Transnational Corporations Review Volume 6 Number 1 March 2014
www.tnc-online.net info@tnc-online.net 71-85

University-Enterprise Partnerships in the Brazilian Amazon: Obstacles, Dilemmas and Challenges[1]

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Abstract: Universities can play a vital role in making their regions more innovative and globally competitive, contributing then to the development of their regions. Although there are many ways to promote regional development, a key factor is the partnership between universities and private firms, which can generate economic growth and also enhance the competitiveness of the regions where they operate. This paper analyzes the partnership between universities and private enterprises in the Amazon, a peripheral region located in northern Brazil. The data collected from fieldwork show how difficult is the absorption of knowledge produced by universities, whose role in the region must be strengthened in order to promote the expected socioeconomic changes.

Keywords: University-enterprise partnership, innovation, Brazilian Amazon, regional development, national system of innovation

1. Introduction

The economic literature has pointed out that the regional dimension of innovation is essential for promoting not only economic growth, but also competitiveness. There is no doubt that Silicon Valley is something unattainable or even undesirable – given the regional peculiarities – for many regions. Nevertheless, all regions can improve their ability to adapt the knowledge generated locally for their regional innovation needs. Because of the knowledge of their regions, of the understanding of their surrounding environment and, principally, of their remarkable ability to interact with local stakeholders – particularly enterprises – universities can play a key role in making their regions more innovative and globally competitive and, consequently, contribute to regional development.

Brazil has experienced substantial economic growth and modernization since the World War II, reaffirming its place as the largest and most powerful economy in South America. This profound and rapid socioeconomic transformation undergone by the Brazilian economy was driven by an intense process of globalization that offers new opportunities and, at the same time, demands further investment (mainly from enterprises), improvement in the environment, a more skilled workforce, a reorganization of production as well as labour, and so on. Brazilian universities were not immune to these deep changes. In

[1] This research was funded by the Brazilian agency CNPq as well as the Canadian agency IDRC. The views expressed here are those of the authors and do not reflect those of either agency.

order to meet the real interests of their regions, many universities were forced to review their traditional culture and practices, forging a new structure that is now shaped by the ideals of quality and efficiency.

Amid these changes and within a scenario of world economic crisis, regions continue to seek a better way to foster their development and some of them are doing well, while others are less successful and have poor links with the sources of prosperity. Despite Brazil's economic growth, considerable social and regional inequalities persist, in which the North is its poorest region, presenting a sharp contrast to the Southeast Region, which is considered the most dynamic economic engine in Brazil. Indeed, the Northern region's share of Brazilian GDP is low (about 5.3% in 2010) and its social indicators are below the national average, even though this region has a tremendous potential insofar as it is the country's largest region – covering roughly 60% of the national territory (it comprises Amazonia with its extraordinary biodiversity and natural wealth) – it has presented growth rates higher than Brazil's over the last three decades, and has important universities and research institutions.

If the Amazon region has the ability to become developed, one important question lies unanswered: Why does this region remain peripheral? Although there are several possible approaches to explain the economic backwardness of the Amazon region, this article aims at answering it in light of the interaction between universities and enterprises in that region. In fact, universities have a potentially pivotal role to play in knowledge production, which can be transformed, for instance, into innovative products. By analyzing the connection between universities and enterprises in Amazonia, it will be possible not only to shed light on a crucial issue that is so little explored in Brazil, but also to understand the role of universities in Amazonian development. In this sense, this article is structured as follows: The first section presents two important approaches related to the systemic nature of innovation: the national systems of innovation (NSI) and the regional innovation systems (RIS), which are used here as an analytical framework. In the second section, the discussion focuses on the role of universities in regional development. Based on data collected from fieldwork, the third section analyzes the interaction between universities and enterprises in the Amazon region.

2. Innovation and regions

Schumpeter can be considered a pioneer in the economic analysis of innovation. In fact, his original and inspiring analysis focused on the role of innovation in economic development, which was conceived as a process of qualitative social and economic change, driven by innovation, coming into existence in historical time. Although it is beyond the scope of this paper to make a discussion about Schumpeter's work, it is important to stress here three interconnected points: (a) the main features of economic development, in his view, were the actions of entrepreneurs, who mobilized those necessary financial resources for obtaining the existing factors of production in order to combine them in new ways, these new combinations being responsible for innovations, which are embedded in new production methods, products, markets and industrial organizations (Schumpeter, 1982); (b) the importance of entrepreneurship to successful innovation relied on the fact that entrepreneurs, due to their dynamism, were the only class capable to overcome the apathy, immobility and even resistance to new experiences seen in all societies with the purpose of achieving their goals; and (c) innovation is attributable to individual entrepreneurs and also to large firms, whose importance deserved Schumpeter's attention in his later works (Fargerberg, 2003).

