Subnational Innovation Policies in an adverse political and institutional landscape: the case of the Innovation System of Rio de Janeiro, Brazil

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Abstract

The objective of this article is to analyze the innovation policy of the state of Rio de Janeiro, Brazil in the context of its specific political and institutional environment. The analysis departs from the recognition that the State of Rio de Janeiro has a great potential to develop a diversified set of ST&I activities, especially in connection to the Oil and Gas industry given the great concentration of this sector and connected S&T institutions in this State. Considering the potential that many scholars assign to natural resource sectors as drivers of development, it is critical to understand in how far the state institutions seek to address this potential and implement consistent strategic policies. We find a great distortion between the emphasis given to national and global issues in opposition to an incapacity to tackle local and regional ones on a systemic way and implement long run development strategies. A fragmentary and clientelistic logic present in the political habitus reproduces itself in the scope of ST&I policies. These characteristics have to be understood from a perspective deeply rooted in the historical process of creation and evolution of the state's institutions. This does not allow conclusions in the direction of "system failure" diagnosis. It's not about getting institutions right, based on some imported benchmark. Rather, the challenge to effectively benefit from the potentialities connected to natural resources in developing countries calls for a deeper and broader understanding of power structures and the historical processes that shaped them.

Keywords: Innovation Policy; Innovation System; Rio de Janeiro State; Institutions; Oil and Gas industry

Introduction

The state of Rio de Janeiro has the unique property of being a focal point of attention in Brazil and in the world. Recent mega-events, especially the Soccer World Cup and the Olympic Games, contribute to reinforce its prestige. A rich cultural scenario, with world known spectacles such as the Carnival, music and audiovisual industries, contribute for its role as "cultural capital" of the country. Another special feature of the state of Rio de Janeiro is that fact that it hosts a significant part of the Brazilian production network in Oil and Gas and connected S&T institutions. Major breakthroughs in deep sea technologies that are worldwide recognized have been made possible through long term investments and efforts of a regionalized innovation system under the leadership of Petrobras.

A constantly neglected fact, however, is the scarcity of positive counterparts to this projection and prestige. There is a fundamental contradiction between the role and potential of Rio de Janeiro and the incapacity to mobilize and concretize consistent regional development strategies. Local and regional issues are traditionally left in the background. This pattern is observable in a variety of spheres, such as in the academia, political debates and media. Undoubtedly, this specificity of Rio de Janeiro (both the city and the State) generates negative effects to the design of public policies and the ability to diagnose and confront specific local or regional economic and social problems.

At the moment, the State of Rio de Janeiro, in spite of its capital having hosted the Olympic Games, is facing a serious fiscal crisis at the same time as its economic indicators point to a fall in economic activity and employment. Obviously, the global economic crisis and the current Brazilian political and economic crisis have an influence on that. However, the crisis in Rio de Janeiro also has local determinants.

The objective of this article, in light of this contradiction, is to evaluate some important issues related to the political context and its influence on the regional innovation policy of Rio de Janeiro, specifically the strategic focus of Rio de Janeiro's S&T promotion institutions. The main hypothesis is that this distortion between the emphasis given to national and global issues in comparison to local and regional issues contributes to an institutional scenario that is adverse to policy formulation. And these characteristics have to be understood from a perspective deeply rooted in the analysis of the historical process of creation and evolution of the state's institutions.

Despite the challenges posed by the actual economic conjuncture, the relevance of development-related and long-term themes remains. In this sense, regional innovation policy plays a crucial strategic role. It constitutes a fundamental element of any contemporary development strategy. Understood as the convergence of S&T, industrial and regional policies it carries the potential for transforming Rio's endowments and potentialities into long term development drivers. Departing from the conceptualization of structural change as a fundamental element for economic development process, this work uses the innovation system framework as a reference.

Besides this introduction, this work is composed of four parts. The first part brings a general characterization of Rio de Janeiro - city and State - in terms of its history, geography and economy. With the purpose of explaining the political and institutional scenario, a characterization of the historical trajectory of Rio de Janeiro is presented as an important element for setting its contemporary power relations and political logic. The second part presents the analytical framework of Innovation Systems and discusses the adequacy of the Regional Innovation System (RIS) framework, shedding special light on the strategic relevance of innovative activities connected to the extraction of oil and natural gas (O&G) in the State of Rio de Janeiro. In the third part issues related to the regional innovation policy are analyzed, taking into account the legal-institutional framework that conditions it, the institutional infrastructure that operates it and its relation with the productive complex of O&G in the region. Finally, in the last session we present the final considerations.

Rio de Janeiro: Economic Geography and Historical-Institutional Trajectory

1.1. Historical-Institutional Trajectory of the State of Rio de Janeiro

The concept of 'capitality' is fundamental to understand the economic, political and social reality of Rio de Janeiro. The capitality of a city or region derives from its capacity to embody the representation of a country for the rest of the world (Lessa 2000) and, at the same time, from its capacity to be the main reference in national context in terms of culture, politics and intellectual production, constituting the focal point of civilization, nucleus of modernity, 'theater of power' and place of memory (Motta 2001).

This remarkable peculiarity of the City of Rio de Janeiro has its importance because it was constituted while giving the contours to the economic and historical formation of the State of Rio de Janeiro. Historically, the city of Rio, as colonial, imperial and republic capital, consolidated its position as one of the main stages of the national political disputes at the same time as these were imbued with local political disputes. But, economically, the

"capitality" of Rio de Janeiro interfered in the formulation of public policies and development strategies, collaborating to reinforce the polarization of Rio's economy around its metropolis (Osorio and Versiani 2015). This section discusses these historical determinants and their reflections on institutional structures and the configuration of power relations.

The initial occupation of Rio de Janeiro connected to its role as military fortification and logistics axis. In the colonial period, Rio was firstly occupied as a consequence of the expulsion of french invaders in the sixteenth century and then, in the seventeenth and eighteenth centuries, as a consequence of the economic expansion of silver producing regions (in Spanish America) and gold producing regions (in Minas Gerais). Its logistics function is consolidated as an axis for cabotage trade and the outflow of the production of precious metals, due to its strategic geographical position.

Combined to its commercial and military function, the city of Rio additionally took on the function of political-administrative center with the shift of the colonial capital from Salvador to Rio de Janeiro in 1764. This transference had, among its motivations, the need to structure a fiscal apparatus for the production of gold and the need to fiscalize the activities of contraband and the transgressions of the colonial pact (Lessa 2000). From that moment on, the city enjoys the status of capital, which will only be lost in the XX century.

At that time the City's pattern of accumulation was marked by commercial capital. As the new center of the colonial political-administrative power, the city experience significant expansion of spending linked to public administration and the state bureaucracy. This influence, which was more tenuous in the colonial period, became intense from 1808 onwards, when the Portuguese Court settled in the capital. With the arrival of D. João IV, profound changes were made in the sense of strengthening the state apparatus that enabled customs inspection and the collection of taxes. The reforms were radical and introduced a series of institutional innovations that modernized the Brazilian public apparatus. These changes reinforced the centrality of Rio de Janeiro as an axis of modernity, making it the "ground zero" for structuring the modern national institutional apparatus. To a great extend, this institutional transformation was based on a re-conceptualization and adaptation of institutional structures from abroad.

On the economic front, the reinforcement of this pattern of accumulation contributed to consolidate the role of the city of Rio as main driver of the economic formation of the State of Rio de Janeiro. The polarization around the capital intensified in spite of the expansion of economic activities to other cities in the State at the beginning of the coffee cycle[1]. According to Lessa (2000), the expansion of coffee production in the State of Rio had the city of Rio itself as starting point.

At the political level, this role of the city of Rio was consolidated in the imperial period (1822 - 1989). In 1834, based on a technocratic perspective, the national capital was elevated to the condition of neutral municipality. This new condition, which lasted until the enactment of the first republican constitution in 1891, implied that the capital should represent an environment in which politics could manifest itself in a manner that was as distanced as possible from local political questions. In the Republican period (1989-1964), until the constitution of 1937, the city of Rio was a federal district, breaking the monarchical government logic, but remaining in line with the intention of creating an exclusive environment for national politics. Under this context, the head of the municipal executive power was appointed by the head of the national executive and the proposals voted by the municipal council that were vetoed by the municipal

[1] The period recognized as the 'coffee cycle' in Brazilian economic history started only in the second quarter of the 19th century (after the gold cycle that was one of the early stimulus to Rio de Janeiro city growth) and lasted until the first half of the 20th century.

executive were not submitted again to the municipal council but rather directly to the senate (firstly the empire's senate and then the republic's one)[2].

This peculiar institutional arrangement assigned a specificity to the political logic of Rio de Janeiro. According to Osorio (2005), national and local political logics, instead of being dissociated, were strongly imbricated. While the former was the object of relatively greater attention, the latter co-evolved in the background, progressively crystallizing a web of spurious political practices and clientelistic relationships with the national political sphere.

