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ACADEMIC INVENTORS AND PATENT RIGHTS: STRUCTURE OF COLLABORATION IN ACADEMIC PATENTS AND UNIVERSITY PATENTS IN BRAZIL

Many countries have adopted measures to protect the results of academic research through the use of patents and to promote the transfer of knowledge from the public to the private sector. In parallel, studies have focused on discussing the importance of networks of university researchers for the transfer of university specialization in economically viable applications. This paper uses the dynamics of academic patent ownership to analyze the collaborative networks university-industry in Brazil. The database was built from the patents published by PCT with Brazilian priority for the period 2001-2015. Academic patents can be described as "university academic patents" under the ownership of the university; and "academic non-university patents" are those that have at least one professor bonded to the University and listed as an inventor in the patent application. It was verified that the collaboration of Brazilian universities with the productive sector is still small, only 11,8%. However, the lack of university-industry interactions is more significant when the patent is under the ownership of the university compared to "academic non-university patents". 68.2% of university patents do not collaborate with other institutions. If we add to the public research organizations, the percentage is 73.5%. Of the total non-university patents, 49.7% owned to companies, followed by 30.6% of patents attributed to individuals. Ownership of the patent may be an indicator of the commercial interest of the invention, but the evidence in this paper indicates that higher university ownership is not correlated with higher quality academic patents. Our discussion reinforces that recent innovation policies in Brazil have encouraged the hype of university patenting. Another factor is also in the ability of companies to absorb knowledge. The results achieved are pioneering in what regards Brazil. It would be interesting to analyze the potential and economic value of the licensing of the university and non-university academic patents.

Keywords: academic patent, university, industry, collaboration, Brazil.

Introduction. The university-industry relationship in the area of research and development (R&D) is a long-standing collaboration. Recent changes in the characteristics of this relationship, particularly on the growth of university patenting and the formal transfer of technology, have attracted considerable attention to the academic environment as well as to the public policies structuring (Mowery et al., 2001; Breschi et al., 2008; Lissoni et al., 2009; Permanent et al., 2013).

In the American continent, particularly in Latin America, government policies of most countries have backed the model "Sábato triangle", which focuses on the Academy-Industry-Government relationship. In Brazil, not very differently, reformers recognize gaps and inadequacies of the top-down model of science policy, although this gap has contributed in the 80s for the reformulation of the university structures from the bottom-up movement of incubators in municipalities and universities scattered throughout the country. From the 1990s, there is a significant concern with the application of more dense models, such as the Triple Helix (Etzkowitz et al., 2005) model.

With the clear difficulty of segmenting the branches of education and development, public education policies in Brazil are now protected by the Federal Constitution revised in 1988, in which education is a "right of all and duty of the State and the family". All its subsequent regulation gives the university a role in social and sustainable development, as well as in inserting the country in the international scenery, to the point of triggering a significant expansion of the Brazilian Federal University System in the last two decades.

To understand the science, technology and innovation systems of a country requires the use of several innovation indicators, patent statistics being an important one. The universities filing of patents has contributed to triggering several studies in the US and European countries in recent decades (Lissoni et al., 2008; Thursby et al., 2009; Lissoni, 2012; Perkmann et al., 2013). However, the main studies related to the Brazilian case have now focused primarily on the institutions that hold the applications for university patents and lay emphasis predominantly on protection requests made in the domestic market (Póvoa, 2008; Amadei and Torkomian, 2009; Querido et al., 2011; Oliveira and Nunes, 2013).

The studies related to academic patenting presented in Europe have tried to show that European universities contribute little to innovation compared to the US academic panorama. Bearing in mind this pessimistic perspective, and in response to it, the concept of academic patenting was expanded, extending data analysis for those who have actually participated in the invention and not just focusing on the applicants of the patent. Thus the "academic patenting," was distinctly defined by Lissoni (2012) as: "any patent signed by at least one academic scientist, while working at his or her university".

That way, the academic patent can be of two types: "University academic Patent" when the university figure as an applicant of the patent; and "academic non-university patent", when the university does not appear as an applicant for the patent but has an inventor with a connection to a university.

