UNIVERSITY-INDUSTRY RESEARCH COLLABORATION IN THE BRAZILIAN OIL INDUSTRY: A BIBLIOMETRIC EXAMINATION

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Introductory notes: issues of the thesis

The thesis subject is concerned with the evolution and dynamics of university-industry research collaboration in the Brazilian oil industry, through Petrobras’ case. Using the innovation systems approach, the thesis discusses the role of universities in the innovation process, and how science and technology policy, and corporate strategy, influence the collaborations between Petrobras and the university system.

The main question that needs to be addressed is: “How the increasing university-industry collaboration in the Brazilian oil industry has helped to improve the technological development process?”. The answer to this question should clarify: i) the role of S&T policy related to the Brazilian oil industry to improve university-industry collaboration; ii) the effects of Petrobras’ corporate strategy in relation to collaboration with universities on its innovative process. Based on these the thesis will focus on the evolution and dynamics of collaborations between Petrobras and universities in Brazil and elsewhere, through analysis of data on patents and scientific publications.
This research combines quantitative and qualitative research methods. Therefore, we use bibliometric analysis complemented with qualitative evidence extracted from interviews with academic researchers, and research and technicians at Petrobras. It is expected that this will shed more light on the nature of the relationship between Petrobras and universities, and on the real purpose of these interactions.

The purpose of this essay, which is directly part of my in-progress-Ph.D work, is to present some preliminary results of my research, and to discuss with lectures and other students at Globelics Academy 2015, some important topics that may enrich my work. For this reason, this paper focuses on how the collaboration between Petrobras and universities varies over time and according to the country of origin of the partner, through the analysis of bibliometric data.

The paper is structured as follows. In the first section we discuss the theoretical background of university-industry collaboration and its importance for the innovation process. This is followed by a discussion about the use of bibliometric methods to analyze the interaction between university-industry (U-I) and its limitations. Then we present a brief retrospective about the development of the Brazilian oil industry and the role of universities in this sectoral system of innovation. Next, we present an outline of methodology and a results analysis according to the evolution in number of publications; partnerships between institutions and countries; and scientific impact. The final section presents conclusions and outlines future work.

University-industry collaboration

From the Second Industrial Revolution, with the rise of science-based industries, the importance of university structure has been recognized. Universities and public research organizations have become important knowledge sources to improve the innovation process.
Formerly, universities had two main functions: teaching and research. However, in recent years, their role has been expanded: what is called the “third mission”. This new mission is related with the generation, use, application and exploitation of knowledge for outside the academic environment (MOLAS-GALLART et al., 2002). In other words, it is about the ways in which universities interact with society, especially with industry, and contribute to technological change and economic development.

There are different approaches about the university’s role in the innovation process. The National System of Innovation approach put the firm as a central actor in this process, acknowledging the leading role (FREEMAN and SOETE, 1974; LUNDVALL et al, 2002; LUNDVALL, 1992; NELSON, 1993). Another approach called the “Triangle” model of Sábato assigns to the state the role of coordinator and promoter of the innovation process (SÁBATO and BOTANA, 1968). A third theoretical approach, the “Triple Helix” thesis, underlines a prominent role for the university in the innovation process (ETZKOWITZ and LEYDES/DORFF, 2000). In this paper, we adopt the National Systems of Innovation approach.

The concept of “innovation systems” understands innovation as a dynamic process, where a diverse range of organizations and institutions interact and affect the development, use, and diffusion of innovations. In this view, the universities are only one of the components of the innovation system. Nonetheless, their interaction with the industrial sector are seen as one of the most important in the process of innovation (LUNDVALL, 1992; NELSON and ROSENBERG, 1993).

Despite the crucial importance of universities in the innovation process, they cannot be seen as simple engines of innovation (FLORIDA, 1999). Their contribution depends on the kind of transformation in progress on local economy (LESTER, 2005).
Universities can contribute moreover to technological progress via several channels and mechanisms. The main contributions are summarized by Martin et al., (1996) as useful knowledge inputs, new instrumentation and methodologies, qualified human resources, professional networks, engineering knowledge, and creation of new firms. Furthermore, these contributions can happen through direct or indirect ways, and vary between knowledge fields, industrial sectors and countries (PAVITT, 1998).