As a result, a culture based on a cosmopolitan vision formed in Rio de Janeiro. This culture prioritized national and global issues in detriment of local and regional ones. Because of this difficulty in forming a critical awareness of regional reality, there is a historical deficit in the formation of critical mass in academic and political debates. This is reflected, until today, in a difficulty in properly assessing the challenges and elaborating appropriate regional development agendas for the State of Rio de Janeiro (Osorio et al. 2015).

At the beginning of the 20th century, the city of Rio de Janeiro definitively consolidates its 'capitality'. Massive public investments for urban modernization engendered great multiplier effects on the city's economy and its surroundings. However, according to Osorio (2005), as of 1960 two events led to important changes in the political and economic dynamics of Rio de Janeiro. The first is the transference of the capital to Brasilia, which began in 1960 and was completed in 1974. Even with many federal organizations remaining in the city, the volume of federal public resources allocated in Rio decreased sharply, affecting the economic dynamics of the old capital and its metropolitan surroundings.

The second event relates to the military dictatorship established in the country after the coup of 1964. In the late 1960s, political leaders of left-wing parties had their mandates revoked throughout the country. Because Rio was the main stage of national political articulations, local political leaders aligned with the right were also affected by cassations. This generated a political void in Rio de Janeiro and constituted a large avenue for the rise and hegemony of a political group[3] strongly associated with a clientelistic logic, first in the city and then in the whole state (Versiani 2016). This chapter of Rio's political historical represented an important fracture in its institutional trajectory (Osorio, 2005).

Since this period, the essence of Rio's clientelism is the focus on specific and localized interests such as those of specific poor communities, neighborhoods, religious groups or professional categories, intermediating the provision of public services in exchange of electoral payoffs (Versiani, 2016). By doing so, political actors manage to captivate those groups, claiming to themselves the prerogative as exclusive defender and benefactor. This sets the foundation for completely linking the political status to the maintenance of electoral performance and to the generation of benefits associated with corruption and spurious alliances. Part of this rationale is not to provide definitive solutions to main problems of these captive groups (in order not to kill the golden eggs chicken). From this follows the perception that politics is not about main collective interests and ideological and programmatic issues, but rather a question of using political status and proximity to power in order to provide solutions to particular problems associated with fragmented interests, as if the benefits of public services were not a right, but a privilege.

[2] In order for the municipal executive to have its veto confirmed by the senate, a web of spurious relations was established between politicians form this two spheres. Not seldom, this implied in the municipal executive 'buying' political support by employing relatives of senators in the local bureaucracy.

[3] Represented by the figure of its leader, Carlos Chagas Freitas, who governed the city of Rio and the Rio de Janeiro state during the dictatorship years. The markedly clientelistic stile of making politics of this group was labeled as ‘Chaguismo’.

In this scenario, needless to say, any commitment to programmatic and ideological issues was not only hindered[4] but less likely to emerge and establish itself. As a result, because of the dominance of particular or clientelistic interests, there was a fragmentation of the political logic. Therefore, political leaders, in addition to aligning themselves with the regime, committed themselves to a new institutional framework, in which a political logic prevails that hinders the design of public policies that are coordinated with each other and connected to a long-term development agenda.

In 1982, with the gradual relaxation of the dictatorial regime (that ended in 1985), some important political actors could come back to Brazil and run on elections to executive and legislative powers in states and municipalities. That was the case of Rio, where Leonel Brizola, an nationwide important leftist leadership before 1964, won the elections. However, this change in the political scenario, despite weakening the former hegemony of the Chagas Freitas group, was neither able to break it nor to reinforce an alternative to the clientelistic political logic. As a result, governors had to deal with demands and pressures from state deputies and local mayors in order to achieve governability, compromising in higher or lower degrees their original political programs (Sarmento, 2008).

Three aspetcs can be identified as a legacy of this institutional fracture and the subsequent events: i) significant loss of economic importance in the national scenario[5], ii) deterioration of the public machine[6] and iii) the difficulties in terms of designing development strategies and coordinating policies.

The typical pattern of politics that became hegemonic in Rio almost five decades ago proved to be very resilient, engendering a vicious circle with negative consequences[7]. In the current century, most prominent political leaderships in Rio de Janeiro can be seen as connected to the clientelistic logic and to corruption. Since 2000, two groups held the state administration. One led by the former governor Anthony Garotinho and other led by the former governor Sergio Cabral.

The first group, associated with the barely charismatic leadership of Garotinho, was in power from 1999 until 2006. A recurrent strategy was to grant benefits to poor communities as a way to gain electoral benefits[8]. In addition, there are many indications of articulation of formal political power with parallel state (associated organized crime). In 2008, a former head of the state pole force, Álvaro Lins, was imprisoned due to association with 'milícias'. These are criminal organizations mainly constituted by policemen that take over control of favelas

[4] In the period of military regime in Brazil, the political structure was formed by two parties, one of them represented an 'official' opposition that was severely regulated, with a variety of measures that went from censorship to cassations and torture.

[5] For example: below average growth rates of GDP and employment during decades and the loss of importance in many industrial sectors.

[6] Some symptoms of this deterioration can be identified in the relatively low number of state public employees per capita and the long periods (more than two decades in some cases) without promotion of public tenders for hiring new human resources to important state secretariats such as those dedicated to development, planning and to science and technology.

[7] Due to the scarcity of systematic thinking about Rio de Janeiro's specificities and political and economic reality the current status and evolution of the political and institutional patterns has still not been sufficiently investigated and discussed by academic community. Still, its possible to infer how this context impacts on the challenges and effective possibilities for promoting long run development initiatives.

[8] To illustrate, without the pretention to be exhaustive, in 2006 the former governor Rosinha Garotinho (Anthony Garotinho's wife and part of his political group) was accused of using state government social programs to grant votes for political allies. In may 2017, she was condemned for that crime. In 2013, she faced processes associated to administrative irregularities during her mandate. In 2016, again, Rosinha Garotinho faced similar complaints related to electoral irregularities while she was mayor of a municipality in the Northern Region of Rio de Janeiro. More recently Anthony Garotinho was enprisioned because of illegal use of social program created by his political group.

(poor areas, partially with characteristics of slums), which were previously dominated by drug dealer organizations, in order to use violence to explore those communities.

The second political group, led by the ex-governor Sergio Cabral, also engaged in several spurious policy practices. Relatively less related to explicit clientelistic practices but strongly related to corruption, this political group currently is beening investigated by authorities. The investigations and judicial issues related to them have already culminated in the imprisonment of Sergio Cabral and some important members of his political group.

1.2. The Economic Geography of the State of Rio de Janeiro

Located in southeastern Brazil, the State of Rio de Janeiro occupies a prominent position in the national context as it is the federation unit with the third largest population (about 16.5 million inhabitants[9]) and the second largest GDP (in the order of 626 billion BRL[10]). The State of Rio has among its most striking characteristics the polarization around the metropolitan region. This region concentrates more than 70% of population and employment and more than 60% of GDP. The polarization is even more intense when one considers only the city of Rio de Janeiro, which concentrates relatively more employment and GDP than the population, which points out the adverse conditions of the municipalities of the metropolitan periphery. These municipalities, most notably those of the Baixada Fluminense, are characterized by low productive density, poverty and poor social indicators in the areas of health, education and public safety.

Table 1. Weight (%) of GDP, Formal Employment and Population in subregions of Rio de Janeiro

Territory	GDP	Employment	Population
Metropolitan Region	64,7	77,4	74,3
City of Rio de Janeiro	*45,1*	*57,2*	*39,2*
Northeast Fluminense Region	0,9	1,3	2,0
North Fluminense Region	14,8	6,1	5,4
Serrana Region	3,3	4,3	5,0
Baixadas Litorâneas Region	7,4	3,5	4,7
Middle Paraíba Region	5,9	4,8	5,3
Center-South Region	1,1	1,4	1,7
Green Coast Region	1,9	1,4	1,6
State of Rio de Janeiro	**100,0**	**100,0**	**100,0**

Source: IBGE and RAIS/MTE.
Obs.: Population and Formal Employment Data correspond to 2014. GDP's data corresponds to 2013.

Among the other regions, the most important in terms of population, employment and GDP are the North Region, the Baixadas Litorâneas Region, the Serrana Region and the Middle Paraíba Region. The North Region, in particular, is notable for the industrial activities developed in the city of Macaé, the base of Petrobras' operations in the Campos Basin. The official state map that follows provides a panoramic perspective over geographic dimension

[9] Estimated population for the year 2014 according to IBGE (Brazilian Institute of Geography and Statistics).
[10] Estimate for GDP of 2013 according to IBGE's system of regional accounts.

(nearly 43.000 km², comparable in terms of area and population to Netherlands) and regionalization of Rio de Janeiro.

Figure 1. Map of Rio de Janeiro State and its regions.

