, distributed in 64 public and 17 private institutions (institutions that provided information to MCTI in 2009). However, estimates point to the existence of 140 NITs. In general, the support system for facilitating knowledge transfer has improved over the past few years due to the creation and evolution of NITs. These, however, remain poorly staffed.

4.2. Spinoffs

A policy trend in this area is the increase in the number and scope of innovation policy instruments for firms: grants for pre-incubation and in incubation (First Innovative Firm Programme PRIME); venture capital funds covering more stages of a technology-based firm growth trajectory (seed and regular VC); and reduced interest loan programmes which can reach close to zero for innovative MSEs at incubation and seed stages (Zero Interest Rate Programme JURO ZERO), as well as more flexible university-industry cooperative mechanisms and decentralised grant programmes (*PAPPE Subvenção*).

Since 2009, the First Enterprise programme (PRIME) – which provides start-ups, in a first phase grants from the Economic Subsidy Programme, and in a second phase, subsidised loans from the JURO ZERO programme – has supported the creation of university spinoffs. It awards locally competitive milestone-based small grants of up to €96,552 (R$200 thousand) to start-ups. It is a decentralised programme. Anchor incubators selected through a competitive call lead a local network of agents. The PRIME programme benefited 1,381 start-ups up to 2010. Each was awarded €48.3 thousand (R$ 120 thousand), from the Economic Subsidy Programme, for a total of €66.8m (R$166m). Programme expenditures for the 2010 call were €80.5m (R$200m). This was the last call. A reformed edition of the programme was announced several times over the last half of 2011 and first half of 2012, but a new one has not yet been issued. Zero Interest Rate Programme finances projects and

business plans of innovative micro and small enterprises (MSEs) for up to 18 month. Since 2007, the programme financed 60 projects for a total of €13.3m (R$33.1m).

The PAPPE Subsidy (*PAPPE Subvenção*) programme uses resources from the Economic Subsidy Programme to co-fund innovative projects by MSEs selected through state-level public calls managed by FAPs and other local organisations. It employs criteria that respond to local needs and objectives. It funds firms with annual revenue up to €4.2m (R$10.5m) with grants in the € 80.5-161 thousand (R$ 200 - 400 thousand) range. Up to the end of 2010, 414 MSEs got grants by the programme in 13 units of the federation. Total investment reached €106.6m (R$265m), of which €46.3m (R$115m) in counterpart funds from FAPs, local SEBRAE units and state industrial federations. Taking into account the 1,600 proposals received in the calls of the twelve federation units the project average value is €100.6 thousand (R$ 250 thousand). A programme similar in nature to it directed specifically to the North, Northeast and Centre-West regions called PAPPE Integration (*Pappe Integração*) was launched in 2010 with €35.4 m (R$88m) call to partners in 18 federation units of these regions.

Private support systems for the early development of university spin-offs in form of early-stage venture capital and business angels are still widely lacking. FINEP's regionally based seed capital programme (*Inovar Semente*) allows the participation of business angels as minority partner investments in the fund and provides them with guarantees on lost investment. However, there is no public support for the creation and development of business angel networks. In June 2012, there were only three formal angel groups in operation and two existing public seed capital funds, however the latter had investment floor target well above the financial needs of university spin-offs and other technology-based start-ups.

Support for incubators and more recently for technological parks, has continued to increase.

4.3. Inter-sectorial mobility

In terms of inter-sectorial mobility, this is generally low. While public researchers cannot move easily between the public and private sectors, many professors provide consulting to business firms, mostly large ones. The 2005 Innovation Law created a general framework for mobility of public higher education institution professors and researchers. It sets forth the legal principles to allow for a researcher to quit temporarily university post to work in a research project or for a researcher take a leave of absence from university post to create technology-based firm.

An involvement of the business sector in the governance of universities and PROs is non-existent in the public sector. There are a few exceptions in private research universities, where representatives from the private sector can join the university boards.

4.4. Promoting research institutions - SME interactions

The interaction between research institutions and SMEs aims to improve with the Sibratec programme. The Sibratec umbrella programme launched in 2007 aims to support business technological development through promotion of research and development activities for innovation and supply of metrology and technological extension, assistance and transfer services. Its operation is through different networks of local agents catering to local productive requirements. Between 2007 and 2009, with resources from FNDCT / Sectorial Funds, Sibratec invested €122.3m (R$304m) in the implementation of eight technological extension state networks, six thematic innovation centres and 18 technological services networks involving 54 institutions and 527 laboratories. Sibratec is composed of three types of networks.

1) Innovation Centres, composed of universities and research institutes with experience in business interactions. Its objective is to transform knowledge into commercially feasible prototypes for the creation of new technology-based firms or incremental innovation in existing firms.

2) Technological Services Institutes for the provision of metrology, norms, calibration, conformity analysis and essays through the articulation and modernisation of existing entities and networks.

3) Technological Extension network to stimulate demand for specialised innovation assistance through consultants to make business diagnostics, propose solutions and prepare research projects for submission to research institutes.

4.5. Regional Development policy

In the last few years there has been an effort on the part of the federal government to decentralise research policy by transferring researches to state agencies, which run the programme locally. The first was CNPq's First Research Programme (PPP) to fund young researchers' projects. Second was Finep's Programme for Supporting Research in Enterprises (PAPPE) that gives research grants to individual researchers to work with a university to assist in technological development. PAPPE is co-funded with FAPs. It operates in 20 states, funding 599 projects in 540 firms and its last edition 2006 budget was of €8.4m (R$21m). Finally there was, the still on going, PAPPE Subvenção programme aimed at decentralising the flagship direct innovation subsidies for innovation programme for provision of (grants) to firms. The programme is implemented in seventeen states and has a total budget of €100.6m (R$250m).

State research agencies research expenditures are made through competitive calls and are generally distributed as follows (percentages for Fapesp in 2009): scholarships (36%) (São Paulo grants 45% of all doctorates); research projects, including thematic (42%); special programmes for strategic areas (11%) and support to technological innovation (11%).

As far as research and innovation policies are concerned the federal government and increasingly the regions (state governments) identify joint

priorities and set the share of resources that each will contribute with. This process happens through the implementation of programmes and operational activities related to STI. The creation of sector funds brought a new perspective of funding to the national and regional scientific and innovation systems. The governance structure was reinforced by the implementation of Science & Technology Secretariats Council CONSECTI with the representation of all the states. The Council debates and defines regional and state priorities linked with the national ones, and tries to establish a budget level, or at least, identify finance sources at the public and private sectors.

These efforts have generated at another level an integration of the "territorial reality" in their national scientific strategies. In practice, that implies that the regional authorities and PROs are increasingly developing innovation network activities. This shared policy implementation and the relative flexibility it allows to state partners is one of the products of the negotiation between the Federal Government research and innovation policy makers with CONFAP and research support foundations - FAPs. Another prominent example of this emerging research policy partnership trend between the MCTI and the states is the Regional Scientific Development programme, which has established 519 agreements with FAPs for a total value of €33m (R$84m) to support projects in regional ROs with a lack of qualified researchers.

4.6. Preliminary assessment

Most policy measures to reinforce the cooperation between universities, research and business were launched after the passing of the 2005 Innovation Law and therefore it is too early to assess their effectiveness and impact. Recent research, however, has continued to show that Brazil has a low high tech share (PROTEC, 2012; IEDI, 2011) as well as a lowly developed business culture and a high reluctance of PROs to cooperate with the private sector.

The number and scope of policies designed to support innovation that have complementary impacts on researchers and research activities have increased over time particularly following the launch of the 2005 Innovation Law, which targeted efforts in some of these areas.

One exception is support to incubators, which dates back to the late 1980s. Since then the programme has grown and its scope was enlarged to comprise support to technological parks. In October 2010, Finep launched a call to fund the expansion and development of technological parks with an €16.1m (R$40m) budget.

One year earlier, in March 2009, FINEP had made an €4.0m (R$10m) call to support Technological Innovation Nuclei (TTO in English or NIT in Portuguese) at public universities/research centres, which funded eight projects involving 73 institutions. By the end of 2009 there were 80 of those Technological Innovation Nuclei, distributed in 64 public and 17 private institutions. However, another policy activity in this area did not take place until March 2012, when Finep issued a public call for university-industry cooperative projects in the

development of assistive technologies of €7.8m (R$20m) (*CHAMADA PÚBLICA MCTI/SECIS/FINEP/FNDCT – Cooperação Empresa-ICT – TECNOLOGIA ASSISTIVA – 01/2011*).

In 2012, Brazil was one of the few large middle-income countries that recorded high in number of filing patents by the Patent Cooperation Treaty (PCT) for two consecutive years. After a high of 15.6% in 2011, applications have risen 4.1 percent in 2012, while other emerging economies have placed less patents, as India (-9.2%) and Russia (-4%). However, the result was below the world average. Other middle-income countries also suffered falls in 2012 after highs in 2011, as Turkey (-16.3%), Mexico (-15.6%) and South Africa (-5.3%), according to the World Intellectual Property Organization (WIPO) on 19 March. The growth of deposits around the world in 2012 was 6.6%, over the previous year. The countries that contributed to the result were Japan and United States, which together accounted for 48.8% of 194,400 patent applications. Among the companies, the Chinese ZTE led the ranking of the greatest depositors of 2012. Applications for registration of patents requested by Brazilian companies have increased only 4.1% in 2012, well below growth of 15.6% in 2011, according to preliminary data of the World Intellectual Property Organization (Wipo).

The Brazilian performance in the area of innovation in 2012 was also lower than the high of 6.6% in global patent registration requests. Of 194,400 requests made in 2012, only 587 (0.30%) came from Brazil. China, Japan and the United States accounted for 75% of the growth in orders last year. Compared to other Member countries of the Brics, the only Brazil beats South Africa, who requested 302 patent registration. China had 18,627 requests (9.6% of the total), India, 1,208, and Russia, 958. WIPO does not show any Brazilian company among the list of 50 most asked that patent in 2012. ZTE, China's first, with 3,906 demands in the period. In the ranking of universities, there is also no Brazil, as institutions of China, Malaysia and Israel appear on the list alongside the Americans.