Following Schumpeter's legacy, several researches on innovation, based on a microeconomic approach, were undertaken, the common denominator being the fact that firms almost never innovated in isolation. On the contrary, innovations were a direct result of an intense and deliberate process of interaction and interdependence between firms and other institutions (such as universities, government bodies, other firms, research institutions and so on). In addition, these institutions are shaped by national and regional contexts in which norms, laws, and rules affect their behaviour and also determine innovations insofar as they can be an incentive or even an obstacle to the innovation process. In summary, innovations became analyzed in a wider theoretical framework, i.e. in a systemic approach. The reason for this lies in the fact that they come up in a "system of innovation" which encompasses a set of different institutions that are responsible for the creation and commercialization of knowledge.

The concept of "national system of innovation" (NSI) has its roots in the beginning of the 1980s, when Christopher Freeman wrote a draft paper for the OECD expert team on Science, Technology and Competitiveness. However, the term was first used (in a published form) by Freeman in his 1987 book, now a classic, "Technology Policy and Economic Performance: Lessons from Japan", which showed a clear correlation between economic growth and technological innovation. During the 1990s, two important theoretical and empirical researches on NSI were Lundvall (1992) and Nelson (1993), who employed the concept of NSI in order to characterize the systemic interdependencies within national economies. However, both of them used distinct approaches to the analysis of NSI. Lundvall aimed at offering a new theoretical perspective and an alternative to the neo-classical economics by emphasizing how important interactive learning and innovation were for the competitiveness of nations in a world increasingly internationalized as well as globalized. In turn, Nelson highlighted empirical case studies revealing not only the complexity, but also the diversity of NSIs. Despite this diversity, there was, in Nelson's words (1993:3), a new spirit of "techno-nationalism" in the air, which meant the combination of "a strong belief that the technological capabilities of a nation's firms are a key source of their competitive prowess, with a belief that these capabilities are in a sense national, and can be built by national action".

This new approach to innovation was the starting point for a vast literature that has sought to analyze, by means of public policies drawn up and implemented at the national level, those institutions and mechanisms responsible for the emergence of innovations. Thus, a broad definition of NSI, provided by Edquist (2006:183), includes "all important economic, social, political, organizational, institutional and other factors that influence the development, diffusion and use of innovation". Over the last twenty years, this literature has not only played an important role – and also proved to be influential among researchers and policy-makers – in describing and understanding phenomena connected with innovation and competence building, but also showed its vitality, a good example being the two recent works by Edquist and Hommen (2008) and by Cassiolato and Vitorino (2009), who use the concept of NSI as their analytical framework. The first book presents case studies of ten small countries in Europe and Asia, whose NSIs show some specificities that shape innovative activities and, at the same time, some similarities; while the Cassiolato and Vitorino's work is directed towards the BRICS countries. With respect to these five countries, their NSIs underwent a deep change. Despite these transformations, all these NSIs have common features and striking differences.

It is important to stress here that the concept of the learning economy is derived from studies of NSI. In fact, to better understand the role of the latter, it was crucial to capture the real meaning of knowledge and learning as well as the way in which they interacted with economic development. The deep changes,

whose main characteristics were an intense globalization process, information technology and deregulation of markets, which the world economy was undergoing had impacts on national economies, which reacted in different ways insofar as they had distinct capabilities not only to innovate, but also to deal with transformation. Marked by the rapid obsolescence of knowledge and skills, these changes – with major implications for economic development strategies and territorial governance – were a clear signal, according to Lundvall (1992; Lundvall and Johnson, 1994), that the world was moving towards a "learning economy", where the success of individuals, firms, regions and countries, more than anything else, reflects their capability to learn and also to forget old practices.

Another important approach related to the innovation systems framework is the Regional Innovation System (RIS), which was inspired by the NSI concept and based on a similar rationale that emphasizes territorially-based innovation systems. Since the mid-1990s, the literature on RIS has been principally developed by Philip Cooke, who has a widely understood definition of RIS: It “consists of interacting knowledge generation and exploitation sub-systems linked to global, national and other regional systems for commercializing new knowledge” (Cooke, 2009: 3). A crucial point raised by Asheim and Gertler (2006) is that the geographical configuration of economic actors (firms, workers, associations, organizations, and government agencies) is fundamentally important in shaping the innovative capabilities of firms and industries.

There is plenty of empirical evidence pointing out that innovation is the major driver of economic growth, contributing to an increase in productivity as well as in living standards. Within this context, regions are perceived as relevant actors insofar as they can meet their own and national development goals by supporting innovation. Despite this fruitful combination between regions and innovation, it is important to recognize and accept the diversity of RIS – both within and between countries – which implies the absence of a perfect innovation policy model for all different kinds of region, i.e. "there is no one 'best practice' innovation policy approach which can be applied to any type of region" (Tötdling and Trippl, 2005:1204). The OECD countries provide useful examples that reinforce the diversity of RIS as well as the importance of a differentiated regional approach. In fact, approximately 13% of OECD regions are responsible for 50% of total OECD R&D investment, in which patents and R&D are most concentrated on the leading regions of those knowledge-intensive OECD countries. However, there are emerging regions that are not driven by S&T (Science and Technology) and whose main focus of attention is directed towards non-technological innovations (for example, a new business model), talent and creativity. These industries are influenced by the regions where they are located and are very important for regional competitiveness (OECD, 2011).

