

Innovation in Oil and Gas in Brazil: agents, policies and networks¹

Marconi Aurélio e Silva²

ABSTRACT

The study of economic progress and development of States is a tradition in several different fields of knowledge, especially the ones related to Social Sciences. The recent focus granted to technological innovation and competitiveness caused by it, interpreted as a trigger for growth, made it necessary to research what are determining factors that play a role in the construction of an institutional organization able to generate strategic synergy among governmental objectives, private investors, academia and civil society, in order to achieve integrated and sustainable development. It is a fact that, traditionally, mainstream analysis of innovation and creativity emphasizes economic results, not social results. However, this article aims at investigating if *relational assets* play a role in stimulating the creation of a collectivity, especially for the oil and gas industry in Brazil. Here, innovation is construed as a process of *relational creation*, not of *creational destruction*. The goal is to identify the role of social dynamics so that societies are able to continuously create, innovate and reinvent themselves, beyond market logic. This study proposes a qualitative-quantitative methodology, based on the following steps: (1) revision of interdisciplinary literature of this specific field; (2) analysis of the content of data and documents regarding policies implemented in Brazil to innovate in the oil and gas industry, mainly focusing on the history of how R&D were institutionalized (through Cenpes-Petrobras), the creation of research networks (CT-PETRO, Petrobras' Thematic Networks, etc.) and funding strategies; (3) partially scripted interviews with different players involved in the Brazilian system for innovation in this industry; (4) execution of an electronic survey with members of research networks; and (5) network mapping, through Social Network Analysis. Among expected results is clarifying how these relationships became intangible assets to Petrobras and started to have an important role in its global innovation strategy. Therefore, through the identification of restrictions and opportunities, the goal is to suggest policies that encourage more integration and synergy among different agents.

Keywords: Relational Creation; Innovation Policies; Oil and Gas; Petrobras; Cenpes.

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² D. Sc. Candidate in Political Science, Federal University of Pernambuco (Recife, Brazil). Fellow Capes. E-mail: amarconi77@hotmail.com. Supervisor: D.Sc. Marcos Costa Lima.

Relational Creation for Human Development

The history of human evolution is a testimony of how the human race overcame challenges and restrictions inflicted to its species. Throughout the centuries, *homo sapiens* developed several practices whose goal was to take them to new stages of development that would mainly allow them to achieve more promising horizons to their own survival, thus improving quality of life, both in individual and collective levels.

At first, this knowledge was extracted from common sense and daily experiences, on one's own or in groups, mostly expressed through social conventions set forth by them. Later, with the appearance of new habits for the production of knowledge, especially as of the Renaissance and the Enlightenment that took place during the so called Scientific Revolution, whose *rational* explanation of life phenomena became the standard construal, the act of institutionalizing scientific and technological research started being divided into several fields of knowledge. This was adopted by modern universities and big companies, and this approach was quickly popularized through the massification of technological education and college education, especially in Europe and in the USA in the XIX and XX centuries. Such cultural movement resulted in a significant change in the ways of producing and generating symbolic and material wealth, which grew strong with endless demands created by the Industrial Revolution and by processes of intense urbanization that followed.

On the other hand, the increase of the world population, associated to a growing lack of resources to meet consumption needs, as well as to the need to reinvent products and processes that were more appropriate to cultural and aesthetic requirements of each era, also had direct impact on the process of developing more sophisticated means of production . As a result, several successive technical and economic standards started to appear. Some authors claim that there were at least five waves of technical progress since Modernity:

Table 1.0 – Successive waves of technical progress

LONG WAVES OR CYCLES			MAIN ASPECTS OF DOMINANT INFRASTRUCTURE		
<i>ESTIMATED TIMEFRAME</i>	<i>KONDRATIEFF WAVES</i>	<i>SCIENCE, TECHNOLOGY, EDUCATION AND TRAINING</i>	<i>TRANSPORTATION AND COMMUNICATION</i>	<i>ENERGY SOURCES</i>	<i>UNIVERSAL LOW-COST KEY ELEMENTS</i>
1780-1840	Industrial Revolution: production in textile plants	Learning while working, learning in practice, school of religious dissenters and scientific societies	Water channels, roads, wagon paths	Hydraulic energy	Cotton
1840-1890	Age of steam energy and railways	Civil and Mechanical Engineering Professionals, technology institutes, massification of primary school	Railways (iron rails), telegraph	Steam engines	Coal, iron
1890-1940	Age of electricity and siderurgy	Industrial R&D industries, national Chemistry and Electricity laboratories, industrial standardization laboratories	Railways (steel rails), telephone	Electricity	Steel
1940-1990	Age of mass production (“Fordism”) of automobiles and synthetic materials	Industrial and governmental R&D in large scale, massification of college education	Freeways, radio and TV, airlines	Oil	Oil, plastic
1990-?	Age of microelectronics and computer networks	Data networks, global R&D networks, continuous training and education	Information channels, digital networks	Gas / Oil	Microelectronics

Source: Freeman & Soete (2008, p. 47).

