

Theme 7: Place based innovations

The pharmaceutical system of innovation and the industry-university interaction in the state of Rio de Janeiro, Brazil

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SUMMARY

The state of Rio de Janeiro has the second largest concentration of pharminochemical industries and pharmaceutical laboratories in the country. Besides, there is a large number of research centers and universities that regionally can be important sources of innovation for the development of the sector. The general objective of this article is to present the preliminary results of the analysis about the pharmaceutical system of innovation of the region, considering the existing strengths, weaknesses and challenges for its development, with a special emphasis on the creation of partnerships between industry and university. The results point out that, in spite of the State's potentiality in the production of knowledge in the area and human resources formation, the pharmaceutical industry of Rio de Janeiro has been presenting a negative growth since the mid-1990's, with a fall in the number of units, number of formal employment and physical production. The State's government has been trying to change this negative situation but the actions taken are still too incipient, especially concerning the industry-university partnership.

INTRODUCTION

The regional system of innovation approach enables a deeper understanding of the process of innovation in one region. It helps to identify the main actors involved in the learning process to generate innovations and the obstacles that need to be solved by local institutions. Lundvall *et al.* (2002) have said the regional approach is complementary to the national system of innovation approach.

Cooke *et al.* (1997) offer an evaluation of the regional innovation systems under two perspectives: one which emphasizes the issue concerning the importance of regional policies to ensure regional autonomy and the other one from the standpoint of the systemic potential,

such as the strengthening of industry-university interaction. This article is focused on these two perspectives. In order to complement this approach, Fauré and Hasenclever (2007) remind us on the importance of the location on industry development, but emphasize that local development is also a “result of the intervention of supralocal factors” (p.15), and this should be understood as a multiple scale phenomenon. Based on this view, an analysis about the pharmaceutical sector development is presented in the state of Rio de Janeiro during the last 15 years, as well as the new government strategies for its fostering.

After becoming the pioneer state in the Brazilian industrialization process, Rio de Janeiro went through approximately five decades of successive events – the transfer of the capital to Brasilia, the unfortunate merger of the state of Guanabara with the state of Rio de Janeiro, the premature end of industrialization, the migration of publicity agencies and financing area to São Paulo, as well as the negative impacts of privatization on the local work market – which led the State to lose importance in the national scenario and the industrial leadership position to the state of São Paulo (Fauré and Hasenclever, 2005; Lessa, 2000).

Data on the economic growth of the state of Rio de Janeiro demonstrate that this was more moderate than the national average over the last years. The State GDP grew at an annual average of 2%, while at a national level the annual average growth was of 3%, between 1996 and 2008. The transformation industry, for example, accumulated a decrease of 15.4% during the period of 1996 to 2008, while at a national level the transformation industry accumulated an increase of 28.3%. On the other hand, the extractive industry of the state of Rio de Janeiro presented an extraordinary result, with an accumulated growth of 173%, above the national growth, which was 77%. The high level of growth refers mainly to the expansion of the oil and iron ore extraction activity. In 1966, the extractive industry was responsible for 1.5% of the total industrial production. In 2008, this number increased to 15.4%. But the transformation industry maintained its participation in almost 10% of State GDP. Even in the

transformation industry, the emphasis fell on the production of coking coal and oil refining, representing 5% of the gross value of production of the total industrial sector, in 1996, moving to 8% in 2007. Therefore, it can be observed that the state of Rio de Janeiro went through an important structural change process, with a prevalence of the services rendering activities (including trade) and extractive industrial production, representing together 80% of State GDP. This emphasis on the extractive industry calls the attention to the State's industry, which is becoming specialized in oil and mineral extraction, while other industrial sectors are drastically reducing their production, as was the case of the pharmaceutical industry, whose gross value of industrial production has accumulated a decrease of 42% (Hasenclever *et al.*, 2012).

The reduction in the transformation industry activities in the state of Rio de Janeiro and the changes occurring in the national context in the beginning of the 1990's, with a strong impact over the chemical-pharmaceutical sector (Paranhos, 2012) led to a reduction of the sector in the State. It is important to mention that the absence of specific local policies to foster the pharmaceutical sector, which only began by the end of the 1990's in a specific and timid manner, helped to reinforce the negative scenario. Nevertheless, the pharmaceutical industry follows the general industrial trend, concentrating itself in terms of local units and employment volumes especially in the Southeast region, and more specifically, in the states of São Paulo and Rio de Janeiro (Selan, Kannebley Jr. and Porto, 2007).

In 2010, the state of Rio de Janeiro's economy begins to show signs of recuperation triggered by new oil findings. The actions endeavored by the state government to reduce violence and improve the image of the state in the country and in the world have also contributed to attract new investments, including the Olympic Games of 2016 (Hasenclever *et al.*, 2012; Urani and Giambiagi, 2011). Thus, under the standpoint of regional development approach, it is relevant at this point to identify the sectors with an important participation in

the national scenario and that are also representative in the State – being the pharmaceutical sector one of them – to improve the capacity installed and the industry-university interaction, as well as to develop the regional system of innovation.

The article is divided into four sections, besides this introduction and the conclusion. In the first section the research methodology is presented. In the second section, the secondary data relating to the scientific capacity and human resources formation are analyzed, as well as the data on the institutions, employment and physical production of the pharmaceutical sector in the state of Rio de Janeiro. In the third section, past and present state government's actions for the development of the pharmaceutical sector are listed. And, finally, in the fourth section, the field research reports about industry-university partnership are analyzed.

I - METHODOLOGY

The general objective of the article is to analyze the behavior of the pharmaceutical system of innovation of the state of Rio de Janeiro in the last 15 years, by evaluating its strengths, weaknesses and the challenges that exist for its development. Besides, it is expected that the actions of the actors involved in this endeavor to develop the sector and generate innovations, especially through industry-university interaction, can be discussed. This is a way to emphasize the advantages that exist in the state of Rio de Janeiro, capable of keeping the local actors in the State, what are the disadvantages faced by these actors and what are the challenges that the state government must face to reduce the disadvantages, to increase the advantages and to promote the return of the sector's growth and development in the State.

