

INTERACTIONS BETWEEN ACTORS OF THE COLOMBIAN SYSTEM OF SCIENCE AND TECHNOLOGY: A TEST OF SÁBATO'S TRIANGLE MODEL¹

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INTRODUCTION

The creation of Colciencias, in the late 1960s was a response to regional and multilateral initiatives promoted mainly by the Organization of American States (OAS) and the United Nations Educational, Scientific and Cultural Organization (UNESCO). Colciencias has since been the government agency in charge of science, technology and innovation (STI) policy-making and implementation, including funding of STI activities and projects. It also exerts the secretariat of the Colombian National System of Science and Technology (SNCyT by its name in Spanish).

In 1991, when the SNCyT was created by law, the institutional set-up followed the Sábato's triangle model. The composition of the decision-making bodies included representatives of three sectors: government, the academic-research community, and the productive sector.

There are many studies on S&T policy in Colombia (see for instance Jaramillo, 2007; Jaramillo, Botiva, & Zambrano, 2004b; Monroy, 2004; Villaveces & Forero, 2007) but none on the evolution of the SNCyT as such. Therefore the focus of the research will be the institutional framework: Colciencias, the SNCyT and its decision-making bodies. The final objective of this project is to explain the system of science and technology (S&T) governance and policy-making in Colombia, and the underlying communication processes.

This paper is organized as follows. The first chapter presents the Latin American school of thought on science, technology and development, making special emphasis in the period of the sixties when Sábato proposed his model. The second part is the theoretical framework, where the main models for representing tripartite relations (i.e. Triple Helix, Sábato's Triangle, National Systems of Innovation Systems –NSI) and network theories are summarized. In chapter three I briefly describe the evolution of the STI institutions and the policies in Colombia, during the period 1989-2008, when the SNCyT has operated. The fourth section deals with the methodology. Results are presented in chapter five. And lastly, preliminary conclusions are drawn, and a research agenda proposed.

1 THE LATIN AMERICAN SCHOOL OF THOUGHT ON SCIENCE, TECHNOLOGY AND DEVELOPMENT

The way practitioners and academics deal with Science, Technology and Innovation Policies (STIP) has evolved over the past 60 years, both in developed and developing countries, although in the latter nations lagging behind a decade or so. The starting point of public research

¹ This is a work in progress, please do not quote or cite. Not to be published.

policy in Latin America date back to the 1950s and 60s, when most of the national organizations in charge of S&T policy and funding were created, promoted by international agencies such as the OAS (Organization of American States) and UNESCO (United Nations Education, Science and Culture Organization). However, in the first half of the 20th century several important (public) research centers had already been created, focused mainly on scientific investigation². In the late seventies and throughout the eighties, the focus was on technology management, in particular technology transfer agreements. During this phase, UNCTAD (United Nations Conference on Trade and Development) and ECLAC (United Nations Economic Commission for Latin American and the Caribbean) played a major role in defining policy issues and helping developing countries to regulate these agreements. In the 1990s, innovation policy clearly emerged in these economies, and many of these countries embraced the systems of innovation approach, based on the experience of the OECD (Organization for Economic Co-operation and Development) countries.

Two periods of studies and thinking on science, technology and development can be identified in Latin America. The first one covers the 1960s and 1970s, and the second one the 1980s and 1990s. The former period was guided primarily by the experience and ideas of researchers and policy practitioners; the later epoch, encompasses a group of people with postgraduate education in policy, management or social studies in science, technology and innovation. I will concentrate on the first period, taking into account that the model object of study, Sábato's triangle, was developed during that time, although the main period of analysis is 1989-2008.

The early school of thought emerged in the 1950s, based fundamentally on practice rather than theory, not having a body of scholars associated (Martínez-Vidal & Marí, 2002). It formulated a research and innovation policy which was advanced for its time, because it went beyond the traditional supply and demand perspective and the linear model. The main proposals were that autonomous technological development was possible, and that it was crucial for endogenous and integral development, incorporating social concerns. In this sense, there are clear connections between the formulations of this school and the "dependence theory" developed by ECLAC.

1.1 Sábato's triangle model

Martínez-Vidal and Marí (2002) agree that the culminating moment of the Latin American school of thought was the (now) famous 1968 article by Sábato and Botana³, in which they propose the triangle of scientific and technological tripartite relations. Despite the school being mainly directed towards S&T policy rather than institutional arrangements, it is well known because of Sábato's Triangle, which offers a simple but clear figure to depict the three groups of actors that have historically been fundamental in the development of S&T: the government, the productive structure, and the scientific and technological infrastructure, as they have been called by Sábato.