As we can see, different historical moments were impacted by different processes for the production of knowledge, as well as by discoveries of new energy sources and technological standards which were introduced into the market. As the generation of wealth required more knowledge to continue its expansion, more people dedicated their time to develop this knowledge:

Agriculture, which, at a certain point, occupied most of the population, now employs less than 10% of people in most advanced economies (and 50% in underdeveloped countries). Not only we see a reduction in the percentual role of this industry at the same time we see an increase in the role of services, but in industrial and services scenarios we also see a growing number of people who now dedicate their time mainly to the generation and dissemination of information, not of products (FREEMAN & SOETE, 2008, p. 22).

Therefore, currently, financial surplus is added to knowledge surplus, which guarantees continuous growth to societies that become more able to juggle them. There are several studies by

economic historians, technology philosophers, knowledge sociologists and other experts³ who claim that scientific and technological development, as well as an increase in the population's educational level, were essential to the process of western prosperity and accumulation of wealth during the last two centuries. That happens because, "[...] we would not have had this broad expansion of the educational system if education had not enabled significant economic advantages" (NELSON, 2006, p. 10). However, these changes resulted in the strong economic drive arising from the continuous creation and encouragement of the free market (POLANYI, 2000).

Therefore, the explanation on prosperity, progress and economic development was not limited only to the educational factor, even though the latter was essential and had huge impact on other social and political aspects of Humanity. A significant set of variables influenced the achievement of this positive situation: nutritional factors; ability to open up to diversity and novelty; encouragement of free initiatives; institutional participation; among others, mostly deemed dimensionless and subjective. With all these elements, a *creative atmosphere* took place, suggesting a synergy between its autonomous participants, able to stimulate continuous reinvention of its own mode of existence and which results in the supply of new merchandise for mass consumption, but also of cultural advances and the determination of a culture of changes.

Implied and codified knowledge starts to appear, therefore, as an immaterial corporate asset whose potential for transformation of social and economic structures is always more intense (LEMOS, 1999, p. 130). However, an ongoing debate has taken place specifically regarding *what is social science, technology and knowledge* and *what is their social use* in the contemporary world (BOURDIEU, 2004; HABERMAS, 2006). It is a fact that scientific and technological research resulting from a broad dissemination of professional knowledge through formal education, started to play a central role in the creation of new boundaries, especially in association with the creation of *innovation* in previously planned products and processes. That happens because, according to what was defended by Schumpeter, the engine for economic capitalist growth is the generation of competitive advantages arising from innovative discoveries, which are results of processes of continuous *creative destruction* and, consequently, of encouragement of permanent consumption (SCHUMPETER, 1961).

These new creative products and processes, aimed at the market, started to be classified as innovations, further categorized as *radical* and *growing* (LEMOS, 1999). The *radical* element is

³ Cf. De Masi (1999); Diamond (2007); Mokyr (1990); Mowery & Rosenberg (2005); Nelson (2006); Rosenberg & Birdzell Jr. (1986).

associated to the development of a new product or process that breaks prior technological standards, reducing costs and improving quality. The *growth* element introduces gradual improvements, throughout time, in radical innovations. Most of the latter is almost indistinguishable to consumers, but it represents a reduction in production costs and a growth in competitiveness.

In this context, the consolidation of a country's political and economic autonomy has been taking place through the results of collective efforts to expand permanent ability to create and innovate, in order to enter the globalized market in a more proactive way. Therefore, the debate about policies that shall be adopted to encourage innovation starts to be significant.

Furtado analyzed the impacts of this transformation on the States, especially less developed states, which contributed to the homogeneity trend of our times:

At the end of this century, there is a general belief that the process of globalizing markets shall be implemented throughout the world, regardless of policies preferred by each country. This is a *technological demand*, similar to the one that drove the industrialization process, which has shapen modern society in the last two centuries (FURTADO, 2001, P. 26).

As already mentioned, countries started to promote scientific and technological abilities which would enable social inclusion based on the creation of new boundaries, as well as the welfare that they wanted. Regarding the concept of *technological dependence*, Furtado highlights the need of better understanding its consequences, because technological dependence surpasses the mere idea of introducing new productive techniques that provide a leap in development and improve levels of economic progress. According to him, a dependent country “[...] demands the adoption of consumption standards as new final products that correspond to a level of accumulation and technical sophistication that only exist in this society as foreign bodies” (FURTADO, 2001, p. 48). Therefore, the author criticizes the belief that having technical and scientific development is to access or compete according to innovation patterns promoted among countries which manage different levels of social welfare operated in several social and cultural contexts. This restricts the perception that true development implies the growth of institutions and agents that constitute local social and political groups and which contribute to the surge of several ways to behave and to contribute towards a sustainable future for Humanity and for our planet. According to Furtado, the main focus of this issue has been shifted, and we no longer universalize technology, but instead consumption standards that ultimately do not promote autonomy, but reinforce dependence (FURTADO, 2001, p. 59).