This article presents the results of the two research projects financed by the *Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro* (Foundation for the Support of Research of the State of Rio de Janeiro) – *FAPERJ*, through the public announcement 'The Scientist of

Our State' (Hasenclever, 2012) and Support to Research (Paranhos, 2011), being this last one still in progress. In this respect, the information contained connects the industry-university interaction results of the first Project to the preliminary results of the second one.

The methodology utilized was a case study developed and resulting from the revision of literature on regional development and the systems of innovation (Cooke *et al.*, 1997); Lundvall *et al.*, 2002, Fauré and Hasenclever, 2005 and 2007) on the national pharmaceutical sector (Bermudez *et al.*, 2000; Buss *et al.*, 2008; Hasenclever, 2002; Paranhos, 2012) and on the development of the state of Rio de Janeiro (Hasenclever *et al.*, 2012; Lessa, 2000; Urani and Giambiagi, 2011). An analysis of the secondary data was also made (Annual Register of Social Information of the Ministry of Labor and Employment – RAIS/MTE; Monthly Industrial Physical Production Research of the Brazilian Institute of Geography and Statistics – PIM-PF/IBGE), and field research to obtain primary data.

In the field research (carried out for the two above mentioned projects), interviews were conducted with 23 important actors of the pharmaceutical sector in the State between 2008 and 2012, within a broader research at a national level. Among the interviewees there are public and private national industries, multinational industries, state and federal government institutions (development and regulation agencies, and policy makers), researchers and innovation agencies from universities and research institutes, industrial associations and actors linked to the sector. In this respect, the results obtained are a compilation of the main factors identified by the actors of the sector itself. The interviews were conducted in their presence, based on forms containing both open and confidential questions. In order to guarantee the interviewee's anonymity and that of the institution in the description of interviews, the identification is made through codes according to Table 1. Since the project is in progress, other interviews are still being conducted, but their results have not been included in this article.

Table 1: Codes of interviewees in field research

Interviewees	Code
National pharmaceutical industries	NPI
Multinational pharmaceutical industries	MPI
Official public laboratories	OPL
Industries of pharmaceutical products	IPP
National CROs	CRO
Pharmaceutical research industries	PRI
Researchers	RES
Innovation agencies	IAG
Industry incubator	INC
Government institutions	GOV
Other actors linked to the sector	OAS

Source: Field Research, Prepared by GEI/IE/UFRJ.

II - PANORAMA OF THE PHARMACEUTICAL SECTOR IN THE STATE OF RIO DE JANEIRO

The state of Rio de Janeiro is seen in the national scenario as the second state in terms of concentration of industries and employment in the pharmaceutical sector, coming after the state of S. Paulo. The specialization of the state of Rio de Janeiro in the sector is present mainly in the capital, with 50 of the 75 industries manufacturing pharmaceutical products in the state, and 16 of the 23 industries of pharminochemical products (RAIS/MTE, 2010). Other cities with industries in this sector are Campos dos Goytacazes, Duque de Caxias, Guapimirim, Itatiaia, Macaé, Niterói, Nova Iguaçu, Paraíba do Sul, Resende, São Gonçalo, São João de Meriti, Saquarema, Teresópolis, Três Rios, Valença and Volta Redonda.

This characteristic of strong concentration in the capital is a state's mark in its different sectors and activities, as can be observed also by the data concerning scientific and technological institutions (ICTs), which includes universities and research institutes. The state of Rio de Janeiro holds a significant specialization in the knowledge areas related to the pharmaceutical sector, showing a strong scientific and human resources formation capacity, as

presented by Hasenclever (2012). There is a total of 39 public and private ICTs, of which three are state universities (UERJ, UENF and UEZO)¹ and four are federal universities (UFRJ, UFF, UFRRJ, Unirio)². Out of these seven universities, only three are not located in the city of Rio de Janeiro, but in Niterói (UFF), Seropédica (UFRRJ) and Campos dos Goytacazes (UENF). There is a total of 158 undergraduate courses in the great knowledge areas related to the pharmaceutical sector: Biologic Sciences (50%), Biologic Sciences I (7%), Pharmacy (22%), Chemistry (19%) and Industrial Chemistry (2%), according to Table 2 below. This scenario is also considered as very significant by Britto *et al.* (2011).

Table 2: Undergraduate courses in the pharmaceutical sector

Knowledge Área	Number of classroom courses
Biological Sciences	79
Biological Sciences I (*)	11
Pharmacy	35
Chemistry	30
Industrial chemistry	3
Total Courses	158

(*) Biological Sciences I: Biophysics, Marine Biology, Vegetal Biology, Biotechnology, Ecology, Genetics, Microbiology and Immunology, Medical Modality, Zoology, Physics and Chemistry.

Source: MEC, 2012.

Also in terms of graduate courses the State's capacity is maintained (Hasenclever, 2012). In the state there are 10 ICTs, being two state universities (UERJ, UFF, UFRRJ, Unirio), three federal research institutes (Fiocruz, IME, IBRJ)³ and one private university (PUC-RIO)⁴. As far as graduate courses are concerned, the concentration of ICTs repeats itself in the city of Rio de Janeiro, and only the three institutions mentioned above are not

¹ Universidade Estadual do Rio de Janeiro, Universidade Estadual do Norte Fluminense and Universidade Estadual da Zona Oeste.

² Universidade Federal do Rio de Janeiro, Universidade Federal Fluminense, Universidade Federal Rural do Rio de Janeiro, Universidade Federal do Estado do Rio de Janeiro.

³ Fundação Oswaldo Cruz, Instituto Militar de Engenharia, Instituto de Pesquisas Jardim Botânico do Rio de Janeiro.