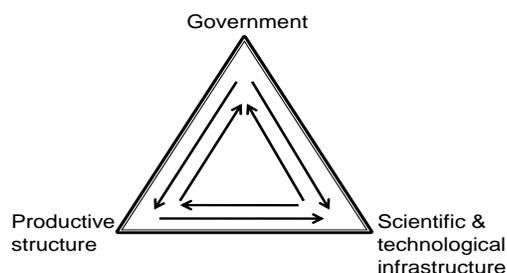
Each vertex of the triangle constitutes a convergence point of multiple institutions, decision agents, production units, etc. The vertices are characterized from a functional perspective and not by their legal nature (e.g. a public firm is part of the productive structure, not the government). Below the original, and very specific, definition, provided by Sábato and Botana, of the scientific and technological infrastructure, which is composed of a group of articulated and interrelated elements:

² For instance, in Colombia Cenicafe (National Coffee Research Center) was created in 1939 and the ICA (Colombian Agriculture Institute) was created in 1962; the CNEA (National Atomic Energy Commission) of Argentina in 1950 and the INTA (National Institute of Agricultural Technology) in 1956.

³ Jorge A. Sábato (1924-1983) was an Argentinean physicist and technologist. He joined the CNEA (National Commission of Atomic Energy) in 1955 and created the metallurgy department. For many years he was interested in the relationships between science, technology and development. Natalio R. Botana (1937) is a political scientist, also born in Argentina. He wrote that paper with Sábato in 1968, but science, technology and development did not remain his area of interest. Today he writes a column in the Argentinean newspaper *La Nación*.

- Education system, which provides the quantity and quality of `men´ who conduct research: scientists, technicians, assistants, operators and administrators.
- Research institutes, lab centers, and pilot plants (formed by `men´, equipment, and buildings where research is done).
- Research planning, coordination and support (granting) organizations (e.g. research councils, science academies, etc.).
- The administrative and legal mechanisms that regulate the functioning of the above elements and activities.
- The economic and financial resources applied to its functioning (Sábato & Botana, 1968, pp. 3-5).

Figure 1. Sábato´s Triangle and the three type of relationships



Source: Sábato & Botana, 1968.

It is interesting to note that Sábato and Botana include S&T policy-making and granting agencies as part of the scientific and technological infrastructure and not of governmental. Moreno, one of the Colombian exponents of the school, said back in the 70s:

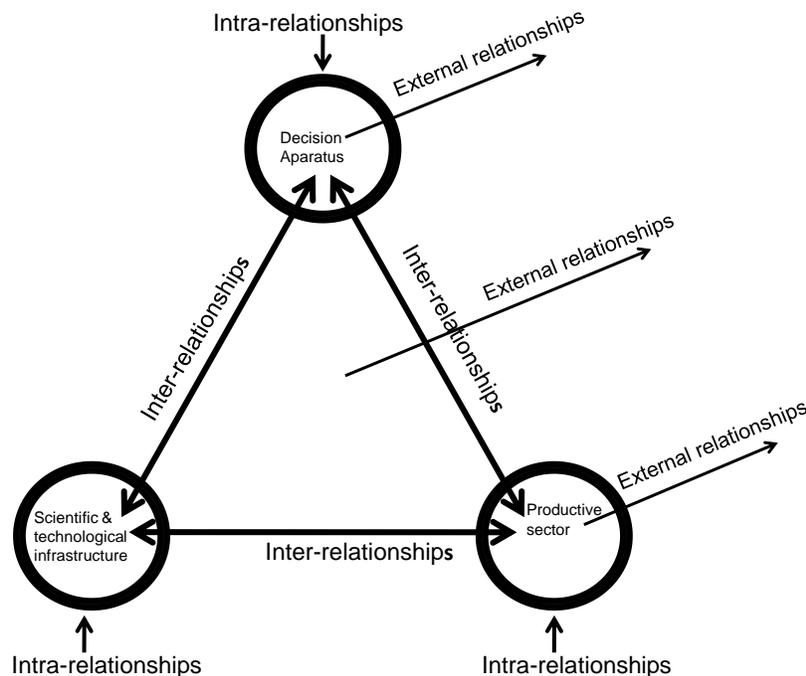
“Unfortunately in some countries [S&T agencies] have been created with an academic bias, very focused on scientific supply, and in many cases depend on the Ministry of Education, which prevents them from having an influence on the productive sector or on economic and social policy” (Moreno, 1975, p. 273).