Source: CEPERJ

With regard to the services sector, there is a particular concentration of activities of high relevance in the city of Rio de Janeiro. Among them, it is possible to list activities related to the production of audiovisual content, media, activities linked to culture, art and leisure, activities linked to tourism and ICT-related services and other activities of greater technological complexity such as research and project designs. In the metropolitan periphery, in general, the presence of services is related to activities that are not very dynamic (SEBRAE, 2014).

The specialization in services in the city of Rio is related to its capitality and its past as bureaucratic capital of the country. Activities related to the creative economy, such as the production of audiovisual content and services related to culture, art and leisure, are directly related to the historical role of the city of Rio in the formation of cultural values and symbolic production for Brazil and the rest of the world. In turn, Rio's past as a bureaucratic capital explains the presence of regulatory agencies, the headquarters of companies and important public agencies in addition to the presence of universities and scientific technological institutions that give base to important activities in areas such as research and design of projects.

With respect to the industrial sector, the productive structure in Rio de Janeiro has a specialization in the activities linked to the oil and gas production chain. In 2013[11],

[11] According to data from IBGE's Annual Industrial Survey (PIA / IBGE).

hydrocarbon extraction, support activities to hydrocarbon extraction and derivatives production activities accounted for 54.2% of industry value added in the State of Rio de Janeiro. The national O&G industry is highly concentrated in this state. Rio accounts for 63.1% of the country's value added in the oil and gas extraction sector and for 78.1% in support activities to mineral extraction. On the other side, downstream sectors are less concentrated and the state accounts for 18.4% of value added in refining and derivatives production.

Table 2. Manufacturing Value Added in Industry Companies with 5 or more employees, according to CNAE 2.0 division, in 2013

CNAE* 2.0 Div	Composition (%) of MVA in ERJ	Weight (%) of MVA Total - Brasil
Total	**100,0%**	**10,5%**
B - Extractive industries	**37,5%**	**28,9%**
05 - Coal Extraction	-	-
06 - Oil and Gas Extraction	30,9%	63,1%
07 - Metallic Mineral Extraction	-	-
08 - Non Metallic Minerals Extraction	0,6%	6,7%
09 - Support Activities to Minerals Extraction	6,1%	78,1%
C - Manufacturing Industries	**62,5%**	**7,6%**
19 - Coke, oil and biofuel derivated products Manufacturing	17,2%	18,4%

Source: PIA/IBGE
*National Classification of Economic Activities of Brazil.
Obs1.: Companies and industrial units with 5 employees or more.
Obs2.: The Rio de Janeiro Oil and Gas produtive system, as considered by Marcellino (2014), includes the divisions 06, 09 e 19 of CNAE 2.0.
Obs3.: Informations for CNAE 05 and 07 divisions were omitteds by IBGE for desidentification goals.

1.3. O&G industry as an opportunity for regional development

The importance of the oil sector in the economy of the State is based on the expressive endowment of reserves along its coast. Historically, the Campos Basin, located near the northern region of Rio de Janeiro, consolidated the position of Rio de Janeiro. Currently, the pre-salt reserves, present in the Santos Basin, which is largely located along the coast of the metropolitan and on the south coast, suggest that Rio de Janeiro will continue to be an important oil producer in the long term.

According to the ANP[12], about 82% of Brazil's proven oil reserves are located in the state of Rio de Janeiro, that is, there are more than 13 billion barrels of oil on Rio's continental shelf. With regard to natural gas, about 58% of the national reserves, that is, approximately 275 billion cubic meters of gas, are on the coast of Rio de Janeiro. This mineral wealth is quite expressive even in international terms.

Obviously, this production generated repercussions in the economy of Rio de Janeiro. Its main facet was the expansion of public revenue generated by the collection of royalties by the State government and by almost all municipal governments. The expansion of the oil and gas productive complex in Rio de Janeiro created a variety of productive links across several sectors. In terms of industry as a whole, however, these reflexes were limited. According to

[12] National Agency for Oil, Gas and Biofuels.

Sobral (2013), the productive structure of the State of Rio remains disconnected and more fragile than that of neighboring states (São Paulo and Minas Gerais), which went through a deeper and more diversified industrialization process.

In the debate about possible development strategies for Rio de Janeiro, there are critical arguments to this specialization, which point out to the fragility associated with the vulnerability of Rio de Janeiro's economic dynamics to oil's international prices (Urani, 2008). This adds to the risk of nurturing a Dutch disease like scenario in the country with over-valued exchange rate and its detrimental effects on export competitiveness of manufacturing, inflation and overall growth (Sachs and Warner 2001, Bresser-Pereira 2008).

This view contrasts with the thesis that highlight the changing conditions in world economy and the opportunities that arise for virtual development based on natural resources. Increasing globalization, associated with a shift in historical trajectories of falling relative prices of natural resources, the diffusion of ICTs and growing environmental concerns and regulations, might open new windows of opportunities for connecting natural resources exploration with consistent innovation policies, combined with bottom-up stimulus in other sectors (Perez et al 2014, Perez 2016, Katz 2013).

Thus, this specialization might accord greater complexity to the 'hollow industrial structure' of Rio de Janeiro[13]. This potential can be seen in two ways: through possible productive links with other sectors present in Rio de Janeiro, such as the naval and steel industries, as well as through innovation in several directly or indirectly associated segments and knowledge spillovers within the regional system of innovation in Rio de Janeiro (Marcellino, 2014). The complex network of research institutions build around Petrobras and partner organizations, associated with the technological challenges imposed by the production of oil in deep waters, constitutes a unique endowment, putting the state in a privileged position for exploring the windows of opportunities envisaged by Perez and others.

These authors also recognize the potential challenges connected to the strategies of those who own or control the main strategic assets. Potential conflicts of interests between development goals and the strategies of big corporations - often multinationals - might be less relevant in Brazil because a national state owned enterprise is the key player. But, as discussed in this paper, a historical view of power relations and politics bring far deeper implication. Challenges are not limited to establishing conducive institutions. This issue seems to be not sufficiently explored by those authors and this paper seeks to provide some contributions in this respect.

The Innovation System and the Oil and Natural Gas Productive Complex in the State of Rio de Janeiro

Our focus of our analysis is the state of Rio de Janeiro and its political, economic and institutional set-up. We depart from the recognition of the IS framework as a useful tool for understanding the challenges and opportunities associated to innovation policy (understood as an articulation between S&T, education/formation, industrial and regional policies) and the promotion of development, giving special emphasis to the potential opportunities connected to Rio's O&G endowment and the historical processes that led to the formation of an important production and innovation network.

The innovation systems framework sheds light on the determinant role of capacity building and innovation for sustained development and the essentially interactive and systemic pattern

[13] The concept of 'hollow industrial structure' refers to the lack of density along many supply networks connected to sectors such as automobile, naval, metalworking, steel, oil and gas, etc. in the State of Rio de Janeiro (Sobral, 2013).

of those processes. The Innovation System (IS) can be understood as a set of institutions and organizations, whose interactions contribute for the generation, use and the dissemination of knowledge. The system includes a wide range of actors such as private and public companies, scientific and technological institutions, development agencies, representative bodies, technical and higher education institutes, policymakers and also the sociocultural patterns (Freeman 1982, 1987; Lundvall 1985, 1992, Cassiolato et al 2003, 2014; Arocena and Sutz 2003; Dutrenit and Sutz 2014).

In fact, in order to tackle all facets of our object, an integrated perspective has to be mobilized, which combines elements inherent to the national and local/regional innovation system frameworks. First, the perspective on the National System of Innovation is partially useful once the main forces associated with the creation and development of Petrobras and the industrial and innovation network of O&G relate to strategic initiatives and decisions steaming from the federal sphere. By chance, some states with relevant occurrences of reserves benefited from this[14]. In early periods, state policies were at most complementary, as discussed in section 3. But these carry the potential of being decisive drives and, thus, how national and state policies interact in respect to the O&G innovation system deserve our attention.

Second, on the other extreme, we find concrete local or regional territories to be especially relevant. As depicted above, main activities connected to the O&G innovation system are concentrated around the cities of Macaé and Rio de Janeiro, building upon all sorts of positive effects and spill-over steaming from proximity and direct and close interaction. An in depth analysis of the characteristics and determinants of the territorial concentration of this system and its processes of capacity building would benefit from the framework of Local Innovation and Production Systems - LIPSs (Lastres and Cassiolato 2005; Matos et al. 2013). In fact, relevant studies from this perspective have been undertaken by (Oliveira and Rubiano 2011, Britto and Vargas 2015).

But, when it comes to understand the specificities connected to the state of Rio de Janeiro, we need to shed special light upon the institutions and the territory in this dimension. This invites us to conceptualize an instrumental analytical framework which we could call a State Innovation System[15].

In this session, the aspects pertinent to the subsystems of production and knowledge use will be presented in general lines. Because it is the most important sector and exerts a strong influence on the innovative activities carried out in the state of Rio de Janeiro, our focus is on the productive complex of oil and gas. The issues related to state innovation policies, inserted in an institutional framework marked by clientelistic and fragmentary logic, and the policies' focus on the oil and gas complex as a vector for the strengthening of the IS in Rio de Janeiro, will be discussed in the following session.