With respect to the channels via which knowledge is transferred between universities and industry, the main types are: codified knowledge (e.g. publications and patents); contracts (e.g. contract research, licenses); cooperation (joint-ventures, personal exchanges); and contacts (meetings, networks; they can be formal or informal) (SCOTT et al., 2001). Due to the range of activities and results, no one single measure can provide a complete picture of university-industry interactions (CALVERT and PATEL, 2003).

Many studies have attempted to develop indicators for measure the contribution of public research to economic development. The empirical studies in this area are based on few main types of methodologies: econometrics, surveys, case studies and bibliometrics analysis (MARTIN, 1996; MOLAS-GALLART et al., 2002). All these methods have some limitations and potentialities.

Econometric studies offer a mechanism for measuring social rates of return to research, but with numerous empirical difficulties. Differently, surveys provide a more robust methodology but they have limitations associated to sample size and number of respondents. Since case studies permit the tracing of historical antecedents, they do not allow for the creation of general propositions (MARTIN et al., 1996). Thereat, the next section discusses the use of bibliometric methods to analyze the interaction between university-industry, or in a wider way, science-technology interactions.
The university-industry collaboration through a bibliometric analysis

Bibliometric analysis is one type of methodology for measuring science-technology linkages, or interactions between universities and industry. Research papers (publications from here on) and patents provide standardized quantitative information allowing for international comparisons between countries, knowledge fields and institutional sectors (TIJSSEN, 2005). They allow us to analyze both the science-technology linkages, as well as the interaction between different institutional sectors (i.e. university and industry).

Science-technology linkages can be analyzed using citations in patents to research papers, for example. Through this, Narin et al. (1997) revealed the increasing contribution of public research to industrial innovation in the United States with a domestic bias in patent citations relations. This domestic self-citation propensity indicates localized knowledge flows and cumulative effects in innovation systems (HICKS et al, 2001).

The interaction between universities and industry can be analyzed by co-authored publications and joint-patenting (co-assigned patents). In this work, we will focus in this type of analysis. We use data on joint-scientific publications and joint-patents (co-assigned and co-invented patents) as an indicator of the incidence of collaborative activity. However, there is a discussion regarding the use of these proxies to evaluate university-industry interaction.

First, both of these forms of activity only capture a small portion of collaboration. Publishing is not a priority for many firms and this trend should decrease in non-science based industries, such as in the oil industry. Also, patenting is not a priority for most academics researches, and a relatively small sample of patents makes it difficult to generalize the findings. Further, co-assigned patents are subject to partner rules, norms, and policies of intellectual property rights – a current topic in university agendas.
Second, collaboration and co-authorship are not synonymous (KATZ and MARTIN, 1997). This is because co-authorship is only one kind of collaboration, and research collaboration does not necessarily result in co-authored publications. In addition, sometimes the authors do not actually collaborate (or work together) on the research.

However, despite these limitations, in the relevant literature, university-industry collaboration has been studied through co-authorship, and co-assignee patents to a lesser degree. This is because these indicators include a broad range of collaborative activity, and may result from diverse ways of collaboration involving flows of capital, human resources and knowledge (e.g. research collaboration, training human resources). Also, data are easily collected; it is possible to build long time series; and they provide international standardized quantitative information, allowing (cross-) comparisons at different levels.

Several empirical studies have used co-authorship to evaluate the interaction between universities and industries. These studies have demonstrated that bibliometric techniques can contribute to the study of the innovation process, especially with regards to science-industry linkages. Thus way, it is recognized that bibliometric indicators have allowed substantial progress in tracing the direct contribution of basic research to technical advancement (MARTIN et al., 1996). Calvert and Patel (2003) looked at university-industry research collaboration in the United Kingdom and concluded that there has been an increase in the volume of university-industry collaboration since the 1980s; the growth did not result from government policy in the mid-1990s. Additionally, firms had a leading role in this result, due to a growing need to collaborate with academics in promising areas of new technologies.

Another example is the work of Butcher and Jeffrey (2005) who use bibliometric indicators to explore university-industry collaboration in a specific technological field. Theirs
findings reveal an increase in academic-industry collaboration with a high proportion of cross-disciplinary publications.

Anderson and Dalpé (1992) analyzed the collaborative research of Canadian coal and oil research communities, via co-authored publications. They found that universities have a significant role in petroleum research publications, followed by industry. In terms of interaction between sectors, petroleum research is, relatively speaking, a lower collaborative than coal, but with a higher level of collaboration between industries.