⁴ Pontifícia Universidade Católica.

located in the capital. In these ICTs, there are 39 master's degree courses, 3 professional master's degree courses and 35 doctorate's degree courses in the knowledge areas related to the pharmaceutical sector, as shown in Table 3. It can be observed that there is a great concentration of courses in the Biologic Sciences I areas, with 33% of the masters' courses and 31% of doctorates' courses, and Biologic Sciences II, with 26% of the masters' courses and 29% of doctorates' courses, besides the 67% of professional masters. In respect of research, the State counts on a total of 307 research groups in Biology (45%), Chemistry (43%) and Medicine (1%), in accordance with the Research Groups Directory of the National Council for Scientific and Technological Development (CNPq, 2010).

Table 3: Graduate courses in the pharmaceutical sector

Characteristics		Number of Graduate Courses		
		Master's	Professional Master's	Doctorate's
Knowledge Área	Biotechnology	2	0	2
	Biological Sciences I (*)	13	0	11
	Biological Sciences II (**)	10	2	10
	Biological Sciences III (***)	4	0	3
	Pharmacy	2	1	1
	Chemistry	8	0	8
Institution	Public	38	3	34
	Private	1	0	1
Total Courses		39	3	35

(*) Biological Sciences I: General Biology, Botanic, Genetics, Biological Oceanography, Zoology.

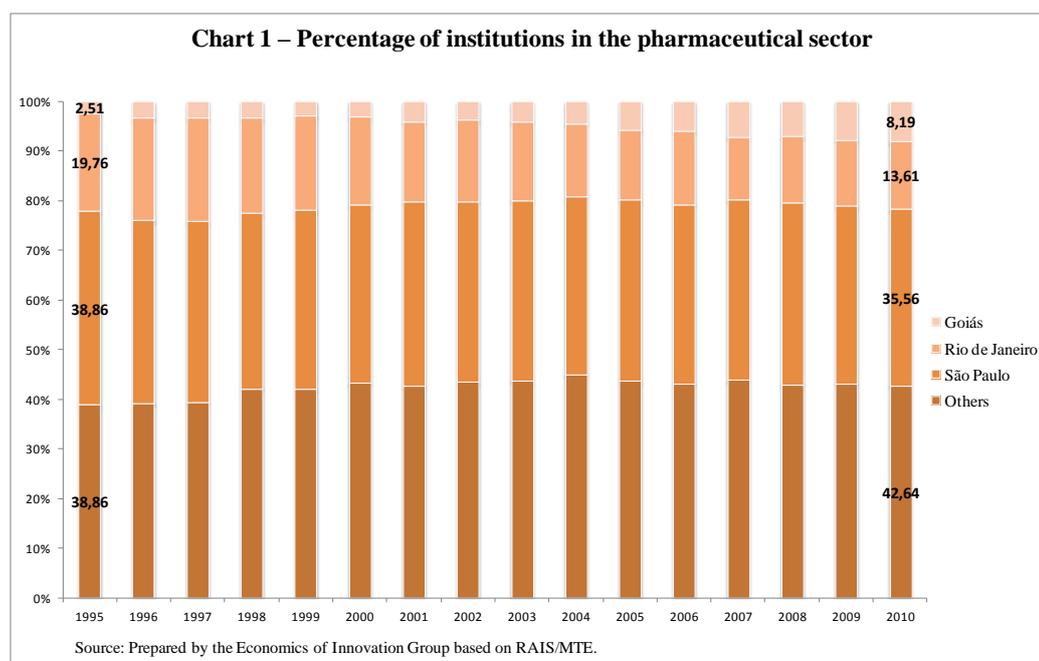
(**) Biological Sciences II: Biophysics, Molecular Biology, Biochemistry, Pharmacology, Physiology, Morphology.

(***) Biological Sciences III: Microbiology, Applied Microbiology, Parasitology.

Source: Capes, 2011.

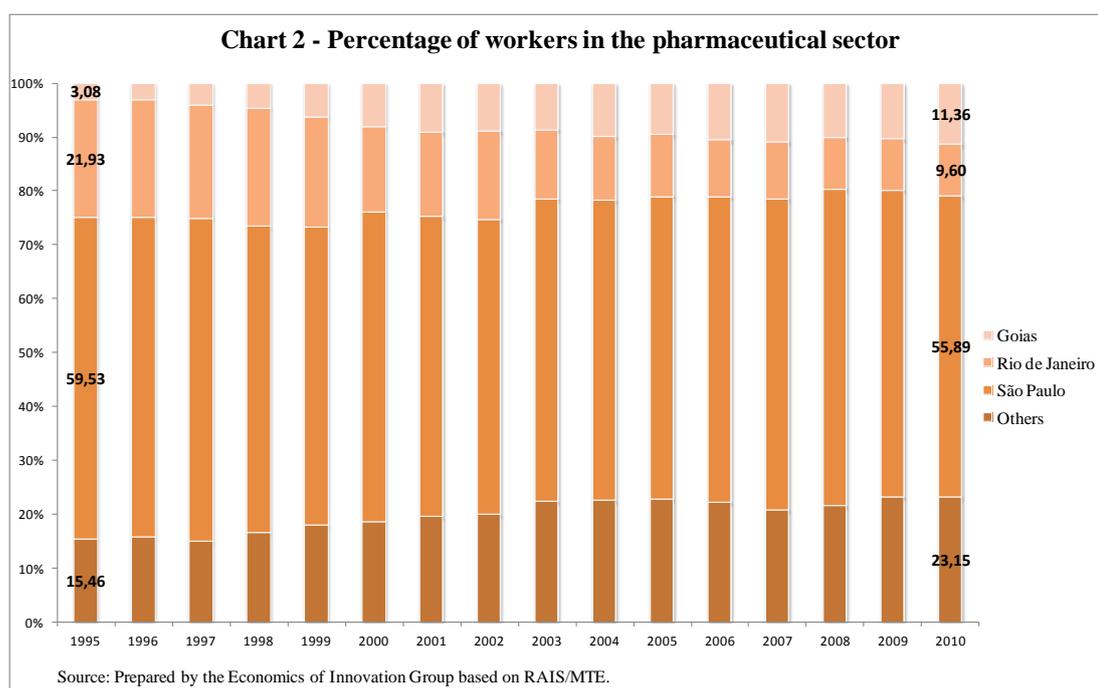
However, in productive terms, as also presented in Hasenclever (2012), the pharmaceutical sector presents a strong decreased in the last 15 years, as can be observed from the RAIS/MTE's data analysis, and PIM-PF/IBGE's, which follows. From the data gathered on the number of industries presented in Chart I, one can see that there is a significant reduction in the participation of the number of industries of the pharmaceutical sector in the state of Rio de Janeiro in the country's total number. In 1995, there was a