According to the MCTI survey FORMICT 2015, the number of Science and Technology Institutions (ICT) grew from 193 in 2102 to 264 in 2014, 73% public of which 69% federal, 28% state and 3% municipal. There is a heavy regional concentration (60%) of ICTs in the South and Southeastern regions. The number of operating NITS in these ICTs went from 94 in 2010 to 180 in 2014. In 2014, there are 54 NITs under implementation. The overall number of patent claims (in Brazil, abroad and both in Brazil and abroad) made by them between 2010 and 2014 grew from 1,078 to 2.163 and the number of patents granted over the same period went from 169 to 350. In 2014, 36 public ad 12 private ICTs had some sort of technology agreement. Total revenues from these contracts grew from R$ 185.5 million in 2012 to R$ 247.5 million in 2013. (Milioni, 2015).

In September 2014, MCTI-CNPq adopted new intellectual property policy. The new rules encourage the protection of knowledge to generate innovation. To this end, the Agency sought to facilitate relations between universities,

companies and researchers. With the publication of normative resolution 34 of 2014, the *Conselho Nacional de Desenvolvimento Científico e Tecnológico* (CNPq/MCTI) establishes a new intellectual property policy, with the objectives to promote the development of projects, stimulate innovation and facilitate relations between universities, companies and researchers. The new standard establishes criteria and standardizes access to information generated from projects encouraged by the CNPq, in addition to defining the roles of each agent, the registration process of innovations. The initiative enhances the role of the technological innovation units (NITs), modernizes the Agency's relationship with the researchers and issues recommendations that reinforce assumptions of the laws of innovation and Industrial property. Further, it makes public IP claims (patent filing, industrial design filing, software registry and botanical product registry) and licensing and commercialization events indicated in the Lattes platform researcher registry.

Other measures issued in 2014 or under development towards improving the IP policy framework include: establishment of a cooperation agreement between INPI (under MDIC), Capes (under the Ministry of Education MEC) and CNPq (under MCTI); the FORTEC association nomination of sitting members to CNPq's advisory committees (CA) which select research projects for funding; development of a normative framework for diffusion of research project information; a CNPq agreement with INPI for diffusion of IP concepts through videos and lectures and establishment of 'Committee to Support Relationship with Business.'

Intellectual property is a concession by the State of a temporary monopoly as a form of incentive and recognition for the effort of those who seek new knowledge. Namely, the granting of patents is a measure of invention and, in certain cases, brings more tangibility to something that might not be a good idea.

CNPq under this new policy voids its participation in the economic gains resulting from the commercial exploitation of creations resulting from projects funded, provided that the partner follows these recommendations: 1) stimulate sharing of economic gains arising from the commercial exploitation of intellectual property; 2) avoid establishing protections that restrict or prevent the development of new technologies and knowledge-based innovations related to the requested protection; 3) give greater visibility to the application for deposit/registration of intellectual protection, its eventual concession, licensing or marketing; 4) get licensing and marketing opportunities for intellectual property; and 5) get options for use and transfer of technology that will contribute to social and economic development of the country.

5. National Programme for Innovation Awareness and Mobilisation – Pro-Inova (Programa Nacional de Sensibilização e Mobilização para Inovação)

The mission of Pro-Inova (http://www.portalinovacao.mct.gov.br, in Portuguese) is to contribute to the Brazilian innovation effort in view of increasing the competitiveness of firms and organisations. Its goal is the diffusion of an innovation culture through spread of knowledge about the legal framework, establishment of partnerships, improvement of knowledge and access to funding and support instruments and promotion of a combined use of instruments. Its targets are firms and their managers.

Pro-Inova partners are representative public institutions - MCTI, FINEP, CNPq, CGEE, MDIC, BNDES, National Industrial Property Institute INPI, National Metrology Institute INMETRO, Brazilian Association for Industrial Development ABDI- and private actors - National Association of Industrial Research ANPEI, National Industry Confederation CNI, National Industrial Training Service SENAI, Euvaldo Lodi Institute IEL, Brazilian Competitiveness Movement MBC, Brazilian Agency for Support of Micro and Small Enterprises SEBRAE, Technological Development Association PROTEC, National Association of Incubators and Technological parks ANPROTEC, National Council of State Research Support Foundations CONFAP and Brazilian Association of Industrial Research Institutes ABIPTI. Its actions comprise support and strengthening of technology transfer units (NIT), sectorial technological bodies and state metrology networks; promotion of innovation events; production of related and relevant material in large scale and promotion of management of innovation.

It aims to set up a good practice in terms of the distributed method of implementation of innovation culture awareness building and diffusion of information on innovation instruments the extensive and dense partnerships promoted, and the continuous monitoring of results. In 2008, the programme reached 23 thousand people through 135 events promoted by partner institutions. By the end of 2010, almost 30 thousand people had participated in 159 events distributed across the country.

- DO: promote widespread and intense partnerships among a variety of innovation actors

- DON'T: forget to continuously analyse results and share lessons learned in order to become more efficient and to adapt to changing environments.

To achieve the goals of mobilization and Sensitization, the Pro-Inova's mission is to contribute to the stimulus to the development of an innovation-friendly environment in the country and aims to:

1- disseminate information about the advantages of investing in innovative activities as well as to promote innovative programs and projects;
2- sensitize and mobilize companies, civil society, technical and entities, universities, research institutes and stimulate and support companies in

the identification and use of tools and programs best suited to your needs; and

3- identify opportunities for improvement of mechanisms, legal instruments and to support technological development and innovation activity.

The main goal of Pro-Inova is to mobilize and build awareness in 5,000 entrepreneurs and executives a year, from 2008, about the importance of innovation and the knowledge of the legal framework and innovation support instruments available. It also provides that until 2010 the percentage of companies who claim to know the instruments to support technological development 25% pass to 65%.

Some of the Pro-Inova main results in 2009 are:

a) Diffused 'The Practical Guide to Innovation in enterprises.' The guide prepared by ANPEI as a result of project supported with resources from the SETEC/MCT and released at INOVATEC, held in Belo Horizonte-MG in the month of October. The Guide contains the Tax Incentives Simulator (law of right) and national incentive programs Locator, regional and State. 1,000 printed Guides to the launch. Updating and dissemination is by electronic means at the following address: http://proinova.isat.com.br/Home.htm.

b) Released the call MCT/CNPq nº 013 SETEC//2009-Pro-innovative Technology and innovation events to support the fulfilment of an agenda of technical events aimed at articulating initiatives of partner entities, with a view to raising awareness and mobilizing the business community and society to the importance of innovation. Value of the call: R $ 8 million, for 2009 and 2010. The call provides for two rounds of support to projects. The first ended on 09.10.09. The second round will be from March to April 2010. Results of the first round of public notice (http://www.cnpq.br/resultados/2009/013_1.htm): 54 projects selected, R$ 3.8 million committed; Northern region-3 projects; Northeast Region: 6 projects; Southeast region: 23 projects, South region: 18 projects and Midwest region: 3 projects.

c) Sector entities to support research, development and innovation - It drafted terms of reference for the amount of R$ 7 million for the period 2009-2010 to the CNPq public call for sectoral entities to support research, development and innovation in companies. It aims to establish actions for the strengthening and the creation of sector entities that contribute to the development of innovative activities in enterprises.

d) National recognition of excellence in innovation management - drafted the terms of reference and the project worth R$ 2 million to develop and deploy the National Recognition of excellence in innovation management, which will be run by Competitive Brazil Movement. The MCTI and FINEP project aims businesses of all sectors and sizes across the country to adopt innovation as a growth strategy, with a view to increasing the degree of competitiveness. From 2010, the recognition is to enable a new category of the FINEP Innovation Prize. The following are the expected results for the project:

- Build and validate a methodology of assessment of excellence in innovation management in firms (and their dimensions and indicators of evaluation)
- Define good management practices innovation in format and language appropriate to the understanding by entrepreneurs from different sectors and sizes of business
- Disseminating innovation management concepts for businesses
- Sensitize and mobilize at least 10,000 companies in the first cycle
- Have at least 1,000 companies registered in the first cycle
- Reward about 50 companies from first cycle
- Monitor 100 companies' programmes in the first cycle
- Constitute a database for benchmarking of best practices in innovation management applicable to companies of any size or segment
- Build monitoring program participating companies to check growth on the level of competitiveness of enterprises. The project will provide still increased practice of managing innovation in Brazilian companies, from awareness, motivation, promotion, awards, mentoring and monitoring of all activities.

e) Main results of the partner institutions of the Pro-Inova - BNDES: 65 innovation services operations of the BNDES card-Total R $ 577 000-RS 7,945 each. National Confederation of Industry (CNI): MEI-Business Mobilization for innovation – Innovation as a priority for the industry. Goal: 60 thousand innovative companies in 4 years; ANPEI: 16 events, to 1,152 people about using the law of right, project management and planning for innovation; CGEE/ABDI: new version of the Innovation Portal-new graphical interface, generation of maps, information on PI, graphic creation and participation of communities, networking; SEBRAE: ALI-Local Agents of Innovation programme: in 2009, 90 agents to serve 4,500 businesses (DF, RN, PR) 2010 Goal: + 330 agents to meet 200 companies, Innovation Workshops 16,500 in all States in partnership with ANPEI, featuring 19,022 people, distribution of leaflets 115,000 manuals "Innovation as a Competitive Strategy of the Micro and Small enterprise"; IEL: Executive education programs (strategy and innovation in firms, strategic management for innovation to Directors) and Corporate Training (for MPE, innovation and financing of innovative action, PI in industry) and PROTEC: 25 courses for companies in partnership with ABDI on technological innovation projects and two national events on innovation (720 participants across the country), 2 themed events (396 participants).

