

How do University Research Groups deal with Science, Technology and Innovation Policy Gaps in Colombia? A Bottom-Up Perspective

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ABSTRACT

This paper explores how university research groups (URG) deal with the requirements of their practices while facing gaps left by on the one hand discrepancies between discourse and actual science, technology and innovation (STI) instruments and, on the other, coordination problems amongst STI policy instruments as implemented through various programmes and governance levels. In so doing, we study cases of research groups in nanotechnologies and biomedical engineering in Colombia, where we conducted semi-structured interviews, stakeholder dialogues in the framework of participatory workshops and collected information about URG activities and strategies. The results show how such groups, and particularly their leaders and their home institutions, adapt to different STI policy discourse and instrument gaps to support their practices, while maneuvering through inconsistencies and incompatibilities characterizing them. Through this process, URG become active players in the construction of such STI policies by acting as 'jugglers' that articulate various STI policy contexts, instruments and discourses simultaneously, in their effort to continue working on their research activities. This work contributes to the understanding of the rationales and dynamics of STI policy implementation from a bottom up perspective, by looking at the actions and learnings and strategies of the involved players.

Keywords: Science, Technology and Innovation Policy, Policy Instruments, University Research Groups, Research Group Strategies, Policy Implementation, Policy Gaps, Policy Discourse, Bottom-Up Perspective.

1. INTRODUCTION

Policy scholars typically study the design, implementation and evaluation of STI policies from

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a top-down perspective (Defazio, Lockett & Wright, 2009; Luukkonen & Nedevea, 2008, Dutrénit et al., 2017), looking at theoretical logics not necessarily contrasted with reality (Kuhlmann & Ordonez-Matamoros, 2017). However, it is increasingly acknowledged that the best way to understand (and anticipate) the determinants of success of such policies is by looking at research activities 'on the ground', that is, on the ways researchers respond to such policies (both symbolic, via discourses, or material, via policy instruments) from a bottom-up perspective. Indeed, many scholars have long shown how STI policy makers adjust their understanding, programs and policies based on what they observe of the research practice in order to improve the quality of their interventions (Kuhlmann, Shapira & Smits, 2010; Kuhlmann & Ordonez-Matamoros, 2017).

According to Rip & Nederhof (1986), the success of any national STI program depends on its ability to mobilize the best researchers. This can only happen, however, by taking advantage of their relative dependence on such resources and on their ability to align their own research interests with the opportunities offered, where policy networks are often formed between both policy makers and implementers (Orozco & Chavarro, 2006; Orozco, Ordonez-Matamoros et al., forthcoming). This implies for the program managers to move their goals in order to align themselves with the interests of researchers (Rip & Nederhof, 1986).

Arvanitis et al. (1995), Vinck (1996) and Gómez and Jaramillo (1997) are among the few authors who study the links between STI policy makers and researchers at the level of policy implementation from a bottom-up perspective. That literature shows that, in the implementation process, researchers make a translation of STI policies with respect to their resources, constraints, strategies and working tradition, focusing on what happens in a particular STI policy domain or with a specific STI instrument.

Authors like Kuhlmann, Shapira and Smits (2010), and Kuhlmann and Ordonez-Matamoros (2017) propose the 'Innovation Policy Dance' as a metaphor depicting the relationship among actors associated with innovation practices, policies and theory where participants learn from each other by interacting and co-evolving, like in a "dance," where researchers adapt their "*dance steps*" to the signals given by evolving policy instruments to take advantage and exploit the opportunities (or avoid new burdens) opened before them.

This article looks at the ways researchers in the fields of nanotechnology and biomedical engineering react/adapt/learn from interacting with STI policy instruments' and discourses' gaps in Colombia. Although we acknowledge that some patterns may be found in other scientific fields, we opted for focusing on these two areas of research only⁶.

In this framework, we opt for a bottom up approach to study STI policy in Colombia by looking at what happens with researchers and other actors who face, not only discrepancies between policy discourse and instruments actually implemented, but also STI policy gaps left by instruments implemented at the same time, sometimes complementing, sometimes contradicting, duplicating or neutralising each other. We specifically address questions such as what are URG strategies to take advantage from STI policy gaps to 'survive' or even grow?

⁶ In fact, in a parallel process with researchers working in the social sciences at the Universidad Central (Bogotá, Colombia), we found that several of the hypotheses proposed here were confirmed to a large extent, with some variations, however. These findings deserve further investigation in a separate effort.

Public policies cannot be evaluated only in terms of their rationales, institutional framework or the design of their instruments, as they must carefully take into account the level of implementation. In so doing, we focus on practices under which the actors deal with gaps left by STI instruments and policy discourse, as well as gaps left by the lack of programme coordination at different governance levels (i.e. national, local or institutional). We also highlight the learning process resulting from having to handle a variety of discourses and instruments which, in some cases, present tensions and contradictions, or open up opportunities to them.

To illustrate the relevance of this discussion, we study two cases in Colombia looking at two research groups: one working in the field of nanoscience and nanotechnology in a peripheral city in Colombia (Bucaramanga) and another one in the field of biomedical engineering in the Colombian capital city (Bogotá).

2. LITERATURE REVIEW

This literature review emphasizes the studies on STI policy gaps in the Latin American context. We start by briefly presenting some aspects of the STI policy in terms of the discourse gaps. We then focus on policy instruments' gaps and finish by looking at some of the strategies research groups have used 'to survive' despite or thanks to the gaps they often face. The specificities of the situation in Colombia are explained in each case.

2.1. STI policy discourse gap

Since the nineties, STI policy in Latin America, specifically in the case of Colombia, Mexico and Argentina, was framed under the neoliberal economic policies (Guzmán Tovar, 2015). At least at the level of the discourse, they focused on strengthening science and technology as a means of increasing economic productivity. During this period, a National STI Systems perspective arose, acknowledging the importance of private actors in some industrial sectors.

In this context, STI policies are thought to respond to a bureaucratic translation of the mainstream understanding of the role of governments that are highlighted and copied from the hegemonic countries of knowledge production (Arocena & Sutz, 2006). This resulted in the implementation of STI policies operated from beliefs that have overlooked STI dynamics and specificities locally (Arocena & Sutz, 2017; Kuhlmann & Ordonez-Matamoros, 2017). These bureaucratic processes governing the STI dynamics highlight the sheer distance between conceptualization and practice (Kreimer, 2015).

According to Guzman Tovar (2015), the discourse about strengthening science and technology is present in the Colombian public policy as in other countries such as Mexico and Argentina. However, as the author posits, *"the absence or lack of incentives and specific support in areas such as funding the training of researchers, public investment in research and development, convergence between education policy and science policy, and institutional strengthening of universities and research centers and scientific networks allow thinking of a gap between the level of discourse and level of practice, between what is said*

and done". (p. 138)⁷.