There are only a few studies that use joint-patenting to evaluate the relationship between universities and industry. This number is even lower when we consider those that use co-assigned patents as an indicator of collaboration. Some works focus on specific technological fields, such as Gao et al (2013) who looks at university-industry collaboration in the Chinese Information and Communication Technologies industry, exploring collaboration patterns and their changes. They find that only 10% of the total patents are collaboration patents; and in terms of co-assigned patents, industry-industry collaboration prevails, followed by university-industry collaboration.

Funk (2013) examines joint-patenting of US universities and shows that most joint patents are co-assigned with US firms. This occurs more often in industries with strong intellectual property rights and these co-assigned patents receive more forward citations than university-only patents. The author concludes that this kind of partnership is an important source of knowledge for both universities and industry.

These examples of studies demonstrate that bibliometrics techniques can contribute to the study of the innovation process, especially with regards to science-industry linkages. Besides that, there are an increasing number of studies using scientometrics methods. This is, despite the limitations discussed before, because the method provides several ways of analysis and allows (cross-) comparison at different levels.
The Brazilian oil industry and the role of universities: a brief retrospective

The Brazilian System of Innovation is considered to be at an intermediate stage of development (see MAZZOLENI and NELSON, 2007). Scientific structure had a late development in Brazil, even when compared to other Latin American countries. The first Brazilian university, the University of São Paulo, was founded in 1934. Added to this, the late process of industrialization in the country, and import substitution policies adopted, contributed to the lack of science-industry linkages. These facts, jointly with the late start of monetary and financial institutions in Brazil, help in the understanding of the Brazilian system of innovation’s current stage (SUZIGAN and ALBUQUERQUE, 2011).

Thus, scientific institutions do not mobilize a contingent of researchers in similar proportions to developed countries, and firms have a limited involvement with innovative activities. Consequently, the interactions between universities and industry are limited. As pointed out by Suzigan and Albuquerque (2011), the pattern of university-industry interaction in Brazil is narrow, with few points of interaction, and successful cases of interaction have long-term historical paths. One of these examples is geosciences, with oil and gas production by Petrobras.

The history of the Brazilian oil industry’s development can be separated into 6 phases: i) from the 1930s until Petrobras’ foundation; ii) from 1953 to 1964: Petrobras’ probation; iii) from 1965 to 1975, when the company focused on refining; iv) the 1980s, when the company changed the orientation of its activities to oil exploration; v) the 1990s-2000 period, with major institutional changes; and vi) from the mid-2000s, with the discovery of a new exploratory frontier in Brazil.

The first phase is characterized by the absence of geological knowledge, due to the lack of technicians and materials. This lack of technicians would delay the development of the sector and
brought doubts on with regards to foreign technicians’ work. Such controversy led to the formation of a local technical staff, with Brazilian geologists (DIAS and QUAGLINO, 1993).

The shortage of foreign currency is a mark of the second phase, jointly with the embryonic stage of the local machinery industry and lack of qualified human resources (ALVEAL CONTRERAS, 1994). To resolve these problems Petrobras assumed a leading role in the industrialization process via imported substitution, attracting foreign companies to produce in Brazil and supporting the local ones.

Until this phase there was not a university structure able to help in the development of the oil industry. There were no university courses in geology, for example (DIAS and QUAGLINO, 1993). In order to meet its needs Petrobras signed agreements with Brazilian universities for the training of geologists and sent their employees for training in foreign universities.

The company also created its own human resources training center near the University of Brazil (now Federal University of Rio de Janeiro) in 1955, called “Centro de Aperfeiçoamento e Pesquisas de Petróleo”. This center was the embryo of Petrobras’ Research and Development Center (ERBER and AMARAL, 1995).

Petrobras’ strategy of training human resources has two main objectives: empowering their technical staff to buy foreign technologies and enabling them to enhance the operational capability of the equipment used (FURTADO, 1995). That strategy was crucial for the development of the oil industry and fundamental for the company’s success.

In the third phase, the Petrobras Research and Development Center (CENPES) was created. In this period the research and development (R&D) activities were focused on refining. The complete integration between R&D activities and operational functions would only happen in the next phase, when Petrobras reoriented its activities to oil and gas exploration and production.
The fourth phase is marked by an economic and energy crisis, with oil shocks in 1973 and 1979, and the economic crisis in Brazil (known as the “lost decade”). Nevertheless, the new discoveries of oil reservoirs in deep waters have mobilized a large amount of investments from Petrobras in oil exploration and production.