What does the triangle shows us? How can we use it? In an attempt to answer these questions, Sábato and Botana argue that “the model does not only aim to be an analytical instrument that represents reality, but also demonstrates that the mere existence of the triangle ensures the rational capacity of a society to know where and how to innovate” (Sábato & Botana, 1968, p. 5). In this sense, the model is normative, as it presents how things should be, how the three sectors should come together to define a national STI strategy, the capabilities that each vertex should have to do what they have to, and how through the resulting relations between them they implement the strategy. Oteiza partially reinterprets Sábato and Botana’s approach. He talks about an open or closed triangle, explaining that when the triangle closes, the ties between the three vertices are created, dynamic knowledge is generated, and transfer to society is achieved (Oteiza, 1997, p. 127). Back then, Latin American governments did not have the capacity to formulate and execute S&T policies, and the model was not based on what could be observed in the region, but rather how they wanted national STI policy to be. It was ideal model.

As mentioned above, it can clearly be inferred that a series of relations between the triangle components exist, and that the actual existence or lack of these relationships as well as their fluidity and intensity is what characterizes the triangle (Amaya & Alvarado, 1977, p. 159). The model distinguishes three levels of relations: i) the ones established within each vertex (intra-relations); ii) the ones between the three vertices of the triangle (interrelations); and, iii) those that are

established between the triangle (or between each one of the components) and the external environment (external relations).

Figure 2. Scientific and technological triangle



Source: Amaya & Alvarado, 1977

The interrelations between the three groups of actors are the most important for explaining and evaluating the performance of an S&T system. It is at this level where, according to Sábato and Botana, the generation of self-decision capability in the field of science and technology is placed and observed. Sábato and Botana say that the interrelation between the government and scientific and technological infrastructure takes place through two flows: resource allocation by the government to the vertex of S&T infrastructure, and the demand for knowledge and technology generated by the government. The government is related to the productive structure through the action taken on the research community, implying no direct government intervention or funding of the productive sector. Finally, the relations between the productive structure and the scientific and technological infrastructure can occur through the interchange of personnel (occupational mobility), where they can share ideas and potential mutual demands (Sábato & Botana, 1968, pp. 7-8).

2 THEORETICAL FRAMEWORK

For the purposes of this article, literature on Science and Technology Policy studies (STP studies for short) was studied in order to highlight the major issues at stake: systems of governance and policy-making of S&T, and the relations among the actors involved. This literature provides inputs for understanding communication channels, interactions, and linkages among the main actors in an STI system. Different STP approaches were reviewed, such as the Triple Helix model, the innovation systems approach and the principal-agent theory⁴. Attempting to understand research and innovation systems as systems of communication we will need to contemplate

⁴ Principal – agent theory will not be addressed in this paper, as it will be applied in the following phase of this project.

networks and the interactions between actors, rather than on the actors themselves⁵. In a later phase of this project network theories will be used to analyze the social features of STI systems.

Different models have been proposed to study STI systems or knowledge-based systems, and the relations between the main actors - government, industry and academia - such as:

- National Systems of Innovation –NSI (Edquist, 2005, 1997; Edquist & Hommen, 1999; Lundvall, 1992; Lundvall, Johnson, Anderson, & Dalum, 2002; Nelson, 1993).
- Triple Helix model of university-industry-government relations (see Etzkowitz & Leydesdorff, 2000; Leydesdorff, 1998; Leydesdorff, 2000; Leydesdorff & Meyer, 2003)
- Triangle of Sábato (see Sábato, 1975; Sábato & Botana, 1968).
- 'Mode 2' type of knowledge production (see Gibbons, et al., 1994; Nowotny, Scott, & Gibbons, 2001).

The first three models are essential because they all focus on tripartite relations. They will provide the analytical and normative frameworks to explain the organization and representation of the Colombian SNCyT. These models are used to understand processes related to knowledge generation and transfer, policy-making and decision-taking, and how crucial information is diffused within the systems. Generally speaking, the models emphasize several aspects: flux of information, institutional arrangements, and relationships, pointing to an enhanced role of knowledge in the economy and society (Etzkowitz & Leydesdorff, 2000). The main difference between the models is who plays the main role; in the words of Etzkowitz and Leydesdorff: "The Triple Helix thesis states that the university can play an enhanced role in innovation in increasingly knowledge-based societies. The NSI approach considers the firm as having the leading role in innovation and, in the Triangle model of Sábato, the state is privileged" (Etzkowitz & Leydesdorff, 2000, p. 109). In Colombia, Sábato's Triangle model⁶ and the NSI approach were adopted for the organization of the SNCyT.