This observation suggests that policies cannot be evaluated only in terms of their institutional framework of STI orientation and design of their instruments but must take into account the operational translation in the level of implementation of the instruments by the target population (i.e. research groups). It is indeed important to approach what happens at the level of local actors, their activities, the impact, contributions and limitations that those instruments may have on them. As Tovar claims, it is important to "*strengthen institutions and interactions that make scientific networks; they must understand individual and collective paths for modeling and knowledge generation strategies consistent with these and their stories*" (Guzmán Tovar, 2015, p. 145)⁸.

It is therefore essential to understand micro-level strategies and practices, and to study the choices that support local dynamics with respect to the set of institutional, local, regional, national, and international instruments that surround or influence research practices.

In Colombia, for instance, the law 1286 of 2009 guides the national STI system for economic development with the idea of increasing the productivity and competitiveness of the country, while promoting the welfare of its population and regional development. In the document titled Vision 2019 (DNP, 2006), the vision for the country is established as consolidating a democratic political model based on freedom, tolerance and fraternity, anchored in a socio-economic model with no exclusion and a State guarantor of social equity. In this political context, STI would be a factor of emancipation as it was two centuries ago. The law establishes as an objective: "*to strengthen the National Science and Technology System and Colciencias (the Colombian National Science Foundation) for a productive model based on science, technology and innovation, to add value to the products and services of our economy and promote the productive development and a new national industry.*"⁹ Furthermore, one of its specific objectives seeks to promote entrepreneurship and business creation and to constructively influence in the economic, cultural and social development.¹⁰ However, the Law 4 of 1992, in its Article 19, states: "*No person may serve simultaneously more than one public office nor receive more than one salary from the public treasury, or companies or institutions in which the state has a majority share*"¹¹, thus imposing limitations for public university professors to receive remuneration for their possible involvement in the spin-offs the policies set as a target. It wasn't until July 6th, 2017, that the law 1838 eliminated this limitation. This is a clear example of a discourse-instrument gap.

However, programs for improving technologies resulting from research initiatives, allowing them to scale up from the laboratory to pilot plants and business plans are almost non-existing. Furthermore, known cases of university spin-off companies are still scarce and even some of the cases exemplifying spin-off experiences are really closer to licensing examples

⁷ Translated by the authors

⁸ Translated by the authors

⁹ See article 1 of the law 1286 of 2009 (translated by the authors).

¹⁰ See article 2, specific objective number 6 the law 1286 of 2009 (translated by the authors).

¹¹ See article 19 of the Law 4 of 1992, available at: <http://www.alcaldiabogota.gov.co/sisjur/normas/Norma1.jsp?i=1166>, accessed on June 6th, 1992.

than spin-off companies in the strict sense.

In fact, between the discourses established in policies such as the ones stated in law 1286 of 2009 and the actions really taken, there is an evident gap. The funds invested do not reflect the objectives formulated, where science is typically relegated over other areas such as national defense. STI investment is very low in Colombia, where the percentage of GDP spent on R&D is one of the lowest in the region. Political discourse made science an enhancer of business sectors, but the agendas or programs for the consolidation of national science and its regional networks are weakly supported. The discourse also incorporates notions of systems and networks, but its implementation is more rhetorical than real. As Guzmán posits, these are established as *“more as a bureaucratic task and not a true end to the consolidation of national scientific communities”* (Guzmán Tovar, 2015, p. 146)¹².

Also, the discursive statements about STI focus on innovation as the key to the definition of public policy without being the fruit of a collective reflection with academics and the public sector. They were based on neoliberal economic policies and their instruments were designed from political or managerial areas away from the scientific world. They are not concerned with understanding and linking the scientific field with the local context (Guzman Tovar, 2015) and these policies were left to the market to define the needs and finance the projects.

Besides, there were not specified mechanisms through which the possible outcomes of research can be leveraged to the socio-economic objectives sought. Consequently, the research and the use of the knowledge generated by scientists in the region had little relevance (Kreimer, 2015) although it relates to the strategic objectives in terms of the institutions of politics. Due to the existence of 'incomplete systems' there are weak links between science and industry, or these don't function in a virtuous way, and have low capacity to make effective use of social knowledge. Thus, academic research is not incorporated into practices or new products or new processes developed by other actors.

2.2. STI policy instruments gaps

We have already discussed policy gaps understood as the distance between discourse and practice. We now focus on the gaps left as the result of instrument mismatches, which leave spaces on the instruments really needed by the STI actors and lead to high transaction costs. According to Chaminade and Padilla-Pérez (2017, p. 195) *“coordination among public organizations for designing and implementing STI policies in developing countries is frequently poor. There is even some competition among them for gaining access to public funds and international aid. National councils or ministries for STI, ministries of economy and education, and ministries that conduct and coordinate STI in specific areas (energy, health, etc.) have their own agendas and budgets.”* In Colombia an example of this was the calls for proposals for supporting technology transfer initiatives opened in 2013 by Innpulsa, which presents itself as the *“the Business Growth Management Unit of the National Government, created on February 2012 to promote entrepreneurship, innovation and productivity as axes*

¹² Translated by the authors

for business development and Colombia's competitiveness"¹³ and Colciencias, separately and with very similar purposes¹⁴. Both initiatives tried to foster technology transfer capabilities, but the Innpulsa call allowed proposals to be presented by only one institution or University, while the Colciencias one required organizations to ally in order to establish a joint technology transfer office. In this sense, research groups could benefit more directly through the Innpulsa call than through the Colciencias one. However, the support that prevailed over the following years was the one Colciencias provided, in an effort to correct the overlap that happened on 2013.

As we can see, coordination gaps result from implementation of STI policies. both competing and complementing STI policies. According to Edler (2017), there are several types of STI policy instruments. Kreimer (2015) identifies 3 types of instruments. Among others: 1) funds for research, which are granted directly to laboratories and institutes block grants; 2) the subsidies provided by competitive funds as opposed to the previous instruments; and 3) subsidies for scientific cooperation networks¹⁵.

In Colombia, various kinds of instruments have been deployed as a practical foundation in the management of scientific knowledge since the nineties (Guzmán Tovar, 2015). There have been policies that seek to strengthen relations between universities and industry and to support the development of basic skills (number of PhDs, support institutions, infrastructure development, regional integration and international insertion) to correct the little regard of companies and the population to the performance of STI activities and the weak STI investment in the country. Also, as part of the process of development of basic skills an invitation to researchers to group together into networks (Cancino et al, 2014; Velho, 2004) and URG (Orozco et al, 2013) was extended several year ago. In addition, Colciencias¹⁶ established measurements or categorization criteria, such as: criteria for the categorization of RG, competitiveness criteria in the process of knowledge production, parameters for accessing resources, a model for the quantification of publications as a way of visibility of the activity and its results. In addition, the development of basic skills has been mainly focusing, during the last years, on training at the highest levels (Masters and PhDs), less on supporting research and even less on entrepreneurship.