Petrobras conducted a major learning program, named the Technological Capabilities in Production Systems for Deep Waters Program (PROCAP), which existed as PROCAP 1000 between 1986 and 1992; PROCAP 2000 from 1993 to 2000; and PROCAP 3000 between 2000 and 2006. These programs underlie a relevant learning process of the company and produced structural changes, especially in terms of their relationship with Brazilian scientific institutions (FURTADO, 1995). The agreements with Brazilian universities about training graduate students and research contracts were intensified.

An example is the agreement between Petrobras and the University of Campinas to train masters in Petroleum Engineering signed in 1987. From this the Center for Petroleum Studies (CEPETRO) was created. The Center is acknowledged for contributing to training of human resources, as well for the advancement of scientific knowledge related to the industry (GIELFI, 2013).

The liberalizing of the Brazilian oil and gas industry is the mark of a fifth phase. In August 1997, Petroleum Law (Nº 9.478) was passed, which ended the monopoly of Petrobras and established a new regulatory environment within the industry. This law also ensured a share of royalties collected from oil production was earmarked to go towards funding R&D activities in Brazilian scientific institutions – thus instituting the Oil and Gas Sectoral Fund (CT-Petro).

As part of the new institutional environment, in the sixth phase a new mechanism was established for funding R&D activities, called the ANP R&D Clause. A clause in the concession contracts for exploration and production of oil and gas establishes that concessionaire companies
must spend on R&D a value equal to 1% of gross revenue generated by high profitability or high production volume fields; of which resources at least 50% of obligation value must be invested in scientific and technological institutions accredited by the National Petroleum Agency (ANP).

Figure 1 shows the expenditure of these mechanisms for funding collaborative R&D activities in the Brazilian oil industry. In total, between 2000 and 2013 it was expended R$ 3.7 billions in collaborative R&D with Brazilian S&T Institutions.

**Figure 1 – Expenditures on collaborative R&D**

![Graph showing expenditures on collaborative R&D from 2000 to 2013](image)

**Source:** Author’s own. Data sourced from CNPq and ANP websites.

In this period there was a discovery of a new exploratory frontier: enormous oil fields in the deep water off the Brazilian coast, the Pre-salt reserves. This discovery brings scientific and technological challenges and relates to the training of qualified human resources.

It is important to highlight that the role of universities in the Brazilian oil industry has changed over time. At the beginning the role of universities was more restricted to teaching, but it
has evolved over time, expanding into teaching and research activities. Moreover, the establishment of new mechanisms for funding R&D activities in scientific and technological institutions intended to encourage (even indirectly) university-industry interactions, placing universities in a privileged position in the Brazilian oil system of innovation.

**University-industry collaboration in Brazilian oil industry: a Petrobras’ case**

The aim of this paper is to obtain quantitative information on the extent and nature of research collaboration in the Brazilian oil industry, using bibliometrics techniques, through the case of Petrobras. In particular it focuses on how this collaboration has evolved over time, and according to the institutional sector and country of origin of the partners. We also compare the scientific impact of these publications.

We used the Scopus (Elsevier) database to retrieve publications authored by Petrobras through affiliation search. Scopus has a search engine which distinguishes among affiliations that have similar names by assigning each affiliation in Scopus a unique number and grouping together all of the documents affiliated with an organization (Scopus Affiliation Identifier).

The Scopus database was chosen because it includes the three Petrobras technical publications: Bulletin of Geosciences, Technical Bulletin Production and Petrobras Technical Bulletin. The search was restricted to articles and conference papers from 1957 to 2013, retrieving 2,959 records.

When available, we use the affiliation information to assign a unified organization name to each publication. In this way one publication can be authored by more than one organization, but they are all authored by Petrobras. Then we categorize the organizations according their institutional sector (industry, universities, research institutes or others) and their country of origin (as Brazilian or foreign institutions).
Scientific production of Petrobras has an increasing tendency between 1957 and 2013 (Figure 2). The number of publications by year has been growing over time, especially since the 2000s, when the number of publications per year trebles. Almost 87% of total publications are from the period 2000-2013.

Figure 2 – Trends in Petrobras publications: 1957-2013
(by type of collaboration)

![Graph showing trends in Petrobras publications]

Source: Author’s own. Data sourced from Scopus database.