6. Universities and Research Centres

Because of the challenges facing global economies in terms of the skills and resources required to capture, create, diffuse and use new knowledge, some universities and research centres throughout the country started a comprehensive set of innovation-support strategies. Universities in Brazil are responding to these challenges with the increase of technology transfer offices, starting courses and programmes in entrepreneurship and commercializing ideas, broadening administrative and academic support for all kinds of TT activities.

There seems to be a growing recognition in Brazilian universities that innovation is not only about being able to set up modern research infrastructures and to attract researchers. In order to support innovation and the transfer of knowledge created by universities (alone or in conjunction with firms and/or governments) universities also need to bring about a reorganizational process that incorporates new managerial skills, entrepreneurial culture and other resources for innovation.

The last two decades experienced a long list of new support agencies of private or public nature, science parks, business incubators, as well as providers of specialized training to university personnel in technology transfer, IPR and innovation management and to students in business planning, marketing, negotiation skills and finance. The list continues.

As mentioned earlier, Brazil's Innovation Law has mandated federal universities and research centres to structure and establish NITs within their facilities. The Brazilian Innovation Agency (FINEP)[3] still provides funds to universities and research centres for the creation of NITs through specific yearly calls.

The expectations built by policy makers around NITs relies on the success of some important US TMOs. Therefore, the growing belief is that NITs will internalize on the domain of the Brazilian regulatory framework for stimulating innovation through technology licenses, intellectual property and contracts management and the development of strategic partnerships with key external players in industry and government. The expectations around this will depend – on a substantial basis – on the quality of human resources trained to operate and manage the NITs, as well as on overcoming the cultural rigidness that persists in several of the country universities in terms of more cooperation with industry (British Council, 2015).

However, technology management offices cannot be expected to become the solution for effective technology transfer through university-industry cooperation. As Ulrichsen (2015, p. 7) points out: "This extends well beyond the well-known technology transfer offices supporting university spin-outs and

[3] FINEP is the Brazilian Portuguese acronym for Financiadora de Estudos e Projetos. FINEP is the operational supporter of innovation and some applied R&D projects in Brazil. The funds and the policy orientation is provided by the country's Ministry for Science, Technology and Innovation (MCTI).See < http://www.finep.gov.br/>.

technology licensing, to include, for example: building and sustaining major corporate partnerships; industrial liaison; developing and delivering workforce training programmes and courses; facilitating access to the university, particularly for local SMEs; developing their innovation infrastructure e.g. incubators and innovation centres; and initiatives supporting local economic development and innovation".

Despite a growing policy framework and some initiatives of successful university-industry cooperation here and there, there is still a limited IPR and TT culture in Brazilian universities (Livesey, 2013). The lack of clear and long-term policies for innovation take-up and the difficulties to source and maintain top staff for NITs did contribute to the problems most commonly encountered. In addition, NITs are not a creation of the Innovation Law. The Law has just turned mandated in federal institutions the need to have NITs locally established so that federal universities and research centres could be able to take more advantage of the economic benefits generated by the knowledge spill-out to firms and other agents. Figure 1 presents the evolution of NITs created in Brazil until 2010.

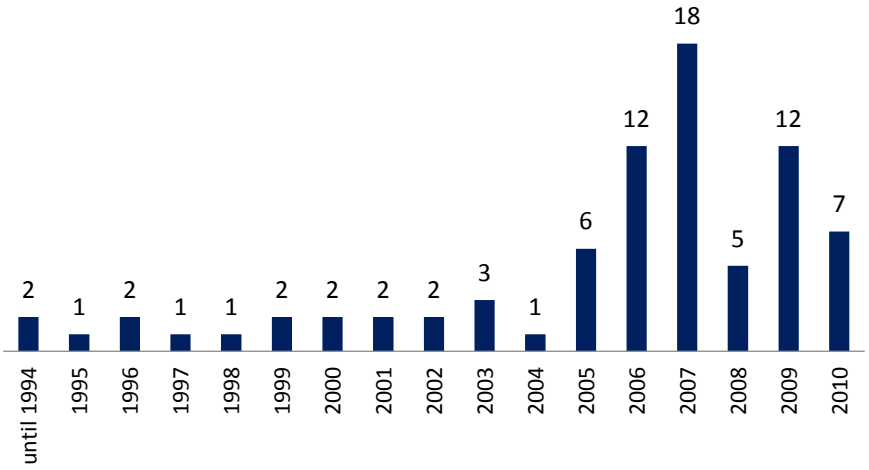


Figure 1 – Evolution of NITs in Brazil

Source: authors' compilation on data provided by the Brazilian Ministry for Science and Technology

As the country's richest regions, the Southeast and the South concentrate the larger part of NITs recently established, accounting for 2/3 of the country's total NITs (Livesey, 2013).

The Brazilian National Intellectual Property Institute (INPI) is playing an important role in the efforts to reduce these shortcomings. However, with limited budgets and personnel, the backlog and delay in the granting of patents limits the competitiveness of Brazilian firms and universities in their efforts to internalize on the results achieved by technology transfer and commercialization of new knowledge. As Figure 2 demonstrates, in 2010 Brazil held a case backlog per examiner similar to that of Japan with nonetheless one tenth of Japan's patent applications. As a result, it is commonplace to see

scarce well-funded Brazilian projects filing their patents directly in the US instead of in Brazil.

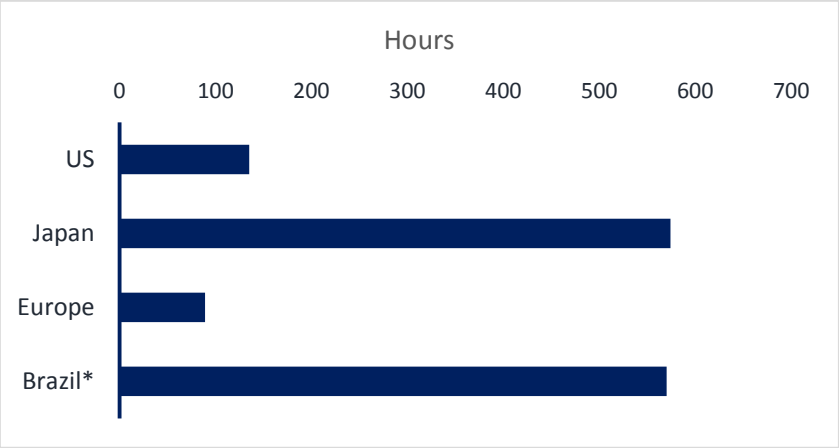


Figure 2: Patent Case Backlog Per Examiner – 2010 (Economist Intelligenc Unit)

Despite difficulties, the INPI is playing an important role in disseminating new practices in IPR education. The INPI has created a masters' degree in intellectual property and innovation management, which was later on followed by a PhD in the same area. INPI also offers several short courses on a presence or distance learning basis.

Technology transfer, research valorization and entrepreneurship promotion are not new themes in Brazil. In mid-1990's, the Catholic University of Rio de Janeiro (PUC-Rio) had started a thorough process of entrepreneurship promotion culminating in the creation of one of the first business incubators in Brazil, the Genesis Institute, together with a research unit entirely dedicated to private equity and venture capital research, called Nep/Genesis. Nep/Genesis was involved in the first initiatives in the country that culminated in the creation of business angels associations, venture forums and the organization and training of personnel in public agencies that finance innovation-related projects nationwide. PUC-Rio, in addition, created in early 2000 a 9-month certificate programme with a series of entrepreneurship-related activities ranging from business planning, entrepreneurial culture to marketing and venture financing.

The University of São Paulo, followed by the University of Campinas, both situated in the State of São Paulo, are the most R&D and patent-intensive universities in Latin America and both have a series of training programmes targeting both students and personnel involved in TT and IPR activities. Other Brazilian universities also play an important role in creating NITs and other support infrastructures that contribute to the dissemination and production of R&D that is relevant to industry. The list can be extensive but we cannot forget to mention institutions such as the Federal University of Rio de Janeiro, the Federal University of Minas Gerais, the Federal University of Rio Grande do Sul, the Federal University of Santa Catarina and the Federal University of Pernambuco.

Other institutions as federal laboratories and research centres such as the Osvaldo Cruz Institute (Fiocruz), the Brazilian Agricultural Research Corporation (Embrapa) and the Renato Archer Information Technology Research Centre (CTI Renato Archer) also play a leading role in the dissemination of best practices and new knowledge arising out of their research facilities.

Some acknowledged cases of university-industry cooperation for innovation in Brazil are summarised as follows:

- the ten-year project developed by The University of Campinas in partnership with a fine chemical company analysed in Botelho, et al. (2009)
- the experiences of different Brazilian universities with the pharmaceutical industry detailed by Paranhos & Hasenclever (2011);
- the experience of The Federal University of Pernambuco with small and medium sized enterprises in the software sector in Recife, as analysed in La Rovere & Rodrigues (2011);
- the experience of software firms with research universities in Rio de Janeiro (Botelho, Alves, & Bastos, 2010) and the experience of The Federal University of Santa Catarina and EMBRACO, a manufacturing company, that has been in existence for 20 years even after the company was acquired by Whirpool, an American home appliance manufacturer;
- the long-term R&D cooperation experience of Petrobras research facility with the Catholic University of Rio de Janeiro, the University of São Paulo, the University of Campinas and the Federal University of Rio de Janeiro in projects dealing with the risky pre-salt oil and gas layer, as analysed in Pellegrin et al. (2010) and Botelho & Bastos (2010).

Effective technology transfer efforts are high dependent on the level of cooperation between industry the traditional sources of knowledge creation, namely as institutions of research and higher education (Audretsch, Lehmann, & Wright, 2014). The Brazilian literature mentioned earlier relates successful experiences involving university-industry collaboration to a mindset in university units oriented to the promotion of effective and long term relationships with the local communities of entrepreneurs, established firms and governments (Suzigan, Albuquerque, & Cario, 2011).

