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The role of university-firm relations to foster regional development: evidence from Brazilian Amazon

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The role of university-firm relations to foster regional development: evidence from Brazilian Amazon ¹

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Abstract

The role of universities for the innovation process of countries or regions had been widely explored. In lagged regions becomes a reference not only for qualification and research but concentrates brains and fixes qualified people. This paper analyses innovation and especially the interaction of firms with universities and research institutes, as strategy to face the low internal investment capacity in innovation. Our focus is the ultra-peripheral region of Brazilian Amazon and it is part of a larger research project which investigates these interactions internationally. The interest in studying these interactions in Brazil are based on findings that the investments in R&D by the private sector are low, and the national (and thus regional) innovation systems are immature (Albuquerque, 1998). Data was collected based on a questionnaire applied to firms, adapted by Federal University of Minas Gerais, Brazil from the Carnegie Mellon (Cohen, 2002) and Yale Surveys (Klevorick, 1995) on firms' interaction. The sample was taken from a database of university-based research groups registered in CNPq (national agency of research funding), that declared some kind of innovative relationship with firms. Although, the interaction between universities and firms has been considered crucial for the development of innovation, we found very few interactions resulting in a low complementary role or even substitute R&D efforts of these firms. Results show that the continuous interactions between firms and university are restricted to agronomy, energy, electrical and mining engineering. And that the role of university in leading the process is not sufficient to suppress the peripheral condition of the Amazon region.

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1. INTRODUCTION

Development based on innovation implies institutional arrangements involving multiple agents, firms, universities and research institutes, educational institutions in general, the financial system, legal systems, market mechanisms, and governments that interact in order to conduct cooperative actions to learn from each other in a certain region. Given the current scenario of globalization and the speed of product cycles, in lagged regions universities and research institutions, create the potential for the development of science and technology skills, supporting the productive sector. Moreover, cooperation between agents can take place in several levels and can occur in different ways through consultancy, licensing, contract research, joint research, etc. The nature and intensity of these relations of cooperation within a more or less formal system of innovation is crucial and can affect how knowledge is generated and distributed (INZELT, 2004). Although the northern region of Brazil has major universities and institutions for scientific research that may contribute to the development of these new technologies, the interaction processes between universities firms are incipient. In one hand businesses have little inward investment in R & D on the other would need to improve their technical capacity to absorb the knowledge produced in universities and research institutes (Cohen; Levinthal, 1990), to be able to interact and truly cooperate.

Thus, this article aims to analyze the patterns of interaction between universities and public research institutes to firms in the Amazon in order to understand the contribution of the academic institutions in the region's development. The article has four sections besides this introduction. The second section presents a literature review on the development and national and regional systems of innovation. The third presents the region's productive base and indicators of Science and Technology. The fourth describes the methodology used in research and the fifth discusses the results of the survey, which is performed a more detailed analysis of interaction between universities / institutions and firms in Amazon.

2. Development in the Perspective of Innovation

The analytical framework of this work focuses on the interactive approach of the innovation process, present in the Neo-Schumpeterian Theory / Evolutionary Theory. According to this theory firms do not innovate in isolation but are constantly in a context of networks of direct or indirect relationships with other firms, educational institutions and research infrastructure of public and private research, national and international economy, among others. The systemic nature of the process of innovation, are particular important to analyse in developing countries as those systemic factors act as a growth strategy to achieve a better technological performance and consequently the economic development of a particular country or region. This analysis can identify networks that encourage learning and networks and interactions that are absent currently but are enhanced at a certain point in time and space. A strong interaction between the pure science and technology (Rosenberg, 2006) demonstrates that firms gain better results as the basic research progresses. However, we believe that is more feasible in a particular region due to a mix of agglomeration of different institutions (research institutes, universities and firms) and spillover effects than to another with different conditions. We cannot forget that learning mechanisms can be both internal and external to the firm (Dosi, 1984). Attention to internal sources will require an approach between the phases of creation, and thus overcome the lack of communication between the stages of the innovation process, but also the external sources are an important mechanism of learning. Actually, the creation of technological capacity at the firm level will also depend on the ability to interact with their corporate customers, competitors, contractors, universities, laboratories, government agents, consultants and researchers (Freeman, 1988). This is particularly truth in peripheral areas where the internal capabilities are not always there. The presence of a university plays an important role in qualifying and fixing people who are able to create or absorb technical specifications. Suzigan and Albuquerque (2006) highlight the main contributions of scientific institutions in an immature Regional Innovation System: an instrument for helping to focus on identifying opportunities and linking the country to international flows, and support for industrial development, providing the knowledge necessary to the entry into strategic industrial sectors, and as a

source for some creative solutions that would hardly be obtained outside the country. More specifically, the contributions of academic research for technological advancement occur through several mechanisms and vary between industrial sectors and there are branches of science whose progress is most relevant for technological innovations. Klevorick (1995) points out the advances in scientific knowledge as the most important source of technological opportunities. However, in developing countries, due to an industrial structure that invests little in R & D, even if universities produce knowledge to support the innovative activity of enterprises (Klevorick, 1995; Cohen, 2002) firms not always have qualified workers and may present low absorptive capacity, thus the sharing of knowledge produced in universities and research may be underused (Schiller; Schätzl; Revilla Diez, 2009). So we may say that the university-firms interaction is specific to each country or region and depends on the infrastructure of science and technology. This interaction can open a range of job opportunities for all stakeholders - students, researchers, among others, and thus a coincidence of interests between the productive sector and academia. The practice is crucial to stimulate research themes, at least for purpose of research applications.

As clearly demonstrated Cassiolato and Lastres (1998), in lagged regions, investments in R & D and technical expertise stimulate innovation and diffusion of technologies, and organizational and institutional innovations can also lead the economy to sustained growth. Thus, the countries and regions are able to create an institutional environment capable of providing the technical expertise, innovation, dissemination and adoption of new technologies. As the depart conditions are more difficult to start innovating individually, this environment should foster for institutional arrangements: the relationship/interdependence between basic research and applied research between researchers and entrepreneurs, innovation, dissemination increasing qualification of manpower.