The State of Rio de Janeiro hosts an expressive group of organizations and institutions focused on the generation of scientific and technological knowledge. To some extent, this is due to its past as national capital. This helps to explain the presence of numerous federal

[14] In fact, in early periods states with relevant on shore reserves, such as Bahia, constituted relevant sites for establishing production structures of Petrobras. But both the initial off shore exploration - which started at relatively less deep sea ground - and the role of Rio de Janeiro as the capital until 1960, contributed for the concentration of O&G activities in this state, as detailed above (Novaes 2010).

[15] Regional Innovation System (Cooke 1992; Cooke et al 1997; Doloreux, 2003, 2004; Doloreux et al. 2004; Arancegui 2009) might be regarded as a good framework for tackling issues related to this dimension of analysis. This framework has been predominantly applied to analyze innovation systems in sub national portions of territory in developed countries - especially in Europe. But it is not specifically connected to political arrangements at the state level within a federalist structure as the one of Brazil and it does not incorporate issues related to the specificities and challenges of developing countries, which play a major role in reinterpreting and applying the innovation system framework (Cassiolato et al. 2012; Cassiolato et al. 2014).

institutions connected to the productive sphere and to science and technology infrastructure (Marcellino et al, 2013).

Regarding its innovation capacity, the industry of Rio de Janeiro shows results below the national average. This pattern can be illustrated by Rio de Janeiro's rate of innovation, which shows worse results than Brazil as a whole. This is an indication that the results of the innovative efforts are concentrated in a smaller proportion of companies compared to other states.

At the same time, data relating to innovative efforts ignore a specificity of Rio de Janeiro. The IS of the State stands out for having the highest proportion of R&D expenditures in total spending on innovation. This evidence reveals the intensity in this type of innovative effort, typical of larger firms, which are likely to concentrate the benefits of this investment (Britto et al. 2015). The companies involved in oil and gas extraction activities, which are generally large in size and invest in R&D, contribute significantly to this pattern.

Table 3. Percentage of companies which introduced innovations in Brazil, states and regions - 2000, 2003, 2005, 2008 e 2011

Regions and Federation Units	Innovation general rate				P&D and Innovation Expenditures			
	2003	2005	2008	2011	2003	2005	2008	2011
Brasil	**33,30%**	**33,40%**	**38,10%**	**35,60%**	**21,80%**	**20,70%**	**24,50%**	**29,80%**
North	**34,90%**	**32,30%**	**35,80%**	**33,20%**	**19,30%**	**15,60%**	**13,90%**	**11,70%**
Northeast	**32,40%**	**32,00%**	**33,80%**	**36,30%**	**6,20%**	**11,60%**	**13,80%**	**23,60%**
Southeast	**31,40%**	**32,00%**	**37,20%**	**34,40%**	**25,70%**	**22,30%**	**28,00%**	**33,80%**
Minas Gerais	34,90%	29,50%	41,40%	40,50%	14,40%	14,90%	20,80%	20,60%
Rio de Janeiro	25,00%	25,70%	32,90%	29,60%	38,50%	39,30%	47,70%	68,30%
São Paulo	31,10%	33,60%	36,40%	33,30%	25,60%	21,50%	26,30%	28,70%
South	**37,70%**	**37,30%**	**41,60%**	**36,90%**	**15,20%**	**18,10%**	**17,40%**	**25,80%**
Paraná	36,90%	40,50%	42,70%	33,50%	12,50%	14,00%	18,20%	25,10%
Santa Catarina	35,90%	34,90%	37,90%	34,60%	15,50%	22,50%	16,90%	24,50%
Rio Grande do Sul	39,90%	36,50%	44,10%	42,20%	18,10%	18,30%	17,10%	27,60%
Center West	**31,70%**	**30,80%**	**39,90%**	**39,40%**	**5,90%**	**4,20%**	**6,90%**	**5,50%**

Source: PINTEC/IBGE.

Considering the importance of the activities related to the extraction of hydrocarbons, it should be noted that it can be considered as the main vector of the research structure in Rio de Janeiro's IS. Petrobras' role is historically important due to its large investments in research infrastructure, capacity building, support for the technological development of its suppliers and partners, and also for investing significantly in research structures in universities. The company is considered the main structuring actor of knowledge and interaction networks in the state of Rio de Janeiro. According to Turchi et al (2013), between 1992 and 2009, approximately 54% of the value allocated in R&D contracts by Petrobras was concentrated in scientific and technological institutions located in Rio de Janeiro.

In particular, Rio de Janeiro is characterized by the presence of S&T centers and research groups linked to the oil and gas complex (Marcellino 2014). Most of these centers are linked

to the main universities of Rio de Janeiro: UFRJ, UFF, UERJ, UNIRIO and PUC-Rio[16]. Emphasis can be given to UFRJ, which hosts most of these centers and research groups in its main campus, in Fundão Island, This proximity favors intense interaction processes, either through academic collaboration or transfer of intellectual, physical and human resources. The main centers, all located on the main campus of UFRJ, are CENPES[17], COPPE[18] and the UFRJ Technology Park. In fact, according to Turchi et al (2013), between 1992 and 2009 about 25% of the value allocated in science and technology contracts by Petrobras was directed to UFRJ (and in second place to PUC-Rio with about 12%), while other State institutions together received about 17%.

CENPES is Petrobras' R&D center, responsible for leading the company's technological effort and coordinating interaction activities with suppliers and partners. COPPE, as a pioneer institution in engineering postgraduate studies in Brazil and for its academic reputation, is a traditional and important partner of Petrobras, especially in applied research. The UFRJ Technological Park, which counts with the presence of R&D laboratories of global players in the O&G industry, engages in research with a focus on deep-water production technologies and other important areas to make production feasible in the Pre-Salt. Despite the unfavorable national and international scenarios for the oil sector and Petrobras, these technological centers continue to be important for the capabilities and research skills they possess.

The fundamental aspect of these capacities and competences in research is the fact that, although they are inserted in the logic of the productive complex of oil and gas, they are not restricted to it. An example of this is the abundance of research fields and capacities that CENPES hosts. According to a survey conducted by Marcellino (2014), CENPES has 24 internal divisions, each with a focus on research that encompasses several areas of knowledge in engineering and natural sciences with potential for synergies with other sectors of activities.

Table 4. Internal sections of CENPES and related knowledge areas.

Sections of CENPES	Related Knowledge Areas
Enviromental Rating and Monitoring	Enviromental Engineering, Ecology
Bioestiography and Paleoecology	Geosciences
Biotechnology	Biology, Chemistry, Chemical Engineering, Environmental Engineering, Ecology
Fuels	Chemistry and Chemical Engineering
Product Performance in Engines	Mechanical Engineering, Chemical Engineering
Lift and flow	Mechanical Engineering
Renewable Energies	Various Engineerings
Well Engineering	Oil Engineerings and others
Natural gas	Chemistry and Various Engineerings
Geophysics	Geosciences
Geochemistry	Geosciences and Chemistry
Hydrorefining and Special Processes	Chemistry and Chemical Engineering
Lubricants and Special Products	Chemistry and Chemical Engineering
Corrosion materials and equipments	Metallurgical and Materials Engineering

[16] Universidade Federal do Rio de Janeiro, Universidade Federal Fluminense, Universidade do Estado do Rio de Janeiro, Universidade Federal do Estado do Rio de Janeiro e Pontífice Universidade Católica do Rio de Janeiro.
[17] Leopoldo Américo Miguez de Mello Research Center, linked to Petrobras and responsible for conducting and coordinating research and development activities.
[18] Alberto Luiz Coimbra Institute for Graduate Studies and Engineering Research of UFRJ, which fulfills the function of coordinating the postgraduate courses of technology-based courses at UFRJ.

Collaborative visual core	Computer Science
Petrochemicals	Chemistry and Chemical Engineering
Pilot Plants	Various Engineerings
Primary Processing and Oil Evaluation	Chemistry
Chemistry	Chemistry
Reservoir Recovery and Analysis	Chemistry, Chemical Engineering, Civil Construction, Mechanical Engineering, Oceanography
Water Reuse	Production Engineering, Mechanical Engineering
Sedimentology and Petrology	Geosciences
FCC Technology (Fluid catalytic cracking)	Chemistry
Subsea Technology	Civil Construction, Electrical Engineering, Mechanical Engineering, Naval and Ocean Engineering, Metallurgical and Materials Engineering, Various Engineerings

Source: Marcellino (2014).

In terms of human resources, the population of masters and doctors in the State of Rio de Janeiro concentrates in the areas related to Petrobras. According to Marcellino et al (2013), the relatively higher concentration of doctors in areas of knowledge linked to engineering and the so-called natural sciences is a characteristic of the IS of the State of Rio de Janeiro. According to a survey carried out by Viotti et al (2010), between 1996 and 2008, about a quarter of doctor grades granted in in Rio de Janeiro were in engineering, while the national average is only 12%.