In Brazil, the academic sector has had a significant contribution to technological development, when measured by patent indicators. Silva (2014), found that more than 60% (233) of the published patent applications under the PCT (Patent Cooperation Treaty) filing with Brazil as priority filing country, between the period 2002-2012, contains professor, formally linked to the Higher Education Institution (HEI), as inventors in these applications. Surprisingly, the industrial property rights (IPR) ownership was not shared with the university. The study demonstrated statistically that the real contribution of the Brazilian academic sector accounts for 19.5% of total 3106 patent applications published by the PCT. This is much more than previously admitted when analyzing the data under the sole perspective of the applicant. Out of the 233 (38.5%) academic patents classified as "academic non-university patent", it was found that in 173 (74%) inventors have professional docent bonds with public higher education institutions and in 60 (26%) have professional docent bonds with private institutions (Silva et al., 2014).

It is important to note that in Brazil the legal system differs when it comes to public or private universities. It is also known that the scheme covers different connotations even in the public academic environment in the analysis of local, state and federal institutions. These distinctions may be due to regional disparities in the country and also to the fact that Brazilian universities are young and at different stages of maturity, autonomy and financial resources when compared to European and American institutions.

Even though the contribution of the Brazilian academic universities has a significant role in the country's technological development, research gaps in the university-industry interaction are still latent. The same happens to the factors that lead academic inventors to establish institutional collaborations, but not making any reference to their respective institutions in formal patent applications.

The gap between science and technology is also presented in other emerging countries. However, considering that Brazil is the seventh economy in the world, it is true that the Brazilian innovation capacity is still unsatisfactory and requires a more efficient innovation system and further integration into global innovation networks (Chan and Daim, 2012).

This paper seeks to analyze the situations and institutional collaboration's properties of the applicant's field of Brazilian academic patents published in the PCT system with Brazilian priority for the 2001-2015 period. Within this universe, it also seeks to identify the propensity of interaction with the productive sector comparing "university patents" and "academic non-university patent".

Section 2 presents the importance of universities in the innovation process. In section 3 academic patenting in Brazil will be presented. The method is described in Section 4. Section 5 exposes the results and discussions. Section 6 refers to the conclusions and future perspectives.

Debate on academic patents background. The international literature has already analyzed the effective participation of inventors linked to academic institutions in the commercialization of knowledge. This analysis, especially in Europe, seem to point to what became known as the "European paradox", since the European academic system has a sound scientific basis, but at the same time has many difficulties in transferring the knowledge so that they could become economically viable technologies (Lissoni et al., 2008).

The difference of patent records held by European universities in relation to the US allows a preliminary connotation that the European academic system contributes little to patent activities. However, Lissoni et al. (2008) have concluded that European universities do not contribute less than American. In fact, the answer is related to differences in legislation, as a significant part of patents that have university inventors in Europe are under ownership of companies, government agencies and non-profit organizations, or are registered by the inventor himself, in an independent way.

Considering these facts, the author considers that European universities were less likely to require the ownership of patents, due to the "professor privilege", which was common in many European countries until the last decade. This privilege gave the industrial property rights over the research's results, paid for by their own universities, to the academic inventors (Lissoni et al., 2008; Damsgaard and Thursby, 2013). This differs from the US, where the Bayh-Dole Act, passed in 1980, gives American universities Industrial Property rights over inventions which were funded with federal funds.

In general, while countries like Denmark, Finland, Germany and Norway have made their IPR laws more similar to the Bayh-Dole Act, Italy, on the contrary, introduced the professor's privilege in 2001. In the case of Sweden, for example, the professor's privilege had a lot of influence until the last decade, just like the role of funding agencies in the case of countries such as Italy and France, where these agencies impose control over the intellectual property rights of researches that have been financed by them (Damsgaard and Thursby, 2013). In Brazil, the main innovation agency (FINEP), allows the parties to settle intellectual property issues themselves. This decision is regulated by a separated agreement and the parties are required only to inform the agency about the outcome of IPR negotiations on the projects it funded.

Although the participation of HEIs in National Innovation Systems is widely discussed and accepted in academic and political context, the participation of inventors is still questioned (Damsgaard and Thursby, 2013). In Brazil, it can be said that the situation is more discursive when analyzing the participation of inventors linked to public universities, particularly the federal institutions.

In this sense, when analyzing the contributions from universities, one must check the teaching work contract format with the institutions, given that also as of the Innovation Law 10,973/04 advent, Brazil has stimulated development of collaborations between universities and the productive sector, as well as the promotion and favouring to form scientific knowledge and technological based spinoff and startup firms for the purpose of innovation.