Regarding entrepreneurship, SENA, the National Apprenticeship Service, has been supporting entrepreneurs through seed funding since the beginning of the XXI century¹⁷.

¹³ See <https://www.innpuasacolombia.com/es/nuestra-organizacion> (accessed on march 3rd, 2018). The statement was translated by the authors.

¹⁴ The call opened by Innpulsa was the "Call IFR 002 to improve the institutional capabilities of technology transfer and commercialization". The one opened by Colciencias was the "Call to establish a bank of eligible proposals for the creation or strengthening of research results transfer offices".

¹⁵ (Currie-Alder, Arvanitis and Hanafi, 2017, p. 7) establish that competitive calls "push to connect with 'best-in-world' ignores opportunities for regional collaboration, despite similarities in climate, geography, history, resource scarcity, and socioeconomic problems".

¹⁶ Colciencias (Departamento Administrativo de Ciencia, Tecnología e Innovación) is the main funding organization and is by law in charge of the coordination of the National Science, Technology and Innovation System -SNCTel policies and programmes.

¹⁷ The Fondo Emprender (which roughly translates to Start-up Fund) was established on the year 2002 through the law 789, article 40. Available in Spanish at:

However, ten years after the Seed Fund was established, the national government created Innpulsa. This, although it's mostly positive because it enriches the national entrepreneurship system, has also created some overlapping on the support available for entrepreneurs, who have to go to one institution for seed funding (SENA) and to the other (Innpulsa) for other available programs, but still lack a comprehensive support system.

2.3. Research Groups Strategies

An additional perspective to the ones already presented, refers to the opportunities opened to RG's strategical actions as a result of their adaptation to such mismatches, where one can find a supplementary scenario: filling the gaps existent at the STI system level, where a mismatch represents an opportunity for policy experimentation (Chaminade & Padilla, 2017, pg. 200) and for new institutional arrangements, which in some cases may open up possibilities to function in a more efficient way. In fact, according to (Dutrénit et al., 2017, p. 39), in the framework of the evolutionary perspective of the Innovation Systems, *"the agents of an organization perform actions subject to the internal rules of the organization and define modes of execution that allow them to adapt, to execute their functions and achieve their objectives. Also, organizations, as sets of agents, set their inter-organizational rules to relate to others and reach their goals."*¹⁸

As a matter of fact, since the 1980s, many authors have studied RGs as actors, bearers of projects and of research strategies (Lemaine et al, 1982). Some have focused on the most convenient arrangement of their work (Vinck, 2010) considering the strategies of the researchers, and the resources and constraints that come from the institutional and organizational context. They show that the URG also work as a protection for weak research projects at the beginning of their trajectory, combining several types of resources to support the nascent projects locally until they achieve sufficient strength to meet national and international quality and compete (Vinck, 1992) or collaborate internationally (Ordoñez, 2008; Ordoñez, Cozzens & García, 2010). In this perspective, one can think of RGs as actors that adapt strategically to STI policies and instruments. This is one of the aspects we will try to show in this paper.

Observing RGs over time, some authors have studied their trajectories and shown that the differences between them have to do, not only with their context of action (objectives of STI policies and institutions, local situation), but also with their internal dynamics and evolution (collective projects, organization, preferences in terms of recruitment of its members, definition of excellence, etc.). According to these authors, they not only adapt their organization regarding the opportunities but also organize to support long-term projects and research agendas (Dutrénit et al., 2017), in the face of tensions and contradictions between the conditions of funding and autonomy in research processes (Hubert & Louvel, 2012). In this context, the URG also becomes an actor in the sense that generates rules that frame their activities and goals for its members (Louvel, 2011). RGs also design strategies to deal with dilemmas and tensions that arise at each stage of development (López-Yáñez & Altopiedi, 2015) or from the need to produce a social impact of research (Van der Weijden,

http://www.secretariassenado.gov.co/senado/basedoc/ley_0789_2002.html (accessed on march 3rd, 2018).

¹⁸ Translated by the authors.

Verbree & Van den Besselaar, 2012). Based on these studies, we can hypothesize that the URG interact with STI policies and their instruments, learning from these interactions and developing their own strategies (Kuhlmann et al, 2012).

These frameworks also emphasize the role of the URG leader. López-Yáñez and Altopiedi (2015), taking an evolutionary perspective to study RGs, show that the leader has a significant role in the pathways and organizational forms taken by the group at different stages of development. Also, studying the role of the URG leader, Göktepe (2008) finds that this actor is relevant in the entrepreneurial cultures at universities.

From another point of analysis, Verbree et al (2015) study the relationship between academic leadership and scholarly performance. These authors show that a leader committed to the research group, and networking to provide visibility, contributes to improved academic performance, in terms of number of publications and citations.

According to O'Kane et al (2015), the roles taken by principal investigators facing changing contexts of public funding are diverse and include: research designers (maintain a core research program and are selective regarding the funding sources to which they apply), research adapters (have a sufficiently broad research focus to work on emerging issues, which allows them to access various funding sources), research supporters (maintain a core research program to strengthen existing trajectories), and research pursuers (manage short-term research agendas, responding mainly to funding sources calls) (O'Kane et al., 2015).

Concerning researchers' ability to obtain resources, Ebadi and Schiffauerova claim that those mediating relations between different collaborative networks are better positioned to get access to resources than those working in relative isolation. As the authors posit, *"Occupying a network position which would allow researchers for some control over the flow of knowledge and information in the scientific community will not only enable the researchers to get access to more knowledge, but it would also open more funding opportunities for them... Gatekeepers seem to be great candidates for collaboration. If one gets connected to them it may not only enhance his/her ability to access knowledge or expertise from various scientific fields, but it may also improve the chances of success in acquiring research funding"* (Ebadi & Schiffauerova, 2015, p. 15).

Other studies show that some sources of funds require an excessive management effort of researchers, due to the controls and reports required, decreasing the benefits (Cunningham et al, 2014). Thus, it is evident the importance both skills to obtain resources, as well as those to manage them and meet the bureaucratic requirements of funding agencies.

Furthermore, social studies of science and technology¹⁹, underline the importance of networking between actors and show that informal exchanges and interactions are key to the generation of knowledge and innovation so that tacit knowledge is transferred from one player to another (Vinck, 2010).

In fact, scientific dynamism and evolution depends on interactions with other researchers

¹⁹ The "laboratory life" has been a central issue on sociology of scientific knowledge (Latour & Woolgar, 1986; Knorr-Cetina, 1995)

through academic and institutional practices such as participation in academic conferences and practices in other research groups. Vinck (2010) underlines the existence and the need for personal social networks in shaping the scientific facts. These networks are characterized by weak ties and facilitate access to resources and knowledge, and the dissemination of knowledge globally (Granovetter, 1983). Likewise, negotiations with funders allow researchers to understand priorities and mobilize resources.