percentage of 19.8% of the country's pharmaceutical sector industries located in the State, including pharmaceutical and chemical manufacturers and drugs for human use. However, by the end of the period analyzed, 2010, this percentage reaches only 13.6%. This fall of 6 percentage points (p.p.) becomes more important when compared to the fall of 3 p.p. in the state of S. Paulo and the strong growth of more than 5 p.p of the state of Goiás. It is important to mention that these trends also occur in absolute number, with a reduction in the number of pharmaceutical industries in the state of Rio de Janeiro of 46% and in the state of S. Paulo of 28% in the 15 years and a growth of 156% in the state of Goiás.



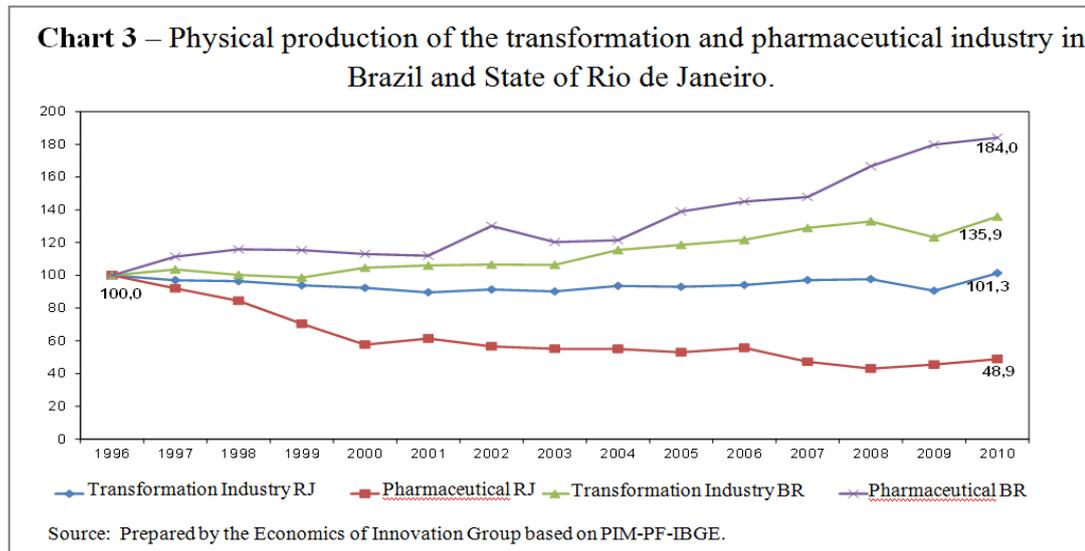
It was possible to obtain from the RAIS/MTE listings the number of formal workers employed in these institutions. It is important to mention a more expressive fall than that occurring in the institutions. In 1995, 21.9% of the workers were employed in the pharmaceutical sector of the state of Rio de Janeiro, but in 2010 this percentage decreased to 9.6%, causing an important fall in the formal employment number in the sector of more than 12 p.p.. The state of S. Paulo has also presented a decrease, but much smaller (4 p.p.), while

the state of Goiás has increased almost 3 times its participation in the formal employment numbers of the pharmaceutical sector of the country and the rest of the group, with the other states of the country, presented an increase of 8 p.p. This demonstrates a decentralization of employment in the pharmaceutical sector, with a significant loss in the state of Rio de Janeiro. However, when analyzing the absolute numbers of employment in the pharmaceutical sector, it can be observed that there is a reduction of 36% in the state of Rio de Janeiro and an increased of 435% in the state of Goiás, being the growth in the state of São Paulo equivalent to 36% between 2010 and 1995. That is, the state of S. Paulo has lost participation, but did not have a fall in the number of employees, while the state of Rio de Janeiro has lost participation, reducing the number of employees in the pharmaceutical sector.



It is also worth observing that the fall in the number of workers was followed not only by the reduction in the number of institutions, but also by the significant fall in the physical production of the pharmaceutical sector in the state of Rio de Janeiro, in accordance with PIM-PF/IBGE data. In order to illustrate this fall, Chart 3 below presents the rates of physical

production of the pharmaceutical sector and transformation industry of the state of Rio de Janeiro and Brazil, from 1996 to 2010, based on the year of 1996.



The curious fact is the evidence that the relation between the physical production of pharmaceutical and transformation industries in the state of Rio de Janeiro, during the period in question, is opposite to their behavior within a national context. In the state of Rio de Janeiro, the pharmaceutical industry presents a fall in the physical production, reaching minus 57% in 2008, the lowest rate in the period analyzed, and minus 51% in 2010. These values are inferior to the transformation industry of the state of Rio de Janeiro which does not present a very positive evolution, but keeps stable.

On the other hand, the growth in the physical production of the pharmaceutical industry in Brazil is higher than the physical production of the transformation industry in the country during the entire period analyzed. The transformation industry at a national level presents an increase of almost 36% in 2010, while the physical production of the pharmaceutical industry presents even superior rates, reaching 84% of growth in 2010 as

compared to 1996. This shows the great importance of the pharmaceutical industry in the country, as a dynamic sector which has been growing every year.

III – SUPPORT POLICIES TO THE PHARMACEUTICAL SECTOR IN THE STATE OF RIO DE JANEIRO

From the data presented in the previous section, it is possible to observe that, in spite of the existing large scientific and human resources formation capacity, the position of the state of Rio de Janeiro is being modified with the loss of many institutions and workers which used to be part of the pharmaceutical group active in the State. Starting from this reality, one should mention the main actions endeavored by the state government to change this situation. To this effect, we hereby present a survey on the main actions of the state government in the last years, as shown in Hasenclever (2012).