A new regional development approach has recently emerged in Europe: The smart specialization strategy, whose implementation to the European regional context largely reflects a RIS logic (McCann and Ortega-Argilés, 2011). The concept of smart specialization was first published by Foray, David and Hall in 2009, in a paper elaborated for the ‘Knowledge for Growth’ team, an independent advisory group to the European Commissioner for Research and Innovation, and since then it has become even more important in European circles. Indeed, smart specialization will have a determining role to play in research and innovation investments insofar as it will be a precondition for using the European Regional Development Fund during 2014-2020 (European Commission, 2011).

According to McCann and Ortega-Argilés (2011: 3), smart specialization envisages that "the identification of the knowledge-intensive areas for potential growth and development are related to the role of certain classes of players (researchers, suppliers, manufacturers and service providers, entrepreneurs and users) and to the public research and industry science links. The players are regarded as being the agents who use their knowledge-acquisition facilities and resources (human capital, ideas, academic and research collaborations) to scan the available local economic and market opportunities, to identify technological and market niches for exploitation, and thereby act as the catalysts for driving the emerging transformation of the economy".

3. The role of universities in regional development

There is a wide recognition that universities have always contributed to the development of nations. However, it is relatively recent the concern with their contribution to the development of the regions where they are located (OECD 1999, 2007; Goddard 1998, 2005; Atkins, Dersley and Tomlin, 1999; Goddard and Puukka, 2008; Goddard, Robertson and Vallance, 2012). This concern stems from pressures of a world economy increasingly globalized in which the regional/local environment is as important as the national macroeconomic situation in determining the ability of firms to compete in a global economy (OECD, 2007). Within this context, the regional/local availability of knowledge and capabilities shall have the same degree of importance as physical infrastructure, which can make the universities regionally engaged a key element in the process of regional development.

Following the above theoretical framework, universities can play a pivotal role in the process of regional development, which goes beyond the traditional missions of meeting the country's labour market demands for skilled manpower and also of providing capacity to meet national research and technological development needs. Indeed, universities might become the main disseminators of economic growth in their regions insofar as they produce knowledge – an essential asset for innovation – that can be transferred to firms through partnerships as well as the creation of new ones. These firms will be able to commercialize the knowledge produced and have great potential to generate spin-offs in the regional economy.

If the learning economy is intrinsically associated with the ability to learn of all economic agents, in which learning not only encompasses competence building and a wide access to information, but also permeates all segments of society, and contributes considerably to the job creation in knowledge-intensive sectors, the learning region is highly dependant on network knowledge, which is related to the skills of individuals as well as the knowledge transfer among groups. In fact, the linkage and, principally, the synergy between public and private institutions are central elements in this network or learning system for promoting regional innovation. However, as Morgan (1997: 501) highlighted wisely, "learning, of course, is worth little if there are no opportunities to implement what has been learned". In this regard, regional economies should create and encourage market-oriented universities, which will have a closer interaction with the rest of society and, as a consequence, will have much more to offer to their own regions.

Universities have been perceived as a necessary and valuable asset of the regions, and their active engagement in the regions where they are located can become a powerful engine of economic regional development, principally in those lagging regions where the private sector is an emic or even limited, with low levels of investment in R&D and in other innovation-related activities. The regional engagement of

universities embraces a wide spectrum of activities, which are related to research (technology transfer and innovation), education (such as lifelong learning and continuing education), and social engagement (public access to cultural activities, voluntary work by staff and students, and so on). These activities involve many constituent parts of universities offered to, or in cooperation with, society at large, compelling universities to interact more closely with their regional environment (OECD, 1999; 2007; Goddard and Puukka, 2008).

This understanding that universities play an important role in the "knowledge-based" economies, which is strongly recognized by economic literature (Mowery and Sampat, 2006), was apparently maintained by the European Union (EU) in its new regional development approach. Based on the concept of the smart specialization strategies, several documents were produced by research teams for the EU as part of the Europe 2020 strategy, and all of them highlight the importance of universities for regional growth. In of these documents, Foray et al. (2012:78) underline that there is "a range of mechanisms by which universities can contribute to regional innovation systems. Universities can, for instance, stimulate the entrepreneurial spirit of their staff and students, provide advice and services to SMEs, and participate in schemes promoting the training and placement of high level graduates in innovative businesses. They can also host incubators for spin-offs in science and technology parks and provide valuable input to innovative clusters and networks. Furthermore, Universities and Businesses should directly cooperate in curricula design and curricula delivery to ensure that graduates have the right skills and transversal competences. By having businesses cooperating with the educational side of Universities, talent attraction and retention would be enhanced in the region".