The role of public financing in university-industry cooperation is fundamental, even though it appears it is more effective to those players with a previous history of cooperation with the selected partner (Alves, Quelhas, da Silva, & Lameira, 2015; Alves & Pimenta-Bueno, 2014). The dynamics for the public financing of multi-partners R&D projects leading to innovation in Brazil, both in the nation's richest state (São Paulo) and in federally funded projects, appears to give birth to conflicts among partners as well as, in some cases, discontinuity in the project mission (Alves & Pimenta-Bueno, 2014). This is more common in the cases in which valuable knowledge comes out in the course of the collaborative project development (Alves, Quelhas, da Silva, & Lameira, 2015;

Botelho, Alves, Schwartzman, & Christophe, 2009). The antagonism arising out of a series of specific problems that affect efforts to establish long-term and mutually beneficial relationships between universities and industry also contributes to an increasing incidence of more conservative actions from companies that look for universities and research centres as a way to promote access to the public resources available.

This aspect characterises the nature of university-industry cooperation in Brazil as something much more similar to a service provision strategy, from universities to firms, than one that fosters innovation through a line of action that produces synergies and long-term cooperation ties to all stakeholders involved. One consequence of this is the treatment of intellectual property, which is virtually non-existent in the relationship between companies and universities in Brazil (Livesey, 2013). The cases of success mentioned in the literature usually involve experiences of university-industry cooperation leading to innovative projects and successful technology transfer from university to industry committed by experiences that precede the government support mechanisms.

In the lines that follow, we will discuss two selected institutional efforts from universities and research centres to strengthen the country's innovation performance through publically supported technology transfer initiatives. It is important to mention that our aim is not to compare one experience with another. If we do so, the results can be somewhat biased since there are important variables that we are not capturing that could not be appropriately controlled for, like historical background, cultural and social structures. What we can see from these experiences and others mentioned in the literature is that experimentation of approaches to exploit the resources and capabilities is necessary to support the entrepreneurial mission of research universities and for effective knowledge and technology transfer (Botelho & Almeida, 2010; Colombo, D'Adda, & Piva, 2010; Audretsch, Lehmann, & Wright, 2014; Santos & Torkomian, 2013; Alves, Quelhas, da Silva, & Lameira, 2015).

6.1. The University of São Paulo

The University of São Paulo (USP) is Brazil's most important research university. According to the British Times Higher Education, USP ranks top 60 worldwide. The University is maintained by the State Government of São Paulo under a percentage of *circa* 5% on the state's Value Added Tax (VAT).

USP has over 90,000 undergraduate and graduate students training on its 42 research and teaching units and four hospitals spread out in its seven campuses. Despite its excellence in research, USP has only recently established a technology transfer office. This NIT, created in 2005, is called USP Innovation Agency. Today, it offers its researcher and students community a myriad of services aimed to bridge a more open and effective approach with industry. As Figure 3 shows, the number of patent filed has grown substantially since the creation of its NIT.

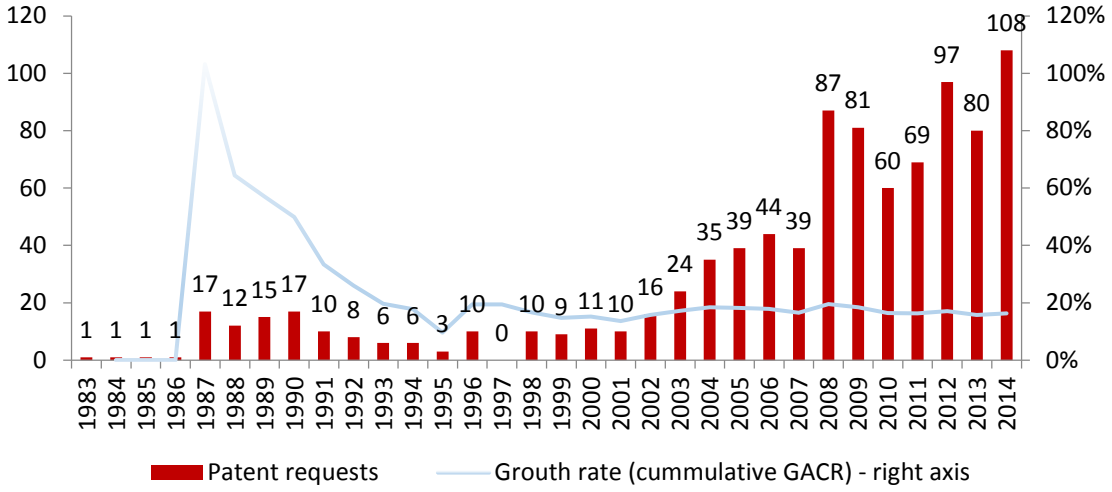


Figure 3: Patents filed from USP Innovation Agency

Source: USP Innovation Agency

The substantial increase observed in the university's patents filed is due to the state of São Paulo Innovation Law. This law mandated local state universities to establishing their own NITs. As a result, there was an increase in the number of specialized personnel supporting researchers and students as well as in the use of law offices in São Paulo helping in negotiating IPR between interested parties and in writing the patent requests. The resources came from the São Paulo Research Foundation (FAPESP) and from other assimilated federal instances. The university is aware that its patents granted before 1995 have already expired so that a massive effort is in place to encourage its research community to protect the IPR arising out of their research efforts. The areas with research efforts more strongly concentrated on patenting in USP are chemistry and physics, followed by medicine, engineering and biology.

Up until now, USP holds *circa* 600 patents granted by Brazil's INPI and by international patent organizations, such as the United States Patent and Trademark Office (USPTO) and the European Patent Office (EPO). The main complaint by the USP Innovation Agency and its researchers regards the backlog of INPI in granting a patent, which may take from 8 to 12 years depending on the complexity of the patent request. It is important to mention that the 20 years life span of a patent in Brazil is in effect reduced by the backlog time. That said, the higher the backlog, the lesser the time the patent holder will have to obtain value out of his/her invention. Internationally, the average patent granting backlog reaches up to 5 years since the patent filing (Ulrichsen, 2015).

Table 3: USP patents per area of knowledge – as of 2010

Business segment	Total number of patents	%	Total of patents under secrecy phase	%
Agriculture and agroindustry	25	4%	9	7%
Foods and beverages	38	6%	9	7%
Energy	27	4%	7	5%
Machinery and equipment	167	28%	38	28%
Materials	81	13%	34	25%
Health (inc. human and animal care)	192	32%	35	26%
Information and Communications Technologies	12	2%	2	1%
Environmental and sustainable technologies	20	3%	0	0%
Others	39	6%	2	1%
Total	601	100%	136	100%

Source: adapted from Dias (2011)

The USP Innovation Agency has promoted a series of policies and procedures to strengthen technology transfer and commercialization strategies for the knowledge produced in the University. On average, between 1982 and 2014 the university has filed 1018 patents. The number of patents licensed in comparison with patents filed was 4.5%. After a significant increase between 2008 and 2010, after 2010 the proportion of patents licensed has decreased dramatically. Figure 4 presents the evolution of patents filed and the incidence of patents licensing from the university to industry.

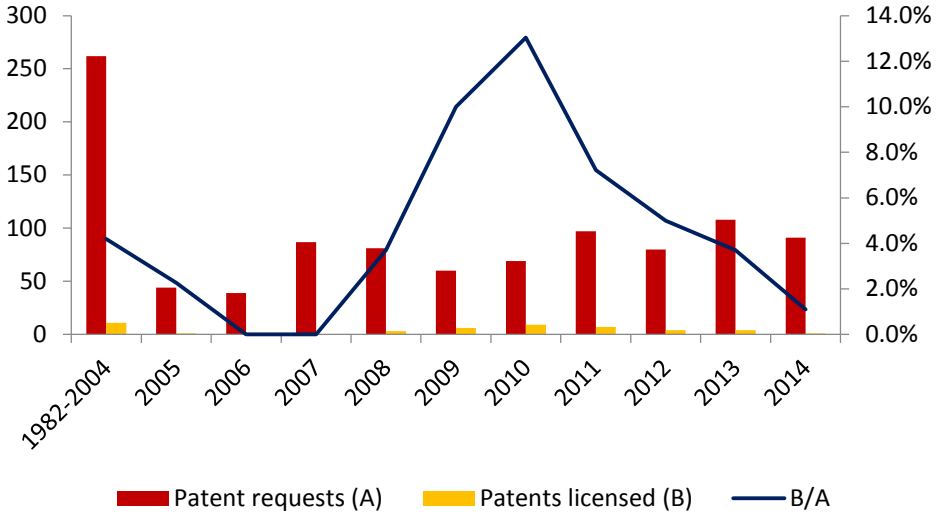


Figure 4: Patent filed and licensed – University of São Paulo
Source: adapted from Dias (2011)

The most representative segments are biopharmaceuticals, medical equipment and cosmetics. Table 4 presents a list of recent firms, which until 2011 have licensed patents, software and copyrights from USP.

Table 4: Companies licensing patents from the Univesity of São Paulo

	Company	Business Segment
1.	Aché	Pharmaceutical
2.	AGX Technology	Information Technology
3.	BASF	Chemical
4.	Bio Art	Medical Equipment
5.	BiOLAB	Pharmaceutical
6.	Biosafe	Biotechnology
7.	Brink Mobil	Education
8.	Ciclofarma	Pharmaceutical
9.	Cristalia	Pharmaceutical
10.	EMS	Pharmaceutical
11.	Essentii	Pharmaceutical
12.	Farmacore	Pharmaceutical
13.	Forward	Chemical
14.	Inovamat	Materials / Nanomaterials
15.	Itautec S.A.	Information Technology
16.	Lam Educacional	Education Materials
17.	Marca	Construction
18.	Natura	Cosmetic
19.	Notox	Biotechnology
20.	Pelo Nova	Cosmetic / Pharmaceutical
21.	PHB Industrial S.A.	Biotechnology
22.	Sales Computers	Information Technology
23.	Silvestre Labs	Chemical / Pharmaceutical
24.	Vencofarma	Pharmaceutical
25.	Ventrix	Medical Equipment
26.	Vitrovita	Glass / Ceramics

Source: Adapted from Dias (2011).