The Brazilian innovation law had the strong inspiration of the US legislation (Bayh-Dole Act), for patent ownership issues. However, for the university-company relationship the inspiration was in the French Law of innovation (La Loi sur l'innovation et la recherche – 1999) addressing four major themes: Financing Innovation in the companies; IPR rules for U-I projects; Rules for the mobility of researchers; Stimulating

the creation of startup (Koeller, 2009).

Although the NIT has a significant role in the increase of patent applications of Brazilian universities (Póvoa, 2008; Oliveira and Velho, 2010), the appropriability question is just one of their actions. In fact, there are few NIT that effectively performs all the activities required by the Brazilian law. This fact can be attributed to the short structure period of NIT, the internal regulations of the HEI and the lack of qualified technical personnel. The latter is supplied, palliative, for scholarship students and interns (Arbix and Consoni, 2011), which reflects that the landscape of regulation and operation is still incompatible with the dictates of the Law.

It is noteworthy too, the role played by FORTEC, the representative body of managers for managing the innovation policy and industrial property activities and technology transfer in universities and research institutes. The FORTEC initiative, established in 2006, is an integrated effort done by the country's knowledge institutions in the pursuit of a legitimate representative body on IPR issues to allow professional training and exchange of experiences on the subject (Oliveira and Velho, 2010). From raising awareness to the issue of industrial property in Brazil, FORTEC has become an institution similar to international organizations such as AUTM (United States), Réseau Curie (France), Praxis-Unico (UK), among others.

Academic patents have a number of different statistical applications. They are the main indicators of Technology Transfer activity and are key indicators of university-industry relationship. This is due to the fact that they provide important information both at institutional and individual level. Academic patents can also be a useful indicator of business activities, as they often provide the basis for the creation of firms.

However, the analysis of patenting arising from universities have led to a deep discussion of IPR issues on the academic sector, and not only related to universities, but to all kinds of scientific institutions that catalyze and convert scientific progress in technological development. Nevertheless, many studies on the Brazilian academic patenting have been restricted to applicants of patents, and are focused on the domestic market only.

In this context, it is important to highlight the role of academic institutions for economic growth. These are barns of knowledge available within the systemic environments. Even though universities are not in the centre of the National Innovation Systems model, the major role they play in innovation systems is remarkable responding to the growing demand for innovation from companies. In this respect, it is possible to see a greater involvement of universities in the innovation process.

By assuming that knowledge is a consensual part in the innovation process in national and regional systems and, in turn, recognizing that the university is a catalyst in the knowledge production, one can assume that the inventor is a creative agent and conveyor of expertise and technology (Etzkowitz, et al., 2000).

Academic patents: the geography of academic Brazilian inventors' contribution. The commercialization of knowledge generated by universities as inputs for industrial innovation has led to the analysis of ways and the potential of the Academy's knowledge transfer to the firm. Literature has shown that companies see patents and scientific publications as the main outputs of knowledge transfer carried out by universities (Bekkers and Freitas, 2008).

Patent systems seek to encourage the development of inventions through the granting of a temporary right to economic exploitation in exchange for the release of technical information. Patent statistics have been used as indicators of inventive activity, innovation and, therefore, technological progress (Griliches, 1990; OECD, 2005).

In this context, universities and their faculty have played a major role in the development of new technologies. They have also contributed to the dynamics of the industrial sector, both indirectly, by widening the scientific basis, and directly, through scientific publications and economically useful knowledge with the industrial application (Lissoni et al., 2008).

In Brazil, the need of university-industry interaction to boost economic development and promotion of

innovations is widely spread. It was mainly driven, since 2004, by the promulgation of the Brazilian Innovation Law (Law 10,973/04), which established several mechanisms to facilitate collaboration in the public-private relationship. Strongly inspired by US law (Bayh-Dole Act), Brazil has also created institutional offices inside the universities in order to manage its faculty IPR.

While the need for university-industry interaction is a reality in all countries that aim technological development, in practice, it is far from being a relatively easy action. In Brazil, it can be said that this relationship becomes even more complex since a substantial part of Brazilian science comes from public institutions, especially universities. This is configured in a recent system in collaboration with the productive sector.

It is still possible to verify that in Brazil, students of Brazilian graduate programs are prepared to play much more academic than business activities. To these facts, it is known that only 0.4% of PhD trained in the country is absorbed by the most innovative companies in Brazil (Velho, 2007; Dagnino, 2007).