As already mentioned in the previous section, smart specialization is a development strategy guided towards innovation, whose focus is on a region's main features and competitive potential. In order to encourage regional diversity and, at the same time, avoid wasting European financial resources, it is necessary not only to find out the region's precise competitive advantages, but principally to concentrate all investments in those recognized top priority areas, being essential for this strategy the involvement of all regional players, including universities. The document 'Connecting universities to regional growth: a practical guide', which was commissioned by the EU, explores the ways in which universities can effectively contribute to regional growth and smart specialization. In this sense, Goddard and Kempton (2011:2) stress that universities can "play a key role in defining a regional smart specialization strategy by contributing to a rigorous assessment of the region's knowledge assets, capabilities and competencies, including those embedded in the university's own departments as well as local businesses".

Summing up, universities can do much for the regions where they are located. The academic literature and the emerging body of documents on smart specialization reinforce and even amplify the existing connection between universities and the socioeconomic development of their regions. However, there are several obstacles to making this regional contribution of universities feasible. These obstacles are related to manifold aspects, such as funding sources (difficult economic conditions affect either universities and governments or firms, which would have less capital to invest in innovation); the governance, leadership and management of universities (the limited – or absence of - internal incentives, the lack of flexibility and autonomy, and also the institutional and cultural aversion to changes can constrain their active regional engagement); the distinct logics and perceptions (short vs. long-term) of regional agents (which can lead to a mutual distrust and be a barrier to a close interaction between firms and universities); firms' misinformation on the appropriate expertise within universities; diffuse public policies (wrong incentives

– mainly financial and regulatory – can hamper partnerships and regional innovation processes); and regional structure and governance (local governments often have neither prospective vision nor political project for the region).

Despite those barriers, the literature provides many successful examples (OECD, 1999; 2007). Three main lessons can be drawn from them. Firstly, there is no single way to promote regional development and the diversity of case studies is a concrete illustration; secondly, the regional context matters insofar as some factors – culture, institutions, entrepreneurial capacity, governance, productive structure, funding and regulation of universities – are decisive for regional success; and thirdly, the building of a shared and favourable vision on development potential of their regions, in which universities, firms and local government overcame their mutual distrust and understood not only the challenges to be faced by all of them in favour of regional development, but also their respective missions in this process.

4. Universities and enterprises in Amazonia: reality and expectations

As seen in the previous sections, universities truly matter to the development of their regions and might have an active and decisive role to play in the regional development process. Within all existing key factors in the promotion of regional development, one observes a critical factor at play: The interaction and cooperation between universities and private enterprises. Although intricate to come into existence, the partnership between these important regional actors can promote economic growth and enhance the competitiveness of the regions in which they operate. To fully assimilate possible partnerships, actors must absorb the novelty that may emerge from these interactions. This can be the starting point to understanding the existing gap regarding knowledge and some selected innovation indicators between regions in Brazil. With respect to investments in scholarships and research funding, it can be seen in table 1 the massive concentration of resources in the Southeast region, which accounted for 52.3% of the amount of investment, while the North received only 4.3%, i.e. almost thirteen times less. It should be noted that the South and South eastern regions have almost 70% of all investments in scholarships and research funding.

Table 1. CNPq: Total investments in scholarships and research funding by region, 2000-2009

Region	Investments (R$ Thousand currents)									
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
North	**9.670**	**16.435**	**14.602**	**17.436**	**29.498**	**27.483**	**43.637**	**57.721**	**62.327**	**56.748**
Northeast	60.305	77.009	67.283	71.570	112.936	120.925	132.608	201.236	190.155	195.194
Southeast	256.480	297.909	288.661	331.728	428.060	474.369	502.174	628.756	615.439	688.110
South	72.037	92.345	90.880	101.341	127.120	133.519	140.322	193.875	195.260	214.461
Midwest	28.121	35.093	37.633	37.749	53.098	58.071	57.402	72.685	84.509	100.579
No information	25.814	22.975	32.314	26.245	19.355	14.438	12.994	26.165	38.921	45.741
Subtotal	452.427	541.767	531.373	586.069	770.067	828.136	889.136	1.180.438	1.186.612	1.300.834
Other investments	41.608	39.454	67.299	65.121	24.130	20.465	14.279	11.100	16.963	5.493
Total	**494.034**	**581.221**	**598.672**	**651.190**	**794.197**	**849.270**	**903.415**	**1.191.538**	**1.203.575**	**1.306.328**

Source: Authors' elaboration with data from CNPq/AEI (2011). Obs: It includes financial resources from the *fundos setoriais* program. It does not include financial resources from the *Programa de Interiorização do Trabalho em Saúde* (agreement with the Ministry of Health in force from 2001 to 2004). (1) It includes those MCT (Ministry

of Science and Technology) and CNPq's programs of institutional capacity building, research with no institutional affiliation and Institutions abroad; and (2) resources related to management actions and institutional concessions through agreements.