2.2. A Brief History of Brazilian industry and technology policy

In Brazil, national development programs focused on the imports' substitution model that lasted from the 1930s to the early 1980s, this way the nation build an industrial complex with high levels of inter-sectoral integration. However, had insufficient technological development, and specific technical deficiencies, and especially, had little integration with the international market.

During this period the pattern of investment and establishment of industries in Brazil was based on attracting multinational investments, occurring thus a paradox: an industry with strong presence of foreign capital, but extremely closed, with almost no international integration. According to Carleal (1997), despite the strong presence of multinational firms, the activity of basic research developed at the headquarters of these firms and therefore outside the country do not promoting R&D investments and improvement in the innovative activities .

During the 1980s a weakening of the Brazilian industry was tied to the limited capacity to develop new technologies with new products, new production processes within an organization more efficient and leaner (Coutinho, 1994).

From the 1990s, begins an intense process of economic and institutional reforms aimed at resuming the process of Brazilian development, only now in a context of globalization, emergence of new patterns of competition and accelerating technological progress, or rather within the new pattern of expansion of the global economy (Diniz, 2008).

In the mid-1990s, the Federal Government introduced a program to create macroeconomic, infrastructure and institutional conditions aiming to create competitive conditions under a free market agenda. Therefore, Brazilian industrial policies, adopted in this period, favored both the modernization and increasing the competitive power of the Brazilian industry, reaching, increased productivity, significant savings in working capital, administrative and organizational structures and management processes more lean efficient. According to Sabóia and Carvalho (1997) despite the remarkable growth in labour productivity from the 1990s onwards, industrial production, have not printed a momentum required for the economy as a whole. However, the Brazilian industry is one of the largest and most diversified among developing countries (De Negri and Salerno, 2005).

More recently (since 2002), the government policy includes the industrial, trade and technological innovation with the creation of several laws and structures for innovation, seeking to induce the necessary changes in order to raise the competitive level of the Brazilian industry.

3. Productive Structure and Dynamics of Science, Technology and Innovation in the North

As the current literature and the various federal agencies (IBGE, CNPq, IPEA), which explicitly show the data of the Northern Region (some listed below) one can say that the states of Para and Amazonas, are those with greater economic participation within the region. Thus, it is necessary a fast context of current productive activities of these states in order to declare the region's importance nationally.

The state of Pará, although in recent years has experienced a slight diversification and vertical integration of production, including both the agricultural sector, and the processing industry, still carries a heavy reliance on natural resource exploitation and in particular of mineral resources with low added value (Diniz et al. 2007). These sectors continue to receive more investment than those that involve more technological advances. We should point out that the diversification of industry occurs in sectors such as food, clothing and footwear and it is concentrate around the metropolitan area. Moreover, the state has only two industrial districts which are mining industry related, have export vocation and are 700km away from each other, not profiting from spillover effects to the rest of the state.

In the state of Amazonas, a small industrial ring around the city of Manaus was established, yet very dependent on imports. However, there is an effort to substantially change their production function, encouraging those more capital-intensive and technology in an effort to modernize whose speed and depth are hardly unprecedented in Brazilian industry (Machado et al, 2006).

3.1. Current Dynamics of Economic Production in the North

Despite cover almost 60% of the country' area, region's share of national GDP is low. In 2008 the region recorded a total GDP of 53 billion Euros, which accounted for only 5.2% of the national GDP, representing a slight increase compared with the year 1998 when this share was 4, 2% and GDP per capita rose from an average of 1400 Euros⁶ in 1998 to 4080 Euros in 2008, showing a significant increase in the region during this period, however, well below the GDP per capita national who from 2360 Euros to 6360 Euros, during the same period analyzed. Among states in 2008, only Amazonas approached the

⁶ At a current rate of 1Brazilian real to 0,45 Euros.

national average around 5760 Euros, while Para had the lowest GDP per capita in the region 3160 Euros.

As regards the analysis of the participation of productive activities as gross value added (GVA), can be observed, as shown in Table 1, the states of Amazonas and Pará stand out compared to other states, especially in respect to the activity of the manufacturing industry, where in Amazonas represented 30.7% of gross value added in 2008 and Pará to 10.8%. Other activities in the Amazonas predominant concern to management, public health and education (17.8%) and the activity of commerce and maintenance and repair services (11.5%), while in Pará, still stand out management activity, health and public education (17.7%) and in extractive industry (14.0%).

Still, according to Table 1, the average share of industrial activity in regional GVA was only 9% while the national average corresponds to 16.6%, and only the state of Amazonas was up to this national average. The activities of agriculture, forestry and logging, presented to a regional average share of 8.9%, while the national average was only 4.0%. These data reinforce the predominance of primary activities on the industrial activities, which results in great pressure on natural resources on a critical area for global change.

Table 1: Share in regional and National GVA participation per state in 2008

| | Participation (%) in GVA at current prices | | | | | | | | |
|---|--|-------|-------|-------|-------|-------|-------|-------|-------|
| | BRAZIL | NORTH | AC | AM | AP | PA | RR | TO | RO |
| Total | 100,0 | 100 | 100,0 | 100,0 | 100,0 | 100,0 | 100,0 | 100,0 | 100,0 |
| Agriculture , forestry and forest exploitation | 4,0 | 8,9 | 13,5 | 4,0 | 2,8 | 2,5 | 9,5 | 5,1 | 11,5 |
| Cattle and fishing | 1,9 | 5,1 | 5,1 | 1,4 | 1,0 | 4,6 | 13,5 | 1,3 | 9,3 |
| Extractive industry | 3,2 | 1,4 | 0,1 | 2,7 | 1,1 | 14,0 | 0,2 | 0,2 | 0,4 |
| Manufacturing industry | 16,6 | 9 | 3,4 | 30,7 | 2,8 | 10,8 | 6,2 | 2,9 | 3,2 |
| Building | 4,9 | 6,8 | 7,5 | 5,7 | 4,0 | 6,8 | 4,0 | 8,2 | 13,3 |
| Production and distribution of electricity ,gas ,water sewage and street cleaning | 3,1 | 3,1 | 1,5 | 2,2 | 1,5 | 4,6 | 2,0 | 1,4 | 6,7 |
| Trade ,maintenance and repair services | 13,6 | 13,1 | 13,9 | 11,5 | 15,9 | 12,5 | 15,8 | 11,2 | 13,4 |
| Accommodation services and meals | 1,8 | 1,5 | 1,6 | 2,1 | 1,8 | 1,5 | 0,8 | 1,5 | 1,1 |
| Transport ,storage and mail | 5,0 | 3,6 | 2,1 | 5,8 | 2,4 | 3,8 | 2,7 | 2,4 | 2,4 |
| Information services | 3,8 | 1,9 | 2,1 | 1,9 | 1,9 | 2,7 | 1,9 | 2,5 | 1,5 |