As a result, to think about policies that encourage innovation and creativity solely under the perspective of generating economic wealth, based on the global standardization of consumption standards and market practices, seems to underestimate the local creative potential and condition public efforts, in the sense of promoting high yields resulting from pro-consumption innovations, which are, most of the time, for the benefit of private multinational clusters protected by patents or copyrights.

Therefore, there are restrictions for the existence of a debate about such an important subject without including social and cultural gains that the creative and innovative environment enables and assumes, that is, about reciprocal additions arising from a relationship of differences, especially in the issue of taking development to those who really need it, groups excluded from its current path. That supposedly happens because this *relational experience* produces a cultural movement which is able to increase the level of growth of social structures and to reverse previously mentioned conditions of submission and dependence, triggering more interest in participation.

This article, from the field of Political Sciences, aims at revisiting main ideas related to this subject and offering an alternative interpretation to the issue of innovation as the single goal and most important result of the process of human development. Innovation is considered a phenomenon closely connected to social dynamics and the relationships existing therein. This research does not aim at encompassing all literature written about the subject throughout several areas of knowledge⁴. The goal is to go beyond a narrow understanding of this phenomenon based on an interdisciplinary approach, according to an interpretation of economic principles which condition the study and the promotion of policies intended to encourage it.

The phenomenon of innovation and creativity requires relational aspects from the societies or groups under analysis, because, according to Sawyer:

Innovation is born in a complex social and organizational system. It is impossible to explain creativity in a business without explaining social and cultural aspects of the organizational complexity out of which those innovations were born. It is essential to understand not only groups of individuals who constitute creative processes, but also the nature of team work and cooperation, roles played by organizational structures and market forces (SAWER, 2006, p. 286).

⁴ Also because, as Fagerberg (2006) said, there is a significant growth in the amount of works that approach innovation under several different standpoints.

Tzeng (2009), on the other hand, states that an innovation theory requires economic, social and cultural knowledge, and highlights the need to develop a holistic view on the subject. Indeed, most part of current theories on innovation focuses on several (individual) perspectives. Studies on “collective innovation” are the biggest deficit we have in this field (FAGERBERG, 2006, p. 20). It is according to this perspective that this research shall be conducted.

Therefore, the central theory of this study is that the creation and innovation process is based on a specific practice, hereinafter referred to as *relational creation*, in which they take place out of social processes maintained between different entities. In this regard, the need to collaborate, cooperate, participate, value and acknowledge diversity is implied. Human creativity and innovation are processes socially built in collective terms; thus the need to understand them. Also, the construction of a collective body implies *relationships*.

It would be commonplace to claim that what made societies go poor was not only a lack of resources or the alleged exploitation of dependent States by more advanced States, but the former’s lack of knowledge, as a collective body, of how to produce more wealth with the resources available to them (MOKYR, 1990, p. 297). To be unaware of existing capabilities and to resist changes in the *status quo* that restrict social progress may suppress the creative and innovative potential of several societies. Consequently, incentives necessary to collective pro-innovation actions go against this resistance and try to reinforce institutional synergy that guarantees its continuity through change and increases the intensity of efforts to overcome such inertia.

Pizzorno tried to clarify that sociability is not based on social actions by a player who boosts usefulness (or their own interest), but on the relationship between players who establish a social identity among themselves. Therefore, “the object of a social science is the constitution of social attitudes and the way they are constituted through reciprocal acknowledgement during a social encounter between players” (PIZZORNO, 2008, p. 126).

This proposition is not something focused on habermasian communicative rationality, that is, under the logic of best arguments and persuasion caused by it in order to achieve an agreement and subtract the other person’s opinion into their own. In this universe, it is not enough to establish the simple exercise of universal exchange (which would already be a significant effort) for overlapping pairs, but it is necessary to surrender and dedicate oneself to the initial requirements of a dialogue, in order to achieve new collective levels resulting from mutual cooperation. Therefore, there is pragmatic change, since the restricted logic of *win-lose*, inherent to competitions, is ignored, so that a logic of

reciprocally dedicating oneself into the other, that is, to a permanent *win-win* situation, since, after its activation, this will always change both parties.

With respect to mercantilism, the economic dynamic set forth according to relationships decayed upon the establishment of a market society that would substitute reciprocity and redistribution for its self-regulating condition. This is why Polanyi (2000, pp. 76-98) stated that “progress is achieved through social disarray.” On the contrary, it is possible to notice that social disarray generates inclusion and true human development.