These regional disparities in Brazillian investments are also reflected in the research groups. In fact, the data in table 2 clearly show the high concentration of the science and technology (S&T) system in both regions, Southeast and South, which in 2008 had more than 72% of the number of research groups in Brazil, while the Northern region had only 4.7% of the number of existing research groups.

Table 2. The percentage distribution of research groups by region, 2000-2008.

Region	2000	2002	2004	2006	2008
Southeast	57,3	51,8	52,4	50,4	48,8
South	19,7	24	23,5	23,6	23,2
Northeast	14,6	15	14,2	15,5	16,9
Midwest	5,4	5,3	5,9	6,1	6,4
North	**3,0**	**3,9**	**4,0**	**4,4**	**4,7**
Brazil	100,0	100,0	100,0	100,0	100,0

Source: authors' elaboration with data from CNPq/AEI (2011).

An important aspect to be stressed here is the fact that these disparities noted nationwide are also seen inside the Northern region, as shown in table 3. In fact, data show clearly that the state of Para, for example, received 50.6% of total financial resources invested in scholarships and research in the Northern regions. The two largest states of this region, Amazonas and Para, absorb 85.6% of the total investments, while Amapa only receives 1%. The amount of money received by Para is over fifty times greater than that of Amapa, which shows the size of the discrepancy within this region.

Table 3. Total investments in scholarships and research funding in the North Region and in its seven states, 2000-2009.

Region	Investments (R$ thousand)									
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
North	**9.670**	**16.435**	**14.602**	**17.436**	**29.498**	**27.483**	**43.637**	**57.721**	**62.327**	**56.748**
Acre	326	590	615	750	881	820	1.246	2.313	1.797	1.315
Amazonas	3.387	5.998	4.388	6.871	10.640	9.998	18.783	20.772	28.528	19.859
Amapá	163	285	228	103	324	207	495	1.527	1.925	570
Pará	5.012	8.384	7.943	8.497	15.325	12.720	17.901	23.582	21.401	28.732
Rondônia	511	614	845	595	1.050	1.397	2.619	4.603	4.536	2.897
Roraima	106	212	314	216	624	535	629	1.194	1.086	1.006
Tocantins	163	351	268	404	653	1.806	1.964	3.730	3.055	2.369

Source: Authors' elaboration with data from CNPq/AEI (2011).

The table below, which contains the number of Ph.D. per region of the country, supports the argument that there is not only a considerable disparity in Brazil, but also a significant disparity within the Northern region. In fact, it is undeniable that there is a high concentration of the Brazilian S&T system in the Southeast and South regions, since these two regions had, in 2008, 53,498 Ph.D. students, a number that is 2.7 times greater than the total of Ph.D. of the other three Brazilian regions. Specifically in relation to the Northern region, it holds only 4.3% of all Ph.D. in the country, while the Southeast region has 57.7%. In

absolute terms, the number of Ph.D. in the Northern region is approximately 13.5 times lower than the Southeast. Moreover, the two richest regions of Brazil, in economic terms, South and Southeast, have 80% of all Ph.D. in the country, which is a very good example of the existing disparity in Brazil.

Table 4. Number of PhD and resident population in Northern States and Brazilian regions, 2000-2008.

Region/ State	PhD (1)					Resident Population (thousand) (2)					N° of PhD per 100 thousands inhabitants	
	census 2000	census 2002	census 2004	census 2006	census 2008	2000	2002	2004	2006	2008	2000	2008
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(a)/(f)	(e)/(j)
North	**705**	**1.152**	**1.721**	**2.313**	**2.863**	**13.014**	**13.597**	**14.155**	**14.673**	**15.143**	**5,4**	**18,9**
Acre	33	43	66	117	141	572	601	630	656	680	**5,8**	20,7
Amazonas	270	433	652	863	1.068	2.828	2.969	3.103	3.228	3.341	**9,5**	32,0
Amapá	3	7	12	40	65	481	517	552	584	613	**0,6**	10,6
Pará	339	543	733	943	1.102	6.246	6.541	6.823	7.084	7.321	**5,4**	15,1
Rondônia	34	32	78	107	124	1.392	1.420	1.446	1.471	1.494	**2,4**	8,3
Roraima	n.i.	74	79	106	166	327	351	373	394	413	**n.i**	40,2
Tocantins	30	55	151	194	291	1.167	1.198	1.228	1.255	1.281	**2,6**	22,7
Northeast	**3.705**	**5.168**	**7.294**	**9.380**	**11.625**	**48.154**	**49.507**	**50.799**	**51.999**	**53.088**	**7,7**	**21,9**
Southeast	**17.354**	**20.540**	**28.837**	**33.900**	**38.558**	**73.046**	**75.003**	**76.874**	**78.611**	**80.188**	**23,8**	**48,1**
South	**5.034**	**7.165**	**10.312**	**12.711**	**14.931**	**25.327**	**25.922**	**26.491**	**27.019**	**27.498**	**19,9**	**54,3**
Midwest	**1.873**	**2.404**	**3.632**	**4.339**	**5.379**	**11.739**	**12.275**	**12.788**	**13.264**	**13.696**	**16,0**	**39,3**
TOTAL	**27.662**	**34.349**	**47.971**	**57.586**	**66.785**	**171.280**	**176.304**	**181.106**	**185.564**	**189.613**	**16,2**	**35,2**