Figure 2 shows the trend in Petrobras publications according to type of collaborator: universities, research institutes, industries, others. A clear trend in co-publishing can be seen in particular for collaboration with universities. Universities are the main partner of Petrobras with 70% of total publications, followed by industries (11%) and research institutes (9%). Moreover, since the 2000s almost all Petrobras publications were co-authored with another institution, which reveals the growing importance of research collaboration for the company.
In order to obtain a more detailed analysis about the dynamics of collaboration, Figure 3 and Figure 4 shows the trends of collaboration by type of institution and origin. We unify universities and research institutes, which represent the scientific dimension of collaboration, and called them S&T Institutions. Hence Figure 3 illustrates the collaboration between Petrobras and S&T Institutions, while Figure 4 shows its collaboration with industry.

The collaboration between Petrobras and S&T Institutions reveals the major role of Brazilian universities in terms of number of publication by year. The share of foreign universities in the total number of publications has decreased since the 2000s. Conversely, the share of Brazilian universities grows in the same period. This result reinforces the prominent role played by universities, especially the Brazilian ones, in Petrobras’ scientific production.

**Figure 3 – Petrobras collaboration with S&T Institutions by type of nationality: 1957-2013**

(\% total)

![Graph showing Petrobras collaboration with S&T Institutions by type of nationality: 1957-2013]

Source: Author’s own. Data sourced from Scopus database.
The collaboration between Petrobras and industry is smaller than with S&T Institutions, and does not vary over time. In this case, foreign companies are the main partner of Petrobras. The comparatively small Petrobras-industry interaction in relation to scientific production was expected because publishing is not a prior activity to industry, especially in non-science based fields.

An overview about the interactions of Petrobras is shown in Table 1. Here the interactions are categorized in accord to the partners’ institutional sector and country of origin. The table also displays how many times the publications were cited in the Scopus database. We use citation data as an indicator of the scientific impact of publications, so we can compare partner performance according their institutional sector and origin.
Seen by the number of publications co-authored, universities are the main partner of Petrobras in scientific production, as pointed out before. In terms of partner origin, Petrobras has more interactions with Brazilian S&T Institutions. Otherwise, foreign organizations are the main partner in Petrobras-Industry collaboration (58.6% of total publications with industry).

Table 1 – General framework of Petrobras’ interactions and scientific impact

<table>
<thead>
<tr>
<th>Origin</th>
<th>Records</th>
<th>%Records</th>
<th>Times cited</th>
<th>Cites per paper</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>University</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>1,898</td>
<td>89.4%</td>
<td>10,444</td>
<td>5.50</td>
</tr>
<tr>
<td>Foreign</td>
<td>395</td>
<td>18.6%</td>
<td>4,811</td>
<td>12.18</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,122</td>
<td>100%</td>
<td>13,799</td>
<td>6.50</td>
</tr>
<tr>
<td><strong>Industry</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>154</td>
<td>48.0%</td>
<td>308</td>
<td>2.00</td>
</tr>
<tr>
<td>Foreign</td>
<td>188</td>
<td>58.6%</td>
<td>1,364</td>
<td>7.26</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>321</td>
<td>100%</td>
<td>1,657</td>
<td>5.16</td>
</tr>
<tr>
<td><strong>Research Institutes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>183</td>
<td>64.7%</td>
<td>1,081</td>
<td>5.91</td>
</tr>
<tr>
<td>Foreign</td>
<td>105</td>
<td>37.1%</td>
<td>784</td>
<td>7.47</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>283</td>
<td>100%</td>
<td>1,830</td>
<td>6.47</td>
</tr>
</tbody>
</table>

*Source*: Author’s own. Data sourced from Scopus database.

The number of citations reveals substantial gaps between institutional sectors and origin. Publications co-authored with universities were cited 13,799 times, followed by research institutes (cited 1,830 times) and industry (cited 1,657 times). Thus the ratio between the number of citations and number of publications is 6.5 for universities (at all) 6.47 for research institutes and 5.16 cites per paper to industry.

The scientific impact of publications (seen by cites per paper) shown significant gaps according to partner origin. For all universities the ratio is 6.50, but when we separate it by origin the scenario changes: publications co-authored with foreign universities have a better scientific impact (12.18 cites per publication) compared to Brazilian universities (5.5 cites per publication). In other words, despite the lower intensity of interaction between Petrobras and foreign
universities, the scientific impact is better. All institutional sectors have this gap in performance according to partner origin: collaboration with foreign organizations have a better scientific impact compared to Brazilian organizations.