Schumpeterian minimalism contributed to narrow the perspective on the importance of social aspects contained in political issues by restricting it to this capitalist economic logic: “[...] politics itself is determined by the state and structure of economic processes and transfers effects, both in situations provided for in economic theories and in any purchase and sale situation (SCHUMPETER, 1961, p. 72). Even though this author had already started the analysis of its role of technological innovation to dinamize modern capitalism, his deterministic approach on the production of wealth explains that permanent encouragement of technical changes is what motivates the onset of new consumption cycles. Followers of Schumpeter’s theories tried to expand the analysis of peculiarities of the innovative phenomenon, in which the focus continued to be this line of approach (HANUSCH & PYKA, 2007). That is why an analytical analysis of innovation and creativity remains connected to working mechanisms of the market itself. That is, about how subjective value is developed over innovation as a merchandise, to meet laws of supply and demand and which conditions this development.

However, it is important to emphasize that new technologies do not provide for all human needs (MOKYR, 1990, p. 303) because, since this is a social being, the relational factor itself surpasses economic mechanisms that try to explain such condition: “The person is the missing element in the ‘inherited’ economic theory, which defends that to perform what is related to the person, the search is not within people themselves, but among people” (ZAMAGNI, 2006, p. 11).

In this regard, Vigotski (1998) highlighted the role of the mind’s social development, while Burke (2003) developed a perspective on how the social construction of knowledge took place throughout human history. Castells (2000) and Lévy (2007) analyzed in what way the revolution of cyberspace and society stimulated the appearance of new aspects of human sociability, which changed the means of production of collective intelligence and social creativity, based on horizontal and collaborative relationships. Innovation according to the collaborative perspective was also the approach

chosen by Paulus & Nijstad (2003), while Amin & Roberts (2008) focused on the role of learning communities, analyzing organization as a privileged place to ground innovation.

Last but not least, at the end of the XX century, the idea that innovation was understood as a systemic process became really strong (LUNDVALL, 1992; NELSON, 1993; EDQUIST, 1997). Lundvall (1988) interpreted innovation as an interactive process that works interdependently among independent economic objects, and that is why there is an emphasis on the idea of a national innovation system. Johnson & Lundvall (2005, p. 92), on the other hand, emphasized that “[...] knowledge productivity is not rooted in its inherent character, but find its roots in the social relationships of which it is part.” Now, Achibugi, Pavit and Malerba were concerned with analyzing these systems by sector. On the other hand, Freeman and Perez performed several studies regarding the importance of scientific and technological policies for the improvement of economic performance and the promotion of social change.

In Brazil, Arbix (2007) tried to analyze which institutional environments are more favorable to guarantee a pro-innovation culture and economic development. Furtado focused on the issue of technological dependence in underdeveloped countries. Lastres and Cassiolato developed an extensive reflection on the idea of productive local arrangements.

Florida (2011) highlighted that creative and innovative societies tend to become more tolerant and open to differences between its peers; while Storper (1997) performed an interesting reflection of a regional world, based on three dimensions: sectors, production per se and relational organic elements. Therefore, this author suggests that innovation is the result of collective action.

Thus, it seems that the *relational* factor should be reinterpreted and reinstated to the core of this issue. *Relational creation* is a *result of* and *promotes* an encounter between different entities, creating unity (and not uniformity) among diversity, that is, synergy and definition of common goals instead of overlapping and competition. Therefore, creativity and innovation would not be answers only to market demands, produced by individuals. They also would not be designed only to reach the goal of promoting economic development. On the contrary: they would enable the exercise of existence itself, while Humanity, that is, a single family, a brotherhood of differences, which becomes concrete and possible due to reciprocal gifts and the integration of common goals based on their interaction. In this human condition, benefits are distributed to all, because they arise from everybody's participation and appreciation. This may occur exactly through free gifts:

The free gift, for its nature, always stimulates the activation of an intersubjective relationship per excellence, which is based on reciprocity. It is only through reciprocity that we can establish reciprocal acknowledgment, which is precisely what feeds respect for oneself. Acknowledgment is the phenomenon in which an individual is accepted and put into existence in everybody else's world. [...] Both in the free gift and in a gift such as reciprocity, I give to you so that, on your turn, you can give (not necessarily to me) (ZAMAGNI, 2006, p. 13).

Interaction between human beings is a basic assumption of *relational creation*. For Hegel, this takes place based on the full projection between oneself and the other:

[...] Awareness of oneself is the reflection, based on your being in the sensitive and known world; it is basically a response from the Other-being. As awareness of oneself, this is a movement; but when it recognizes itself as different only in comparison to itself as itself indeed, then the difference becomes immediately presumed, as an other-being. Difference is not, and awareness of oneself is only tautology without movement of "I am Me" (HEGEL, 1992, p. 120).

Buber (?) was one of the first authors who contributed to a perception of intersubjectivity and cultural creativity. Eisenstadt, reflecting his work, defines the concept of innovation in Buber as "the power to make changes."