These skills and competences in research are not limited to the companies' research centers. Many research groups and laboratories linked to universities interact and cooperate with these companies and research centers. According to CNPq[19], in 2014, there were 4,147 research groups in Rio de Janeiro, representing 11.7% of research groups in Brazil. Considering only the research groups that reported interaction with companies, there were 1,216 groups in Rio de Janeiro, representing 13% of the countries´ interactive research groups.

According to Marcellino (2014) there is a relative specialization in the university-companies (U-C) interaction in favor of the areas of interest of the oil and gas complex. In fact, in 2010[20], about 37% of all research groups that interacted with companies conducted research in the area of engineering. The other lines of research identified as pertinent to the CENPES divisions account for a proportion of 45% of the total. That is, the U-C interaction in Rio de Janeiro focuses on areas that are of interest to companies of the oil and gas complex.

Starting within the O&G productive complex, the building of knowledge networks can open the door to new possibilities in the form of knowledge and technology spillovers to other sectors. To some extent, this constitutes an evidence that the oil-related activities can play a strategic role for the development of the State Innovation System, both in terms of chaining effects on many sectors and in terms of mobilizing a complex and diversified knowledge base with relevant spill overs to other activities in the territory.

For these reasons, a development agenda for Rio de Janeiro must take into account the potential for innovation provided by activities related to the extraction of hydrocarbons. But,

[19] National Council for Scientific and Technological Development, subordinated to the Ministry of Science, Technology and Innovation.

[20] CNPq data on interactive research groups for 2014 are not yet available for this level of disaggregation.

along the last state administrations neither a solid strategy to build upon this potential nor the appropriate focus on innovation policy could be identified. The following session discusses this issue in more detail.

Innovation Policies and their focus on the Oil and Natural Gas Production Complex

3.1. State and National Innovation Policies in Rio de Janeiro

There are two spheres from which the initiatives to support regional innovation in oil and natural gas emerge in Rio de Janeiro, the national and the state spheres. At the municipal level, it is not possible to say that there is a structure comparable to the other spheres, not even in the capital. A fact that corroborates this view is the lack of municipal secretariats focused on science and technology in most of the municipalities of Rio de Janeiro, and the incipience of most of the few that exist. Even among the most mature, there is no focus on strategic sectors than those related to strictly urban questions.

Of the initiatives of national and state scope, an important dimension is the financing of national and state scientific-technological policies. However, there is no organized data available that allows a full appreciation of the allocation of these resources broken down by economic activity and region. For this reason, it is only possible to make a survey of the expenditures of state governments in S&T in a generic way, without specifying the research expenditures aimed at the activities involved in the production of oil, natural gas and its derivatives.

In absolute terms, the expenditure of the government of Rio de Janeiro with S&T increased in between 2007 and 2014. The main reason for this advance was a change in state legislation which in 2007 determined that FAPERJ's[21] budget would correspond to 2% of Rio de Janeiro's public budget net income, double the amount previously defined (FAPERJ, 2014). This change occurred under the auspices of the announcement of the existence of hydrocarbon reserves in the Pre Sal Basin. Within an adaption deadline, FAPERJ's budget increased in order to approach the new legally established rule. This, of course, reflected on the state expenditure on S&T, which rose from 302 million BRL in 2006 to 418 million in 2007, reaching 800 million in 2011 and culminating in 960 million BRL in 2013[22].

However, the current outlook is negative. In a recent deep fiscal crisis, there has already been an initiative by the government to try to change legislation and reduce FAPERJ's budget from 2% to 1% of state net revenue[23]. In addition, the Brazilian crisis, the global crisis and the persistence of low prices for oil, intensify the negative perspectives on the fiscal result in the coming years, causing a strong decline in the state public revenues, impacting FAPERJ's budget. Regarding the causes of Rio de Janeiro's crisis and the alternative ways of overcoming it, it is understood that FAPERJ and the Innovation System of Rio de Janeiro as a whole must be preserved and strengthened, as they play a crucial role in the process of economic development and structural change.

[21] Carlos Chagas Filho Foundation for Research Support of the State of Rio de Janeiro. It is the leading state institution in terms of investment in science, technology and innovation.

[22] According to data from the Ministry of Science, Technology and Innovation (MCTI).

[23] This attempt occurred at the end of 2015 with a proposal made by the state government in the Legislative Assembly of the State of Rio de Janeiro (ALERJ), which was later rejected after strong mobilization of groups linked to research and science in the state. However, even if the allocation of resources to FAPERJ were not legally diminished, it seems to be significantly delayed during the current state fiscal crisis, affecting deeply researchers, students and state public universities.

In relative terms, Rio de Janeiro, at least until 2013, was the federation unit with the second largest expenditure on science and technology. In that year, the state government spent 960 million BRL on S&T, compared to 771 million spent by the State of Paraná (the third largest expenditure) and 8.7 billion spent by the State of São Paulo (the highest expenditure). It is clear that São Paulo's investment is well above the standard investment of other units of the federation. Partly, this derives from the fact that the GDP of São Paulo is the largest in Brazil.

It is also possible to broadly characterize the allocation of federal resources in scientific technological activities in Rio de Janeiro. In terms of support to research and scholarships, it is possible to compare the amount of resources allocated in Rio de Janeiro by the most important federal funding institutions (CNPq and CAPES[24]) with FAPERJ's. This data provides a comparison parameter between national and state stimulus to S&T activities.

Table 5.CNPq and CAPES scholarships and research support expenditures in Rio de Janeiro and budget executed by FAPERJ between 2002 and 2012 (in thousands of R$)

Year	CAPES + CNPq	FAPERJ Budget
2002	164.808	116.840
2003	178.689	110.000
2004	214.029	138.220
2005	229.704	148.710
2006	237.591	155.380
2007	289.296	225.730
2008	291.714	271.210
2009	400.525	292.110
2010	456.666	356.020
2011	453.014	369.760
2012	565.961	399.080

Source: GeoCAPES, Investments Panel/CNPq and FAPERJ (2013).

It is important to note that the comparative analysis presented overestimates FAPERJ's effort, since the total budget also comprises operating expenses and other expenses besides those with direct purpose of stimulating S&T activities. At the same time, the presented sum of the resources allocated by CNPq and CAPES are only a portion of the federal government's contribution and therefore, is underestimated. In spite of these considerations, we observe that the values allocated by the federal institutions in Rio de Janeiro (even underestimated) exceed the state institution's own budget. This difference reveals that the financing effort in Rio's IS is predominantly federal.

This predominance of national initiatives is also a trend in the oil and gas complex. The validation of this hypothesis is supported by the comparative analysis of national and regional initiatives which foster the innovative activity in the productive complex. There is a set of federal policies and instruments (such as FINEP[25] sectoral funds, BNDES[26] programs, ANP[27]

[24] National Council for Scientific and Technological Development, subordinated to the Ministry of Science, Technology and Innovation and Coordination of Improvement of Higher Education Personnel, connected to the Ministry of Education. The two are the main national organizations for the promotion of scientific and technological activities.
[25] Funder of Studies and Projects, federal public agency focused on the financing of innovation.
[26] National Bank for Economic and Social Development.

initiatives, PROMINP[28], among others) that have the capacity to allocate resources in Rio de Janeiro besides the aforementioned CAPES and CNPq, which together define sectoral priorities that contemplate the O&G complex. At the State level, however, there is not yet a specific program that provides funding, credit or economic subvention to innovative activities exclusively for the sectors of the O&G complex.

3.2. The Institutional Infrastructure of Rio de Janeiro's IS

The institutional dimension of an innovation system plays a key role in the dynamics of innovative activities. This stems from the institutions' capacity to lead or stimulate initiatives aimed at the generation and application of knowledge, technologies and innovations at the regional level. In the Brazilian case, this State activity is foreseen in the Constitution and regulated by the Law of Innovation.

According to this law, initiatives that favor basic research and applied research, whose aimed effect is the advancement of scientific knowledge and the solution of the technological problems inherent to the Brazilian reality, are placed as priority of the State. The generation of knowledge and technologies must be carried out in order to give the country better conditions for national and regional socioeconomic development. For these purposes, the Innovation Law provides for the use of the domestic market and enables the federation units' governments to participate in the national scientific and technological effort.

In enabling the use of the domestic market for the stimulus of innovation, the Innovation Law provides the basis for ANP regulations concerning its local content policy. In terms of production, the regulatory agency establishes a minimum quota of local content (raw materials, services, human resources and other inputs provided by companies located in the Brazilian territory) in the activities of the companies it regulates, including transnational companies present in the country. The ANP also regulates the requirement for a minimum investment in R&D in Brazilian territory to be carried out by companies of the oil sector and its suppliers. The minimum investment in R&D corresponds to 1% of the gross revenue of firms[29].