Europe has presented several studies regarding the effectiveness of academic participation for the production of technological knowledge. This is mainly a return to the criticism that European universities don't do much for the patenting action and, consequently, for innovation, compared to the US academic panorama. From this perspective, and as a response to it, the concept of academic patenting was expanded, extending data analysis for those who have actually participated in the invention and not just focusing on the applicants of patent applications.

In this paper, we consider academic patenting, as defined by Lissoni et al. (2008), when the patent results of an academic research contribution performed by a formally linked professor. So, from now on, it is considered as a university patent all those owned by the HEI and as an academic patent the ones comprising the university patents and the patents signed by the inventor with an academic link (Lissoni, 2012). The latter shall be called "academic non-university patent" (Silva, et al., 2014).

In order to analyze the Brazilian scenario, using the concept of academic patenting, Silva (2014), found that the contribution of HEI is much more significant than previously admitted.

This has been possible through the analysis of all PCT patents documents published in the period 2002-2012, totalling 3106, in which we find that the contribution of Brazilian universities in the technological development, measured by patents, corresponds to 19.5% of all patents. The documents analyzed, 372 correspond to "university academic patents" and 233 "academic non-university patent" as shown in Figure 1:

Going deeper in the study, Silva et al. (2014) found that out of the 233 applications for academic "academic non-university patent", 173 (74%) of them have professors linked to public universities and 60 (26%) have professors linked to private universities. This, in turn, refers to the regulatory frameworks governing the industrial property issues in the public sphere and discusses the scope of the actions performed by the university's Technology Transfer Offices in the management of its portfolio of inventions.

Nevertheless, in principle, the applicability of the method developed from the inventor's perspective might bring practical difficulties, as they do not always have accurate information of the exact period when the invention was developed or if the inventor has a double bond with other institutions, for example, industry, and if this invention is, or is not, directly related to the scientist's academic activities, making it even more complex and necessary to understand when it comes to an inventor linked to public universities in Brazil, and eventually leading to the following issues:

1. The university's NIT was not, or is not, properly structured and operational;
2. The HEI does not have financial resources to cope with the predicted values for deposit, particularly on international routes;
3. The patent comes from actions and research which are older than the researcher's bond with the University;
4. Faculty/researchers lack knowledge about the internal politics and IP legislation;

5. The patenting process was purposely conducted without the knowledge of its bond institution.

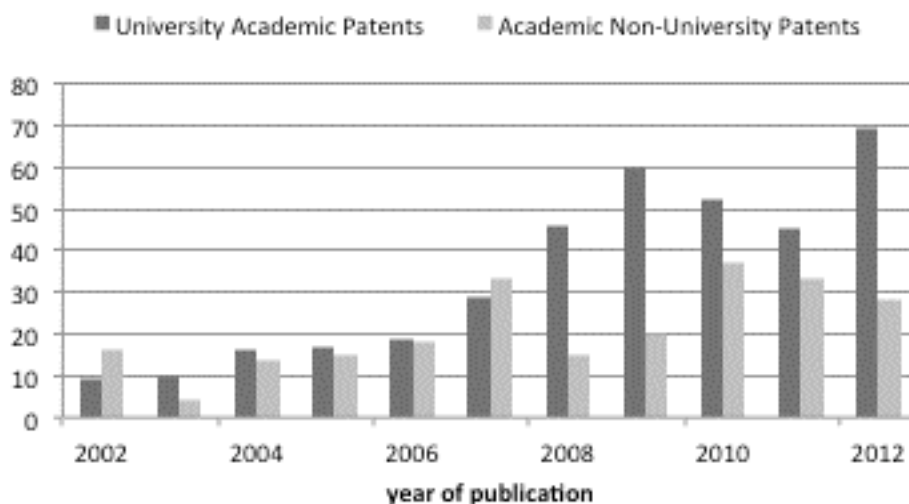


Figure 1 – Annual evolution of academic PCT patent applications with Brazilian Priority published in the period 2002-2012 (Source: Adapted from Silva, 2014)

It is worth noting that university patents are used also to measure the transfer of knowledge from the academic environment. Currently, empirical research has shown that the analysis of academic patents solely from the viewpoint of applicants, do not reflect the actual contribution of universities and their faculty on innovation activities.