For this reason, both science and technology policies as well as those related to industrial development, production and foreign trade, assume increasing importance in the sectorial, regional, national and international agendas, more due to the social dynamics that they may ensue in order to maintain an environment of permanent promotion of creativity and innovation from the development of complementary relations, than by the seasonal profitable outcome that they themselves will provide under the logic of inducing pro-market development. Dynamics with such a focus and that do not take into account their initial precondition of resulting from the construction of social relations will sustain itself, incipient and limited times, on the so-called cycle of prosperity, because it does not establish minimum satisfactory conditions for ongoing maintenance of *relationality* as something that goes beyond the static rationality, whose most intense peaks depend on generational changes or the emergence of individual talents that re-adapt patterns or even suggest new ways of survival based on previous assumptions.

Innovation policies inspired by the paradigm of *relational creation* value the social synergy capable of converging goals and even different interests, to tend to the welfare of their respective populations. Governments, the private sector, educational bodies, and research and development institutions, as well as civil society in general, play an essential role in this dynamic. But they need to

know how to enter into each other realities and, from time to time, learn to lose their own ideas, finding them in others or building new proposals with others. That is why, by increasingly interacting and streamlining their relationships and priorities, these enable the onset of sets of insights based on complementarities that enhance everyone's⁵ action.

Deepening one's understanding of new mechanisms to support this social environment is relevant today not only to mobilize society around increased profits and market expansion, but also to establish a new moment in the debate on what kind of human development one intends to build in extremely unstable times and pointing to the depletion of a model of consumption and unbridled quest for prosperity, in which few excel at the expense of the exploitation of many. This, in fact, serves as an inspiration to the new generation of science, technology and innovation policies in the debate at this beginning of the 21st century (CGEE, 2010).

It is not enough to increase the ability of creation and innovation of a place or group, allowing only access to what's new or directing heavy investments to research and development (R&D), in the productive system or in scientific and technological research institutions. We must go further and establish, overall, policies to encourage the inclusion of all, from the base, not only from an economic and academic point of view, but also from other perspectives, such as ensuring access to aesthetic culture, to popular diversity, to acceptability and tolerance etc. In sum, ensure the *right to creativity and to the experience of innovation*. For example, establishing policies that promote an educational system that leaves aside the reproductive pattern of knowledge and adopts a more proactive and productive knowledge, collectively built, truly transformational and collaborative, as defended by Paulo Freire (1996) in the past and that still, especially today, in the context of electronic culture and social networks, remains so current. Not to mention the policies aimed at urban planning and organization, capable of providing living environments that give rise to different looks on the spaces and cities themselves, offering moments of gathering, integration, exchange of skills and talents, increasing acuteness of perception of the good, the fair and the beautiful⁶.

⁵ On the potential relationship between the relational paradigm and new governance models, see Tronca (2006). On the crisis of the democratic and relational factor, see Morandi (2006). Finally, on innovations in social policy and welfare and the relational issue, see Colozzi (2006).

⁶ All around the world, we see initiatives that aim at collectively debating and building projects of creative cities, innovative cities. In Brazil, a good example of this kind of initiative started in Curitiba (PR), in 2010, with the Innovative Cities Project (www.cidadesinovadoras.org.br). These cities promote life improvements for everybody, not only for members of its community, but also for visitors who can go home and can take new with them new learnings and perceptions added by the experience and history of other people who then become references for them. It is about time to create true "Humanity Labs", able to boost the most noble experiences of human beings who, of course, are much higher than only having access to

Optimizing consumption of human energies, aiming them at more inclusive purposes, reduces waste of potential creative and innovative power arising from stress and growing conflicts, present in today's competitive life. A relational view of the creative capacity presupposes, therefore, participation, inclusion of all potential perspectives, especially those that provide extremely different perspectives, i.e., complementary ones. Therefore, supportive environments are required for this. The proposal is to *create while relating*, not to *destroy while creating*. (SILVA, 2009). In Table 1.1, we present some of the alleged differences of these approaches.

Table 1.1 - Conceptual comparison between creative destruction and relational creation (according to the dimensions of human reality)

DIMENSION	CREATIVE DESTRUCTION	RELATIONAL CREATION
Environmental	Disposal, obsolescence, scraps	Sustainable reuse, recycling, respect for nature
Political	Annulment of the other, competition, overlapping of ideas, low synergy	Respect for diversity, cooperation, appreciation of the dialog, high synergy
Economic	Domination, control, centralization, dependence, innovation in response to market demand and in the pursuit of greater profitability	Diversification, encouragement of productive dynamism, decentralization, interdependence, innovation as a mechanism for full human development
Social	Class conflicts, unfair competition, isolation, fragmentation of society	Participation, equitable distribution of opportunities, encouraging free enterprise, inclusion, complementarity
Cultural	Limited to personal intellectual effort, segmented environments and feedback through previously conceived concepts	Promotes exchange of cultural experiences, a more complex and broader view of reality, ongoing recreation and conceptual innovation of reality, values multi-and transcultural qualities, ensures the right to creativity and to the experience of innovation

Source: Prepared by the author.