2.1 Systems of Innovation

In analyzing the origins and development of the concept of innovation systems, Arocena and Sutz (1999) found an important distinction between developed and developing countries. NSI is an *ex-post* concept for developed countries, built upon empirical studies which show similar patterns. The institutions already exist and work together with the firms; there are innovation networks. In this case the NSI approach explains how those networks function. For Latin America, NSI is an *ex-ante* concept, in the sense that governments have created technology related institutions and are trying to build networks that promote innovation at the firm level, on the basis of the NSI model. They add that this is not insignificant, because "very few patterns of the socio-economic behaviour regarding innovation can be viewed as working in a system-like manner" (Arocena & Sutz, 1999, p. 5). Following the idea of Arocena and Sutz, one could argue that the NSI concept in developing countries has been used more frequently as a normative framework rather than as an analytical tool.

In Latin American countries, including Colombia, the concept has been used to guide policy-making and design policy instruments; to build or organize the system, i.e. to set up the institutional infrastructure and to facilitate the linkages between the different actors. This literature has its limitations for the purposes of this project, despite the application of the concept. In the first place: the forms of representation. NSI literature usually depicts the systems by differentiating among the most important actors and highlighting the central functions needed (see for instance Arnold, 2004; Arnold & Kuhlman, 2001). Meanwhile, representations of the Colombian SNCyT do not display the different participating organizations, but rather the organization of the political system (especially government and governance), using Arnold and Kuhlman's scheme. None of the illustrations are particularly useful for showing the linkages between institutions and individuals, in other words to visualize the social networks. Secondly, the NSI focal point is enterprises, and the

⁵ The description of the actors is the usual analysis done from the system of innovation perspective.

⁶ Explained in the former chapter.

focus of this project is a governmental agency (Colciencias) and its relationships with different communities. In third place, studies that deal with national innovation systems have not been able to address essential 'social' issues regarding innovation, such as trust, norms, and culture (i.e. codes of communication), while the regional approach has concentrated on those aspects as well as the territorial dimension (Holbrook & Salazar, 2004; Holbrook, et al., 2004). Furthermore, the framework does not provide clues for social network analysis or explaining how social capital is built.

2.2 Triple Helix model

There is no definitive evidence as to whether Etzkowitz and Leydesdorff knew of Sábato's Triangle before they proposed their Triple Helix model in 1996⁷. The similarities between both frameworks are evident, but the uses and advances of each one are quite different; there is much more literature (empirical and theoretical) on the Triple Helix model, which provides deeper and better insight into those tripartite relationships. To my knowledge, Sábato's ideas were not further developed and no academic studies have been done using this model. Meanwhile, the Triple Helix approach is very well institutionalized (bi-annual conferences) and many studies have been done applying the model (e.g. books published and special editions of the journals *Science and Public Policy* and *Research Policy*).

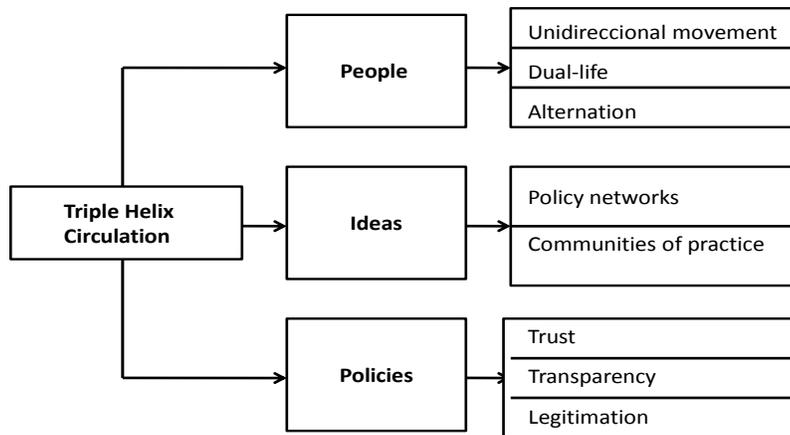
Etzkowitz and Leydesdorff state that the focus of the Triple Helix model is the "network overlay of communications and expectations that reshape the institutional arrangements among universities, industries and governmental agencies" (Etzkowitz & Leydesdorff, 2000, p. 109). The configuration of the Triple Helix depicts three strands representing each sector, and the possible relations between themselves, developing communications, networks and organizations (Etzkowitz & Leydesdorff, 2000).