| | | | | | | | | | |
|--|------|------|------|------|------|------|------|------|------|
| Financial intermediation, insurance and pension and related services | 6,8 | 2,9 | 2,4 | 2,1 | 1,8 | 2,6 | 2,4 | 3,0 | 2,5 |
| Services to families and associations | 2,2 | 1,5 | 1,2 | 1,2 | 1,2 | 1,4 | 1,6 | 1,2 | 1,5 |
| Business services | 4,9 | 2,1 | 1,9 | 2,7 | 1,6 | 2,1 | 1,7 | 3,0 | 1,5 |
| Real estate and rentals | 8,2 | 8,4 | 8,6 | 5,6 | 10,8 | 9,9 | 7,7 | 7,3 | 4,9 |
| Administration health and public education | 15,8 | 27,9 | 33,4 | 17,8 | 46,2 | 17,7 | 27,9 | 47,3 | 23,8 |
| Health and education market | 3,0 | 1,5 | 0,8 | 1,8 | 1,9 | 1,3 | 1,2 | 0,7 | 1,9 |
| Domestic services | 1,2 | 1,1 | 1,1 | 0,7 | 1,3 | 1,3 | 1,0 | 0,7 | 1,3 |

Source: IBGE (2010).

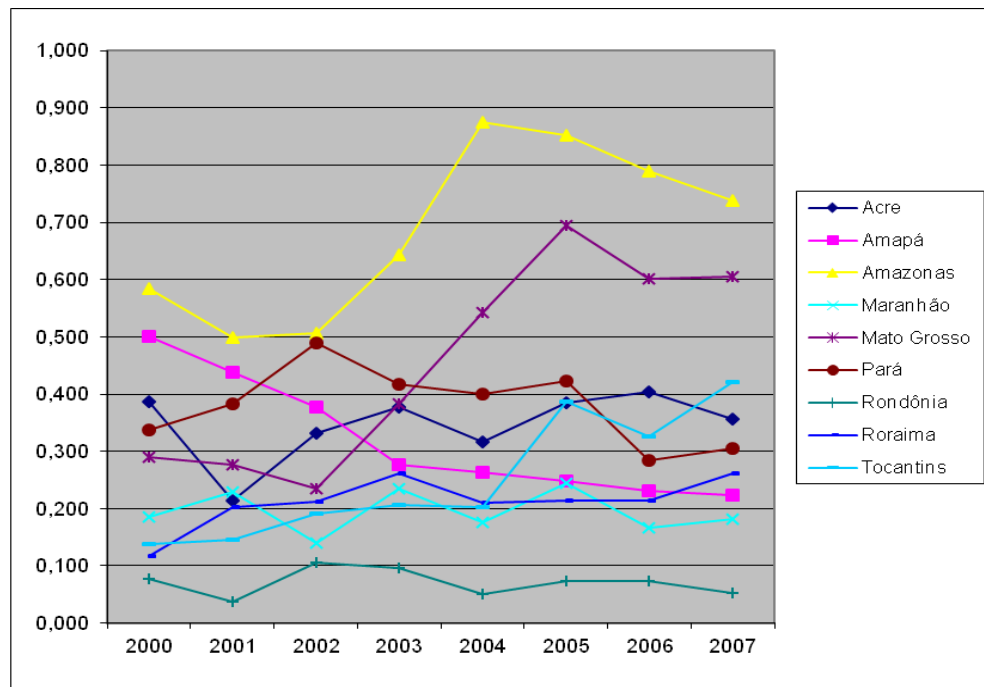
3.2. The current Standards for Science, Technology and Innovation in the North

We analyse the Regional Innovation System with a general index of Science, Technology and Innovation - ST & I, as function of the various indicators such as: Per Capita Government Expenditure, Percentage of Expenditures on S & T Patents; Youth Education Rate, Number of Researchers per Million Inhabitants, Business Incubators, Export Products Technology-intensive and others. Thus we used the Technology Achievement Index (TAI) developed by United Nations Development Program - UNDP, and published in the Human Development Report 2001, which became a reference methodology in the regional innovation analysis.

According to Diniz et al (2009) empirical evidence this index of S, T & I calculated for the region showed little progress during the period examined - 2000 to 2007, with the exception of Amazonas state that had a better relative position, as shown Figure 01.

In the state of Amazonas, as discussed above, the relative position of the index is due to the dynamics of the Industrial District of Manaus (PIM, in Portuguese). In another study on a sample of 327 firms, Diniz (2008) found that 68.06% of firms in the PIM develop innovate products to market local, national and to a lesser extent for the export market.

FIGURE 01: EVOLUTION OF THE GENERAL INDEX OF SCIENCE AND TECHNOLOGY OF THE NORTHERN STATES OF BRAZIL- 2000-2007.



Source: Diniz et al (2009)

In 2002, Amazonas and Pará had similar indexes, from that year Amazonas and Mato Grosso increase exponentially while the other states trend was declining or stable. The recent little improvement in Para state occurs between 2006 and 2007 as a reflect of recent efforts of state government to promote research, science and technology, in particular with the creation of the Research Foundation of the State of Pará – FAPESPA, a 2000km broadband network connecting all public institutions and free access to internet in community associations, indigenous villages and so on, and a trial to establish a Regional Innovation System supporting a competitive forum for major firms with major trade unions, research institutes and firms associations; research networks in certain elected subjects; and science and technology parks.