To this end, policies that encourage the dissemination of skills related to the participative action of society in processes of creation and innovation are key. We assume that these skills can be classified into three categories: (1) **formal**, which are apprehended by the transmission of knowledge accumulated from the different fields of science and technology over time, (2) **informal**, which is

material wealth through the market. Rio de Janeiro (RJ) and Recife (PE) have been making efforts to recover their still existing historical architectural heritage, in addition to their artistic and cultural heritage, to prepare for the 2014 World Cup to be held in Brazil.

apprehended in daily social experience, imbued with the creative elements of social diversity, according to each person's sensitivity; and (3) **relational**, which integrates the skills above and, arising from and in addition to the network of relationships established and maintained⁷ throughout life, can predict trends and propose new directions for collectivity, adapting them in any way possible to the current scientific-technological level, and indicating the requirements to be met in order to achieve more sophisticated stages at these same levels. This forms a sort of virtuous cycle of continuous interaction and renewal.

Innovation is the new being and not-being, because for the person that creates and innovates, the result of their effort is no longer new, but it is for those who will have access to it. Upon access, by those who did not know that which is old to the person who originally created and innovated it, there is initially a reinterpretation and addition of one's self to the original idea and, therefore, this is no longer new (to the second agent) and becomes new to the one who raised the first stage of the relational movement. Thus, it becomes possible to attract the agents affiliated to both opposite sides in order to make them cooperate, so that there is always something new to both sides, completely new, even though it is at the same time old.

The idea of competition, therefore, seems to be more predatory than an inclusive innovative process, as it implies annulling the other's participation, surpassing it by itself, one overlapping the other. In this system, you lose a point of view that constitutes part of the innovation and creation, because it is different from the original meaning proposed. It would be better to persist with the idea of cooperation or collaboration (BERTEA & BRAGA, 2005). Healthy competition, which values the continuous pursuit of overcoming one's self and the best ever achieved, may also stimulate reciprocal creativity.

But one thing is crucial: consensus. For Perez (1998, p. 33) the importance of consensus in these plural contexts, operationalized by relational networks, is a major determinant of agents' success in the Knowledge Society:

The key to the effectiveness of network organizations is consensus. Networks do not work if there is no agreement on the vision pursued. The old assumption of authority or decision of the majority does not work: obedience, when in disagreement, is doable, but it is impossible to be creative without being truly committed to a common direction.

⁷ According to Green (2008: 10), "the less time invested in 'friendship', the harder it is to build a new friendly relationship or to keep alive an existing one."

Consensus can be randomly established, as a kind of voluntary agreement among peers, or result from external pressures, common difficulties and challenges imposed to the social progress movement, contemporaneously. This leads to finding a common path to follow to overcome such obstacles. Not coincidentally, the slogan of Petrobras, which is one of the agents and the main object of this study is "Challenge is our energy" in allusion to the challenges faced by the sector in Brazil in the pursuit and consolidation of self-sufficiency in oil and gas, vigorously pursued over the past sixty years of its existence.

Commitment arises precisely in the appreciation of the contributive potential that each agent can give in the recognition of its own proactive presence. Add to all this the need to prepare *trust agreements*, which make agents aware that the ethics of relationships in favor of joint creation and innovation must prevail over individual results, possession of ideas, the use of results from collective effort by private actors, without any previous agreement or regulation. Moreover, it requires changes even at the level of inter-relationships of the political apparatus itself, in which the interdependence between authority and technical personnel is more intense and more effective (PEREZ, 1998, p. 27). Tzeng goes as far as to say that "innovation requires loyalty" and that is something that only "happens in human relationships" (TZENG, 2009, p. 380).

Harden, Kruse & Blasi (2010, p. 249), making an interesting analysis of innovation and human resources in the context of what they call "shared capitalism", conclude that "[...] a culture of innovation can be developed and sustained thinking about the use of shared capitalism and high performance work policies. This also causes employees to align their objectives and goals with those of the organization." For these authors, there are two main contributions of their study: (1) the combination of shared incentives, cooperative culture and mutual monitoring makes work better; (2) the high performance work system helps solve the problem of the agency when employees work in teams at the low level of organization, enriched with rigorous selection, training, information sharing, clear goals and fair rewards.

But even if one party comes to desert and betray the trust of his peers, following the logic of reciprocity embedded in the relational process, it would be possible to restore the cooperation, provided that the other party resumed his contribution with other agents based on the same initial purpose (Bertea and Braga, 2005, p. 59), but, with more maturity resulting from the experience itself of breaking the previous agreement and, consequently, of not being able to innovate and create relationally as before.