Regarding the Colombian case, several studies have been performed to understand the conditions of the RG, the institution to which they are linked to, their scientific dynamics and strategies, and their productivity and orientation (Gomez & Jaramillo, 1997; Jaramillo, Piñeros, & Alvarez Lopera, 2006; Ordonez, 2008; Ruiz et al, 2009; Orozco et al, 2013; Lucio-Arias et al, 2014).

With the idea that researchers are more efficient if they participate in URG than acting alone, policy instruments have been implemented in Colombia since the mid-90s to encourage their groupings, and criteria have been set to account for their 'quality' and to recognize them. For that reason, we are interested in the way research groups react, organize and make decisions facing changes in the existing policy landscape.

In addition, few investigate the mediating role played by the organizations to which those research groups are ascribed to bridge the gap between, on the one hand, the macro-policy level represented by the government programs and, on the other, the micro-action level represented by the URG strategies and behavior.

In this context, some authors show how Universities are starting to build their own policies, adding complexity to the system with which the URG have to work. For Am (2013), citing (Van der Meulen and Rip, 1996), universities are intermediaries that work "at a strategic level between policy and research performance levels". The relationship between them and their environment is "a back-and-forth of constructing demands, of localized and idiosyncratic interpretations of policy discourses, and of material and structural constraints in practice." Also, Vessuri (1998) shows how the Universities involve themselves in setting up local CTI policies²⁰. In the same direction, Currie-Alder, Arvanitis and Hanafi (2017) find in Arabic-speaking countries that the incentives and policies within hiring organization affect the way in which researchers and URG take advantage of research funding opportunities. For example, "*the expectations to 'publish or perish' for promotion purposes or to simply burden staff with teaching and training duties*" (p.7) can inhibit research efforts aimed at solving local problems or working on potentially novel issues with long-term results.

These aspects explain why this research also attempts to shade light on the ways RGs, URG leaders and universities, as URG home institutions, play a role in bridging the gaps between STI national policy and the instruments and practices at the URG level in Colombia.

²⁰ In Argentina, for example, the Observatorio Integral de Extensión of the Universidad del Centro implemented programs and training for university entrepreneurs and researchers engaging into technology transfer, consulting and communication. For doing this, it develops a local capacity to observe, study, monitor and evaluate, through a set of indicators, these activities, and produce feedback to support the strategy of the research groups (Correa, 2014).

3. RESEARCH QUESTION AND HYPOTHESES

This study aims at contributing to a better understanding of how STI policies and instruments (materialised from discourses) are taken up (or not) by RGs in Colombia, and, in particular, how university research groups²¹ "navigate" through them to adapt, survive, and progress. We aim at supporting policymakers and scholars in deriving lessons while identifying plausible policy-relevant implications. Although the authors acknowledge that higher education policies, instruments and discourses affect URG behavior, our focus is made on STI policies and instruments defined in a relatively narrow way.

Within the range of questions that may arise about STI policies, the research question we have defined is: **What are the survival and development strategies implemented by Colombian research groups in the context of STI policy gaps?**

From that question, we explored four hypotheses tested through both field research and interactive dialogue with relevant stakeholders in the framework of two workshops held in Bogota. The process we followed to build such hypotheses departed from the familiarity of the authors with popular sayings reflecting common understanding about research groups' behavior.

The sayings in Spanish inspiring the hypotheses are:

- a) "*Al son que me toquen bailo*" ("I dance according to the tune");
- b) "*Haciendo malabarismos*" ("Performing juggling acts");
- c) "*Madre no hay sino una*" ("Mother there is only one"); and
- d) "*Al que a buen árbol se arrima, buena sombra lo cobija*" ("If you snuggle up to a tree with good branches, you will have a blanket in its shade").

To facilitate readership in the following parts of the paper we will use a literal translation into English of such sayings, whenever an equivalent expression was not found. Therefore, the four hypotheses and a short label to identify each one are:

H1. "I dance according to the tune": Adapting. The RGs interact with STI policies and have learned to take advantage from them, articulating and combining different types of policy instruments, according to their needs and interests.

H2. "Performing a juggling act": Balancing agendas, contexts and resources. The RGs maintain research lines defined autonomously, which do not depend on STI policy instruments. This hypothesis also highlights the key role of the URG leader in taking advantage of STI policies and articulating instruments.

²¹ The authors are aware that university research groups differ from groups working at autonomous centers or other types of organizations, in the sense that the latter face different challenges and work under different framework conditions for their operation (such as not having financial support as a given). A different study would need to be done to take into account such special conditions. We therefore cannot claim that our results are generalizable for such types of groups, but only to some extent to university research groups.

H3. “Mother there is only one”: The role of home institution. The institutions to which RGs belong play an important role in filling gaps left by policies and instruments at higher levels (regional or national).

H4. “If you snuggle up to a tree with good branches, you will have a blanket in its shade”: **Networking.** In the framework of STI policy gaps between the national and institutional levels, some RGs appeal to their networks and recognition to continue pursuing their research agenda via, for example, assuring access to research tools.

With these hypotheses we studied the cases in the ways explained in the next section.

4. METHODOLOGY

The methodology applied to answer the aforementioned research question has several components. We propose an iterative approach between the construction of hypotheses and their confrontation with the case studies.

First, the definition of the hypotheses was a three-step process: Construction, substantiation and testing. We built a first set of hypotheses based on the nanotechnology case study, where the “Grupo de Investigación en Fisicoquímica Teórica y Experimental”– GIFTEX was analysed²² (Jaime et al, 2016). We opted to frame the hypotheses as popular sayings for easier identification. Then, based on a previously documented case (Herrera et al, 2012), an interview to the leading researcher of the Biomedical Engineering Research Group - IB - was administered to deepen our understanding of the matter as well as to validate the hypotheses in the biotechnology domain. Finally, we tested the hypotheses in the framework of two workshops held in Bogota.

In these workshops, researchers in multidisciplinary fields and research policy scholars and managers, among other actors participated. The framing of the hypotheses as sayings helped to motivate lively and provocative workshop discussions. It is worth mentioning that the leading researcher of the IB participated in the first workshop, which allowed us to complement the information previously gathered given the established hypotheses. The two workshops were held in August and October of 2016 with around 70 participants in each one. In these workshops the discussions turned around reconfiguration strategies, dynamics and implications research groups consider, while dealing with multiple needs, opportunities, barriers and limitations resulting from STI policies and their associated instruments implemented at the national, regional and institutional levels in Colombia. Both workshops were recorded and transcribed for later analysis. On these workshops, the authors administered a poll among the participants aiming at, once again, testing the proposed hypotheses. The poll was conducted based on the methodology proposed by Reyes (2008)

²² This group worked in close collaboration with another group called Centro de Estudios e Investigaciones Ambientales (CEIAM).

where, taking advantage from episodic memory, participants react to cartoons portraying different scenarios (these cartoons are found in the appendix 1). This exercise was complemented by a voting system which yielded results the participants could see on the screen and contrast their responses with the group's outcomes. About thirty responses were gathered.