3.2.1. An analysis from the Research Groups

Another important indicator of science and technology is shown in structure formation collected through scientific research groups located in the higher education institutions in

the region. Some states include the largest number of research groups, in view of the greater volume of lines of research, researchers, students and technicians available. The state of Para is the highest ranked among the states in the region with the largest number of research groups, 379 groups. Then the state of Amazonas and Tocantins 362 and 135 respectively (Table 2). However, when analysing the number of research lines, researchers, students and technicians, the state of Amazonas surpasses all states, with a more diversified research framework.

On the other hand, when we confront the region with data from the data recorded in Brazil, there is a long way to go. The largest share is the number of researchers, representing 7.2% of the national and smaller amounts to 5.8% of total participation of students in the country.

TABLE 2 - NUMBER OF GROUPS, RESEARCHERS, STUDENTS, TECHNICAL, RESEARCH AND RELATIONS ACROSS STATES, CENSUS 2008 .*

| STATE | Groups | Research lines | Researchers | Students | Technicians |
|-----------|--------|----------------|-------------|----------|-------------|
| Acre | 38 | 203 | 313 | 180 | 64 |
| Amapá | 36 | 117 | 206 | 142 | 36 |
| Amazonas | 362 | 1.664 | 3.362 | 3.028 | 682 |
| Pará | 379 | 1.492 | 2.892 | 2.650 | 485 |
| Rondônia | 48 | 202 | 390 | 303 | 25 |
| Roraima | 72 | 227 | 418 | 199 | 31 |
| Tocantins | 135 | 555 | 908 | 807 | 120 |
| Brasil | 22.797 | 86.075 | 159.948 | 177.702 | 24.143 |
| Norte | 1.523 | 6.126 | 11.582 | 10.275 | 1.724 |

Source: CNPq, Census 2008.

It may occur double counting of the number of researchers, students and technicians, as some individuals participate in more than one research group thus, was counted more than once.

Nevertheless, there are advances in scientific research, especially through the most common types of relationships between research groups that interact with firms. These interactive research groups are also located in greater numbers in the state of Para, representing 33.8% of the region, which interact with 68 firms inside and outside the region. (Table 3).

Notably, the indicator identified by the scientific advancement of these relationships with groups of firms have confirmed (either early-stage), the development of activities in the region more closely related to scientific research, also with transfer of technology developed by the group for firms expressed by ratio number 7 in Table 3.

However, due to its tradition of teaching and applied research, this indicator shows that scientific research has moved slowly, given that relations are still prevalent in low temporal

nature, as expressed by the ratio 2, ie, scientific research considerations the results of immediate use.

TABLE 3 - TYPE OF RELATIONSHIP BY STATE, REGION OF BRAZIL AND GROUP, 2008 CENSUS *

| Interactions | AC | AP | AM | PA | RO | RR | TO | NO | BR |
|---------------------|----|----|-----------|-----------|----|----|----|-----|-------|
| Groups | 1 | 6 | 33 | 52 | 8 | 4 | 13 | 154 | 2.726 |
| Firms | 8 | 8 | 45 | 68 | 12 | 4 | 25 | 228 | 3.865 |
| Rel. 1 | 0 | 3 | <u>18</u> | <u>39</u> | 4 | 1 | 8 | 100 | 1.488 |
| Rel. 2 | 5 | 4 | <u>23</u> | <u>47</u> | 3 | 4 | 9 | 121 | 3.061 |
| Rel.3 | 0 | 0 | 5 | 12 | 0 | 0 | 0 | 20 | 334 |
| Rel.4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 130 |
| Rel.5 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 4 | 119 |
| Rel.6 | 0 | 0 | 2 | 7 | 0 | 0 | 0 | 10 | 281 |
| Rel. 7 | 3 | 1 | <u>13</u> | <u>29</u> | 3 | 2 | 5 | 71 | 1.710 |
| Rel.8 | 0 | 1 | 1 | 6 | 2 | 0 | 2 | 15 | 289 |
| Rel.9 | 0 | 0 | 3 | <u>15</u> | 3 | 0 | 5 | 35 | 776 |
| Rel. 10 | 0 | 1 | 6 | <u>12</u> | 0 | 1 | 6 | 35 | 665 |
| Rel. 11 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 6 | 64 |
| Rel. 12 | 3 | 0 | 7 | <u>15</u> | 1 | 0 | 3 | 44 | 612 |
| Rel. 13 | 0 | 0 | 3 | 7 | 0 | 0 | 0 | 13 | 196 |
| Rel. 14 | 0 | 2 | 2 | 3 | 4 | 0 | 4 | 20 | 698 |

Source: CNPq, Census 2008.

Note 1: Firms are not located necessarily in the same area of the group.

Note 2: There is no double counting the number of firms in more disaggregated size of the table, but there is double counting in the total sum obtained. This is because the same firm may be mentioned groups located in more than one region or UF

Note3: We admitted up to three types of relationship.

Table 4 presents the types of relationships between research groups which interact with firms, considered by CNPq.

TABLE 4- TYPES OF RELATIONSHIPS BETWEEN RESEARCH GROUPS

| LEGEND FOR TYPE OF RELATIONSHIP |
|---|
| Rel1 - Scientific research regardless of immediate results |
| Rel2 - Scientific research fostering immediate use of the results |
| Rel3 - Activities for non-routine engineering including the development of prototype head series or pilot plant for the partner |
| Rel4 - Activities for non-routine engineering including the development / manufacturing equipment for the group |
| Rel5 - Development of software for non-routine activities by the partner group |

| |
|---|
| Rel6 Software development partner for the group |
| Rel7 - Transfer of technology developed by the group for the partner |
| Rel8 Transfer of technology developed by the partner for the group |
| Rel9 - - technical consultancy activities not covered by other types |
| Rel10- Supply, the partner of material inputs for the research activities of the group without binding to a specific project of mutual interest |
| Rel11 - Supply, by group, material inputs for the activities of the partner without connection to a specific project of mutual interest |
| Rel12 - Training of staff of the partner by the group including training courses and on job training |
| Rel13 - Training of staff of the group by the partner including training courses and on job training |
| Rel14 - Other prevalent types of relationships that do not fit in any of the previous |

Source: CNPq, Census 2008.