This study considers that the willingness to cooperate is, therefore, a constitutive element of every human being, given that collaborating with others is more suitable and wise than remaining

detached, as it is through the other that I acknowledge myself, as previously seen . Collaboration also reinforces greater commitment by mutual monitoring of the actions of agents involved.

Melania Verde (2008) identified some characteristics or components of the so-called *relational assets*. According to the author, *relational assets* are neither economic assets (because they do not have a market price), nor public assets. They inaugurate a third category of assets, whose purpose is the promotion of *human happiness* (BRUNI & ZAMAGNI, 2004). It is composed of some elements, namely: *identity, reciprocity, simultaneity, intrinsic motivation, emerging fact* and *gratuity* (VERDE, 2008, p. 8).

If human happiness is achieved not by individual isolation, but by relationships that produce mutual recognition, the purpose of human existence is, yes, to live well, but with others. Creativity and innovation can enrich such quest. If creativity and innovation generate wealth and development from free enterprise, carried out under an inclusive relational dynamics would generate, in addition to the expected goals, happiness, integration, need for joint coexistence between different beings, complementarity, sustainability etc., as it would not consider others merely customers or competitors, but include them, in freedom and equality, in their own world. Human beings, therefore, seem to be able to do, thus, the sole thing that has been made possible only to them in nature: create, innovate and relate, from others to themselves and from themselves to others.

Gui (1996), in turn, highlights the *degree of reputation* as a key element in ensuring *longevity of relationships*, which, in turn, would indicate their quality.

For Ngugi, Johnsen & Erdélyi (2010), relational capabilities, when used by small and medium companies, subsidize the creation of value and innovation. Mueller & Cronin (2009), in their turn, state that “[...] identifying the mechanisms thought to be relational support to the teams helps in the actual creative process of these teams.”

A feasible methodological method for the study of the relational factor may be the Analysis of Social Networks, disseminated by Barabasi, Granovetter, Degenne, Forsé, Hannemann, Wassermann, Faust, White, among others. To this end, a relational query on innovation requires not only to analyze the *other*, but to analyze *with the other* and to understand how this affects their creative initiatives.

Which **object of research**, in the Brazilian context of technological innovation, best lends itself to such analysis? The Centre for Research and Development of Petrobras (Cenpes) and networks encouraged by public policies intended to stimulate the integration of different agents with the purpose of innovation in the industry (CT-PETRO Networks and Petrobras Thematic Networks) seem to be the

best examples of Brazilian innovative effort and operationalization of creation based on the relational factor. For five decades, the state monopoly of the exploration and production of these resources in Brazil allowed the accumulation of expertise in such a way that endowed the country with technologies that are unique in the world, in terms of access to resources under the sea, in deep waters. Petrobras, still controlled by the federal government, became one of the largest companies in the world and acts as a major inducer of Brazilian scientific and technological development (LIMA & SILVA, 2012).

A recent study by IPEA – the Institute for Applied Economic Research (2010), shows that the company has enormous inductive power, so that at least one in every 10 existing businesses in Brazil directly or indirectly provides goods and services to Petrobras. Moreover, “[...] about 40% of engineers and scientific professionals and nearly 50% of researchers formally employed in Brazil work for suppliers of Petrobras. Even if they do not always meet Petrobras’ demands (MCT, 2012).

Moreover, both the operation of the CT-PETRO Sector Fund (since 1999) and the new demands of local technological content and direct investments in R&D in the Brazilian ICTs, arising from the new contractual obligations imposed by the National Petroleum Agency (ANP) for the contracts related to the pre-salt wells (since 2007), are generating a broad institutional context of interconnection via pro-innovation cooperation networks, involving different agents in Brazil and even abroad. This complexity has been observed and presented in national and international forums (such as occurred in the 4th National Conference on Science, Technology and Innovation, held in Brasilia in 2010, and in different global conferences of the industry, such as the Rio Oil & Gas, the OTC, the World Petroleum Congress, among others) as a successful model of partnership relations established between state, private sector, academia and civil society.

Cenpes and the oil and gas innovation networks connected to it synthesize Brazil’s efforts to create, with its own capabilities, strategic differences, which need to be better understood: (1) considering its history; and (2) regarding the existing relational dimension as a basic premise to the synergistic ambiance often required in efforts of this nature, in which different agents are focused on promoting innovation and overcoming the challenges in contemporary society.

Moreover, the sector will continue to be the main energy source of mankind, despite the fiercest debates related to environmental issues, sustainability etc. It is estimated that the dependence on oil and gas will remain strong for the next 30 years, when their demand should increase by, at least, 40% more (YERGIN, 2010, p. 899-900). Thus, “[...] the need for new supplies – conventional, renewable and alternative – added to concerns about price, safety and climate, triggered a wave of innovation and

research among all energy industries” (Yergin, 2010, p. 898). This explains the effort of Petrobras and the Brazilian Government to remain in the industry’s technological frontier, which will represent not only guaranteed access to strategic petrochemical and energy resources in this century, but also ensure national sovereignty and security, as well as the very survival of the State as an articulator of the desired national development.