By allowing the federation units to participate in the research effort, the Constitution gives subnational innovation systems a certain degree of autonomy in the conduct of scientific and technological development policies. This participation, in addition to not being mandatory, does not provide for a homogeneous structuring of initiatives in the states. The design of a innovation policy is dependent on the state governments in connection to their own development strategies. However, there is a certain level of centralization of this strategy around the transversal institutions of the national innovation system (such as CAPES, CNPq and MCTI), which regulate and transfer resources to state instances such as Scientific and Technological Institutions (ICTs) and Support Foundations for Research (such as FAPERJ).

In the case of Rio de Janeiro, the current legal framework relies on the State Law of Technological Innovation, which dictates the general lines of ST&I policies for the state government. In addition to addressing the incentives to technological innovation and research at the state level, this law determines the structuring of what it calls the State Innovation System of Rio de Janeiro, indicating the role to be fulfilled by each actor. FAPERJ and the ICTs are identified as the main agents and executors through the promotion and encouragement of technological transfer to productive sectors, scientific and technological research, the formation of cooperation networks and partnerships in the innovation effort, the

[27] National Agency of Oil, Gas and Biofuels, governmental body that plays the role of regulating and stimulating the development of the sectors that compose the oil and gas productive chain in Brazil.
[28] Program for the Mobilization of the National Oil and Gas Industry.
[29] Type of specific tax for hydrocarbon extraction activities established by the Brazilian Constitution.

equipping of facilities and training of human resources for the viability of innovative activities.

There is an institutional hierarchy in the state ST&I policy. This structure is basically composed by the State Government (as the maximum entity), the State Secretariat for Science, Technology and Innovation of Rio de Janeiro (SECTI) and the State Council for Science and Information Technology (CONSETI). The State Government is responsible for defining general strategies in its planning and allocation of resources, especially the Technological Development Support Fund (FATEC[30] - FAPERJ's main source of funds); SECTI is responsible for conducting government policies and programs focused on the theme of ST&I, and CONSETI, based on the definition of guidelines, is responsible for establishing the priorities of state industrial and technological policy.

According to the aforementioned Law, the configuration of the State Innovation System is characterized by a significant decentralization. On one hand, FAPERJ and the ICTs have a high degree of autonomy in the execution of their policies to support innovation. On the other hand, SECTI and CONSETI exert influence in the definition of general strategic guidelines for the conduct of the S,T&I policy and therefore, can define priorities.

CONSETI's capacity to conduct innovation efforts is partly compromised due to its subordination to the national innovation policy and its definition of guidelines. This subordination occurs as the state innovation law foresees the observance of the guidelines of the CNPq and other federal institutions responsible for defining priorities for the national industrial and technological policy.

There are, therefore, two aspects that hinder coordination and render unfeasible a more active state ST&I policy. The first is the Brazilian legislation itself and the characteristics of a relatively centralizing federalism, which limits the ability of different regions to set priorities that comply with regional development strategies distinct from the national strategy, which often ignores regional specificities.

The second is influenced by the peculiar political logic of Rio de Janeiro and by the fact that the public machine of Rio de Janeiro has deteriorated significantly in the long period of its economic and social crisis. Frequently, this scenario allows for policies to follow the imperatives of clientelistic relationships and fragmentary interests, distancing themselves from the necessary coordination of efforts. A strong indication of this weakness is the lack of important actors in CONSETI and the separation between the configuration of FAPERJ's edicts and the configuration of the state productive structure itself.

Evidence on this matter can be verified by observing the divergence between the actual composition of CONSETI and the composition envisaged in Law 5,361/2008 and the pulverized aspect of the resources foreseen in FAPERJ's edicts, despite the recent advances (Marcellino et al. 2013).

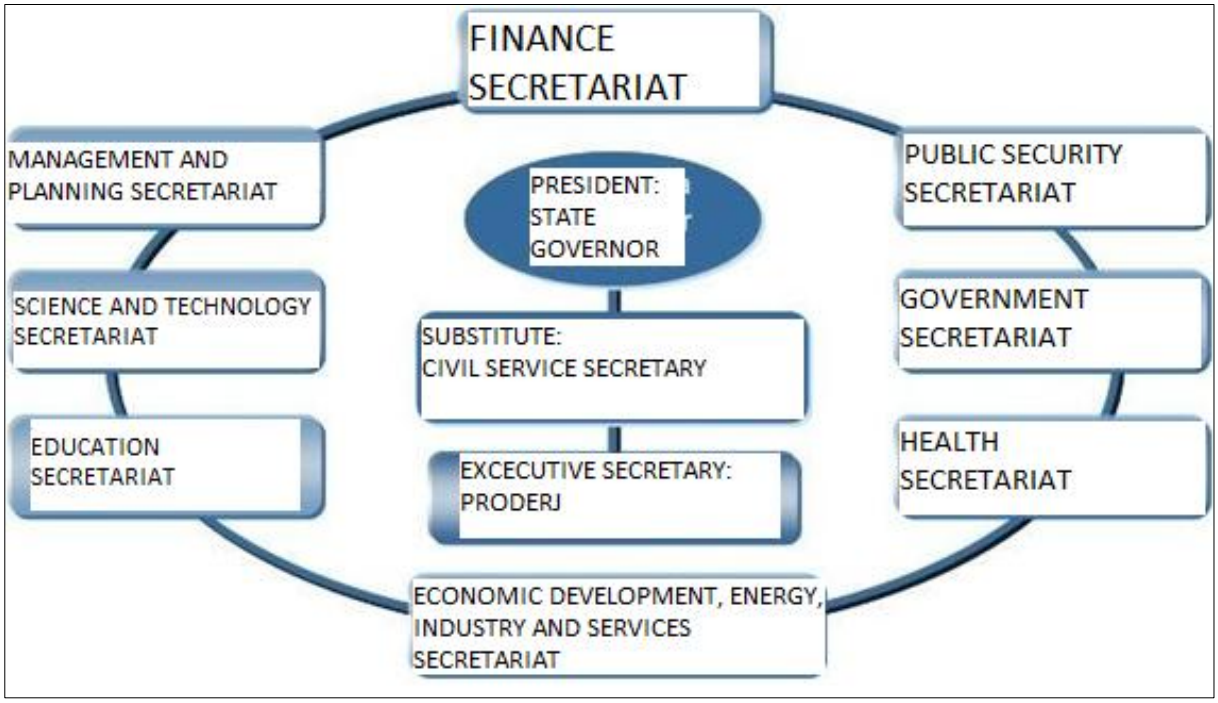
According to the legislation, CONSETI should be formed by the following actors: i) Secretary of State for Science and Technology (in the condition of President of the Council); ii) Secretary of State of Finance; iii) Secretary of Planning and Management; iv) Secretary of State for Economic Development, Energy, Industry and Services; v) Secretary of State for Agriculture, Livestock, Fisheries and Supply; vi) Chief Executive Officer of FAPERJ; vii) Technology Director of FAPERJ; viii) Rector of UERJ; ix) Rector of the UENF; x) Rector of the UEZO[31]; xi) other representatives, of the Governor of the State's free choice, of the following institutions: 1 representative of federal universities; 1 representative of the federal

[30] Support Fund for Technological Development.
[31] UERJ, UENF and UEZO are the three state universities that exist in Rio de Janeiro.

institutes (IFF, IFRJ and related); 1 SEBRAE[32] representative; 1 representative of FIRJAN[33]; 1 representative of ICTs; 1 representative of the Federation of Foreign Chambers of Commerce; In addition to (xii) an executive secretary of the Council, of the Governor of the State's free choice.

CONSETI's current structure is shown in figure 2. It can be seen that CONSETI only includes representatives of governmental institutions that are directly or indirectly involved in the formulation and implementation of innovation policies. There are no members representing ICTs, universities or the productive sector. This absence indicates an excessive emphasis on the representation of actors that are part of the public management; points out the existence of deficiencies in the connection between the subsystems of knowledge generation and use and the subsystem of innovation policies.

Figure 2. CONSETI Current Structure.



Source: Own elaboration

With respect to FAPERJ, the attendance to the 92 municipalities of Rio de Janeiro is one of the institution's strategic priorities (FAPERJ 2013). In the context of social policies and the provision of basic services to the population, the logic of universalization has the potential to generate positive impacts, but this does not necessarily apply to policies that support scientific and technological development. Whether due to the geographic heterogeneity of the state of Rio, or to the potentiality identified in the oil and gas productive complex, it is worth questioning an emphasis on the universalization strategy.

This institution currently has 46 programs that support activities related to science, technology and innovation, which are operated through edicts. It is not possible to analyze in depth the operation of these programs because FAPERJ does not provide organized data on resources allocated in each one. However, a general appreciation of the programs and edicts launched between 2007 and 2016 shows that the operation of these programs does not happen

[32] Brazilian Support Service to Micro and Small Companies.
[33] Federation of Industries of the State of Rio de Janeiro.

regularly. That is, while a small set of programs have their edicts released with defined frequency (annual, biannual, etc.), the edicts corresponding to most programs are released with undefined frequency.