We can add that the challenges of the Northern Region are higher due to the historical low rate in technological innovation as well as going through transformations in productive areas that need to see encouraged more applied research to meet the need to compete nationally and globally. Another added challenge is the maintenance of tropical forest, essential for balancing the global climate. The state of Amazonas has established more efficiently by keeping the concentration of its population and productive activities around the capital. However, isolated people within the forest faces worse health and education indicators and the State, up to now, as not being able to cope with these problems.

4- Methodological Aspects

The results presented here are the conducted data collection by the North Region research group as part of the research project: interactions of universities and research institutes with firms in Brazil, coordinated by Suzigan and Albuquerque (2006). We depart from data on research groups registered in the Directory of Research Groups. This institution provides in its database information on the various research groups belonging to universities and public research institutes (PRI's), according to the methodology proposed by Rapini (2006). Among the information included groups that had some kind of interaction with production firms. From this information it was possible to identify forty firms that performed effectively interactions with universities and/or RPI's in the seven

states that make up the Northern Region. Of this total, 19 firms responded to the questionnaire providing evaluative information about the interaction with universities and/or RPI's. Most of these firms are located in the states of Para and Amazonas with 7 and 6 firms respectively or approximately 70% of the total. In Amapá, three firms responded to the questionnaire, two firms in Rondônia and Roraima only one company. Tocantins and Acre were the only two states that have not register any interaction between firms and research groups. We register that the knowledge is built in a bidirectional flow of information; we mapped those interactions before considering the quality or the results of those for innovation.

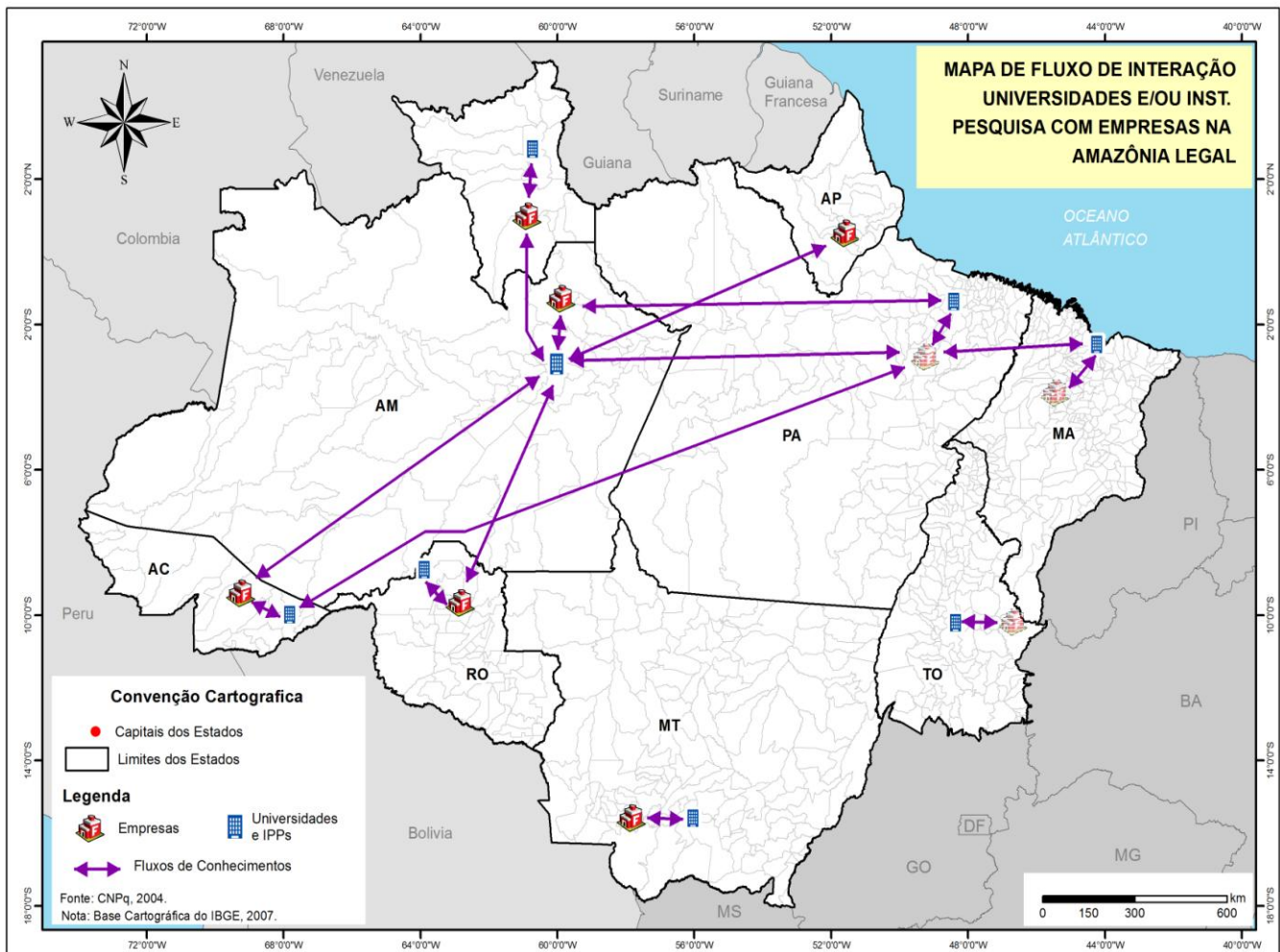


Figure 1 –MAP OF LOCATION AND REGISTERED INFORMATION FLOWS

We can see from the map above the polarization of Manaus and Belém where are

concentrated major universities and research centers, thus although isolated (or because of that) we can define a hierarchy of cities based on presence and absence of universities, the highest ranked training institutions.

With regard to the sector to which they bind the firms that make up the sample, the majority, or seven firms (36.8%), is associated with the manufacturing industry, while the Electricity and Gas sector covers 26.3% of the total of firms, five. The other firms are represented in industry research and development with four firms, the Agriculture, Forestry and Logging with two firms and extractive industries with a company, as shown in Table 5, below.