The focal point of the state of Rio de Janeiro's action was the creation of tax incentives aimed at the production and trade activities of the pharmaceutical sector, so as to keep the industries installed and to attract new industries. In 1998, the Program '*Rio Fármacos*' was launched, as per Decree nr. 24.857/98. The sectorial program foresees the development of the chemical industry for biotechnological, pharmaceutical, drugs and cosmetics applications. It is a program to foster the pharmaceutical chain, granting special tax conditions to the industry, wholesalers and distributors that are part of the pharmaceutical chain, and also offers a line of credit of up to 200% of the fixed investment to be released in monthly installments during the five years of operation of the new industries. It also considers as fixed investments the expenses incurred by the industries in bio-equivalence and bio-availability tests, necessary for the production of generic drugs.

A few years later, in 2004, a new incentive decree to reduce taxes on the circulation of goods and services (ICMS) was created by Decree nr. 36.450/04, granting a reduction of 4% of the estimated credit on the internal output amount and the reduction of the ICMS tax base to 12%, thus decreasing the tax burden by 8% for the pharmaceutical chain industries. In the case of imports, when customs clearance takes place in the ports or airports of the State, the Decree also provides for the granting of the referred to ICMS or the domestic purchase of inputs and goods for the fixed asset.

As to innovation, one should mention the State Innovation Law nr. 5.361/08 and Decree nr. 42.302/10 that rules the Law, created with the objective of encouraging innovation and scientific and technological research in the productive sectors of the state of Rio de Janeiro. It is also possible to observe that the government intends to give priority to the purchase of products developed based on this law.

Another form of action on the part of the state government has been the financing to projects through the state support agencies: Faperj and the Foundation of Support to the Technical School (Faetec). Through the publication of official announcements, these agencies support scientific, technological and innovation activities, through teaching and/or research institutions, as well as technological innovation projects of industries located in the State.

In addition to these programs, there are also the recent actions on the part of the state government starting in 2010, especially the Secretariat of Economic Development for Energy, Industry and Services (Sedeis), established with the objective of changing the course of the pharmaceutical sector in the State, seeking a return to positive growth figures. In 2011, after a number of seminars and discussions⁵, a group of important actors of the pharmaceutical sector

⁵ “Guidelines for a Development Policy of the Pharmochemical Sector of the State Rio de Janeiro” on 03/19/2010, “Guidelines for a Development Policy of the Biotechnology and Pharmochemical Sectors of the State Rio de Janeiro” on 04/12/2011 and “Workshop Invest Rio: What is missing for the State of Rio to become a Biotechnology *locus* ?” on 10/17/2011.

of the state of Rio de Janeiro ⁶ with the support of Sedeis, created the Executive Group of the Industrial Complex in Life Sciences of Rio de Janeiro (GECIV-RJ) with the purpose of establishing and developing the guidelines of state policies for the strengthening of the productive and innovation complex in life sciences (State Decree nr. 43.315/2011). This moment seems as the beginning in the state of Rio de Janeiro of a period of greater attention to public policies for the pharmaceutical sector, in this case with a focus on biotechnological products.

In 2013, Faperj publishes the first announcement devised, discussed and prepared in the context of GECIV-RJ to support projects of research, development and biotechnological innovation in human health in the state of Rio de Janeiro, to finance the creation of projects to carry out preclinical or clinical tests, in phases I, II and III.

IV – THE INDUSTRY-UNIVERSITY PARTNERSHIP IN THE BRAZILIAN AND STATE OF RIO’S PHARMACEUTICAL SYSTEM OF INNOVATION

As far as industry-university relationship is concerned, the results of field survey in the State present the same national pattern of less structured industries in their innovation activities and with a great emphasis on the production of generic drugs; and the universities unprepared to interact with the industrial sector, especially due to their rigid internal structure and to the difficulties of functioning faced by the technological innovation nuclei (NITs). These characteristics, common both to pharmaceutical industries and universities, seem to indicate that they are not prepared from the standpoint of their strategic positioning and their mission to innovate and contribute to the local development, exactly as it should be expected in a country where their creation occurred in parallel. Industry, established from the

⁶ Invest Rio, Vital Brazil Institute, BioRio, Technology Network of Rio de Janeiro, State University of Rio de Janeiro, among others.

importation of technology, has left the university aside for the generation and transfer of knowledge (Suzigan and Albuquerque, 2011).

In what respects the type of collaborative activities carried out between industry and universities, the major part refers to tests which depend on university equipment and technical knowledge already developed internally. This means that little new knowledge is being created in these activities, since they are specific activities performed randomly and for a brief period of time without the involvement of great new knowledge and research. It is interesting to observe the fact that knowledge is the main motivation factor mentioned by the industry but, paradoxically, the main activity carried out by partnerships are related to experimental development activities. These experimental projects are linked to the application of knowledge in new products and processes or improvement of the existing ones. In general, they are short duration projects and do not necessarily generate new knowledge, even if the literature (Rosenberg, 1982) points out several cases of exceptions to this rule.

In the present research, the use of knowledge in the universities in most cases has originated as a consultation to analytical and test activities that the industries need to develop and the knowledge about the equipment to conduct these tests, that many times the industries do not hold. In the university researchers' perception, the main motivation factors for the collaboration with the industry are the possibility of application of their research to reach the society and the availability of additional resources for their work. According to a university researcher in the state of Rio de Janeiro, "these theses must have a social result, can be used for other theoretical researches, undoubtedly, but it will be useful when they reach the society. While the human being does not benefit from that knowledge, it will still be a theory" (RES13_2012). From one side to the other, there are strong reasons to explain the apparent paradox between a view that knowledge is the main contribution of the university and that its main contribution is in fact closer to the solution of practical problems.