In addition to the sporadic and erratic character of some of FAPERJ's programs, through an analysis of their objectives, it is possible to notice a diversification strategy in the Foundation's activities. Most of the programs that are concluded – generally, those whose edicts are launched with greater frequency – focus on strictly academic activities, linked to higher education institutions, with no emphasis on knowledge areas or productive sectors. In summary, these programs are dedicated to supporting universities and their students, teachers and research groups on different fronts: granting scholarships, supporting postgraduate activities, promoting research without thematic focus and funding for infrastructure improvements.

There are also programs with a defined sector focus. Among them, six programs prioritize lines of research related to life sciences, especially human and animal health and biology and biotechnology related topics. In fact, the existence of such programs has a connection with the region's potentialities and social demands, since there is a complex of firms and other organizations connected to the health sector in the State of Rio that, connected with the Brazilian Universal Health System and with nationally renowned ICTs specialized in research, owns an important potential in the state's innovation system.

There are other isolated programs for areas such as the environment, information and communication technologies, agriculture, design, sports and the arts (including audiovisual). Differently from what was observed in the case of life sciences, however, these isolated programs do not constitute a coherent set capable of justifying the specific strategic focus in any of these areas. In spite of being included in the regional innovation policy agenda, the activity in these areas apparently occurs in a pulverized, sporadic form, disconnected from a broader strategy.

Lastly, out of the 46 existing programs at FAPERJ, no specific program aimed at research or innovation activities related to the oil and gas complex was identified. However, there are three programs of a certain prominence in FAPERJ whose design, in theory, allows the institution to act alongside the oil and gas productive complex. These are the *Rio Inovação, Pensa Rio* and *Prioridade Rio* programs.

The *Rio Inovação* program, which has so far only launched a single edict in 2013, targets micro and small companies in Rio de Janeiro with innovative projects in priority areas, such as energy, refinery and port services, shipbuilding and petrochemical industries. However, according to the results announced in the 2013 edict, the scope of activities assisted by the program differed from that initially intended. Of the total of 25 million BRL allocated, only 3 million went to companies whose activities are linked to oil and natural gas (Marcellino, 2014).

The *Pensa Rio* program aims to support the study and topics considered as strategic for the State of Rio de Janeiro. There is a regular frequency in the operation of this program. In the last ten years four edicts were launched. However, the pulverization of efforts again appears as a characteristic of FAPERJ. This is deduced from the very expressive amount of prioritized themes, ranging from 35 to 39 research themes.

The *Prioridade Rio* program is dedicated to supporting research on topics selected as priorities by the government departments of the state of Rio de Janeiro. Since 2007, five calls for proposals have been launched. The 2007 edict reveals concern for five areas, all related to public administration, essential public services (health, education and security) and sustainable development. In 2008, the program's focus was increased as the edict only aimed at research related to the theme of public security. In the 2010, 2012 and 2014 edicts,

however, there was a significant increase in priority themes, probably due to the adhesion of other secretariats to the design process of the program's edicts.

This adhesion of new instances, however, did not favor the connection of their demands and the boost of synergies. Apparently, the structure of these edicts reflects a definition of priorities through modules presented by each government secretariat without a greater effort of strategic coordination. The issues related to the technological agenda of oil and gas production have not been comprehensively addressed by the program neither in the initial edicts nor in the most recent ones. This pattern is visible in the table 5.

Table 5. Distribution (%) of FAPERJ investiments among institutional S,T&I support programs, except regular flow support to students, researchers and scholar publications - 2007-2014

Institutional Program	Total	Share
Pensa Rio	132.566.688,08	24,0%
Support to Teaching and Research Institutions in the State of Rio de Janeiro	118.353.159,18	21,5%
Support to National Institutes of Science and Technology in the State of Rio de Janeiro	101.421.527,76	18,4%
Support to State universities of Rio de Janeiro	80.522.640,73	14,6%
Support to Technological Innovation in the State of Rio de Janeiro	53.300.842,00	9,7%
Prioridade Rio	40.310.646,33	7,3%
Support for the Dissemination and Popularization of Science and Technology in the State of Rio de Janeiro	13.323.824,53	2,4%
Support for the Improvement of Teaching in Public Schools in the State of Rio de Janeiro	11.923.012,28	2,2%

Source: FAPERJ (2014, 2014a, 2014b, 2014c, 2014d, 2014e, 2014f, 2014g)

Among the institutional programs operated by FAPERJ there is a set regarded as strategic inserted in a logic of meeting three kinds of demands. Demands from private sector, education and scholar demands and demands from other public sector. The low connection between FAPERJ support and private sector is reflected by the fact that less than 13% of important share of the institutional programs were directed to meet private sectors demands (that is, 9,7% allocated in the program dedicated to technological innovation in Rio de Janeiro and 2,4% allocated in the program dedicated to dissemination of S&T, potentially promoting diffusion of innovations among firms). As pointed out, even the share dedicated to public sector demands, more than 50% (support to research institutions, public schools, state universities and to national S&T institutes located in Rio) probably is not well connected to explore synergies with entrepreneurial demands, even in the oil and gas industry.

3.3. The O&G Complex as a focus of programs and policies for scientific and technological development at the State level

At the state level, Rio de Janeiro counts with a set of institutions dedicated to scientific-technological and industrial development (ICTs). In addition to the state secretariats for

economic development, energy, industry and services (SEDEIS) and for science, technology and innovation (SECTI), with similar purposes, there are autarchies linked to these secretariats with the capacity to develop policies for these purposes, such as FAPERJ, AGERIO[34] and CODIN[35]. In addition to these government instances, the Federation of Industries of the State of Rio de Janeiro (FIRJAN), as representative body, and the Rio de Janeiro's section of the Brazilian Support Service to Micro and Small Enterprises (SEBRAE / RJ) also collaborate in this regard.

In an effort to map the regional policy initiative, Marcellino (2014) lists, among the actions that emphasize innovation in the oil and gas complex, the recent creation of SECTI's oil, gas and heavy industry superintendence, the support to the formation of a subsea production cluster, within the framework of SEDEIS, and the Rio Capital of Energy program, which involve both the aforementioned government secretariats and state ICTs. The initiatives that embrace ST&I in a generic way, without sectoral or thematic specification, comprise the efforts undertaken by AGERIO, FIRJAN and FAPERJ. Among the initiatives that address sectoral issues related to the oil and gas complex and the issues of science, technology and innovation, are the initiatives carried out by institutions such as FIRJAN and SEBRAE.

The Rio Capital of Energy program, created by the state government in 2011, aims to coordinate efforts to address the issue of energy associated with sustainability. With a focus on both companies and ICTs present in the state of Rio, the sectoral scope of the program extends beyond activities related to the oil and gas complex, encompassing other segments such as the traditional electricity sector (generation, transmission and distribution), ethanol production and other types of biofuels and sectors related to alternative energy such as wind, solar and nuclear energy.

The program is structured around two committees, a strategic one composed of authorities and representatives of institutions and a technical one, composed of specialists from the program's partner companies and a coordinator linked to SEDEIS. While the former is responsible for defining the strategies that will guide the projects of participating companies and institutions, the second is responsible for selecting and monitoring the projects approved. The four areas of activity on which the Rio Capital of Energy program is structured are: technological innovation, energy efficiency, carbon economy and massification of the concept of sustainable energy.

These support activities to innovation, which are the most prominent in the program, follow a multisectoral scope defined around the activities pertinent to the composition of the energy matrix in Rio de Janeiro. Among the supported research projects, a good proportion addresses issues related to the electric sector or alternative energy sources. Of the projects and initiatives supported by the Rio Capital of Energy program that are related to the activities of the O&G complex, many deal with the creation of more environmentally friendly fuels and biofuel, research on natural gas technologies and the support to IBP and ONIP's[36] initiatives. The articulation of the program with projects promoted by companies occurs predominantly in the scope of the electric sector and the sugar and alcohol sector, while the relationship between this program and O&G related research limits itself to universities and class entities (IBP and ONIP).

[34] State Agency for the Development of Rio de Janeiro. Linked to SEDEIS, it has the purpose of promoting companies and initiatives capable of stimulating the development of the state of Rio de Janeiro.

[35] Industrial Development Fellowship of the State of Rio de Janeiro, state administration body whose mission is to stimulate the industrial development of Rio de Janeiro through attraction of large enterprises, institutionalization of industrial districts, among other instruments.

[36] Brazilian Institute of Oil, Gas and Biofuels and National Organization of the Oil Industry. Both fulfill the role of representing the groups involved in the production of oil and oil derivatives in Brazil.

As we see, the innovation support approach of the Rio Capital of Energy program rather contemplates other activities. Thus, despite its proposal and objectives, the program has little dialogue with the innovative effort of the O&G complex.