Source: authors' elaboration with data from CNPq/AEI (2011).
OBS: (1) Source: Directory of research groups in Brazil – number of N° de Ph.D. researchers registered in the censuses of the directory, without double counting; (2) Source: IBGE.

This same logic is repeated in the Northern region insofar as both states, Para and Amazonas, for example, have respectively 38.5% and 37.3% of all Ph.D. in the region, while Amapa has only 2, 3% of the universe. The two largest states in the Northern region – Para and Amazonas – have 75.8% of all existing Ph.D. living in the region, while the other five states have less than 25%. This disparity can also be seen when there is an association of the number of Ph.D. with the resident population in those regions because the North has insignificant numbers compared to the Brazilian richest regions.

It is important to take into consideration the relationship between the total amount of financial resources invested in the region and the number of Ph.D. living in that region. Although the volume of investments in different regions of Brazil is in line with the "logic " mentioned above – the amount of money invested, for example, in 2008, in the Northern region is about ten times less than the amount for the Southeast region, which accounted for 53.6% of total funds invested in scholarships and research funds in that year - there is a visible effort made by the Brazilian government to tackle the problem of regional disparities (see Table 5). In fact, the data below show clearly that investment per Ph.D. in the Northern region not only increased over time, but also became, principally after 2004, higher than other Brazilian regions, especially the Southeast, which is undoubtedly the most vibrant region of the country in socioeconomic terms.

Table 5. CNPq: Total investments in scholarships and research funding by the number of Ph.D. by region, 2002-2008.

Region					Ph.D.				Investment by Ph.D./year			
	2002	2004	2006	2008	2002	2004	2006	2008				
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(a)/(e)	(b)/(f)	(c)/(g)	(d)/(h)
North	**14.602**	**29.498**	**43.637**	**62.327**	**1.152**	**1.721**	**2.313**	**2.863**	**12,7**	**17,1**	**18,9**	**21,8**
Northeast	67.283	112.936	132.608	190.155	5.168	7.294	9.380	11.625	13,0	15,5	14,1	16,4
Midwest	37.633	53.098	57.402	84.509	2.404	3.632	4.339	5.379	15,7	14,6	13,2	15,7
South	90.880	127.120	140.322	195.260	7.165	10.312	12.711	14.931	12,7	12,3	11,0	13,1
Southeast	288.661	428.060	502.174	615.439	20.540	28.837	33.900	38.558	14,1	14,8	14,8	16,0
Total	499.059	750.712	876.143	1.147.690	36.429	51.796	62.643	73.356	13,7	14,5	14,0	15,6

Source: authors' elaboration with data from tables 2 and 5.

These observations are important for producing a more realistic picture of a situation in which there are visible signs of efforts that have been made by the federal government with the purpose of trying to reduce regional disparities. However, these observations do not diminish those disparities at all. In this regard, the data displayed here stress not only the high concentration of the Brazilian system of S&T in the Southeast and South regions, but also significant differences among states in the Northern region.

Despite these advances, several problems have emerged and left without an adequate response, and two of them deserve special mention: 1) lack of shared actions between universities, enterprises and the state. – this partnership is common in developed economies – and 2) the tiny participation of the private sector in the financing and implementation process of innovations. It was precisely due to the perception of these problems that the federal government conceived in 1999, the *Fundos Setoriais de Ciência e Tecnologia Program* (the Sectoral Funds for Science and Technology Program), which provides instruments for financing research projects, development and innovation in Brazil. It is important to highlight not only the intention of establishing a pattern of long-term financing, but also to stimulate greater participation and joint action of enterprises with universities and public institutions. By knowing the investments and efforts made, it is possible to understand not only the level of interaction between enterprises and universities, but also the role played by them, as already discussed, in the development of their regions.

The table below, based on an official survey, shows a clear picture regarding innovative firms in Brazil. In this sense, only 38% of Brazilian firms can be considered innovative, 4,2% perform some R&D, and a meagre 3% do this continuously. It is interesting to note that the Northern Region has some similarities with the national context, i.e. approximately 36% of firms are considered innovative, 2.5% perform R&D activities, and a little bit more than 2% do it in a regular basis. The main point here is that knowledge spillovers are difficult to occur in such a low density network. In addition, if the absence of a continuous urban network and the considerable distance between the three industrial districts and the Region are taken into consideration, traditional spillover effects can be inexistent.