The Triple Helix model focal point is communication, interactions among actors, which they exemplify as the "flow of blood in the arteries of the circulatory system" (Dzisah & Etzkowitz, 2008). Following these authors, three core elements of the triple helix circulatory system are people, ideas and innovations (see figure 1 in Dzisah & Etzkowitz, 2008). For the purpose of this project, the emphasis is on policy diffusion rather than innovations or knowledge dissemination, so an adaption of the figure is proposed (see Figure 3 below). Drawing on Dzisah and Etzkowitz, the focus on the Triple Helix circulation is policies, but that also requires the two other components: people and ideas. Regarding the circulation of people the three possibilities described by the authors correspond perfectly to the Colombian case. The lateral mobility, or revolving door, is very frequent in Colombia, from both the business world and the academia to the government.

In the case of ideas, information flows through various networks, which could be called policy-networks and communities of practice. The CPNCyT can undoubtedly be understood as policy-networks, defined as "a set of relatively stable relationships which are of non-hierarchical and interdependent nature linking a variety of actors, who share common interests with regard to a policy and who exchange resources to pursue these shared interests acknowledging that co-operation is the best way to achieve common goals" (Borzel, 1997). The concept of communities of practice, understood as groups of workers (people) informally bound together by shared experience, expertise and commitment to a joint enterprise (Gertler, 2001), can also be applied to the Colombian SNCYT and its decision bodies. Finally, the dissemination of policies is based on trust and transparency, elements that contribute to legitimize policy-making and implementation processes.

⁷ The first time they refer to Sábato is in their 2000 article (Etzkowitz & Leydesdorff, 2000, p. 109). However, in an earlier article Etzkowitz, Mello and Terra make a short reference to Sábato's triangle presenting the evolution of innovation policy in the State of Rio de Janeiro (Brazil) and the leading role that the government had in developing the industrial and research spheres (Etzkowitz, Mello, & Terra, 1998, p. 366).

Figure 3. Triple Helix Circulation - the case of policies



Source: Prepared by the author, based on Dzisah & Etzkowitz, 2008.

Similarly to the *a priori* or *ex-post* concepts of the NSI mentioned in the section above, there is a discussion of the different roles that the Triple Helix model plays in developed and developing countries. In developed countries it is an empirical model which describes how these actors interact. In the latter, it is a normative model that countries try to apply or copy by organizing the main components, assuming that the main elements exist (Dzisah & Etzkowitz, 2008, p. 4). The challenge in developing countries is to make the components work together, to cooperate, since they tend to work in isolation.

3 THE EVOLUTION OF SCIENCE & TECHNOLOGY INSTITUTIONS AND POLICIES IN COLOMBIA 1990-2008

Looking back and identifying the landmarks in the history of S&T policy and institutions in Colombia, we can identify five periods, although the beginning and end dates are not precise. For the purposes of this document and based on other authors (Jaramillo, et al, 2004), recent history will be divided into four periods: i) pre-1968: before the creation of Colciencias; ii) 1968-1988: Colciencias, the early years; iii) 1989-2000: creation and development of the SNCyT; and iv) 2001-2008: the up and downs of the SNCyT. A fifth period began in February 2009 with the enactment of a new Science and Technology Law, which modified Colciencias' status and responsibilities, and changed the name of the SNCyT to include the word innovation. Not all the periods mentioned above are equally important for the purposes of this document so I will develop the periods 1989-2000 and 2000-2008 in greater depth, since the SNCyT was created and developed during those years.

Table 1. Landmarks in the development of S&T in Colombia

Pre 1968	1968 - 1988
<ul style="list-style-type: none"> • 1963: UN conference on the application of S&T for development • 1964: OAS conference on S&T policy and planning • 1967: Punta del Este Conference of American Presidents • 1968: Fusagasuga conference: basis for creation of Colciencias 	<ul style="list-style-type: none"> • 1970: creation of first master's programs • 1983: IADB - ICFES credit program • 1983: IADB - Colciencias first credit program • 1986: First doctoral program • 1987: International Forum on S&T policy • 1988: S&T Mission
1989 - 2000	2001 – 2008
<ul style="list-style-type: none"> • 1990: Law 29 – S&T law • 1991: IADB - Colciencias second credit program • 1991: Decrees 393, 585, 591: creation of the SNCYT, regulation of contract and association models in S&T • 1993: Mission of Science, Technology and Development • 1995: IADB - Colciencias third credit program • 1995: National Innovation System launched • 1996: Law 344, SENA resources to S&T activities • 1999: Creation of the Colombian Observatory of Science and Technology 	<ul style="list-style-type: none"> • 2001: Law 643 created the Health Research Fund • 2001: Publindex launched: index of Colombian scientific journals • 2002: ScienTI platform launched • 2002: World Bank – Colciencias credit for doctoral programs and scholarships • 2005: Maloka forum: discussion of a new law for S&T started • 2006: Visión Colombia 2019: long term plan for STI

Source: adapted from Jaramillo et al (2004) and updated by the author.