However, the number of obstacles that exist in this relationship is so huge that this results in a lack of encouragement to pursue this interaction. The main problem consists in the bureaucracy that involves the universities, a marking characteristic of the Brazilian public organs. In spite of the strong encouragement to these partnerships, little was done by the government to prepare the actors for this interaction. Besides, the need to create the NITs, as imposed by the Innovation Law (10.973/2004) was carried out in a confused manner, since adequate conditions were not offered to the universities, as for example, to make financial resources available to hire specialized personnel. The lack of planning has generated great obstacles for the proximity between industries and universities, broadening the difficulties that are normally present in this relationship.

The second obstacle mentioned was a set of factors which are intrinsic in the industry-university relationship, the lack of trust, the non-involvement and the poor communication existing between researchers and industries. In more developed systems of innovation and with a larger experience in this type of relationship, these obstacles can be reduced, but will always be present due to the differences in the environment, time, objective and view of industry and university.

The third obstacle present is the difficulty of negotiating intellectual property in the development of joint research and the rendering of services. The main reason found for this difficulty lies on the high expectation of universities to obtain a large amount of additional resources with licensing. The difficulties found with the arrangement of scientific research have also been mentioned by the interviewees as an important obstacle to industry-university interaction. Also related to this problem is the lack of calibration of equipment in the universities, another obstacle to interaction. In both cases there is an exaggerated pressure on the universities since they are not responsible for all this, and are mainly focused on learning and research which have no requirements of this sort. However, this pressure exists since

there is not a network of small technology based industries to perform these activities and to serve as a bridge in the industrial and academic partnership⁷.

Among researchers, an important obstacle were the difficulties encountered in the family management of Brazilian industries, resulting in low innovation investments, in the inexistence of an internal structure capable of collaborating with the universities, the lack of qualified personnel in R&D activities and an absence of long range perspectives about research. It is believed that this is an obstacle that only the sector development and a professional attitude in the management of industries will be capable to overcome.

It can be observed that the obstacles existing for industry-university interaction in the Brazilian pharmaceutical system of innovation are problems that can be solved in a larger scale, through the establishment of research budgets in the universities and a better structure, rules, procedures and less bureaucracy. The problems become more serious since, besides the intrinsic obstacles in the industry-university relationship, many others are also present, making this interaction even more difficult. But, it is believed that with the broadening of cases and experiences these problems tend to become smaller.

Regardless of the number of obstacles, the interviewees stated that the main form of resolving them is to be persistent, flexible, try to understand the partner's point of view and to negotiate case by case. Besides, some factors, such as the personal relationship among the participants in the industry and researchers and employees in the universities, can help to make the bureaucratic process easier and faster; a perception on the part of the government about the importance of innovation so as to create a regulatory framework and programs to foster industry-university relationship and innovation; an interest in the Project and the recognition acquired when interacting with the industries; and the knowledge about the entrepreneurial and industrial sector acquired by the students and researches of research

⁷ For further details on this discussion, see Paranhos (2012).

groups interacting with the industry, have also been mentioned as important factors to make this relationship feasible. The interviewees mentioned that in the presence of professional personnel in the industries holding this information about the academic sector, the relationship can be easier and with less difficulty for its development.

The NITs have been an important facilitating factor in this process. They have demonstrated to be very relevant in the communication between industries and researches and in the creation of routine actions to make contact, prepare contracts and to follow-up on projects. In spite of the difficulties for the development and structuring of these groups, the opinions on their performance are very positive, even if their entire potential is not being totally utilized. On the side of researchers, who are assisted in different activities, especially in the filing of patents, that in the past they had to learn and do it by themselves, in the initial contacts and in the formulation of partnership and intellectual property rights contracts, as shown by the report of a state of Rio de Janeiro researcher: “I can see that the NIT had a great progress. It has already a group of adequate personnel, with lawyers, etc. But there is no further advancement since Brazilians still do not recognize the importance of protecting the national intellectual capital” (RES1_2008).

The creation of routine actions in the NITs seems to be a way of establishing their own rules to facilitate the dissemination of university research to the entrepreneurial sector, such as the approximation of the industrial sector to the university, assisting in the identification of the ideal partner and in the reduction of the differences of expectations by industries and researches. The activities to make academic research public, the creation of networks, the preparation of contracts, the mounting of projects and partnership management, seem to be very effective and positive in the development of the industry-university relationship.

Several of these problems and obstacles faced by the industry and the universities occur because the government has established the industry-university relationship as a focal

point of its strategies to foster the generation of innovation in the country. However, the actions endeavored were started in a premature manner, without a previous analysis of issues and related needs, concentrating mainly on the financing of academic research in partnership with the entrepreneurial sector. Even with its disordered strategies, the government today plays an important role in the financing of moderate size national industries and still lack sufficient resources for innovation investments. In accordance with the industries in Brazil, government financing has increased its capacity to carry out more partnership projects, acting like an organizer in the approximation process with the universities. A large part of the industries interviewed has already received or receives public resources for the financing of their partnerships.

In spite of the importance of government financing in Brazil, many criticisms have been made to the programs and public announcements in this sector, especially in respect of the greater destination of resources to the universities, the short time available to develop a partnership, an average period of two years, that would be insufficient to conduct research in this area, which last approximately ten years, and to the distribution of resources to different sectors, without a specific target. Besides the other problems relating to the process of evaluation and selection of projects submitted to the bureaucracy in their presentation and execution.

However, government actions and encouragement to the industry-university interaction are not the only factors necessary to promote the relationship and the generation of innovation. The pharmaceutical sector is very complex and depends on the creation of well developed governmental institutions to work in a proper form. Regulating aspects and intellectual property rights are very important for the production and innovation in this sector. For this reason, jointly with the present government action for the development of the pharmaceutical sector in Brazil, it is mandatory to create a regulating framework and the

improvement of efficiency and agility of the regulating agencies, government institutions and public universities. These factors will contribute to reduce uncertainty and to increase the industry's inclination to assume risks and to invest in production and innovation.