This is justified by the fact that a substantial portion of patent applications may be owned by another holder (Thursby et al., 2009; Sterzi, 2013).

Methodology. In order to analyze academic patenting in Brazil, we collected information on all patent applications with Brazilian priority registered with the Patent Cooperation Treaty (PCT) during the 2001-2015 period. Data were taken online from Espacenet, the Worldwide Patent Statistical Database, which is a service supplied by the European Patent Office and available at Worldwide.espacenet.com. For data extraction, we used the “Advanced Search” option, inserting the term WO in the publication number field, and BR in the priority number field resulting in a sample of 4,617 patent applications originating in Brazil for the years under review.

The identification of academic patents required first and foremost that we reclassified all patents by the inventors’ names. Each record was handled individually by the authors and manually analyzed and classified. In the categorization for data analysis, two databases were built:

1. A database of patent’s with a focus on the applicant (BdPtsBR), organised by the publication year in the 2001-2015 period. A classification was made of the applicant, seeking to find the universities formally listed in patent applications.

2. A database of patent’s with a focus on the inventors (BdInvBR) was also built, in order to search for the institutional connection of individuals with universities. The next step was to individually check the names of those inventors vis-à-vis the individual names in the Lattes platform. Lattes is a repository, developed by the National Scientific and Technological Development Council (CNPq), to register the individual CVs of all Brazilian researchers. The BdInvBR has data, separated by year, which contains: the full name of the inventor; a link to Lattes; a link to the HEI establishment to which the researcher belongs,

and the academic qualification of the inventor, as having a Master's or a PhD. There were 10,412 names of inventors analyzed, were found 1,808 with institutional commitments to public or private HEIs.

For the match of the inventor with an HEI, we have always considered the filing date of the patent application. At the level of the academic inventor, we used data mining tools, Phyton, and bibliometrics techniques, such as the co-authorship network. The disambiguation of homonyms and orthographic errors made the inventor's correspondence challenge greater with the more than 3.5 million curricula registered at the base of the Lattes Platform. Among Lattes' facilities is integration with other databases, such as Scopus, Scielo, Lilacs, INPI, among others. This integration allows the identification of the network of the scientific and technological collaboration of the researchers. For example, by accessing the curriculum of researcher "A" it is also possible to access the curriculum of researcher "B" or "C" who have collaborated with "A".

One particularity is the case of public servants linked to Public Research Institutes or government entities also having a teaching link in Brazilian Universities. In these cases, if the link was of collaborating professor or invited, we maintained the connection with its main institution and not as "academic inventor".

One of the applications of identification of the academic patents is the analysis of the social networks of the inventors as a source of diffusion of the knowledge. This fact makes relevant the big human effort applied in the disambiguation of names to find the academic inventors.

Out of the total 4,617 patent documents published by the PCT with Brazilian priority in the period 2001-2015, we found 935 academic patents (see Table 1), being 611 "university academic patents" and 324 "academic non-university patents".

Table 1 – Patent applications, inventors, and professors in Brazil

	2001-2005		2006-2010		2011-2015		Total
Patent Application	862		1650		2105		4,617
Inventors' Name	1914		3654		4844		10,412
Academic Inventor	228		654		926		1,808
Mean Inventor/ patent	2,2		2,2		2,3		
Academic Patent	Univ Pat	Non-Univ Pat	Univ Pat	Non-Univ Pat	Univ Pat	Non-Univ Pat	Total
	59	64	207	132	345	128	935

Thus, from a survey of academic patents, it was possible to establish the institutional collaboration in the patent applications, considering the partnership arising from the Universities (UNIV), Public Research Organizations (PROs), Research Funding Agencies (RFA), Government Institution (GOV), Non-profit Institutions (NPI), INDUSTRY (IND) and private individual inventor (INDIVIDUAL).

Results and discussion. Collaboration of university patents. The patents and their inventors' data can bring information as collaboration networks for research development. Such networks may mean a greater degree of interaction and knowledge transfer since the actors involved tend to share information between groups for obtaining technical progress (Lissoni, et al.; 2013; Thursby, et al.; 2009, Bellini, Piroli, Pennacchio, 2018).

Table 2 refers to the institutional interaction of patent applications under ownership / co-ownership of the universities. In this case, it may be suggested that Brazilian universities work isolated since 68,2% of patents are assigned exclusively to universities. These patent's may even have institutional collaborations between research groups from other universities, but without interaction among other non-academic institutions.