3.1 1989-2000: The creation of the National S&T System

The end of second period (1968-1988) is characterized by major efforts to “place” S&T policy at the centre of the economic and social debate. Most of these efforts were promoted from within Colciencias, with the support of universities, the Colombian Association for the Advancement of Science) and other governmental agencies. The two most important events of the latter part of the second period were the first foreign credit for S&T granted by the Inter-American Development Bank (IADB) and the S&T Mission.

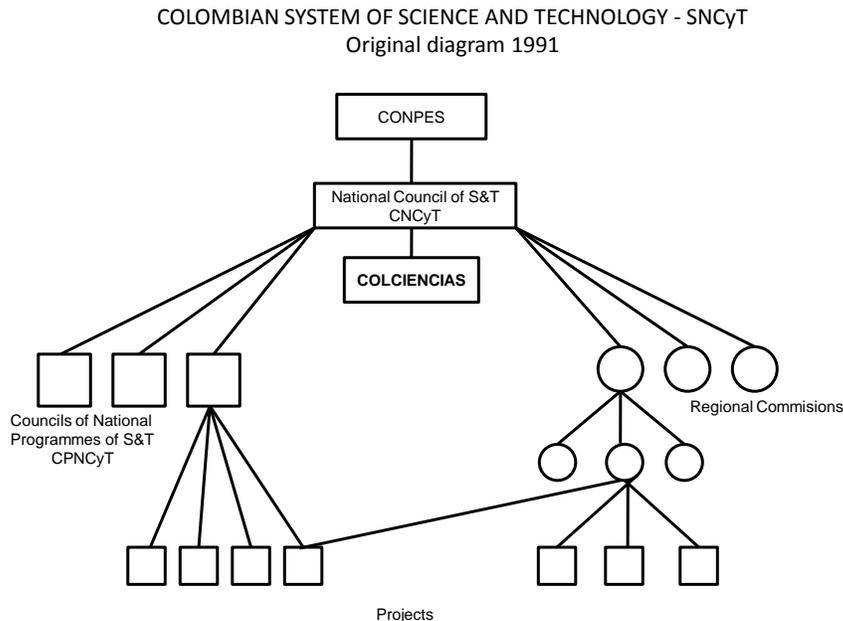
The third period is certainly the most important in the development of science and technology in Colombia, considering that new organizational and institutional arrangements were set up and new instruments were developed. The decade of the nineties, in particular the early 90s was marked by the “*apertura*”, the opening of the Colombian economy to the world. Changes in the S&T system were accompanied by changes in the economic model.

In 1990, after a long lobbying campaign in Congress, the Science and Technology Law (Law 29) was enacted, and several decrees were issued few months later. The principal changes include the creation of Colombian System of Science and Technology, re-launching the National Council of Science and Technology, and re-organization of Colciencias. Colciencias was given a

clearer role in policy formulation, and was ascribed to the National Department of Planning, who is in charge of economic and social planning and the national investment budget.

Below is the original graph of the structure of the SNCyT, which shows the different coordinating and directive bodies. It is interesting to note the focus on projects rather than on institutions that develop R&D projects.

Figure 4. Representation of the Colombian SNCyT 1991



Source: Colciencias, 1991.

The structure and composition of the SNCyT is not new in itself. The system is organized in three levels: national, regional, and by S&T fields, and at each level there are councils where the coordination of S&T policy takes place. All of these bodies are collegiate corps based on Sábato's Triangle model, which integrates three institutional spheres: government, academia and industry⁸. None of the agencies mentioned before constitutes in itself a new administrative structure, i.e. a public office. With the exception of Colciencias, they are only coordinating mechanisms.