Especially in the state of Rio de Janeiro, several obstacles were listed as significant in hindering the development of the pharmaceutical system of innovation, being among the most commented the high tax burden, mainly the ICMS, the absence of support policies on the part of the state government and the strong development of sector in the state of S. Paulo. The last point was mentioned by an interviewee from a pharmaceutical research industry: "The disadvantages are obvious. The economy is not in Rio de Janeiro, but in S. Paulo. This is by itself a big problem, in spite of all this knowledge" (PRI3_2011). The comment reflects the great importance of S.Paulo's economy for the country and the importance of the pharmaceutical sector in this State. The interviewee from a national pharmaceutical industry and an actor linked to the sector emphasized the tax war issue existing between the states, the high tax burden and the absence of effective policies for the sector. The pharmaceutical industry interviewee had no knowledge about the Decrees (mentioned above) that offer tax incentives to the pharmaceutical productive chain. The second comment shows that such Decrees do not seem to generate many virtuous effects.

"[...] this is what I mentioned before, the tax issue. I believe that Rio de Janeiro, as a tax collector, is ahead of all the states, is one of the states with the highest tax burden. The other advantages are more common to the other states [...]. As to the state's support to the pharmaceutical industry, I considered it zero. I do not identify any kind of support on the part of the state, both in the tax question and in the structure question. I'm unable to identify [personally] any kind of support through actions taken by the State or efforts endeavored to this end" (NPI11_2011).

“[...] the disadvantage of the ICMS for the production and distribution. [...] Goiás has offered a choice to the industries [...] [located here], to move to that state with great tax advantages. The number of large distributors that existed in the state of Rio de Janeiro decreased and just one or two were left. [...] [The tax incentives Decrees are not adequate] to attract new investments, [but] at least to help those who are here. [...] I think that they took some actions to help a little, but this is still too incipient. The tax burden problem on drugs which is still very high, here in the state of Rio de Janeiro the ICMS is still too high for the pharmaceutical industry and represents a fundamental factor today when the tax burden is discussed. If Rio had a proactive action concerning the ICMS, then a lot of people would want to move to this state” (OAS7_2012).

Nevertheless, certain advantages in the state of Rio de Janeiro have also been mentioned as compared to the other states of the country. Among them are the existence of several centers of academic and scientific excellence, which leads to a high demographic density of researchers; the group located in Jacarepaguá which generates qualified labor; the port and airport for the entry and exist of goods; the proximity with clients, even if suppliers are in S. Paulo, due to the agility in sales; and the good moment of investment attraction which the state of Rio de Janeiro is going through, according to the comment of an interviewee from a pharmaceutical research industry mentioned below. However, as explained by a researcher from a university of the state of Rio de Janeiro, which follows, a stronger connection between the universities and the industries has not yet occurred due to the lack of government support. On the other hand, the actor linked to the sector comments on the loss of professional personnel to other states: “[...] unfortunately in the state of Rio de Janeiro we don’t have any of this, all these laboratories that I mentioned to you are from the state of

S. Paulo, none of them is from Rio. [...] I can mention several researchers from Rio who are working for [this company in SP]” (OAS7_2012).

“I think we have a great intellectual capacity in the State. I don’t doubt that, [...] [this university] is a Center of intelligence which in spite of all the infra-structure] problems has a lot of good people. This is an advantage. It is obvious that, the moment we live here in Rio de Janeiro also represents an advantage in terms of visibility and investments. It is obvious that from now on with these conditions and this growth there will certainly be more people wanting to put money here. So, this is good” (PRI3_2011).

“If you look back, ten years ago and now, it is completely different, the government is much more sensible [to university-industry partnership]. But, I think we are not being able yet to ‘score a goal’. We are doing everything right, but the final part we are not being capable to do. We are not doing it because we don’t have this resource incentive” (RES14_2012).

It can be noticed in the state of Rio de Janeiro that the large number of researchers and the ICTs, as well as the other advantages mentioned above, have not been sufficient to attract, on their own, the industries and to foster the pharmaceutical sector in the State. This occurs because of the obstacles related to the tax burden and the low dynamic attitude of the economy, which are generating negative effects on the sector’s development. The need to have industrial and innovation policies in the state of Rio de Janeiro to support the development of sector and to stimulate industry and university partnerships is clear.

CONCLUSIONS AND POLITICAL IMPLICATIONS

In spite of the academic excellence presence in the state of Rio de Janeiro appearing as a great advantage for the State's pharmaceutical sector, this has not been sufficient to promote industry-university interaction. This is due to the fact that the state government took a long time to initiate concrete actions to develop the productive and innovative capacity of the pharmaceutical industries. The creation of GECIV-RJ and the first actions that it has been taking demonstrate that this scenario should be going through changes in the next years with the strengthening of the pharmaceutical sector and, as a consequence, the expansion of interaction with the state's universities.

Based on the analysis of literature, the secondary and field research data, in conclusion, can be summarized under five main points that should be stressed out so as to increase the relationship between industries and universities; 1) the need to strengthen the internal structure of R&D in the pharmaceutical industries for the generation of innovation and to improve the interaction with the academic sector, 2) the need to restructure and modernize the internal structure of the universities; 3) the need to have a previous planning about the government's actions and the creation of an adequate environment for innovation; 4) the fundamental role played by government financing and support to innovation activities of both industries and universities' NITs, even if still in the initial phase, and 5) the need to make proper and efficient rules devised to the pharmaceutical sector. In the state of Rio's system of innovation, in particular, one emphasizes: 1) the need to review the tax burden on production and distribution; 2) the creation of industrial and innovation policies at a state level, especially in order to strengthen the technological infrastructure capable of promoting a better interaction between industry-university.

To sum up, both the pharmaceutical industries and the universities are actors with a strong potential to interact and to develop innovation, but this interaction is not spontaneous, it has to be promoted and stimulated. The most important actor for the development of an industrial and technological policy is the government, due to its potentialities to foster or to obstruct the development of a sector.

In terms of lessons pointed out by the state government, two can be mentioned. First, the state government must act jointly with the federal government seeking improvement in the performance of certain federal organs with a stronger effect over the pharmaceutical system of innovation, so that the articulation among these organs can be broadened, with a better utilization of actions and improvement of the innovation environment.