TABLE 5 – NUMBER OF FIRMS BY SECTOR IN THE NORTH

| SECTORS | NUMBER OF FIRMS | (%) |
|---|-----------------|-------|
| Agriculture, Forestry and Forest Exploitation | 2 | 10,5 |
| Extractive Industry | 1 | 5,3 |
| Extractive Industry | 7 | 36,8 |
| Electricity and Gas | 5 | 26,3 |
| Scientific Research and Development | 4 | 21,1 |
| Total | 19 | 100,0 |

Source: Field research

4.2. Data Treatment

Data extracted from the questionnaire addressed to the firms were tabulated according to the methodology used by a network of researchers that studies local production arrangements' and local innovation systems - REDESIST⁷, that analysis qualitative levels of importance (not important, somehow important, moderately important and very important), given by firms in the survey, rates on quantitative degree of importance, which follows a scale from 0 to 1. From this perspective, the closer to one, the more the activity is considered important for firms, in the other way, the closer to zero the index the less important is the variable.

5. Dynamic Interaction of Universities and RPI's with Firms in the Region

Innovative activities include all steps necessary to develop products (radical innovations)

⁷ *Index = (0*Nr of null answers + 0,3*Nr of low + 0,6*Nr of medium + Nr of high) / (Nr of firms in the sample).

or processes (incremental innovations) new or improved, enabling the expansion of knowledge of the firms to produce and market goods and services as discussed by Kim and Nelson (2005). Thus, in this study, we identified the types of innovative activities that are developed by firms in partnership with universities and public research institutes (PRI's), analyzing the strategies used, the importance of universities and PRI's, the relevance of the knowledge areas for the productive sector within the region, besides the main reasons for interaction.

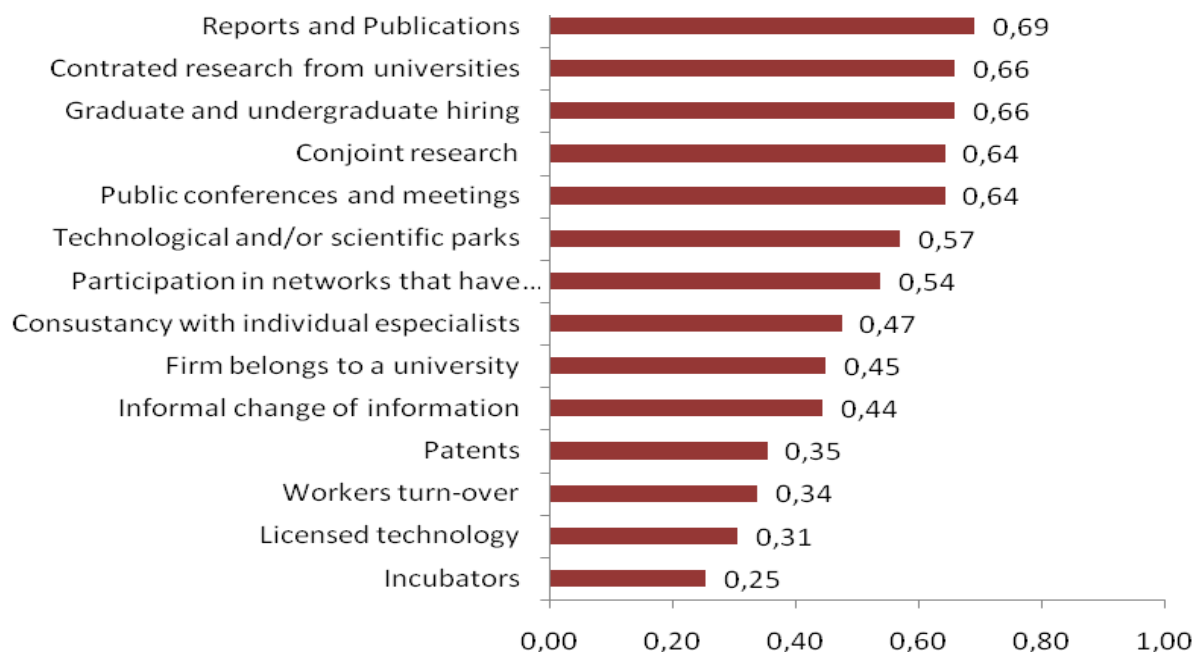
5.1. Information Sources

In this study, we assessed the sources of information provided by universities and RPI's. With regard to sources of information generated by the universities to conduct innovative activities of enterprises, the data presented in Figure 02 consider the main factors according to their degree of importance for firms in the region analysed.

As noted, the three main sources of information for firms of our sample, are the publications and reports, with index of 0.69, then, are considered universities research and the graduates and undergraduate personnel employed, both with the same indicator of importance, 0.66. The research conducted conjointly and public conferences and meetings, also were consider relevant information sources provided by the universities by these firms. Likewise, firms have found to be of little importance, temporary staff exchanges, as an indicator of 0.34, and technology licensed to finally incubators 0.25.

Whereas the sources of information coming from external agents into firms, as in the case of institutions analysed, require that it have significant technological expertise in order to acquire, assimilate and improve the knowledge acquired outside of its facilities, it can be observed that universities play an important role to complement and even replace these research firms in the region.

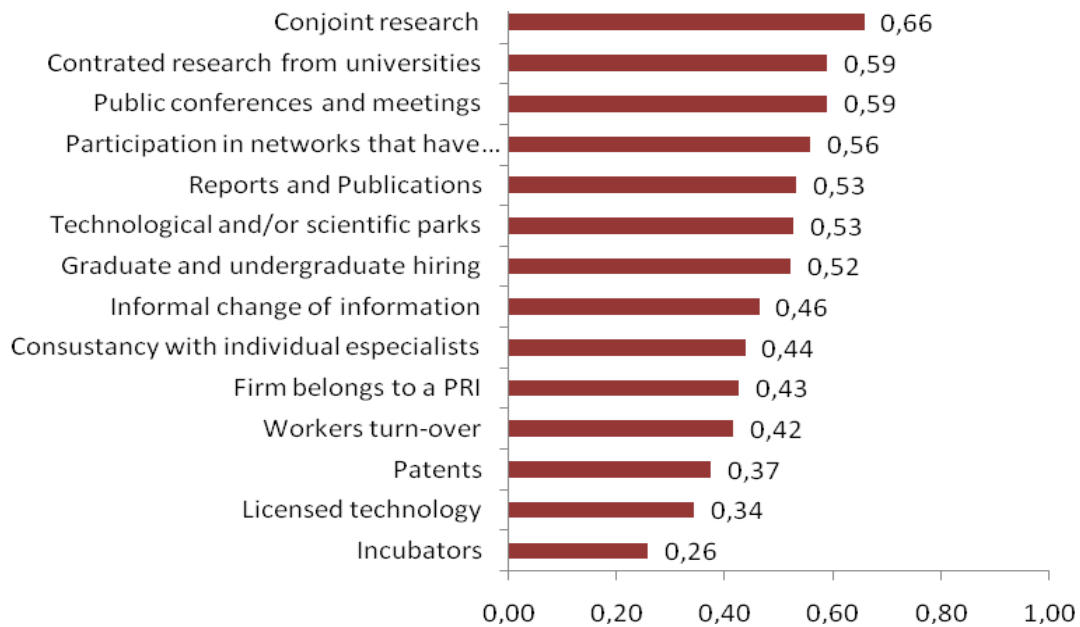
Figure 2 - Importance of Information Sources of Universities in the North Region of Brazil – 2010