Most information regarding university-industry contracts in Brazil are kept in secrecy status. According to the latest information publicly available, the amount of revenues to USP from the licensing of IPR totalled R$ 415,000, from 2005 to 2009. This amount is still very modest for Brazil's largest research university. As a matter of comparison, this amount is equivalent to 0.06% of the total scholarships provided to USP undergraduate, master and PhD students along that same period. It is not expected that the period succeeding 2009 has substantially changed this number whatsoever. In a survey commissioned by the British Council, royalties obtained from IPR licensing in UK univesrsities accounted for 4% of the universities income stream in 2013 (Ulrichsen, 2015).

Despite the relatively low values obtained from the TT contracts awarded to USP from industry-partners, university-industry partnerships are an important lever in the dissemination of knowledge from the university to business segments, even though it looks like the value obtained from this cooperation is not yet being properly captured by the university. This is not at all different in other Brazilian universities, as some recent studies have pointed that out (Alves, Quelhas, da Silva, & Lameira, 2015; Botelho & Almeida, 2010). In addition, according to a survey carried by Dias (2011), only 12% of university-industry projects developed between USP and industry in 2010 have anticipated some sort of technology transfer mechanism in case new knowledge arises from the collaborative R&D project. USP Innovation Agency at times does not

have access to these contracts, as a myriad of them are classified as regular research projects consisting in R&D service provision with limited (new) technology development prospects.

Brazilian entrepreneurs most often complain that a patent may cause more trouble than benefits. The costs to properly maintain and manage IPR can be at times prohibitive and universities offer little infrastructure and qualified personnel to support them in effective IPR and innovation management practices (Alves & Pimenta-Bueno, 2014). This can be particularly the case among startups with limited resources to start a legal battle when its IPR is illegally used by third parties. In fact, as Audretsch et al. (2014) indicate, the extent that there are problems with contract enforcement in developing markets, there are complications regarding the ability of government and universities to capture some of the benefits from technology transfer.

In addition, today's practices to adequately capture the value arising out of a patent can be hard to grasp and patents are commonly attributed qualitative and subjective judgments regarding value and market potential. A common practice mentioned by some of the interviewees consists in starting licensing negotiations with industry parties based on a given percentage of the revenues derived by the patent use. This percentage can be situated on 5 to10 percent of net revenues. The amount agreed upon will depend on the institutional rigidness in the university department and the university's technology transfer office in licensing the IPR, on the maturity stage of the knowledge represented in the IPR and on the quality of lawyers on both sides of the negotiation table. It is no different in USP Innovation Agency.

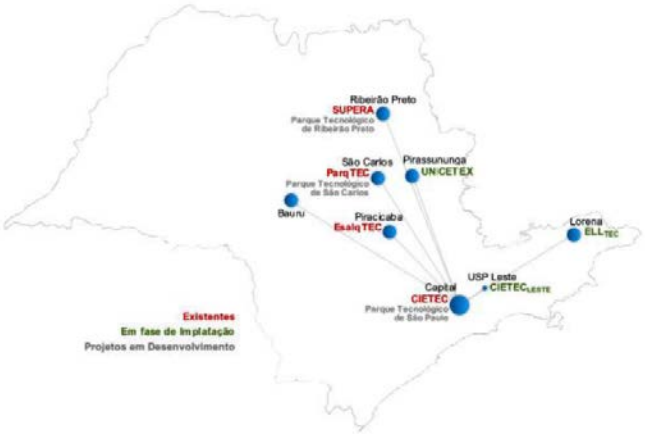


Figure 5: USP's Innovation Habitats
Source: USP Innovation Agency

Innovation habitats contributing to the extension of research produced from the University to society through the creation of startups, business incubators and science parks are part of USP strategy to strengthen its position in technology transfer and knowledge valorisation. Up until now, USP has 7 innovation habitats in the State of São Paulo, as shown in Figure 5. The areas represented cover biotechnology, software, cosmetics, telecom, agriculture, automation, aeronautics and bioenergy, to name the most representative. The USP

business incubators and science parks host startups in areas that are more representative of each campus specialization, such as agroindustry in EsalqTEC (Piracicaba), medical technologies in SUPERA (Ribeirão Preto), varied industry and services applications in CIETEC (São Paulo, capital city) and so forth.

Technology transfer can occur at USP in three different forms. First, through joint R&D projects carried with industry. Second, through licensing of IPR to industry. Third, by spinning out companies created by USP researchers and alumni. The distribution of IPR at USP is as follows: 50% to the inventor/researcher; 40.5% to the department where the invention was created; 4.5% to the administrative unit the department belongs (eg. Polytechnic School, College of Agriculture etc.); and 5% to the university's presidency (*reitoria*, in Portuguese). The São Paulo State Innovation Law establishes that the inventor should be given no less than 5% and no more than 1/3 of the IPR. USP is therefore the Brazilian university that voluntarily attributes the highest percentage of its IPR to the inventor.

As the USP Innovation Agency was formally established in 2005, it started a thorough process to turn the University the holder of patents filed and granted before the Agency was in place. Since 2005 USP is the holder of any patent granted by its inventors.

USP Innovation Agency supports the writing of the patent request and its application within INPI. However, the university does not financially support patent requests in the US or in other countries. There is a specific programme called NUPLITEC[4], coordinated by the São Paulo Research Foundation (FAPESP). As the programme name suggests, the referred is only applicable in the State of São Paulo. Other Brazilian states, such as Rio de Janeiro and Minas Gerais have similar programmes.

Within a 90,000 students' community, USP Innovation Agency is not yet well equipped to support the TT needs of the university. The entire university has three agents and 44 personnel, of which 2/3 are interns with a short-term mandate. Differently than US universities, in which professors and researchers do participate directly in the patent marketing process performed by their Technology Management Offices, inventors do not participate directly in the USP Innovation Agency patent marketing efforts. USP has a patent database available to selected firms so that, if any of them shows interest and needs more information, they contact the Agency so that a meeting with the firm, the inventor and the Agency is set up. The Agency also makes regular phone calls to inform firms on new patent filed that may be proved of some interest for them. In other circumstances, the inventor pro-actively contacts potential firms and then informs the Agency so that a meeting is set up with the interested parties, including the Agency.

[4] NUPLITEC is a Portuguese acronym for Patents and Technology Licensing Unit.

It is important to notice, so far, that USP Innovation Agency still plays a limited role in the commercialization strategies of the knowledge produced in the university. With limited personnel, contacts with firms become sporadic. In addition, the Agency website offers limited information on the excellence that can be found in the university labs. The Agency also has a limited participation in specialized forums, including venture capital communities. Bureaucracy is another aspect, as licensing contracts can be granted on either an exclusivity or a non-exclusivity form. In the former, as mandated by the Innovation Law, a public call is set up so that other firms can have the same chances to be granted access to the technology. In this case, the interested party offers a bid value and the chosen proponent is the highest bidder. In the latter, there is no need to initiate a public call process. When a patent is licensed on a non-exclusivity basis, the fee charge is fixed upfront and its value depends on the maturity of the knowledge at hand, on the number of consultancy hours provided by the inventor to the licensee (up to 8 hours a week), on the "idealized" market value of the patent and, finally, on the royalties to be charged. There seems to be no specified methodology adopted and the Agency tends to establish a case-by-case process in assessing the market potential and value of the knowledge (Table 5).

Table 5: Royalties and payments negotiated by USP in 2010

Licensing type	Patent application area	Upfront value (BRL $)	Average royalties (reference)	Royalties negotiated
Exclusively	Food	3.000,00	2,8%	2,00%
Exclusively	Food	300,00	2,8%	3,00%
Non-exclusive	Materials	-	Not available	3,00%
Non-exclusive	Materials	4.000,00	the 4,8% from 5,1%	-
Non-exclusive	Health and personal care	3.000,00	the 4,8% from 5,1%	3,00%
Exclusively	Health and personal care	86.587,00	the 4,8% from 5,1%	0,25%
Exclusively	Health and personal care	700.000,00	the 4,8% from 5,1%	3,5%
Non-exclusive	Health and personal care	20.000,00	the 4,8% from 5,1%	8,00%
Non-exclusive	Health and personal care	5.000,00	the 4,8% from 5,1%	3,00%
Exclusively	Health and personal care	7.000,00	the 4,8% from 5,1%	3,00%
Exclusively	Health and personal care	-	the 4,8% from 5,1%	2,50%
Exclusively	Health and personal care	250.000,00	the 4,8% from 5,1%	3,00%
Exclusively	Health and personal care	15.000,00	the 4,8% from 5,1%	3,00%
Non-exclusive	Others	-	Not available	2,00%
Non-exclusive	Others	-	Not available	2,00%
Total		1.093.887		41,25%

Source: Adapted from Dias (2011)

The challenge most often encountered, according to Dias (2011), entails the difficulties to appropriate the costs incurred in both the development of the patented item and in the licensing negotiation processes. In addition, as commonly encountered in research structures, USP researchers themselves do not make use of cost systems to capture the development costs incurred throughout their R&D projects. Dias (2011) mentions circumstances in which the Agency negotiated licensing contracts where the upfront value and the royalties charged were inferior to the costs incurred in the development phase. This case is more frequent in exclusivity contracts.

The USP Innovation Agency is playing an important role in the dissemination and transfer of knowledge generated by its communities of researchers. However, there are important challenges to overcome. Researchers mention the Agency rarely contacts them regarding the status of the knowledge they produce, the projects they are carrying out now and their research agenda for the future. The researchers usually seeks the Agency whenever they need support.