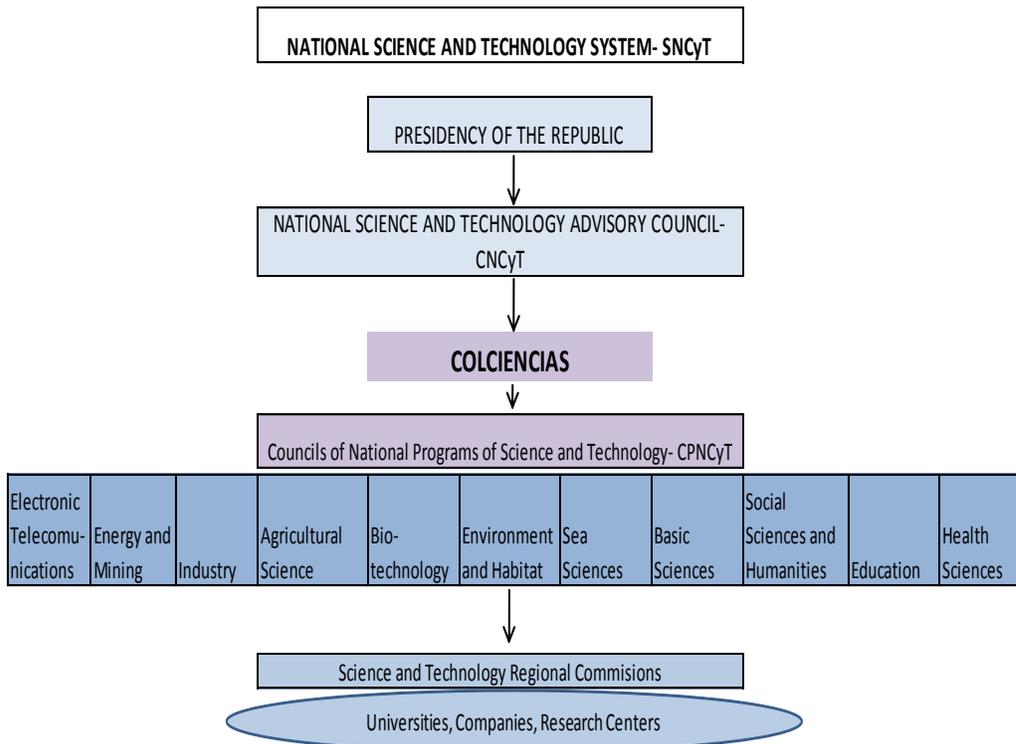
Some of the key ideas that guided the SNCyT were expressed by President Gaviria (Colciencias, 1991, p. V). He proposed a system based on communication, interdependence, and building or creating strong ties of exchange and association (i.e. networks) between various actors, and not on the establishment of bureaucratic agencies.

The system is structured around science and technology programmes, which are understood as broad areas of scientific and technological problems. The domain of the programmes, are either a field of S&T or an economic sector. At present, the eleven national programmes of science and technology are: basic sciences; social sciences and humanities; health; agriculture; biotechnology; environment; energy and mining; industry; electronics, telecommunications and computing; marine sciences; and education.

⁸ The idea of using the Sábato's model was discussed at the moment; it is not *a posteriori* finding that the tripartite model corresponds to Sábato's triangle (Villaveces & Forero, 2007, p. 124).

In 1996, the National System of Innovation was 'formally' created, as part of the SNCyT, and a whole new set of policy instruments was set up to attend to private sector needs. Because of the creation of the NSI, the organizational arrangement of Colciencias changed. The S&T programmes were divided into two groups: those oriented primarily towards scientific research and those oriented mainly towards innovation. See below a common representation of the Colombian SNCyT, differentiating between innovation and scientific programmes).

Figure 5. Representation of the Colombian SNCyT during the 2000s



Source: Colciencias

In fact, the science and technology system and the innovation system are intertwined, not independent, although people for many years talked about them as two different systems. They share the same head, that is Colciencias, they share financial resources, i.e. Colciencias' budget, and the structure of the programmatic councils remained the same as did the form of operation. There are actors operating within both systems, but there are also specific actors for each one. The differentiation is made for the purpose of analysis and, in practice, since they have different specificities and logics, their problems, policy instruments, incentives and timing are different.

Since the conception and creation of the SNCyT, innovation played a major role along with science and technology, together conceived as means of productive transformation. The creation of the NSI was Colciencias' response to the requirement of the productive sectors for a more defined "space" for their demands and needs. The intention, however, was not to fragment the system. In principle and according to the legal and regulatory basis there is only one system. The conformation of the NSI promoted the creation of various innovation-support organizations, such as technological development centres, innovative firm incubators, tech parks, and risk capital agencies.

A feature of national S&T policies is that they have been quite stable over the years, with cumulative effects (Jaramillo, Botiva, & Zambrano, 2004a; Villaveces & Forero, 2007) despite changes in the government. Several factors could be mentioned that have contributed: i) a quite stable and technical bureaucracy (i.e. Colciencias managers); ii) the IADB loans, whose objectives

have not changed much over the years; and iii) a learning organization, which has maintained most of the successful S&T promotion programmes.

3.2 2001-2008

The SNCyT has evolved throughout the years; some changes have been introduced from within the system and others have been exogenous. This period is characterized by a deepening of the articulation of the three groups of actors. For instance, with regard to government agencies, several ministries (e.g. Health, Communication, Energy and Mining) and other public organizations (SENA) have transferred financial resources to Colciencias in order to make special and strategic calls for proposals of interest to these actors.