To examine Petrobras’ interactions via co-assigned patents, we use data of patents granted to Petrobras in the U.S. Patent and Trademark Office (USPTO) and in the Brazilian Patent Office (INPI). Using Orbit database, we retrieved 1421 patents records from 1973 to 2013. Petrobras’ technological production has an increasing tendency in this period (Figure 5).

![Figure 5 – Petrobras granted patents in USPTO and INPI: 1973-2013](source)

Among the 1421 patents granted by Petrobras, we identified 94 that are co-assigned with different organizations, which is 6.6% of total. Universities are the main partner in these joint-patents, with 44 patents or 47% of all co-assigned patents, followed by other companies (37 patents records) and research institutes (13 patents records). In terms of origin, all universities
partners are from Brazil. This fact reinforces the prominent role played by Brazilian universities in collaborative activities with Petrobras.

**Final consideration and future work**

This paper aimed to analyze using bibliometric techniques how the university-industry collaboration in the Brazilian oil industry evolves, through the Petrobras case. As highlighted before, the interaction between Petrobras and universities was crucial to the development of the Brazilian oil industry and the technological trajectory of the company.

The role played by universities in the Brazilian oil system of innovation has changed over time. At first, Petrobras often interacted with foreign universities in order to train its employees, thus transferring knowledge and helping to construct/build a domestic scientific base. Then the company also established agreements with Brazilian universities to create university courses, especially in graduate degree level, and in training qualified human resources. From the consolidation of graduate courses required for development of the Brazilian oil industry, the interaction between universities and Petrobras has expanded into research activities. In recent years, the establishment of new instruments to fund R&D activities granted to Brazilian S&T institutions (especially universities) a huge volume of resources in order to finance their activities.

Despite the importance of the relationship between Petrobras and universities, little is known about the nature and extent of this interaction. This paper provides a macro-view of this collaboration. Our main findings are about the differences in the pattern of collaboration and the gap according the organizations’ respective countries of origin.

We observe that Petrobras’ scientific and technological production has an increasing tendency for the period analyzed. However, the pattern of collaboration differs between scientific
and technological dimensions. The scientific production is more collaborative than its technological counterpart: only 6.6% of Petrobras’ patents are co-assigned with another organization.

The collaboration between Petrobras and universities in publishing reveals the major role played by Brazilian universities. The share of Brazilian universities in the total number of publication has increased since the 2000’s; and comparatively, the share of foreign university has decreasing. However, despite the lower intensity of collaboration between Petrobras and foreign universities in publishing, the scientific impact is better. We highlighted a gap in scientific impact by university origin: publications co-authored with foreign universities were cited twice more than their Brazilian-coauthored counterparts.

In terms of collaboration patterns between Petrobras and universities, our results show a high intensity of Petrobras-university collaboration in scientific production, given the share of co-authored publications. On the other hand, this interaction has a lower intensity in technological production, given the number of co-assigned patents.

Despite the lower intensity of collaboration between Petrobras and universities in technological production, we suggest as a hypothesis that universities have contributed to technological production, but it is not captured by patents indicators. In order to investigate that, for future works we will analyze the content of publications using more advanced scientometric techniques (e.g. science mapping analysis).

Also, it is necessary to investigate if the interaction between Petrobras and universities, with regards technological production, occurs by "indirect" ways; in other words it is required to analyze the affiliations of inventors, and verify if some of them are teachers or researchers affiliated to universities. To indentify the affiliation of inventors, we will search for the inventors names in Lattes Platform, a digital information system designed by the federal National Council
for Scientific and Technological Development (CNPq), which contains a standardized curriculum vitae. This step enables us to identify the academic inventors, and should provide a rich source of information about university-industry collaboration. The approach is also fruitful for tracing knowledge flows and mobility of human resources.

Moreover, it is necessary to observe how the recent policy to fund R&D in the oil industry, through cooperation with S&T institutions, has influenced university-industry interactions. This should clarify the role of S&T policy related to the Brazilian oil industry to improve university-industry collaboration, and if this S&T policy has helped to strengthen the oil sectoral system of innovation.

Together, those futures analyzes should enable an in-depth systematic analysis on collaboration, which allows for uncovering and evaluating linkages between Petrobras and universities.

References