Source: Field Survey.

When analysing the sources of information provided by PRI's, it is observed, as shown in Figure 3, that the factors most relevant to firms, are related to research carried out together, which presented important indicator of 0.66, while ordered from the research that PRI's public lectures and ranked second indicator tied with 0.59. Otherwise, the factors patents with indicator 0.37, licensed technology, as an indicator of 0.34, and incubated with 0.26, is presented as less important for firms. In the case of PRI's may also be noted the relevance of these institutions interact with firms, although in a slightly lower intensity than with universities.

Figure 3 - Importance of Information Sources of IPP's in the North - 2010



Source: Field Survey.

5.2. Area of Knowledge

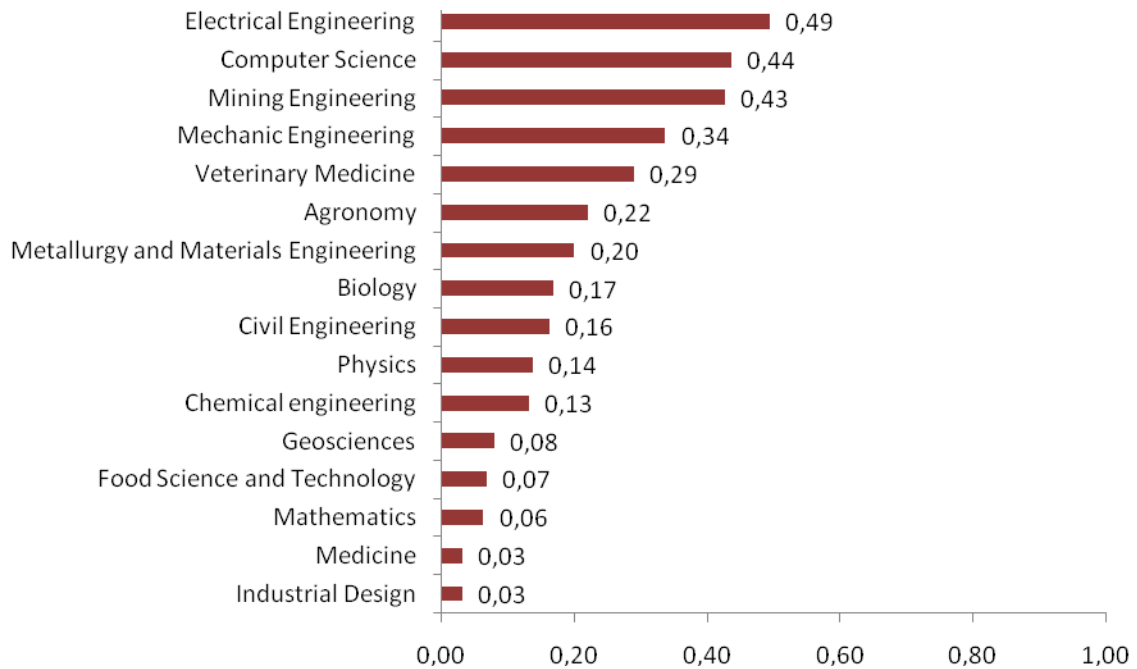
With regard to scientific and engineering disciplines, according to the classification of CNPq, this section evaluates the areas of knowledge that contributed most to the R & D and innovation.

Figure 4, below, shows the results on the relevance of public research conducted by universities, distributed in the following disciplines of science and engineering, and its contribution to industrial innovation.

In the northern region, the fields of knowledge perceive as most important for the productive activities of the firms were: electrical engineering, which has moderate level of importance as an indicator of 0.49; computer science, with indicator 0.44 and mining engineering with indicator 0.43. On the opposite side, the less relevant disciplines according to the firms were: industrial design, medicine and mathematics. As can be seen, none of the subjects showed a level of importance above 0.6 which is the result of the heterogeneity of the production firms that make up the sample, especially those belonging to the two most economically important states in the region, ie, Para and Amazonas.

It stands out especially, observed flows of knowledge that provide a broad contribution and are more dynamic in the relationship between academia and the productive sector in these countries. Stands first in the areas of electrical engineering and mining engineering, which are directly related to mineral extraction activities, led by the company Vale⁸ and electrical activity coordinated by Eletronorte⁹. While the state of Amazonas, the area of computer engineering stands out, given the importance of the electronics sector in the Industrial Pole of the State, comprised of firms like Samsung and Nokia for example.

FIGURE 04 - THE IMPORTANCE OF KNOWLEDGE AREAS FOR FIRMS



Source: Field Survey.

In addition, results confirm the prominent role of engineering, considered the most relevant area to the productive sector. So the knowledge areas of greater dynamism, in these states, are directly linked to the productive sectors of the region which are also the ones receiving more investments, as discussed upwards. Also noteworthy is the low

⁸ The third biggest mining company in the World.

⁹ A state run firm that produces energy in North region of Brazil, is responsible for the third biggest Hydroelectrical Power plant in the World.

importance assigned to areas focused on biotechnology, even the region comprising most of the Brazilian Amazon, that is, the biome that has the highest biodiversity in the country. This demonstrates a serious mismatch between the true potential of the region and the dynamics of the productive sector.