While working on the hypotheses, we analysed the cases from the perspective of the hypotheses as they were evolving. With the idea of tackling the issue of STI policies and instruments from a bottom up perspective, we chose to focus on a technological development project (nanotechnology for the solution of environmental problems through the enhancement of natural fibers) carried out by the URG mentioned, as well as on the trajectory of a URG dealing with multiple developments in the biomedical field related with cardiovascular pathologies, for which a leading researcher was interviewed.

It is important to note that we understood the notion of 'project' not in the administrative sense of a unity of research (as defined by a start date, a completion date, some objectives, a budget, the name of a list of researchers and the resources available) but more as a unit that makes sense for researchers beyond institutional frameworks. Consequently, we began to study the trajectory of these projects to develop a technology and identified various actors, resources and policy instruments mobilized by the RGs in their effort to maintain their strategies and research areas they have established. Through semi-structured interviews and with the leaders of the research groups, active ethnographic observation and a collection and analysis of documents (related to STI policies, policy instruments, project documents, scientific publications, press releases and work documents), we reconstructed the trajectory of the projects and the actions of the RGs to understand how they articulated various resources and took advantage of several STI policy instruments available simultaneously.

With all this information, we followed a case study methodology (Yin, 2014). In this process, we studied how the RGs interacted with STI policies and how they learned to take advantage of the policies implemented at several levels, going from one instrument to the other and to articulate them. We analyzed how their research evolved and under what influences, the role of leader of the RG, the role of their home institutions, and the role of other actors.

In summary, we contrasted the hypotheses with the cases chosen, as well as with some additional ones at a Colombian university, where the focus was on knowledge management and collaboration practices. All this information led to the findings shown below.

5. How do Colombian RGs interact with STI policies and programs?

We studied two research groups. The first one called "*Grupo de Investigación en Fisicoquímica Teórica y Experimental*"²³ – GIFTEX", which works at a Colombian public university, the "Universidad Industrial de Santander" located in a mid-size city (Bucaramanga), and the second one called "*Ingeniería Biomédica*"²⁴ - IB", which works at a Colombian private university, the "Universidad de los Andes", located in Bogotá, the capital of the country.

The GIFTEX group was created in 2004 and works in the field of fundamental and applied physical chemistry. Its research focus is on cellulosic materials. This group currently works on the development of a technology aiming at the decontamination of water based on nanocomposites.

The IB group was created in 1985 and works in biomedical engineering. It focuses on hemostitutives and tissue engineering, among other subjects. We centered our observations on the hemostitutives work they have been doing.

Trying to understand RGs trajectory, activities and strategies, we mainly considered their relations to national, regional and institutional STI policies, programs and instruments, and analyzed the role played by their home institution to take advantage for realizing their research agendas. Since the nanotechnology case was the most studied of all, in the following sections we mainly focus on it and add references to the other cases wherever the hypotheses were found relevant.

"I dance according to the tune" ("Al son que me toquen bailo")": adapting

In the evolution of the RGs studied, we found that the RGs have interacted with a variety of actors in Colombia and abroad.

At the beginning, in 2005, the GIFTEX group was contacted by the Secretary of Agriculture of the Department of Santander to explore the possibilities of working with *fique* (a local plant). As a result, they presented a project proposal, but they did not get funded because the Secretary later prioritized other themes. In fact, they had previously sought resources to work with *fique* through several contacts with the Ministry of Agriculture of the Department of Santander, but they had never obtained financing, which led them to think that "nobody cares about *fique*" in Colombia. As a matter of fact, at that time, regional entities prioritized on other sectors such as cocoa, and the group participated in some projects in these areas to 'survive'. Given the lack of resources from a formal project with the appropriate funding, the group continued to do research on *fique* through undergraduate degree projects. This allowed the URG to have some initial results that served as a basis for presenting other project proposals later on. It then developed initiatives for which it found some funding, therefore without walking away from their core research interests, which would later

²³ Research Group on Theoretical and Experimental Physical Chemistry.

²⁴ Biomedical Engineering.

constitute the area of greatest contribution from the group (cellulosic materials).

In this context, the URG worked on some projects that enabled it to mobilize resources in the short term, enough to remain active and sustain other projects with greater long-term potential, and, in this way, to stay 'alive' as a group by using the link with teaching and the operating resources of the laboratories in the university.

In this case, the URG shows a learning process about how to mobilize various types of resources inside (students, colleagues, among others) or outside the university. They learned to move between policy instruments of different nature (institutional, regional, national and international) to develop their agendas, in a process of articulating their interests with materialization opportunities. In this sense, agendas or topics are developed by "*dancing according to the tune*", that is, maintaining a minimum research core but adapting to the changing financing conditions. In so doing, they run research programs or topics more or less independent of their externally-funded projects, and prepare project proposals trying to blend STI policy instruments to the extent possible in their advantage and consistent with their own research needs and strategy. It is not a totally reactive process of responding to programs or subjects defined by the funding organizations, but of "*dancing according to the tune*" by changing the pace and adapting to the moves made by their dancing partner (funding organization), but always within the limits of one's ability to move in a harmonious way without stepping on the partner's feet.

The case study shows that the research group learns how to generate translation processes in the sense of Callon (2006) regarding the construction of issues among different actors, mobilizing them and rethinking their definition. In this way, the URG articulates policy instruments with its research interests. An example of this is the response of the GIFTEX group to a call for proposals by the Government of Santander to support projects aimed at obtaining new materials from biodiversity in the region. The group found here an opportunity to present a project for the use of *fique*, a fiber with which they had started working earlier and which had been identified as a promising research topic in the region. The interests of the group on research on *fique* were articulated with the financing available from regional promotion entities to work on new materials.

This dance between the strategies of the research group and the policy instruments resulting in research initiatives kept the group active while working on a mix with other topics considered more promising in the long term by decision-makers. The group, in turn, maintains projects that compete among themselves, some of which subsidize other initiatives less attractive to funding agencies in the short term. This shows a permanent dance between the interests of the group and its context.

The group has learned that there are greater chances of getting resources for applied research projects. In the words of its leader: "*in Colombia, the financing issue is limited for basic science and a little less limited for applied science*". Therefore, they permanently monitor funding sources, including those that contrast with their research interests. In this context, they draw more flexible applications focusing on the materials they investigate, but maintain their core research focus. This is facilitated because cellulosic materials have applications in multiple sectors and the group can have projects targeted to each application "*without needing to reconvert ... completely*".

In this scenario, building a research core that can be flexible for multiple applications has

been a central element of the strategy of the group:

"we adapt our materials for specific applications since cellulosic materials can be used for making catalyzers, for making chemical dispersants, for making surface modifiers, surface tension modifiers, for making membranes; we have a heart, a core, a core work, which allows us to look for different applications"

This meant adapting to policy instruments that focused on particular sectors. It is the case of a research project they developed with a hydrocarbons company they managed to convince about the potential applications of the materials worked by the group. This required "*a fairly large amount of lobby efforts*", a management effort from the group to show the company the potential of the project. The funding was obtained, and represented an important source for the groups operation, but it then was stopped due to the crisis in the hydrocarbons sector in Colombia.