From the total number of applications for university patents, it is visible that in only 18,2% of them is

there real interaction with companies. One may suggest, too, that the inventions originating from universities have low interest to the market unless they manage to be transferred or licensed.

Table 2 – Interaction of Brazilian university patents published through PCT, 2001-2015

Classification	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total	%
UNIV	4	8	8	11	9	14	19	33	38	38	25	46	56	62	46	417	68,2
UNIV-IND			1		4	4	7	6	18	11	10	13	10	16	7	107	17,5
UNIV-PROs	1		1		2		1	4	1		1	8	4	12	2	37	6,1
UNIV-RFA	1	1		5	2		1	3	3	2	6	1	3	2	2	32	5,2
UNIV-NPI				1		1					1	1	1	1		6	1,0
UNIV-IND-RFA										1			1		1	3	0,5
UNIV-RFA-PROs											3					3	0,5
UNIV-RFA-GOV									1		1					2	0,3
UNIV-IND-IPP														1		1	0,2
UNIV-RFA-NPI							1									1	0,2
UNIV-PROs-GOV													1			1	0,2
UNIV-PROs-NPI													1			1	0,2
TOTAL	6	9	10	17	17	19	29	46	61	52	47	69	77	94	58	611	100
UNIV-INDUSTRY*	0	0	1	0	4	4	7	6	18	12	10	13	11	17	8	111	18,2

Note: *sum of patent applications with Industry as applicants.

It is worth mentioning the work of development agencies in the process of collaboration and financing of inventions from universities. According to Table 2, the RFA come up with a total of 41 patent applications under their ownership or co-ownership, being the year 2011 especially relevant with 10 patents applications. These correspond to the Sao Paulo State Research Foundation (FAPESP) with five patent applications and the Minas Gerais State Research Foundation (FAPEMIG) also with five patent applications. However, it is important to say, that the identification of partners for the possible technology transfer or licensing is not in the development agencies' IP policy (MCTI, 2013).

The structure of most Brazilians NIT is still maintained by personnel without a permanent contract, mostly scholarship students and interns (Arbixand Consoni, 2011). In this case, there are few who actually perform market analysis in order to identify the countries with the best potential for the protection of the invention. Thus, it is possible that the professor is dealing with the distribution possibilities, due to his network, culminating in licensing agreements or technology transfer.

In this scenario, it can be inferred that Brazilian patents granted to universities and development agencies are fragile regarding the dissemination of knowledge and consequently transfer of technology to the productive sector and society. In this case, as seen in Table 2, patent's assigned to universities and development agencies account for 73.5% (449) of all university patents.

Collaboration of academic non-university patents. Currently, empirical researches have shown that the analysis of academic patents solely from the applicants' point of view does not reflect the actual contribution of universities and their faculty on innovation activities. This is justified since a substantial portion of patent applications may be owned by another holder (Thursby et al., 2009; Sterzi, 2013).

Table 3 shows that academic non-university patents have greater interaction with the productive sector

since 49,7% of patent applications have collaboration with the firm. However, this falls under the assumptions that these patents are coming from faculty consultants or from cases in which the academic has a direct participation in the company, for example, a spin-off firm. (Thursby *et al.*, 2009). However, in Brazil, for consultancies carried out by Professor tied to federal public universities, it is necessary to have the permission of the university. The Professor is allowed only a given number of hours a year to conduct consultancies. This is foreseen in the legislation and also depends on the type of contract that the teacher is subject.

Similarly, it is also possible to verify in Table 3, that there is a significant percentage under the inventor's ownership in an independent way, i.e. without collaboration with other institutions. This can occur due to lack of knowledge of the professor to the procedures and rules for industrial property arising from the university. Lissoni (2012) also argues that the higher the status of the scientist, the university have less control over their industrial property rights.