Even though the São Paulo state's Innovation Law allows full-time state university researchers to dedicate up to 8 hours per week on such consulting activities, companies complain that it is difficult to count on the inventor's support in the adaptation of the licensed patent into the licensee's production process. As commonly encountered in the literature, it may be due to the cultural barriers regarding university-industry cooperation (Aghion, Dewatripont, & Stein, 2008). Another aspect is bureaucracy in the negotiation and licensing process. For firms, time-to-market is an important aspect in their business strategies that cannot be neglected by the university's administration. Once the negotiation is finished and the terms of the license have been properly set up and agreed by the parties, the final approval process involves several instances of the university and significant paperwork. It is no surprise that some firms give up in the middle of a negotiation process.

Last, despite both the federal and São Paulo state Innovation Laws allow for universities and other assimilated bodies to hold equity on spin-offs originated in the universities' research infrastructures, the University of São Paulo has not yet deliberated on the matter. So far, USP cannot hold equity on private enterprises. This poses a substantial barrier for entrepreneurs/inventors who want to license from the university – through a spin-off startup – a technology they created themselves.

6.2. Unicamp

The State University of Campinas – hereafter Unicamp – is the second largest research university in Brazil. Located in the State of São Paulo in the city of Campinas, Unicamp has two other *campi* in Piracicaba and Limeira. Unicamp has 1,750 faculty and over 34,000 students, including 11,400 masters and PhD candidates.[5]

Technology transfer and commercialization activities are carried by Unicamp's Inova, since 2003. It is therefore a NIT established before both the federal and the São Paulo state innovation laws. Inova has *circa* 40 personnel, of which 2 involved in the business incubador management, 6 with intellectual property management, 7 with technology transfer activities, 2 with the business incubation, and 9 with on-going projects including dissemination of TT, IPR and innovation culture, and other on-demand projects. About 20 people are full-time employed by the Inova agency.

[5] As of http://www.unicamp.br/unicamp/?language=en, accessed June 4th, 2015.

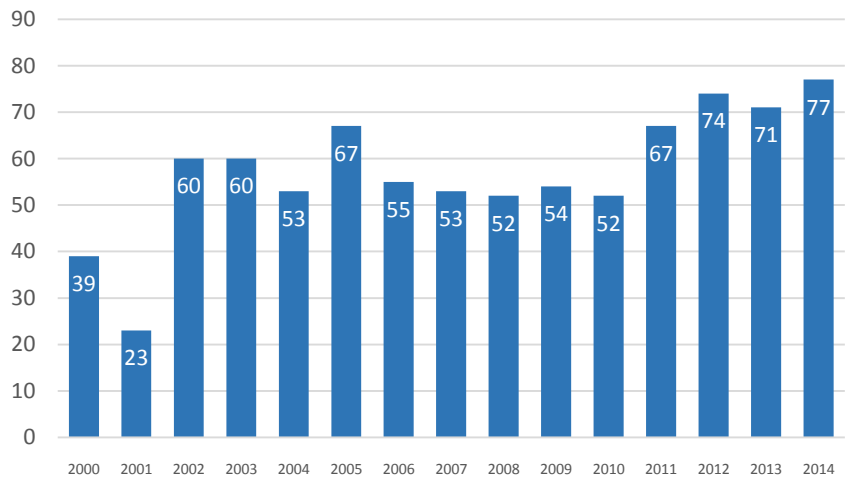


Figure 6: Patents filed – Unicamp
Source: Innova Unicamp

Having so far 857 patent filed, 15% of which in international patent offices, Unicamp is the leading Brazilian university in the realm of IPR and TT practices (Figure 6). The university's innovation agency holds seats in international intellectual property forums and has insofar over 30 patents filed within the Patent Cooperation Treaty (PCT). Until 2014, the university had 95 patents granted, of which seven by international offices. The difference in the number of patents requested and granted is due to the higher backlog on INPI, as previously mentioned.

Table 6: Patents filed by Unicamp in International offices – as of 2010

Patent office	Number of patents requested	%
United States Patent and Trademark Office - USPTO	24	25%
European Patent Office - EPO	9	9%
Korean Intellectual Property Office - KPO	7	7%
Instituto Nacional de la Propriedad Industrial - INPI	4	5%
Intellectual Property India - IP	5	5%
Japan Patent Office - JPO	5	5%
Instituto Mexicano de la Propriedad Industrial - IMPI	4	4%
Instituto Nacional de la Propriedad - INAPI	4	4%
State Intellectual Property Office of China - SIPO	4	4%
Asociacón Colombiana de la Propriedad Industrial - ACPI	3	3%
Australia Government IP Australia - IP Australia	3	3%
Canadian Intellectual Property Office - CIPO	3	3%
Servicio Autónomo de la Propriedad Intellectual - SAPI	3	3%
Dirección Nacional de la Propriedad Intellectual - DNPI	2	2%
Eurasian Patent Organization - EAPO	2	2%
Gulf-Co Operation Council - GCC	2	2%
Indonesian Intellectual Property Office – Indonesia IP	2	2%
Norwegian Patent Office - NPO	2	2%
China Patent Trademark Office - CPO	2	2%
Companies and Intellectual Property Registration Office - CIPRO	1	1%
German Patent Trade Mark Office – DPMA	1	1%
Intellectual Property Corporation of Malaysia	1	1%
Oficina Española de Patentes y Marcas – OEPM	1	1%
Total	94	100%

Source: Inova Unicamp

Until 2011, 73% of patents filed has been concentrated in five departmental units of the university, as follows: Institute of Chemistry – 36%, Faculty of Mechanical Engineering – 11%, Faculty of Electrical Engineering and Computer Sciences – 10%, Faculty of Chemical Engineering – 9%, and Faculty of Food Engineering – 8%. The other 15 departmental units accounted for the remaining 27%. Despite the units in the areas of Medicine and Odontology represented less than 7% of the patent requests made by the university, 239 – or 39% – out of the 610 patents filed until 2010 had direct health, nutrition or medical related applications. Another 239 patents filed were in the area of industrial production, and the remaining 72 in the areas of oil & gas, mining, information and communications technologies, and rural technologies.

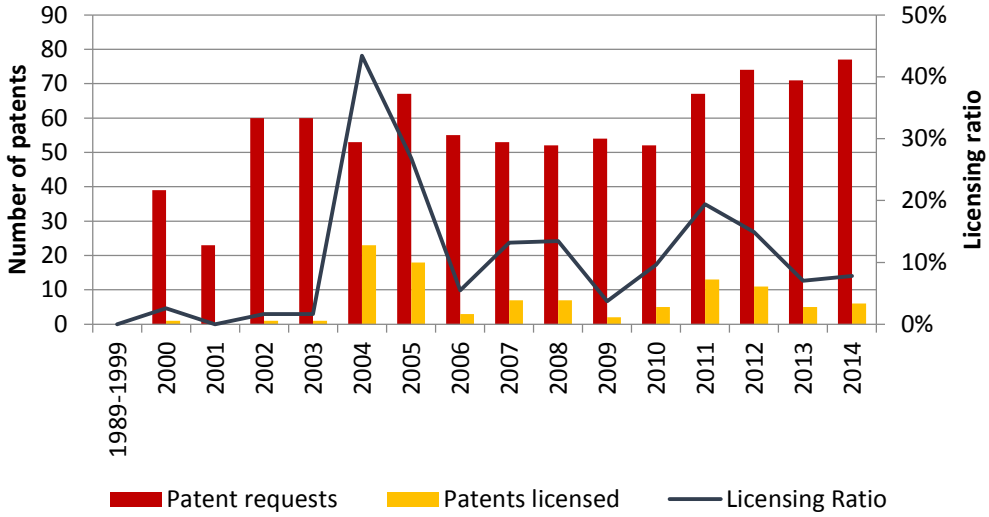


Figure 7: Patent filed and licensing – Unicamp
Source: Innova Unicamp

The number of patents licensed has been decreasing in the last years. After a top licensing ratio of 43% in 2004, this number has been decreasing (Figure 7). It looks like a growing number of patents filed and granted are not being sufficiently translated into new licensing contracts.

Between 2005 and 2010, Unicamp received R$ 1.2 million on royalties derived by its IPR, such as patents, software and related technical expertise. This amount accounts for 0.51% of the total direct disbursements to the university in that period as state and federal government grants for research and scholarships, and as joint research contracts carried with industry segments.

Table 7 lists companies with which Unicamp established licensing agreements between 2005 and 2010.

Table 7: Companies licensing patents from Unicamp

	Company	Business Segment
1.	Cargill Agriculture	Agriculture
2.	Castan Food	Food
3.	Ipixuna Food Products	Food
4.	Proceedings Food	Food
5.	Usina São Francisco	Food
6.	Click Automotiva Industrial	Auto Parts
7.	Biocamp	Biofuel
8.	Genesearch Research Support	Biotechnology
9.	Immunoassay	Medical Equipment
10.	NIS – National Implant System	Medical Equipment
11.	Labsolutions	Medical Equipment
12.	Kolplast	Medical Equipment
13.	Scitech Medical Products	Medical Equipment
14.	DLE – Medical Diagnostics	Medical Equipment
15.	Tech Chrom Analytical Instruments	Analytical Equipment
16.	Tech Filter	Filter Equipment
17.	Enalta	Eletronics Equipment
18.	Cristália	Pharmaceutical
19.	Silvestre Labs Chemical and Pharmaceutical	Pharmaceutical
20.	Aché Pharmaceutical Labs	Pharmaceutical
21.	Incrementha	Pharmaceutical
22.	Labogen Attre Farma	Pharmaceutical
23.	Steviafarma Industrial	Pharmaceutical
24.	Bunge Fertilizers	Fertilizers
25.	Immunocamp	R&D for Medical Equipment
26.	Bioware	R&D for Environment
27.	Orbys	R&D for Materials Technology
28.	Megh Industry and Commerce	Chemical
29.	Contech Biodegradable Products	Chemical
30.	Getec Guanabara Industrial Chemistry	Chemical
31.	SDC – Engeneering, Systems, Eletronics	Information Technology

Source: Dias (2011)

Among the projects carried by the University since 2000, about 18% have had some sort of technology transfer from the university to industry segments (Unicamp, 2015). Details on the nature of the transfer are not available. Until 2014, Unicamp span off 130 firms, employing 4,000 people and generating over R$ 1 billion in revenues (Unicamp, 2015). Figure 8 presents the evolution of spin-offs from Unicamp. Most of the spin-offs originated from the Faculty of Electrical Engineering and Computer Sciences, the Institute of Physics, the Institute of Mathematics, Statistics and Scientific Computing, and the Faculty of Mechanical Engineering. Therefore, these Unicamp departmental units are both the most intensive in patent requests and in spin-off creation.