Within those firms that consider university an important source of information, the fieldwork explored those with an effective kind of collaboration with university groups. Thus, a primary data collection survey was conducted in order to collect firms' perception of the advantages of establishing partnerships with universities, which can be presented only as a reference case study because of a few numbers of

Table 6. Firms that implemented innovations, by degree of importance of sources of information and those that have R&D expenditure by State and Region, 2006 -2008

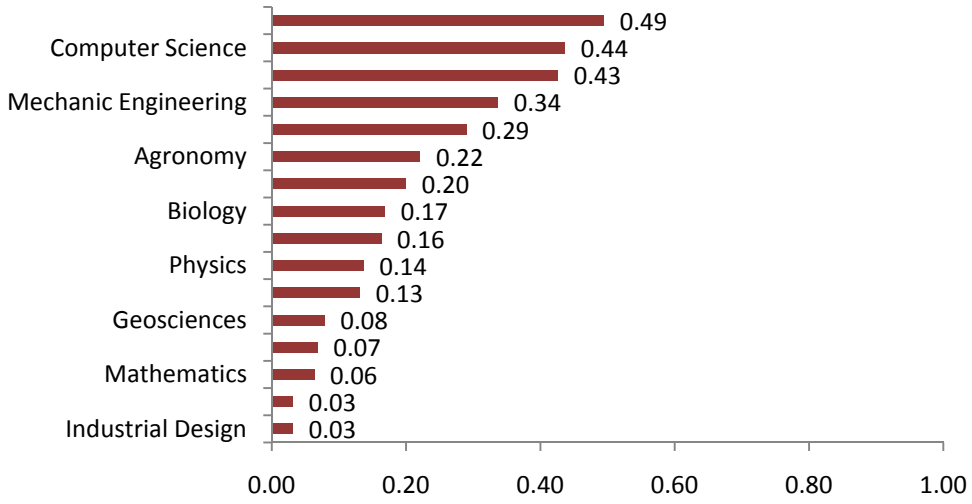
Regions	Extractive, Mining and Industrial Firms	Innovative Firms	Innovative firms which indicate universities has important information sources	Firms that perform R&D	Firms that perform continuous R&D
North	**3 463**	**1 239**	**111**	**85**	**73**
Amazonas	737	449	45	33	26
Pará	1 581	433	59	12	7
Northeast	**10 699**	**3 618**	**425**	**277**	**124**
Ceará	2 085	840	89	25	23
Pernambuco	2 312	729	97	150	15
Bahia	2 967	1 083	102	52	46
Midwest	**5 784**	**2 310**	**506**	**233**	**193**
Goiás	3 301	1 261	350	199	158
Southeast	**54 418**	**20 253**	**2.407**	**2.483**	**1.815**
Minas Gerais	12 578	5 208	608	376	238
Espírito Santo	2 673	953	62	9	9
Rio de Janeiro	5 205	1 713	118	298	204
São Paulo	33 962	12 379	1.620	1.800	1.364
South	**26 133**	**10 879**	**1.677**	**1.189**	**814**
Paraná	8 534	3 641	490	336	223
Santa Catarina	8 472	3 209	473	407	286
Rio G. do Sul	9 127	4 029	714	446	305
Brazil	**100 496**	**38 299**	**5.127**	**4.268**	**3.019**

Source: PINTEC/IBGE

responses obtained. The departure point was the CNPq's database, which provides useful information on the various research groups belonging to universities, 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 effective interactions with universities in the seven states of the Northern region. Of this total, 19 firms responded to the questionnaire providing information about the interaction with universities. Most of these firms are located in the states of Para and Amazonas with 7 and 6 firms respectively or approximately70% of the total. In Amapa, three firms responded to the questionnaire, two firms in Rondonia and Roraima only one. Tocantins and Acre were the only two states that do not register any interaction between firms and research groups.

The qualitative answers were weighted by orders of importance with the purpose of summing them in an index from zero to one, where closer to one gives the highest degree of perceived importance by each firm. Figure 1 shows the knowledge areas perceived as most important for the firms in the Northern region, which were electrical engineering, which has moderate level of importance with an indicator of 0.49; computer science, with an indicator of 0.44; and mining engineering with an indicator of 0.43. It is necessary to stress here that the Northern region is an important location of mining and hydroelectric power activities. On the opposite side, the less relevant disciplines according to the firms were industrial design, medicine and mathematics.