This led the group to propose a redefinition of the strategy. The project with the company allowed them to fund graduate and doctoral students as well as a postdoctoral fellow. Since the funding was suspended, the group strived for finding resources from other sources such as scholarships from Colciencias and the university, but it was not possible in all cases and some people left. In this context of multiple policy instruments, the group learned to move in order to maintain its research core, but the ability to retain students that continue their doctoral education is low given the impossibility to secure funding:

"There are graduate students in Germany, Spain, who are very talented, who left because we could not keep them in our programs. That is very sad, very regrettable, as we don't have a way to keep up the development efforts, and that is because we lack of strong investment support to research."

The URG leader's strategies in this case correspond to the type (O'Kane et al, 2015) call research adapters, where he mobilizes his group to keep their research subject. This case supports the first two hypotheses: the ability of the URG to act and learn to act with STI policies and the maintenance of its research core.

"Performing a juggling act" ("Haciendo malabarismos"): Balancing agendas and funding sources

The cases show various components of the research groups performing juggling acts among STI policy instruments. One is related to the distribution of available resources across areas for which financing is obtained with others that do not have support but which are of relevance to the group (topics being "***cooked at low fire***"). The resources are harnessed to start developing new subjects that may become strategic or perceived as promising in the long term. Hence, researchers make their research agendas more flexible in the short-term to achieve long-term goals. Is like throwing high up an object while dealing with those at hand but keeping an eye on the 'outlier' waiting for it to become a central one in the show whenever the moment comes and room have been made at least temporarily.

The project portfolios can combine several of the strategic positions proposed by O'Kane et al (2015). In that sense, performing a juggling act allows the group to learn to combine exploitation strategies (areas for which they have a solid knowledge base) and exploration ones (new areas with potential but high uncertainty) (March, 1991).

In the case of the GIFTEX group, as the interviewed posits: "*if I have a funded research project on materials with application to hydrocarbons, all along and simultaneously, we take up other lines of research that we are 'cooking,' because that gives us an opportunity to consolidate those lines I see important, otherwise they would not have funding.*" This shows learning about how to leverage resources to work on new areas for which there are not formal funding. As one GIFTEX's researchers stated:

"And then we rely on the resources that come to support a project to permeate other projects of lesser amounts. That allows us to stay up to date and then, when these (other) ideas are consolidated to present to new calls for proposals, where we already have secured results, and where we know we will be successful, then it is like performing a juggling act, in the sense that if I have 100 pesos²⁵, and that project costs 100 pesos, but we have the opportunity to have a material that leaves me 2 or 5 bucks and thus we can support another student who is progressing, we will do things simultaneously, supporting them on the road. Depending on funding, we work."

According to the results of the workshops, another reason for researchers to juggle is the shortage of resources for research projects in national policy instruments.

"That is, now everything is about scholarships (...) 70% of the budget of Colciencias goes to scholarships and very little for projects. I form a PhD and I bring her here and there is no way to finance her work" (researcher who attended one of the workshops).

The case of the IB Research Group is an example of a group's ability to combine instruments. They apply to different sources of financing, which include the Colciencias' Biotechnology and Health National Programs, university grants and scholarships. The IB combines University resources, grants of the Ministry of health and Colciencias funds in order to: organize a biannual international congress; encourage the participation of students in the RG; postulate PhD candidates at two other higher institutions: Georgia Tech and La Joya in California, which are its main research partners. In fact, one of the IB's researchers who graduated from University of Los Andes - Uniandes is nowadays a full time professor at La Joya and is also the director of Ph.D. Students from Uniandes' Biomedical Program. Throughout its trajectory, IB has developed several technologies. Among them, IB has developed collagen membranes that are at the clinical essays phase. IB has taken advantage of its pioneer expertise on the fabrication of these artificial tissues to spin-off BIOMASTER as a way to take this development to the market.

This strategy of "*performing juggling acts*" was also evidenced in the empirical material of previous research. According to an interview with a researcher from the Biomedical Engineering Group at the Universidad Central in Bogota:

"Sometimes we are forced to make decisions when projects are fast approaching strict deadlines and we need to think of new ways to continue under "another candle"."

In addition, we must highlight the IB leader's knowledge on how to balance the

²⁵ The peso is the currency of Colombia.

opportunities of STI policy instruments and the research group agenda. The IB's laboratory has been equipped combining public and private funds (mainly Colciencias and *Fundación Cardio Infantil*²⁶ - FCI), while the access to robust equipment is supplied abroad, i.e. at Georgia Tech laboratories used for experimental testing, during IB's PhD students research internships (who are funded by different scholarships).

Researchers and groups learn to diversify their funding portfolio, "performing juggling acts" to avoid dropping the core topics while opening up new research possibilities. They generate strategies to manage areas of research with different time horizons and speeds.

“Mother there is only one” (“Madre no hay sino una”): the role of the home institution

Continuity of the research streams is achieved because the group learns to combine policy instruments to support specific projects with other support programs offered by the University of which they are part. The support of the home institution allows the group to have continuity in its work, even in the absence of formal research projects.

In the case of UIS, there are several programs to support research, such as full and partial scholarships. Another one is the UIS' mobility program, which provides funding for allowing masters and doctoral students to participate in academic events. Other programs include investment in infrastructure and laboratory equipment. These programs facilitate capacity building. The mobility program allows researchers of the group to meet with external peers, and explore project ideas to work on later, using, for example, an instrument of the national STI policy such as the Colciencias' Diaspora Program. In this case, the university becomes a relevant actor to fill gaps in STI policies.

Another example is the grants the institution offers to allow students to continue to work on research projects while they have access to resources from national programs like the Colciencias fellowship. This is illustrated in the case of students of the GIFTEX Group, who were funded by the project with the oil company, which suspended funding:

“One of the PhD students used the Universidad Industrial de Santander scholarship. These grants are small but serve for maintenance while preparing to participate in the next call of Colciencias for PhD scholarships.”

The institution provides basic support in the absence of other sources of funding to continue the research. The way the researcher or the group moves in the institutional environment strongly influences the ability to use those instruments. As one interviewed claimed:

“So it has become very efficient, I do not know if it's because you already know the intricacies of these things (...), but as far as I know, my impression is that in recent years it has become very efficient the issue of support provided by the university for these things to happen diligently”.