5.3. Search Results for the Company

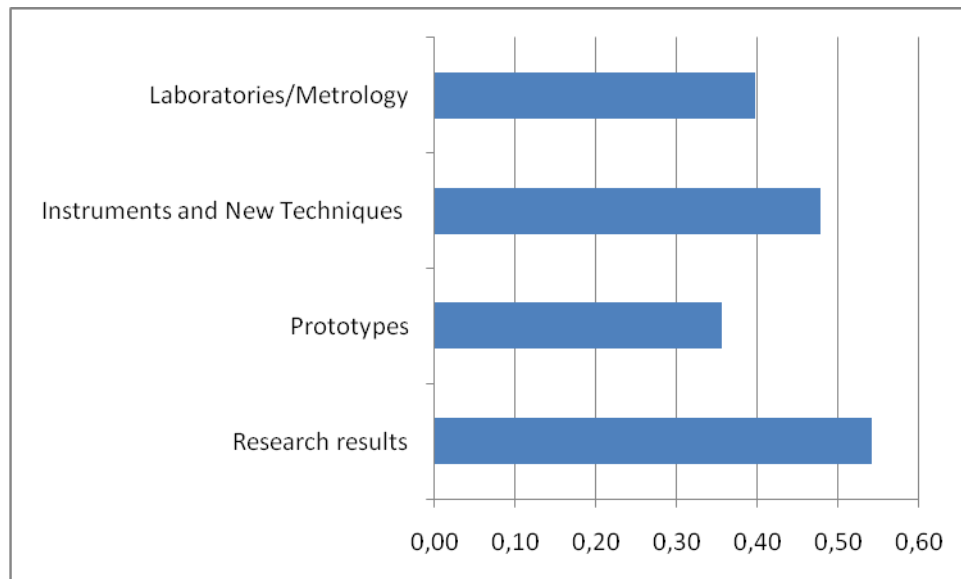
Among the results of research partnerships between universities and public research institutes and firms, we will consider: research results, prototypes, new techniques and instruments beyond the laboratory and metrology.

Figure 5 shows the importance of income and resources produced by universities and PRI's for the innovation activities of firms in the region. The results observed that the contributions of PRI's and universities represent a greater degree of importance were: the search results stand for 0.77 and the new techniques and instruments for of 0.68.

Laboratories already had an important indicator of intermediate index of 0.56, as well as the results of prototypes with 0.51.

Thus, the data reinforce the importance of universities and the complementary role and substitute the search for the R & D in the industry because some firms doing R & D links with universities do not have research labs, or have a department to use the structure of universities to support their activities.

FIGURE 5 - IMPORTANCE OF RESULTS OF RPI's AND UNIVERSITIES FOR FIRMS



Source: Field Survey.

5.4. Reasons for Collaboration

When assessing the reasons why the firms collaborate with universities and / or PRIs, it is observed, as shown in Figure 6, the main reason given, regarding to improvements in the ability of the firm, the indicator of perceived importance was 0,63, while seeking advice from a technological nature and hire additional research appear equally important indicator, that is 0.55, ie, an intermediate level of importance. On the other hand, testing products and processes required for and receive help in quality control were factors that were less important, as an indicator of 0.17 for both. This demonstrates the autonomy of enterprises, as these elements in relation to the institutions analyzed.

FIGURE 6 - REASONS FOR COOPERATION WITH UNIVERSITIES AND/OR PT'S ACCORDING TO DEGREE OF IMPORTANCE



Source: Field Survey.

6. Concluding Remarks

This article tried to analyse the patterns of interaction between universities and public research institutes (PRI's) with firms in the North region of Brazil, seeking to understand the role played by the university leading the innovation process.

Preliminary results of the study indicate that in the North, the interaction between universities and PRI's with firms has an important role in that firms that do not perform activities of Research and Development (R & D) internally. However it is difficult to absorb the scientific knowledge produced by universities and PRI's . This fact is highlighted in the responses from firms that link the research commissioned by them to the institutions analysed together, as one of the sources of information most relevant to the innovation activities of firms

This result can be considered a plus, despite the small number of firms doing R & D in the region. The innovative efforts of firms, in part, arise from the interaction with universities and PRI's, suggesting that these institutions are quite important in that complement and even replace the innovative activities of firms. However, many of these collaborations do not result from formal but informal contacts, between the agents and

the efforts of some sectors to approach the university. These are also the most competitive sectors, since the results showed that some areas of scientific knowledge, such as Electrical Engineering, Computer Science and Mining Engineering, are more relevant to the productive sector of the region. What should be the productive dynamics of the two most important states economically, ie Para and Amazonas. At first, the activities that prevail such as production and distribution of electrical power and extraction of ore and second in the activity of the electronics of the Manaus Industrial District. On the other hand, is notoriously low participation of targeted areas for biotechnology in the region, even the latter comprising the majority of the Brazilian Amazon, which in turn comprises the biome with the greatest biodiversity in the country and one of the largest in the world. This fact requires a greater effort from the public sphere in order to induce productive activities aimed at these sectors.

In this respect, the challenge is to understand the important role of universities and for the PRI's regional innovation system, incorporating it as the basis of the strategies and sector policies, aimed at promoting the sustainable development of the Amazon region. The challenge for institutions and firms is to recognize themselves as part of the system and promote the adequate mechanisms and tools for implementation of sector policies.

In terms of building the system of innovation in the region, the problem lies on the one hand, the limitation of its core businesses, which restricts the spread of the positive effects derived from interaction with universities and PRI's, which is reinforced by the small number of firms carrying out investments in R & D.

On the other hand, it is necessary to strengthen the role of universities and public research institutes. The survey showed that the scientific infrastructure is below a threshold that indicates the scope of the knowledge necessary to increase the efficiency of science and technology interaction. The growth of scientific infrastructure is necessary for those institutions able to meet the demand that will grow as more firms involved in innovation are installing in region, which will also result in increased demand for professionals trained in the region. This challenge is evident through the low index showing the index of C & IT in the North, in particular, Government Spending Per Capita, Percentage of Expenditures on S & T Education Youth rate; Number of researchers per million inhabitants. It requires effort, especially the state and Federal governments to encourage those investments in the region.

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