Second, it is the federal government's role to create an adequate local environment for innovation in the State. There are very significant actions that can be taken to expand the encouragement to innovation and to industry-university interaction in the state of Rio de Janeiro. The creation of GECIV-RJ presents a great potential to attain this, since it encompasses several actors linked to the sector in the State and has been trying to increase the articulation among these actors. Besides, it has been conducting studies for a better mapping of Rio de Janeiro's potentialities for the development of the pharmaceutical sector.

REFERENCES

BERMUDEZ, J.; EPSZTEJN, R.; OLIVEIRA, M. A.; HASENCLEVER, L. *O Acordo TRIPS da OMC e a Proteção Patentária no Brasil: mudanças recentes e implicações para a produção local e o acesso aos medicamentos*. Rio de Janeiro: Fiocruz/ENSP, 2000.

BRITTO, J.; BITTENCOURT, P.; CRUZ, W. Interação infraestrutura de ciência e tecnologia (C&T) e o setor produtivo no Estado do Rio de Janeiro. In: SUZIGAN, W.;

ALBUQUERQUE, E.; CARIO, S. Em busca da inovação: interação universidade-empresa no Brasil. São Paulo: Editora Autêntica, 2011, pp.109-157.

BUSS, P.; CARVALHEIRO, J.; CASAS, C. (Org.) *Medicamentos no Brasil: inovação e acesso*. Rio de Janeiro: Editora Fiocruz, 2008.

CAPES – Coordenação de Aperfeiçoamento de Pessoal de Nível Superior. *Estatísticas: Sistema Geocapes 2011*. Disponível em: www.capes.gov.br. Acesso em: 10 Ago. 2012.

CNPq – Conselho Nacional de Desenvolvimento Científico e Tecnológico. *Plano Tabular 2010*. Disponível em: www.cnpq.br. Acesso em: 07 Jul. 2012.

COOKE, P.; URANGA, M.; ETXEARRIA, G. Regional innovation systems: Institutional and organisational dimensions. *Research Policy*, v. 26, issues 4-5, December 1997, pp. 475-491.

FAURÉ, Yves-A.; HASENCLEVER, Lia (orgs.). *Caleidoscópio do desenvolvimento local no Brasil: diversidade das abordagens e das experiências*. Rio de Janeiro: E-Papers, 2007.

_____. O desenvolvimento local no estado do Rio de Janeiro: estudos avançados nas realidades municipais. Rio de Janeiro: E-Papers, 2005.

HASENCLEVER, L. (Coord.) *Interação entre instituições de ciência e tecnologia e empresas no sistema farmacêutico de inovação brasileiro: lições para o desenvolvimento do setor no Estado do Rio de Janeiro*. Relatório de Pesquisa. Rio de Janeiro: Faperj/UFRJ/Instituto de Economia, 2012.

_____. *Diagnóstico da Indústria Farmacêutica Brasileira*. Relatório de pesquisa. Rio de Janeiro: UNESCO/UFRJ/Instituto de Economia, 2002.

HASENCLEVER, L., PARANHOS, J., TORRES, R. Desempenho econômico do Rio de Janeiro: trajetórias passadas e perspectivas futuras, *DADOS - Revista de Ciências Sociais*, v. 55, n. 3, 2012, pp. 681 a 711.

IBGE – Instituto Brasileiro de Geografia e Estatística. *Pesquisa Industrial Mensal – Produção Física*, 1996-2010. Rio de Janeiro: IBGE, 2011.

LESSA, C. *O Rio de todos os Brasis*. Rio de Janeiro: Ed. Record, 2000. (3a. Ed; pp. 345-412)

LUNDVALL, B.-Å., JOHNSON, B., ANDERSEN, E., DALUM, B. National systems of production, innovation and competence building. *Research Policy*, v. 31, 2002, p. 213-231, 2002.

MEC – Ministério da Educação. *Sistema e-MEC 2012*. Disponível em: www.mec.gov.br. Acesso em: 10 Ago. 2012.

MTE – Ministério do Trabalho e Emprego. *Relação Anual de Informações Sociais*, 1996-2009. Disponível online: <http://www.mte.gov.br/>. Rio de Janeiro: MTE, 2010.

PARANHOS, J. *Interação entre empresas e instituições de ciência e tecnologia: o caso do sistema farmacêutico de inovação brasileiro*. Rio de Janeiro: Eduerj, 2012.

_____. *O sistema farmacêutico de inovação fluminense: forças, fraquezas e desafios ao desenvolvimento*. Projeto de Pesquisa submetido ao edital APQ1 da Faperj. Rio de Janeiro: UFRJ/Instituto de Economia, 2011. (Aprovado para financiamento em 2012)

ROSENBERG, N. *Inside the black box: technology and economics*. Cambridge: Cambridge University Press, 1982.

SELAN, B.; KANNEBLEY JÚNIOR, S.; PORTO, G. S. *Relatório setorial sobre inovação tecnológica na indústria farmacêutica brasileira: uma análise a partir dos indicadores de inovação*. Ribeirão Preto: Fipase, 2007. 79 p.

SUZIGAN, W.; ALBUQUERQUE, E. A interação entre universidades e empresas em perspectiva histórica no Brasil. In: SUZIGAN, W.; ALBUQUERQUE, E.; CARIO, S. Em busca da inovação: interação universidade-empresa no Brasil. São Paulo: Editora Autêntica, 2011, pp.17-43.

URANI, A; GIAMBAGI, F. (Org.). *Rio: A Hora da Virada*. Rio de Janeiro: Campus/Elsevier, 2011.

Decrees and Laws:

Decree of the state of Rio de Janeiro:

- n° 24.857 of November 26 of 1998.
- n° 36.450 of October 29 of 2004.
- n° 42.302 of February of 2010.
- n° 43.315 of November 25 of 2011.

Law of the state of Rio de Janeiro:

- n° 5.361 of December 29 of 2008.

Federal Law :

- N° 10.973 of December 2 of 2004.