Table 3 – Interaction of academic non-university patent published through PCT, 2001-2015

Classification	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total	%
INDUSTRY	6	6	1	2	7	9	12	8	9	23	14	8	17	11	14	147	45,4
INDIVIDUAL		3	2	2	4	5	16	3	8	10	7	6	14	11	8	99	30,6
PROs	2	2			1	1	7		2	3	2	3	4		1	28	8,6
RFA	3	5	1	10	3	2	1									25	7,7
NPI				1				1	2	2			2			8	2,5
IND-NPI								1		3	2	1				7	2,2
IND-RFA		1			1	2	1									5	1,5
IND-RFA-NPI					1											1	0,3
IND-PROs															1	1	0,3
RFA-NPI								1								1	0,3
GOV												1				1	0,3
PROs-RFA													1			1	0,3
TOTAL	11	17	4	15	17	19	37	14	21	41	25	19	38	22	24	324	100
UNIV-INDUSTRY*	6	7	1	2	9	11	13	9	9	26	16	9	17	11	15	161	49,7

Note: *sum of patent applications with Industry as applicants.

It is also worth noting that the “academic non-university patents” assigned to development agencies have a significant decrease from the year 2007 on. As it is shown in Table 3, from the 33 published patent applications with the participation of research funding agencies, only 8 have been published after the regulation of Brazilian innovation law. This may be a result of increased attention of agencies regarding patent protection coming from inventors linked to university and this happens because the innovation law in Brazil establishes that universities have the right to hold on the resulting IPR from its faculty's research when using the University infrastructure. However, many research funding agencies still require a part of the financial results of the licensing of patents that result from state-supported research, differently what is currently happening at the federal level (Stal and Fujino, 2016).

Collaboration in the category of academic patents. In the last decade, a set of instruments were structured to support scientific and technological development in Brazil. Since the restructuring of the Sector Funds, the Industrial Property Law, the Law of Innovation and tax incentives, the expansion of federal universities, as well as the strong performance of development, federal and state agencies, and

the National Institute of Industrial Property (INPI) itself, are key factors to boost Brazilian innovation.

Given the new concept of academic patents, not only comprising patents under ownership of the universities, but also the incorporation of patents signed by an academic inventor (Lissoni, 2012), and from the database built for the Brazilian scenario, it was possible to identify, as shown in Table 4, that the Brazilian academic environment relates little to the productive sector, as more than 44,6% (417) of patent applications are under sole ownership of universities, while 11.4% (107) are related only to University-Industry collaboration. This, considering the total of 935 academic patents held for the period 2001-2015, is shown in table 4.

Table 4 – Institutional Collaboration of academic patents with Brazilian priority published through PCT, 2001-2015

CLASSIFICATION	2001-2005	2006-2010	2011-2015	TOTAL
UNIV	40	142	235	417
INDUSTRY	22	61	64	147
UNIV-INDUSTRY	5	46	56	107
INDIVIDUAL	11	42	46	99
UNIV-PROS	4	6	27	37
UNIV-RFA	9	9	14	32
PROS	5	13	10	28
RFA	22	3	–	25
NPI	1	5	2	8
IND-NPI	–	4	3	7
UNIV-NPI	1	1	4	6
IND-RFA	2	3	–	5
UNIV-IND-RFA	–	1	2	3
UNIV-RFA-PROS	–	–	3	3
UNIV-RFA-GOV	–	1	1	2
IND-RFA-NPI	1	–	–	1
IND-PROS	–	–	1	1
RFA-NPI	–	1	–	1
GOV	–	–	1	1
PROS-RFA	–	–	1	1
UNIV-IND-IPP	–	–	1	1
UNIV-RFA-NPI	–	1	–	1
UNIV-PROS-GOV	–	–	1	1
UNIV-PROS-NPI	–	–	1	1
TOTAL	123	339	473	935

Yet, it is also notorious the high percentage of the patent's under the ownership of academic inventors in an individual way (10.6%), establishing a gap of causes that lead inventors not to link their academic institutions in patent applications.

In the last decade in Brazil, much has been encouraged academic patenting. There is also a boom in technology transfer office in universities. However, few of these have the operational capacity and know-how in all the activities of an office. In some situations, academic patenting has become the centre of production of statistics and participation in university rankings.

Another interesting point brought by the figure is the collaboration and the important role of development agencies in promoting Brazilian technological development. In this category, we find public institutions for research support at both the federal and state levels. In IPR issues, for example, the Brazilian Innovation Agency, (FINEP), allows the universities to decide about the issues related to

intellectual property rights, requiring only the information about the negotiations on the projects it funded, while the CNPq demanded the maximum percentage of 3% for the economic gains of the research also financed by it (RN034/ 2008). This last measure was only repealed in September 2014, when the CNPq could no longer require economic participation. The partners are able to define the ownership in patent applications over the intellectual creation that resulted from projects or scholarships financed by the agency. However, at the state level, it is up to each development agency, represented mostly by the Research Support Foundations, the definition of economic and financial gains policies in appropriability issues.