It is known that, despite the self-sufficiency in oil, reached in 2006, and recent findings of the pre-salt reserves in deep marine waters, the largest added value of this wealth permeates national innovative capacity. Oil as a *commodity* has low added value. Just for you to have an idea, in the annual ranking of the 100 largest global oil companies, the ones with the most sales of derivative products and refining capacity held the top positions, while those who had the most reserves or were the largest producers of crude oil were left behind (BNDES, 1998).

Petrobras synthesizes the Brazilian effort of nationalist industrial development throughout the 20th century. From the political point of view, the oscillations in its industry are extremely sensitive. All one has to do is remember the negative economic impact caused: (1) by the oil crises of the 1970s; (2) by poorly planned Brazilian quest for alternative energy sources, in 1980, which strengthened sugarcane estates in various regions of Brazil, by encouraging ethanol to be used as fuel; and (3) by the Bolivian gas crisis in the 2000s, which caused political instability and intensified the debate on energy security in Latin America, in addition to exposing the real obstacles to regional integration.

This is a very rich and strategic issue, therefore, for research in political science, notably because of the international geopolitical role held by this industry.

Therefore, here is the **research problem** addressed here: do relational assets affect the process of technological creation and innovation in the oil and gas industry in Brazil? Do the policies aimed at stimulating innovation in the industry take this peculiarity into account?

Objectives

- Reconstruct the historical trajectory of the 50 years of institutionalization of R&D&I in the Oil & Gas industry in Brazil, represented by the creation and development of Cenpes-Petrobras, analyzing the performance of agents within and outside the company;

- Understand how relational assets began to impact the creative and innovative capacity of Petrobras (or their absence became a hindrance thereto), whether in the case of Cenpes or in innovation networks connected to it and encouraged by federal policies;
- Identify public policies that best serve the purpose of stimulating the relational creation for integrated and sustainable human development, along the lines proposed herein.

Methodology

- **Research of document, data and content analysis and review of the literature** collected in the libraries of the following institutions: ANP, House of Representatives, Celso Furtado Center, the National Library, BNDES (Brazilian Development Bank), CENPES, CGEE (Center for Strategic Studies and Management of Science, Technology and Innovation - Brazilian Federal District), FGV-RJ (Fundação Getúlio Vargas in Rio de Janeiro), FINEP (Brazilian Innovation Agency), IBP (Brazilian Institute of Petroleum, Gas and Biofuel), IBGE (Brazilian Geography and Statistics Institute, Rio de Janeiro), IPEA (Institute for Applied Economic Research, Brazilian Federal District), and UFRJ (Federal University of Rio de Janeiro), USP (University of São Paulo) and UFMG (Federal University of Minas Gerais). In terms of international literature, copies of books from the following publishers were researched and purchased: Anthem Press, Brookings Inst. Press, Cambridge University Press, Città Nuova, Edward Elgar Pub., FrancoAngeli, Harvest Wheatsheaf Pub., Il Mulino, Instituto Piaget, Les Presses de l'Université d'Ottawa, Longman, MIT University Press, OCDE, Oxford University Press, Philip Alan Pub., Pinter Pub., Princeton University Press, Purdue University Press, Routledge & Kegan Paul Ltda, Stanford University Press, The University of Chicago Press, United Nations University and Universidad Nacional de Quilmes.
- **Partially scripted interviews** with several sources of information related to the industry, aiming at systematizing qualitative data on different views regarding the oil and gas innovation system in Brazil. They represented the following organizations: (1) Public Institutions: (ANP, BNDES, CGEE, CNPq [National Council for Scientific and Technological Development], FINEP, IPEA, MCTI [Ministry of Science, Technology and Innovation], and PROMINP MME [National Program for the Mobilization and Development of Oil and Gas Industry, from the Ministry of Mines and Energy]); (2) Academia (Coppetec Foundation - UFRJ, UFRJ Technology Park,

COPPE-UFRJ [Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering], IE-UFRJ [Economics Institute], IPT-SP [Technological Research Institute at USP], POLI-USP [Engineering School], PUC-RJ [Catholic University of Rio de Janeiro]); (3) Oil and Gas Production Chain (CENPES-PETROBRAS, CHEMTECH, Fábrica Carioca de Catalisadores [Rio de Janeiro Catalyst Factory], IBP and ONIP [National Organization of the Petroleum Industry]).

- **Application of electronic survey** via Moodle software, with members of the Petrobras Thematic Networks, invited by e-mail, evaluating features and results of the innovative effort, as well as issues related to the concept of relational creation proposed herein.
- **Analysis of Social Networks**, through the Ucinet software, with the purpose of visually illustrating the innovation networks of Petrobras and the relationship between its members.

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