Figure 1. Firm's perceived importance of knowledge areas

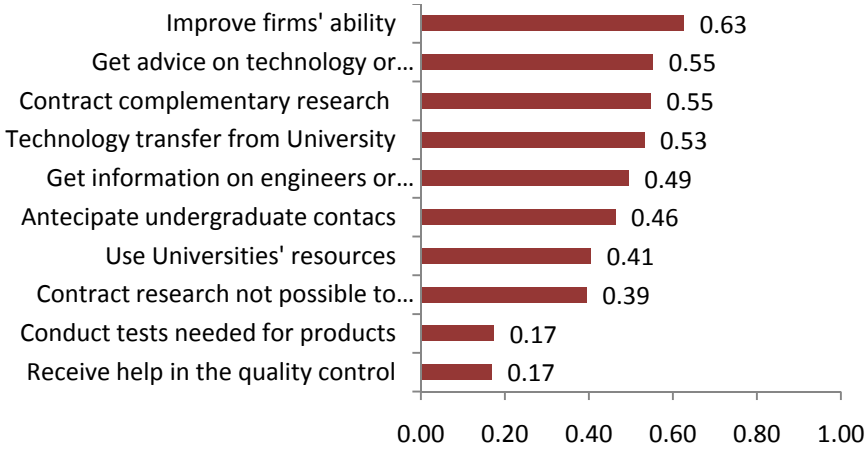


Source: Field survey.

All these results point out that the most dynamic areas of industrial production determine the perception of importance of these same areas of knowledge within universities. Despite being a traditional mining and energy producer, the Northern region is becoming an important cattle and soya exporter, but without industrial processing and this is reflected in the low perception of the importance of food technologies by surveyed firms.

When assessing the reasons for which firms collaborate with universities, answers reflected the expectations of the improvements of a firm's competiveness. The indicator of perceived importance of a firm's ability to improve was 0.63, while seeking advice from a technological nature and hiring additional research appear equally important with indicators of 0.55, i.e. an intermediate level of importance. On the other hand, some other practical tasks, like testing products and processes required for quality control were factors that were less important, with indicators of 0.17 for both (see figure 2).

Figure 2. Perceived importance in collaborating with universities



Source: Field survey.

It is necessary to make some inferences about the low participation of firms and their relatively weak links with university research groups. The first one is that to be a factor that influences regional development, the relationship between universities and enterprises has a long way to go, especially in the Northern region. Another one is that advantages of being in contact with possible breakthrough knowledge produced in universities were not mentioned, which means a relatively conservative positioning from the enterprises side. Thus, traditionally more competitive areas show a higher degree of integration, like mining and electricity. Because of its locational determinants, these activities were performed in isolated areas that contributed not only to the rise in their municipality's GDP, but also to a pronounced increase in the population of their own municipalities. In addition, these strongest areas are in connection with university campus where they were created. However, inequalities are also among the highest and the unplanned urban sprawl causes serious problems regarding basic urban services like sanitation, health and education. On the other hand, the same actors, which are responsible for other high exporting products (cattle and timber), do not seem to see university as a partner and instead of developing local technology to add-value to their products, they rather invest in logistics to export them at competitive, but lower, prices. Regarding innovation and paths to the development, the secondary and primary data collection presents a clear perspective of the existing gap within Brazilian regions and also demonstrates that there is a long road ahead, especially in the Northern region.

5. Concluding remarks

A growing body of literature has underlined that universities can play a crucial role in the development of their regions insofar as they can continuously fulfill their traditional missions – prepare skilled manpower for the labour market and provide capacity to meet the country's technological needs – and fundamentally produce knowledge, which is considered the main innovative engine in a learning economy and that can be transferred to firms spread all over the region. Within this context, a key factor in the promotion of economic growth as well as regional competitiveness is the interaction and cooperation between universities and local private firms. Indeed, the success of many regions around the world relies on the regional capacity building in which the partnership between universities and firms is a concrete and decisive factor.

By looking at the Northern region, the empirical results show – even if theory says that the interaction between universities and firms is essential for regional competiveness (and this is truth especially to those that do not perform R&D activities internally) – that only less than 10% of the innovative firms indicate that universities may be an important source of information. This can be related to the fact that it is difficult to absorb the scientific knowledge produced by universities. However, in case of the Northern region, some areas of scientific knowledge, such as Electrical Engineering, Computer Science and Mining Engineering, are at the same time the most relevant to the region and have more regular contacts with universities. On the other hand, the low participation of biotechnology and research in new materials in the region is noteworthy, even knowing that the Brazilian Amazon is a biome with the greatest biodiversity in the world's tropical areas. It is apparent, principally in the Brazilian Amazon, that a greater effort must be made from the public sphere in order to induce research and productive activities in these sectors. The challenge for institutions and enterprises is to recognize them as part of the system and promote the adequate mechanisms and tools to implement novelties. One of the problems lies on the limitation of its core businesses that incorporate very low technology, which restricts the spread of the positive effects derived from interaction with universities and this is reinforced by the small number of

firms carrying out investments in R&D. In this sense, it is necessary to strengthen the role of universities both at its traditional role of training people and the new ones required of being deeply connected with the social and productive tissue.

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