In Brazil, the development agencies have used the indicator of patents for the production of statistics, but also as a measure of assessment for the release of funding for the professor, graduate programs and companies. This situation undermines the patent system, which seeks to stimulate the innovation process through the right granted to the inventor to exclude unauthorized third parties from making, using, offering for sale, selling or importing the product or process protected by the patent.

The university-industry-government collaboration, widely debated in the Triple Helix model, certainly establishes the importance of synergy in order to promote the disruption of Brazilian universities' institutional walls and reach maturity in the process of technological development. However, even though the fact the investment in the academic environment has already occurred for several decades, the transfer of technology still lacks expansion (Etzkowitz, 2012).

Conclusion. This paper brings the potential to collect data for use in the scientific and political/strategic environment regarding the patents indicators, broadening the concept of academic patenting and introducing relevant quantitative data to the decision-making process of the universities' institutional policies.

This study shows that the Brazilian academic collaboration is still limited when related to the productive sector, meaning companies since this relation occurs in only 11.8% of the academic patents requests published by way of PCT in the period 2001 to 2015.

It can be highlighted that the analysis found that "academic non-university patent" are more likely to interact with the productive sector and other institutions if compared to university patents. It was also observed that 45.5% of non-university patents are assigned exclusively to companies. From the data, it can be that university-industry collaboration also occurs when the university does not figure as applicant of the patent application. Ownership of the patent may be an indicator of the commercial interest of the invention, but the evidence in this paper indicates that higher university ownership is not correlated with higher quality academic patents. We suggest that recent innovation policies in Brazil have stimulated the type of university patenting.

The methodology developed here is not yet used on an ongoing basis by the Higher Education Institutions in Brazil. This is due to the fact a database that enables the cross-checking of teachers with patent bases provided by national and international offices is lacking.

As a perspective, it is considered that the methodology here proposed, and the academic patents case study will make it possible to increase the management efficiency of inventions production activities in which the university is involved and might boost the effective analysis of technology transfer coming from the academic environment to the productive sector and consequently to society.

However, it is necessary to go deeper into the understanding of knowledge transfer and licensing of academic patents. It is also essential to understand the causes that lead academic inventors not to link the universities in patent applications.

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Академічні винахідники та патентні права: структура колаборації в академічному та університетському патентуванні в Бразилії

Більшість країн світу вже запровадили дієві механізми захисту результатів діяльності академічної спільноти та сприяння передачі знань від громадськості до приватного сектору. Так, впроваджена урядом Бразилії інноваційна політика стимулювала хвилю патентування винаходів університетами. З метою підвищення економічної ефективності

винаходів автори наголошують на актуальності та важливості аналізу колабораційної мережі між академічним та виробничим секторами. У статті проаналізовано динаміку патентування винаходів академічної спільноти для оцінки ефективності функціонування колабораційної мережі університет-виробництво в Бразилії. Вихідні дані для аналізу було сформовано на основі звітів Міжнародної патентної системи (Patent Cooperation Treaty) за 2001-2015 роки для Бразилії. У рамках дослідження авторами розглядається «університетський академічний патент» (права належать виключно університету) та «академічний неуніверситетський патент» (принаймні один з винахідників має відношення до університету). Отримані результати свідчать про низький рівень (лише 11,8%) співпраці бразильських університетів з виробничим сектором. Проте розрив у взаємодії університет-промисловість збільшується для «університетських академічних патентів» порівняно з «академічними неуніверситетськими патентами». Так, 68,2% академічних патентів отримано без участі інших сторонніх організацій, з урахуванням державних наукових установ даний відсоток збільшується до 73,5%. У загальній кількості «академічних неуніверситетських патентів» питома вага академічних патентів, право власності яких належать компаніям, складає 49,7%, з них 30,6% є у власності приватних осіб. Автори наголошують, що тип власності на патент є індикатором рівня його комерціалізації. Однак результати дослідження свідчать про відсутність кореляції між якістю патенту та статусом його приналежності до університету.

Ключові слова: академічний патент, університет, промисловість, співробітництво, Бразилія.