Within the infrastructure development program, the university has strengthened a technology park with specialized laboratory equipment. This has allowed the research group

²⁶ In English: Children's Cardiovascular Foundation.

continuity of work and positioning in front of its allies: "it's ... amazing, because now people listen to us and respect us". For researchers, to have the infrastructure and resources within their institution becomes a key point to make progress, which is common with laboratory equipment (Suárez, 2014; Vinck, 2006). As a researcher says:

"... Here we have the latest technology for analytical work... Many of these new large laboratory equipment have opened the possibility to have a synthesized sample. We synthesize the sample today, and tomorrow we will have the characterization of that sample. If we did not have that infrastructure, we would have to pack suitcases, pack the sample and send them elsewhere. People will know what we are producing, they will begin to ask what it is, what that is for, etc. and we will lose competitiveness."

The group has strengthened its capacity to generate more symmetrical international collaborations, thanks to having the infrastructure and skills to take advantage from, a phenomenon that has been evident in studies of partnerships between Latin America and other regions (Gaillard, Gaillard & Arvanitis, 2013). As stated by one researcher:

"And it is for this reason that we now present projects with colleagues from other places in the world, otherwise we will be saying "you make me this characterization, and you make me that," therefore to have infrastructure has been fundamental, so that we can show other people from other places in the world that we do not only have good ideas but also the necessary capabilities and tools."

These researcher mobility programs, scholarships for students and investment in infrastructure and laboratory equipment generate a basis for the development of research, even in the absence of funded projects. These allow starting working on some issues and having some initial results to obtain financing later. In this way, the institution provides a minimum of resources necessary for exploration.

These university support programs for research are further complemented with other programs of support project management. "... *there is also a team that has specialized in handling a lot of formats for submission of projects.*"

The results support the third and fourth hypotheses. It illustrated that the institution to which the group belongs has a key role in filling gaps across policies at higher levels of decision-making at the national STI policy landscape, and provides resources for exploration in areas that may have external funding in the future. The role of the group leader, and how he learns to move along in the institutional environment and combine resources to complement each STI policy instrument with others, is key to take advantage of these institutional supports.

It is important to note that, we also found, through the workshops, evidence supporting an alternative view to these hypotheses, in the sense that sometimes there can be not one but several 'mothers' supporting research groups in complementary ways. This is the case when a URG is led by researchers who take advantage of several institutional affiliations and therefore can fill gaps found on their research trajectory. In the IB case, the organizational "embedded role" of the IB leader is played beyond Uniandes. Not only the IB leader has shown its ability to build international academic networks, but this ability is also present at a local level. From the beginning of its work, it was necessary to establish a partnership between Uniandes & FCI. This is a co-invention network (Herrera et al., 2012) whose main

project is the development of a hemosubstitute (artificial blood), which became the first Uniandes Spin-off. In fact, many of IB's research endeavors have involved Uniandes as well as FCI, which has led IB's leader to express he considers himself as benefiting from "two mothers".

On the other hand, we also found that home institutions can indeed act as a 'burden' for research performance due mostly to heavy bureaucratic procedures. A researcher working in nanotechnology at another university, for instance, referred to the problem his group has when acquiring research material or samples. According to this researcher their acquisitions department has procedures that respond more to administrative criteria than to scientific criteria. A comment from one of the researchers attending the workshops goes in the same direction:

"...the administration must be a tool at the service of research. Administration in universities, in research centers, has to support researchers so that they can work better and faster. In most cases, the administration is organized to control researchers, so that they comply with some indicators and produce money (...), mounted on terribly complex structures and processes and procedures." (researcher who attended one of the workshops).

"If you snuggle up to a tree with good branches, you will have a blanket in its shade" - The role of networking

Sometimes performing a juggling act depends on the abilities of the group leader, who has learned how to move through the existing policy instruments and balance research agendas and needs. This involves, for example, capitalizing on personal networks. This is shown in the case of GIFTEX with a project funded through the "Program for High Recognition Diaspora"²⁷ developed in collaboration with a Colombian researcher ascribed to Cornell University in the United States and graduated from the Industrial University of Santander - UIS. In that case, links between researchers from GIFTEX and Cornell that started long time ago at undergraduate education were used to strengthen the network:

"thanks to the Diaspora program of Colciencias, we started to partner up with a colleague of us ... for obvious reasons: he has experience in using cellulose but the one made out of cotton and other fibers such as nylon, synthetic fibers and has deposited nanoparticles on these materials. We ran into him in 2008 ... in Puerto Rico, in San Juan, at a Latin American chemical congress and we talked about the possibilities of working together, then, at that time, we agreed that we could begin to explore the fact of using fique fibers as support".

From the above text, it can be seen that their personal and informal networks and previous links allow the research group to take advantage of a policy instrument such as the Diaspora Program. International connections open up the possibilities of accessing resources from the national order. This is how the group makes a permanent combination of various

²⁷ A program from Colciencias aiming at strengthening links between Colombian researchers and innovators living abroad.

instruments, and their informal networks contribute to that articulation.

Network creation is also a characteristic of IB's activities. IB takes advantage of the University capacities for creating networks that couldn't have been developed if the University had not counted with the country's first biology PhD program. Also, the IB Director played a very important mediator role when his PhD Thesis started a new research issue at La Joya University²⁸.

In the analyzed situations, we have documented elements associated with the four hypotheses. The group leaders and their networks have an important role in the group's ability to take advantage of STI policies and to combine several of them in order to continue their research. The groups learn how to juggle research initiatives on which to deepen in the short term, with others that may be relevant in the future. Research agendas are tailored to the available resources, but there are core lines that stay over time because the group learns to juggle around different STI instruments to keep them active.

6. Conclusions

This work contributes to the understanding of the role of research groups, their leaders and their home institutions to operate, adapt and sometimes take advantage of opportunities, gaps and contradictions between STI policies and the corresponding policy instruments functioning at the same time. The ability of research groups to 'juggle' with heterogeneous policy instruments becomes essential in the dynamics of STI. We showed that URG learn how to "dance according to the tune" and take advantage of the partner (funding agency) and melody (policy discourse).

One important conclusion is that the ability of URG to take advantage of STI policy instruments depends on collective activities such as building a coherent research group strategy. Indeed, contrary to what was found in the first two hypotheses, where the role of the leader is determinant, it became evident that harnessing STI policy instruments requires RGs members' abilities and willingness to act as pillars supporting RGs leaders. In this case, RGs leaders are necessary but not sufficient conditions for RGs 'survival'. In fact, some of the participants of the workshops stated the importance of having several leaders in the research group in order to succeed in its research endeavors, configuring swarm intelligence. According to some of the participants, the leader requires a team that functions, or to keep using popular sayings: "*one swallow does not a summer make*".