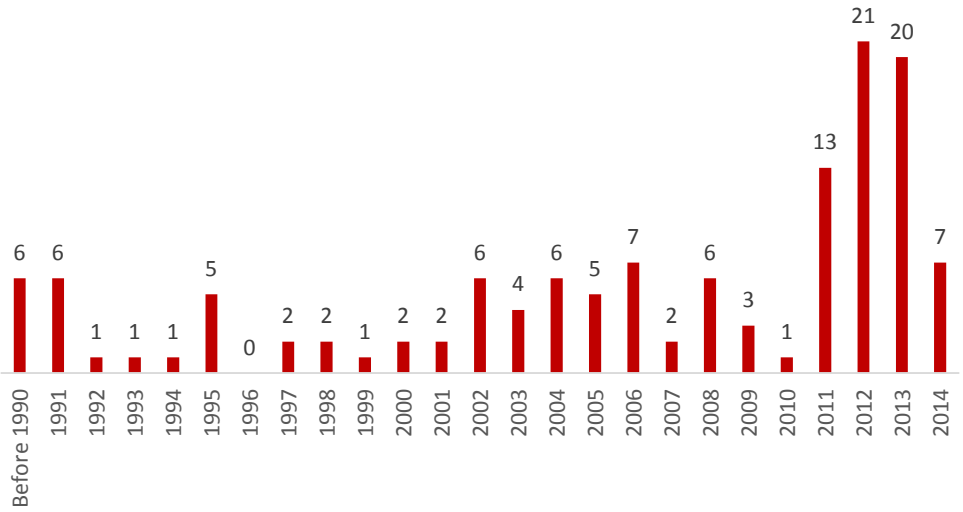


Figure 8: Spin-offs from Unicamp

Source: Inova Unicamp

In case of the share of IPR derived from licensing activities, the share between the university, the inventor, and the university administration is 1/3 to each, as suggested by the State Innovation Law. The filing abroad or under the PCT are only partially covered by the university. Unicamp expects that a company licensing a technology developed by the university's researchers can cover the costs in case it wants to protect the IPR abroad as well.

Just like the University of São Paulo, licenses from Unicamp IPR to industry can occur on an exclusivity or on a non-exclusivity basis. Exclusivity licences depend on public calls and it can occur that a company with which the licensing was under negotiation ends up without the licensing rights. This may happen when another company wins the call or when another company sues the university and the call winner as the loser claims favouritism or another sort of alleged illegal preferential status granted to the call winner. When it happens, the legal issue may take several years for a final verdict. Brazilian universities dealing with IPR and TT, therefore, tend to prefer negotiations based on non-exclusivity terms. However, particularly in areas as complex and uncertain as health and biotechnologies, exclusivity contracts can be a potential driver of innovation, competitiveness and value creation to firms managing to successfully exploiting the economic results derived from the IPR (Lehoux, Daudelin, Williams-Jones, Denis, & Longo, 2014). Non-exclusivity licensing contracts depend on a larger stream of royalties derived from scaling up licensing contracts, which in Brazil are still constrained by poor university culture on innovation and entrepreneurship, little and unexperienced personnel in TT offices or NITs and on the extensive backlog from INPI in patent evaluation and granting (Suzigan, Albuquerque, & Cario, 2011; Botelho & Almeida, 2010; Santos & Torkomian, 2013).

The technology prospection efforts are another characteristic of the university's NIT. Unicamp's Inova agency monitors ongoing and past research projects in

order to check for potential technologies which, if considered of economic interest to industry, are patented and then offered to prospective users in industry. However, this time-consuming process depends not only on an appropriate amount of personnel but also on an extensive background in technology-intensive areas as well as on the entire TT and IPR management processes. These training and capacitation layers precede successful cases in technology transfer and commercialization. Therefore, as a means to tap these gaps in training and capacitation, Unicamp developed the InovaNIT project with resources from FAPESP and FINEP.

The InovaNIT is an initiative aimed to address capacitation gaps in technology transfer in Unicamp and in other university NITs as well. The InovaNIT enabled the training of over 800 professionals from 279 institutions in the country through 44 training sessions covering a variety of topics such as innovation management, NITs structure and management, dissemination of an innovation-like culture within academic structures and so forth (Toledo, et al., 2011).

The InovaNIT project began in July 2007. This project took advantage of the accumulated experience of Unicamp's innovation agency (a NIT called Inova) in TT, NIT management, IP and university-industry R&D projects. The InovaNIT activities include hands-on training and support for professionals working in national NITs - consolidated or to be consolidated - and researchers and lecturers from universities or research institutes. The project also comprised a series of actions targeting the consolidation of social networks between the TT communities in the country. From experience and practical results gathered by InovaNIT, the program therefore sought to highlight the importance of dissemination of good Brazilian management practices of IP and TT for local/regional innovation.[6]

Still in the domain of training, Unicamp also developed a training course named Strategic Management of Technological Innovation Centers (GES-NIT). The course had several editions held in Campinas, totaling over 100 participants. In addition, the University's Library has supported this initiative, by offering the Intellectual Property and Patent Search course in selected databases. These initiatives are offered as distance learning courses as well, most of them free of charge to their participants (Toledo, et al., 2011).

Regarding the scope for licensing negotiations, Unicamp does not define target royalty fees. The royalty fees agreed will depend on each negotiation. Upfront payments only occur on contracts in the pharmaceutical areas. Just like the University of São Paulo, the Unicamp's policy for equity share in spin-offs is not yet clear. Therefore, researchers that start-up a firm exploiting IPR they contributed to create can end up without exclusivity rights, as the university is free to negotiate the IPR with someone else. In addition, despite having a concise innovation policy, as Inova Unicamp is a pioneering one in the country, it focuses extensively on the patenting of IPR instead of on the effectiveness of

[6] As of InovaNIT website. Available at < http://www.inova.unicamp.br/projetos/inovanit >. Accessed on July 6th, 2015.

the negotiation processes. That said, a more thorough assessment of patents that can really have a market potential is not effectively carried so that, as a result, the number of patents that end up “on the shelf’ remains substantially high. Of course, effective TT licensing also depends on the quality of the ecosystem, which includes firms’ utilization of IPR from universities, on the rule of law, and on the overall bureaucracy reduction efforts.

With more than twice the number of faculty and over 3 times the number of students than Unicamp, the USP NIT has the same number of personnel as that of Unicamp. As Dias (2011) points out, from 1994 to 2014, USP has licensed 40 TT contracts, while Unicamp has licensed 95 along the same period. As a matter of comparison, in 2013 the number of papers from USP indexed on STI was over three times as higher than that of Unicamp, reflecting its larger size. However, in the realm of technology commercialization efforts, Unicamp takes a substantial advantage, serving as a national benchmark in TT and IPR management practices.

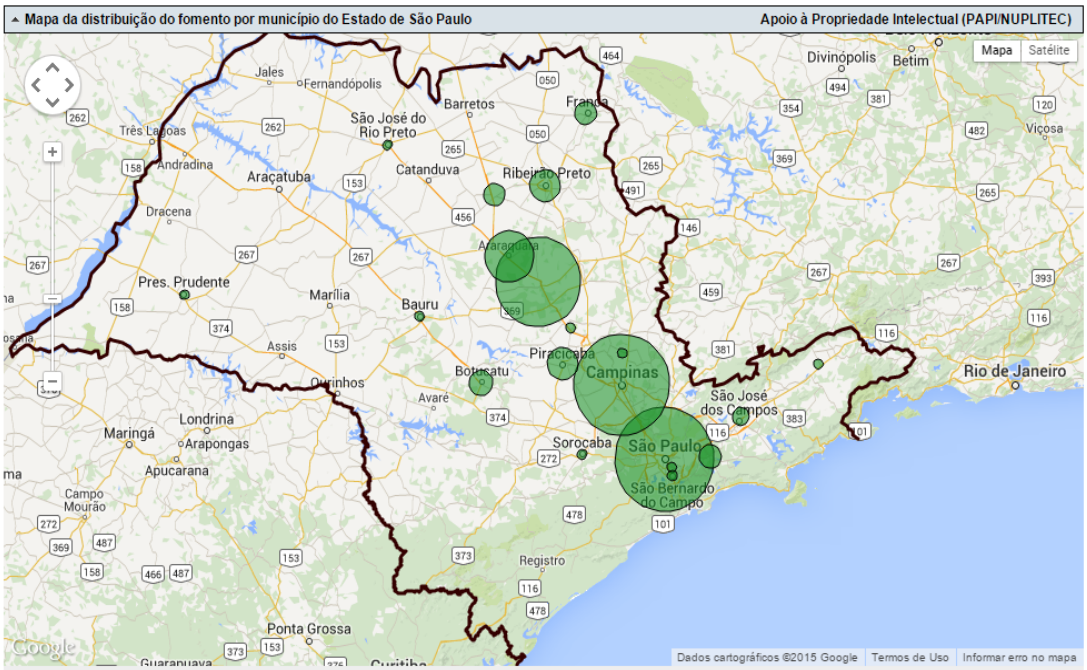
7. Research Foundations: FAPESP's Nuplitec Programme

FAPESP (www.fapesp.br/en) is a Portuguese acronym for the São Paulo State Research Foundation. FAPESP is a state-owned agency with administrative and budgetary autonomy. FAPESP mission is to support research projects in institutions of higher education in all fields of knowledge.