Proceeding with the policies that contemplate innovation in O&G from a sectoral perspective, there is at SEDEIS the initiative to support Rio de Janeiro's subsea cluster, which started in 2012. Although this is not an innovation support initiative, we can consider that it addresses this issue once it constitutes a sectoral policy that operates in a niche that presents cutting-edge technologies in the current state of the global oil industry. The advances resulting from this program have significant potential, since deepwater production requires technological efforts in the subsea area.

SEDEIS's activities in this project are basically carried out through the support of CODIN and AGERIO. CODIN promotes the subsea cluster by working on international dissemination and on the attraction of investments and new companies to the territory of Rio de Janeiro. AGERIO, in turn, follows the guideline of the secretariat by fostering the companies already present in the cluster and providing financial support for any new investments.

Another state-level initiative focused on innovation in the O&G complex is the creation, in 2013, of the OGIP (Oil & Gas and Heavy Industry) Superintendence by SECTI. Created with the objective of supporting program projects focused on the oil and gas and heavy industry sectors within the scope of SECTI's activities, the Superintendence is responsible for training specialized professionals, stimulating R&D and inter-institutional dialogue. In the field of professional training, the SECT and the OGIP Superintendence, through FAETEC, offer Technological Vocational Courses (CVTs) focused on labor qualification demands of the various segments of the productive structure in Rio de Janeiro, including companies of the O&G complex. Regarding R&D activities, OGIP does not foresee the direct granting of resources for this type of activity, but rather foresees indirect actions such as institutional support and stimulus to the R&D culture through the interaction between innovation environments, ICTs, companies and State.

The OGIP Superintendence is recent and its action is still incipient, even though it is the main governmental body responsible for matters related to the O &G complex in a secretariat that is primarily involved in science, technology and innovation. A strong indication of this fact is the lack of more detailed information regarding the projects and initiatives of this superintendence in the institutional website of SECTI.

In sum, regarding the support initiatives for ST&I activities in the O&G complex with sectoral scope, it is possible to say that these are relatively recent at the state or local level (with the oldest starting in 2011) compared to national initiatives. This recent character, coupled with the distinct character of federal and state institutional structures and innovation policies, allow us to infer that regional initiatives are more fragile and have less capacity to impact the innovative activities of the O&G complex within Rio de Janeiro's IS. In the specific case of the O&G complex, regional innovation support initiatives are marginal, incipient or are still in the process of structuring themselves.

In addition, there is a lack of strategic coordination of the programs. While the Rio Capital of Energy adopts a broad sectoral focus and ends up concentrating a smaller proportion of its efforts on the O&G complex, the subsea cluster program is restricted to a specific niche of the O&G complex, rendering difficult any kind of dialogue between these programs' policies. On the other hand, the OGIP Superintendence reveals a focus that extends beyond the O&G complex and encompasses sectors of heavy industry, also hindering coordination with projects. This lack of coordination, therefore, is related to the differences in the strategic and sectoral focus of each program.

Final remarks

In this paper we argue that Rio de Janeiro has, as an important specificity, the establishment of a particularly negative power framework marked by a particular predominance of clientelistic relations and fragmentary interests in its political logic. Obviously, this observation does not imply that other regions of the country and even national politics are marked by a virtuous logic, but rather that, despite all the vicious elements historically present in Brazilian politics, these elements are particularly strong and rooted in Rio de Janeiro's political and institutional history.

As a main consequence of this specificity, especially after the city of Rio de Janeiro lost its capital status, there is a long economic and social crisis in the State. In these times of crisis, several negative effects have unfolded such as: the loss of space in the national economy, precariousness of living conditions reflected in socioeconomic indicators, the disruption of productive chains and the degradation of the public machine, among others. As a substrate of these negative effects, there is a chronic difficulty in formulating and agreeing on adequate solutions to the diagnosed problems, and in building an agenda based on an adequate development strategy for Rio de Janeiro.

At the heart of this strategy it should be the theme of innovation as an articulated element to a cohesive set of state and local strategic focuses. Given the specificities of the productive structure in Rio de Janeiro and the recognition of potential and opportunities for development, the prominent role of production linked to the oil and gas complex in the state and led by Petrobras is clear. Far from adhering to the notion that this specialization is inexorably the symptom of a natural resource curse, this specialization is understood as an opportunity for development because of the great complexity – and diversity – in terms of production, processes, technologies and knowledge inherent to the sectors involved in the oil activity. In this sense, therefore, an innovation policy that takes into account the stimulus to innovation in the complex of oil and gas and the stimulus to knowledge spillover from this complex to other sectors is understood as inadequate and highly desirable.

But, the legal-institutional design of the innovation system in Rio de Janeiro restricts the autonomy of the regional innovation policy, since it must be designed within the broader strategic contours of the national innovation policy. This characteristic, however, is not necessarily bad, provided that the regional policy can adapt itself and complement national policy taking into account regional specificities. This complementarity would also be achieved if the state innovation policy focused on stimulating knowledge spillovers from the oil and gas complex to other activity sectors and productive complexes.

Regarding the promotion of ST&I activities, the predominance of the national initiative in Rio de Janeiro was verified. This shows that the institutional infrastructure has a low capacity to influence and induce processes that motivate research and lead to innovation. Rio de Janeiro's IS does not have a system of direct incentives coordinated to an integrated strategy, based on a government project, which effectively prioritizes a regional agenda for science and technology. The same fragmentary and clientelistic logic operates in the scope of distributing the ST&I support budget. Short term interests of diversified fractions of scientific community displace a long term strategic perspective. A bias can be observed towards the fields of knowledge connected to groups in leading positions in support institutions.

FAPERJ, as the main funding agency for Rio de Janeiro's ST&I efforts, may be a reflection of the fragmentary dimension of Rio de Janeiro's political logic. The pulverization of its initiatives in terms of territory, sectors and research areas indicates a pattern that possibly derives from the particularly fragmentary character of the interests that exert influence on the conduct of the Foundation. This perception comes from a qualitative analysis of the information made available by FAPERJ itself to the public regarding its published programs

and edicts. If organized data on the institution's expenditures in research were available, with good disaggregation levels, the debate on innovation policy in Rio de Janeiro, its management and conduct would benefit a lot.

Specifically concerning the O&G productive complex in Rio de Janeiro's IS, the set of policies focusing on ST&I points towards the lack of coordination and disconnection with a broader strategy. Within FAPERJ, there are no specific program that seek to build upon the potential offered by the O&G complex, either in terms of deepening the research already carried out, or in terms of the possibility of generating spillovers to other sectors. With regard to the other initiatives focusing on the O&G complex – Rio Capital of Energy program, Subsea Cluster program (SEDEIS) and the creation of an OGIP superintendence (SECTI) –, it was not possible to identify convergence of these initiatives' objectives to a common focus. This lack of a single focus and the apparent lack of coordination of policies that support regional innovation in the O&G complex show the disconnected nature of regional initiatives.

This lack of a more coordinated strategy for the O&G sectors in Rio de Janeiro is not identified in other states where hydrocarbon production is more recent and less determinant for state economic dynamics. The best example is the state of São Paulo, whose oil and natural gas production has recently increased due to a portion of the pre-salt that is present on its continental shelf. São Paulo's government, predicting the potential of production growth and understanding the strategic nature of this sector for its development strategy, created a body responsible for formulating a regional strategy in the oil and gas sector. CESPEG (Special Commission of Petroleum and Natural Gas of the State of São Paulo) carried out studies between 2008 and 2010 as a way of subsidizing the design of a strategy for the development of the O&G complex in São Paulo, taking into account topics related to innovation (CESPEG, 2011). This highlights the fragility of the institutional infrastructure in Rio de Janeiro, at least in relation to the state of São Paulo, in terms of the capacity to mobilize, coordinate and carry out initiatives capable of positively impacting the Rio de Janeiro's IS through the O&G complex.

The lack of a specific focus on one of the main productive specializations in Rio de Janeiro with high innovative potential is evidenced by the lack of policies focusing on the opportunities and synergies. On the other hand, this is a direct result of the difficulty of designing and agreeing on a development agenda that is appropriate to the specific characteristics of the state and that is consistent with a correct diagnosis of the challenges to be faced and the opportunities to be sought. Ultimately, this lack of an adequate regional development strategy can be explained by the perception that there is a prevailing power and political logic in Rio characterized by clientelistic relations and fragmentary interests, which always favors short sighted spurious political arrangements.

The case studied, therefore, illustrates the extent to which an adverse political and institutional context can generate obstacles to the success of regional innovation policies. It is important to stress that this does not allow conclusions in the direction of “system failure” diagnosis. It’s not about fixing or redirecting the scope of action of specific institutions, based on some imported benchmark. Rather, the challenge to effectively benefit from the potentialities connected to natural resources in developing countries calls for a deeper and broader understanding of power structures and the historical processes that shaped them.

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