Also, as the cases studied and the workshops show, research groups that develop strategies to maintain a core research agenda will probably be able to strengthen their research lines with multiple support programs. The main research lines are maintained despite the changing environment of policy instruments because the group learns to balance, for instance, research agendas and opportunities for which there is short-term financing, with others that may be put on hold as long as they look promising for the future. It is a task of

²⁸ IB leader plays a role as a mediator agent of knowledge (MAK). It is explained in Jaime, Herrera, Vinck (2006, p. 11): "According to a testimony of the researcher, a significant fact in this second study case is that the know-how applied in Bogotá allows opening a research line at the director laboratory of his thesis in Austin about the hemosubstitutes subject. The subject developed in Colombia by the group director helps him to mediate as a researcher within a new knowledge global network".

juggling between exploration and exploitation of knowledge associated with funding sources and opening and closing opportunities. In other words, group 'strategies' are a necessary but not sufficient condition for group 'success'. That is, group strategies can only function as long as there are research 'ideas' (agendas, topics, themes, problems, etc.) on which strategies are justified, in order to take advantage of the surroundings.

O'Kane et al. (2015) illustrate in their categories of researchers' strategies this focus on the exploration and exploitation of knowledge. Other studies have shown how organizations become "ambidextrous" when they combine these strategies for exploration and exploitation of knowledge (Russo & Vurro, 2010). The cases studied here bring in another direction, showing the efforts and learned lessons from the research groups aiming at balancing both strategies of exploitation and exploration while striving for survival in the framework of scarce resources and limited national support. The balancing effort referring to exploitation and exploration strategies relate, not only to processes of knowledge generation, but also to the way policy instruments and funding opportunities and conditions are combined.

The study also provides another lesson regarding the capitalization of the personal and informal networks. Especially when they involve weak ties, these networks enable groups to take advantage of some information on policy instruments. Furthermore, some studies have shown the role of social capital in technological developments and engineering (Chollet, 2004; Sainsaulieu & Vinck, 2015). The cases studied here, as well as the workshops, provide new insights into the role of social capital on the capacity of groups to take advantage of STI policies. Ebadi and Schiffauerova (2015) have shown that the ways in which researchers connect with each other influence obtaining or not funding for their projects. In the cases studied here, and on the workshops, it became clear that learning how to use those links to combine different policy instruments become very relevant for the groups research activities. Moreover, the international linkages improve the group chances to access funding programs of different levels of the STI policy landscape. In fact, this articulation between international collaborations and access to sources of national funding has been noted by recent studies (Ordonez, 2008; Gaillard et al. 2013). In the situations studied, we observed that these links allow URG to combine resources from different sources. In addition, the cases we studied show that the type of cooperation varies depending on the capabilities on the research groups involved in it. In particular, the availability of research equipment allows cooperation links in terms of peers in a symmetric relation, different from the subordinated integration argued by Kreimer (2006) or the ones originated in the lack of resources (Robles-Belmont, 2009).

Research outcomes with potentially economic and social impact for the country's development, result from the strategy of taking advantage of several policy instruments, instead of being the result of taking advantage of only one instrument, as some of those instruments expect (e.g. stating targeted impacts in proposals presented to calls for proposals published by Colciencias, as an instrument to implement the ST&IP). In practice, overall impacts results from research groups combining several policy instruments, sometimes transcending the national frontiers and some other times taking advantage of institutional policies and even personal contacts and resources.

In this sense policy 'impacts' are mostly the merit of research groups and their home institutions which materialize STI policy ambitions by dealing with constant gaps left by

policies and instruments designed at the national/central level.

More precisely, this work contributes to the understanding of the endogenization of local reconfiguration processes of STI policies, from the practices of the involved actors and the co-construction (or sometimes lack of it) and settlement of tensions between its design and implementation. It also provides insights into second order effects of such policies, lessons that go beyond the time horizon of implementation and that have implications for the way actors organize to take advantage of these support mechanisms. In the implementation of policy gaps emerge that, on occasion, should be borne by the institutions that run them or impede the achievement of the objectives. Kuhlmann et al. (2010) argue that "*Second-order learning concerns sorts of inquiry that resolve incompatible organizational norms by setting new priorities and relevance of norms...*" (p. 7). In the cases studied here, we bring elements about learning how to "*dance*" among actors in the implementation of STI policies. The second-order learning research groups and their leaders and institutions, is vital to use policy instruments and this point is not considered in the impact analysis of STI policies.

The results of this study show that the focus on a policy, program or project is limited, because significant results require a long-term work in which actors articulate several formal and informal initiatives. The various policy mechanisms can be drivers of non-formal working arrangements that are setting interest of researchers.

The evaluation of the results of the policies requires taking into account the interdependence of several mechanisms (Lepori, Barré, & Filliatreau, 2008). A possible entrance for the analysis of this situation is proto-institutions (Lawrence, Hardy, & Phillips, 2002), the configuration of networks and formal and informal collaborations that are consolidating between a policy and another. We contribute in that direction with the results of this study, providing an insight into the implementation of STI policies taking into account the bottom up co-building process among actors.

We notice, however, that, based on the discussions held in the two workshops in Bogota, there is the perception that sometimes research groups are either tempted or forced by home institutions to respond to policy incentives portrayed as opportunities in directions seen as not relevant and leading to inconsistent or even inconvenient behavior. This is the case of current efforts by Colciencias in Colombia to promote patenting, which is seen as adding unjustified and unnecessary burden to group work. Another example is the perception that the classification of research groups led by Colciencias supported by scientometric indicators to promote research collaboration, is in fact leading to undesirable behavior by research groups and questionable effects (more emphasis on excellence than on relevance, and the exacerbation of the 'Matthew Effect' (Merton, 1968)).

In the case of Colombia, very little is known about the research group and university capacities to learn from interacting with different policy mechanisms. Our study shows a relational capacity of research group learning on how to move among different policy instruments, which may be sometimes contradictory.

We analyze research group strategies at striving for 'surviving' in the Colombian STI system by taking advantage of the relatively scarce opportunities opened to them while trying to maintain a core research agenda which make them distinctive from other groups. We focused on two well ranked research groups working on nanotechnology and biotechnology. The first one localized at a provincial public university and the second one in a private

university in the Capital of Colombia. We found that research groups typically adapt to changing conditions and 'dance according to the tune', 'perform juggling acts' and strongly depend on their 'mother institution' For that reason, one line of future research under this approach would be to study a diversity of universities and the role of different "mothers" as support for research groups, given that the URG we studied are both attached to Universities ranked among the top ten of the Country.

Nevertheless, this work could have a possible use for research groups that are in the early stages of their development, by showing the experience of research groups with extensive experience, such as those that were followed to develop this work. Although it is not intended to recommend a way to carry out the consolidation processes of the research groups, the experience and findings shown can serve to recognize the dynamics that have been present, and plan the actions in accordance with them.

Finally, since our analysis is based on two case studies worked in depth, plus two workshops held in Bogota, from the methodology point of view, this paper could be an opportunity to start a new blend approach. Blending 'episodic memory', metaphoric hypothesis, workshop validation, and ethnomethodological approach in order to gather more information than the initially gathered through the two cases studied in depth. Moreover, the bottom up view of the STI policies provides an interesting avenue for future studies on policy effectiveness.

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