São Paulo has a population of 40 million people and the state accounts for 35% of Brazil's GNP. By constitutional decree, 1% of all São Paulo state's VAT belongs to FAPESP. Fund transfers from the state government to FAPESP occur every month. The stability of funding and the autonomy of the Foundation allow for efficient management of the resources, which has had a sizeable impact: while São Paulo has 22% of Brazil's population and 30% of its PhDs in scientific areas, the state contributes with 52% of the country's scientific articles published in international journals. Therefore, FAPESP's role in the financing of scientific advances in the country cannot be neglected.

Since 2007, FAPESP started to support collaborative projects between universities, research centres and industry segments. So far, Brazilian companies in business segments as diverse as mining, machinery & equipment, agriculture, and electronics have developed joint R&D contracts with universities and research centres in São Paulo, with funds provided by FAPESP and by the firms involved. The universities and research centres contribution does usually come in the form of infrastructure and knowledge provision. The amount of funding and the type of projects financed under this collaborative line of support is not available. However, for a few of the initiatives so far analysed, it can be seen that IPR and TT have not been appropriately treated by the parties involved along the negotiation phases that precede project approval (Botelho & Almeida, 2010; Botelho, Alves, Schwartzman, & Christophe, 2009; Dias, 2011).

As a response to these challenges, FAPESP decided to play a more active role in strengthening the protection of the IPR arising out of the research carried in the São Paulo universities, both in Brazil and abroad. The programme's name is NUPLITEC. The programme also supports activities in TT, including studies and practices aimed to strengthen universities TT management and negotiation skills. NUPLITEC also supports inventors on seeking firms willing to provide the funds for the US patent request process in exchange of licensing prerogatives. Figure 9 presents the geographical distribution of the projects supported so far by NUPLITEC.



Município	Nº de Auxílios	Nº de Bolsas
São Paulo	60	0
Campinas	57	0
São Carlos	46	0
Araraquara	15	0
Ribeirão Preto	6	0
Piracicaba	6	0
Botucatu	4	0
Franca	3	0
Mogi das Cruzes	3	0
Jaboticabal	3	0
São José dos Campos	2	0
Rio Claro	1	0
Bauru	1	0

Figure 9: Geographical Distribution of NUPLITEC's supported initiatives

Source: FAPESP < http://www.bv.fapesp.br/pt/116/apoio-a-propriedade-intelectual-papinuplitec/> Accessed on June, 19th 2015.

As Figure 9 shows, the distribution of projects is very concentrated in a few cities where prominent public federal and state universities are situated, such as São Paulo, Campinas, São Carlos, Araraquara, Ribeirão Preto and Piracicaba. These six cities accounted for 88% of all NUPLITEC disbursements.

The number of projects supported by NUPLITEC has diminished since 2009 (Figure 10). As Figure 10 shows, since 2010 the number of projects financed is inferior to those projects supported in 2000. The motivations behind this dramatic decrease needs further investigation. By looking at the list of projects financed in the FAPESP's website, their description suggests other support programmes with higher budgets from both FAPESP and federal agencies can also finance these projects. Therefore, it is possible researchers prefer i) other programmes with more funding available, ii) they are not prone to consider NUPLITEC as their research agenda does not comprise IPR, or iii) they consider IPR an aspect that can be dealt with the university's NIT later on in case something new comes out of their research projects. It is also possible researchers and NITs managers in the State of São Paulo do not know the FAPESP NUPLITEC Programme.

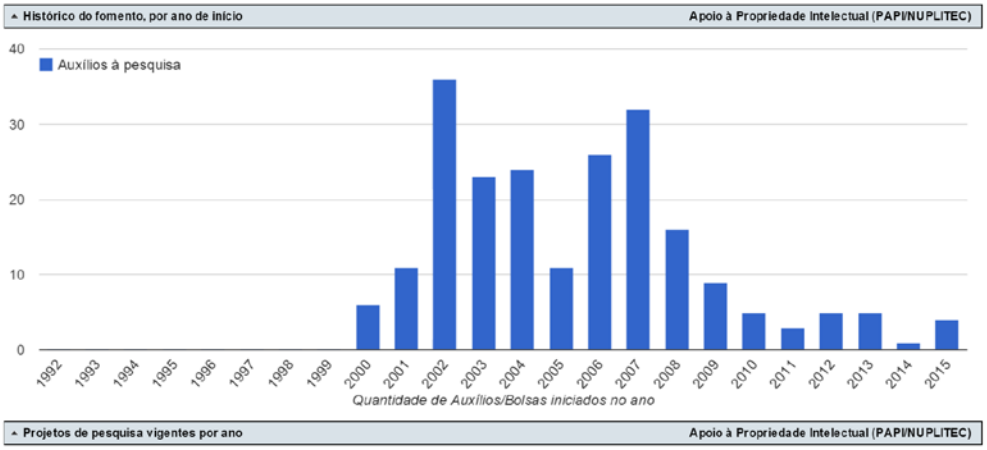


Figure 10: Annual Distribution of NUPLITEC's supported initiatives

Source: FAPESP < http://www.bv.fapesp.br/pt/116/apoio-a-propriedade-intelectual-papinuplitec/> Accessed on June, 19th 2015.

Similar to other federal initiatives, FAPESP NUPLITEC focuses on the IPR side, including patent search, IPR law education, and patent filing support in Brazil and abroad. In fact, the increase in the overall number of patents filed by USP and Unicamp can also be attributed to FAPESP's criterion for selecting R&D projects with the greatest potential for patentability, which certainly has promoted an increase in the number of patents in the State of São Paulo. In addition, tax exemption rules for companies were modified in 2007 to link them to the use of IPRs.

FAPESP plays a leading role played in Brazil and in Latin America as well, as the State of São Paulo hosts the countries' largest GDP as well as leading universities and research centres, including some of global relevance in given areas, such as agriculture, biotechnologies and information technologies. Having said that, FAPESP can better contribute to the actions to strengthen the capacity and competitiveness of firms in the global markets, as well as the institutional role of universities and research centres in supporting them without sacrificing their research and teaching missions so that the economic externalities arising out of technology transfer can be better spurred and widespread.

Agencies like FAPESP and institutional bodies like the Brazilian Ministry for Science and Technology need to help these players in important actions, such as the reduction of entry barriers for new and entrepreneurial firms – most of them coming out of universities and research centres – in face of the constant 'patent wars' evidenced worldwide. The road leading to these solutions will not be easy, as Brazil will have to find a solution of its own. The adaptation of celebrated Anglo-Saxon cases to different European and OECD countries is not always successful (OECD, 2013). Given the disparities and inequalities encountered in Brazilian states, even successful experiences carried in richer states such as São Paulo and Rio de Janeiro will not be easily adapted to other

regions. Even within a given state many disparities appear, as the scattered NUPLITEC disbursements map in Figure 9 suggests.

8. Concluding remarks

Thus far, and considering that many of the initiatives are still emerging or are in course of implementation in the country, the changes in policies and institutions realised in Brazil have not been as successful as desired, given the myriad of internal and external challenges that persist.

If patents filing have increased, the level of licensing has not followed the same pattern. This is in part due to the slowness in the granting of patents from Brazil's INPI. In addition, commercialization activities involve market and business-related aspects that appear to go beyond the current sphere of public support programmes in Brazil. Therefore, Brazilian NITs have to look for new ways to go through the intricate aspects of TT management and knowledge commercialization. In most circumstances, universities tend to be in disadvantage, as firms can more often afford to have access to specialized legal support and are better prepared to assess the market potential of the intellectual property, software or knowhow under negotiation in detriment to universities and research centres.

Without neglecting the importance of these aspects, much of what is said about NITs and technology transfer in Brazil is in the realm of conjectures, for most studies carried so far involve case studies and surveys in exploratory evaluations. It is difficult to replicate the experiences analysed, given the difficulties for making generalizations that influence public policy now and in the future. Therefore, we need new hypothesis that entail more research on the effectiveness of new and more responsive policies for stimulating effective commercialization of technology from universities and research centres to industry. This is not a Brazilian problem only, as Audretsch et al. (2014) point out that, despite growing interest on university-to-industry technology transfer and commercialization, there are still very few studies on the governance of technology transfer offices worldwide.

The discussion developed throughout this report suggests that thinking about the effectiveness of technology commercialization from universities and research centres to industry requires an understanding of how universities organize their technology transfer and intellectual property management. Therefore, performance measurement of NITs in Brazil need not to neglect the governance characteristics and the degree of specialization of each institution under consideration. If public policy evolves without taking these aspects into account, to which we include the removal of barriers for technological information for firms, the provision of greater autonomy and economic incentives for NIT professionals and the improvement the functioning of the Brazilian market, it will be difficult to enlarge and broaden our understanding of technology transfer and commercialization in the contexts to which Brazilian firms are increasingly exposed.

Universities are increasingly required to play a more responsive role in the consolidation and promotion of national innovation systems. This role becomes even more relevant in countries such as Brazil, where most of the skill set of human resources and the infrastructure dedicated to scientific and technological research is concentrated in the (federal) universities and research institutes.

In the context of institutions of higher education and research, the Brazilian Innovation Law paved the way for a comprehensive reorganization of their innovation support infrastructure. This evidenced a series of shortcomings that are becoming increasingly latent throughout the country. The lack of skills in technology transfer and IPR management remains the most commonly cited by the interviewees, followed by the financial and cultural barriers on both firm and university sides for effective university-industry cooperation. In general, a NIT strongly relies on temporary professionals paid with state or federal scholarships. This results in high turnover rates and lower performance. In addition, the still timid participation of industry experts weakens NITs overall performance. However, these seem to be similar to the problems encountered in the literature regarding the contexts of industrialized countries as well.

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