The articulation of actors can also be observed through two factors: information systems and adoption of policies not associated to financial incentives. At the turn of the twenty-first century, Colciencias launched two major information systems known as Publindex and ScienTI. The first one is the ranking of Colombian scientific journals. ScienTI is composed by several data bases such as CvLAC (curriculum vitae), GrupLAC (research groups), and InstituLAC (institutions). The CvLAC contains 170,000 records of people involved in S&T activities, although not all can be considered researchers. In GrupLAC there are around 9,000 entries, of which Colciencias has classified 3,727 groups⁹. These are clear cases of adoption of Colciencias proposals that do not offer direct financial incentives to the users.

Despite the institutional changes that occurred during the previous period, many argue that Colciencias was still facing many problems and constraints. Many experts contend that the functions of policy-making and funding should not be under the domain of same agency (see for instance Hart, 2001; Teubal, 2002). More importantly, within the state apparatus Colciencias had not achieved enough leverage to enforce STI policy, had no legal authority to propose laws, and did not manage its own budget (it depended on the planning sector's budget) (World Bank, 2007, pp. 196-197).

As time passes and Colciencias acquires more visibility, and loses autonomy. Because of its increased participation in the decision-making process and its greater importance in politics, the organization has become more bureaucratic and subject to political influences.

4 THE PROBLEM AND THE RESEARCH METHODS

4.1 The Problem

Colombia has a solid and stable SNCyT, even if it has a small research community, few innovators, and a small and instable public budget for STI. Why is it so solid? Is it because of the organizational arrangements put into place (i.e. Triangle of Sábato model used in all decision-making bodies)? Sábato's Triangle was proposed to characterize the tripartite relations within an S&T system that occur between government, scientific and technological infrastructure, and productive sector.

Many experts believe that the Triangle of Sábato model has failed because no common policy or decision-making has been accomplished over the years, especially when one looks at public policies in which various government agencies should participate. The question is: Has the organizational model had effects other than policy making, such as social capital building and communication of policies? Social capital can be understood as an outcome of social networks, as assets in a network, or as resources embedded in a network. In the words of Putnam, "social capital refers to features of social organization, such as norms, trust and networks, that can improve the efficiency of society by facilitating coordinated action" (Putnam cited by Burt, 2000). The issue of

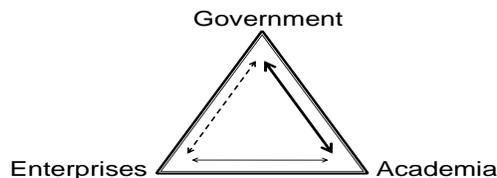
⁹ The rest of the groups are registered but not recognized by Colciencias, because they do not fulfill the minimum requirements.

communication is not for knowledge production, but rather for social networking and dissemination of government, industry or university initiatives among peers and colleagues. Considering that the model is normative, one should analyze the contributions, effects and impacts that the organizational model has had on building the S&T system, and the mechanisms used to make it functional.

Sábato's model proposes three levels of relationships: intra, inter, and external. In Colombia the sides of the triangle do not seem to be equally "developed" nor are all the desired relationships present. One can presume that there are strong links between government and academia, weak linkages between academia and enterprises, and "intermittent" interactions between enterprises and government (see diagram below).

The paper aims to answer the following hypothesis: The model of Sábato's Triangle applied in Colombia has contributed to the cohesion of the SNCyT, building Colciencias' social capital.

Figure 6. Intra-relationships in Sábato's Triangle: The Colombian Case



Source: Prepared by the author, based in Sábato & Botana, 1968.

4.2 Research methods

How can we measure and characterize Colciencias' social capital? The building of social capital can be observed by studying the groups of actors and the communications, interactions and relationships that have contributed to the cohesion of the SNCyT. In this sense, an attempt to characterize the intra and inter-relationships¹⁰ found in the Colombian SNCyT will be undertaken, and the results expected from the development of those relationships. The analysis of those relationships will be done via in-depth interviews, expert panels and analysis of statistical data.

The main objectives of the in-depth interviews, complemented with expert panels, is to discover if the communities recognize the existence of the SNCyT as an institution, and to determine the main policy achievements and failures. Sixteen persons¹¹ were interviewed and four panels with different sectors (government, academic/research community, firms, and representatives from regions), with the participation of 24 persons.

5 PRELIMINARY FINDINGS

Based on the interviews and panels, below are the main results organized around the response to the following statement: The model of Sábato's Triangle applied in Colombia has contributed to the cohesion of the SNCyT, building Colciencias' social capital. It is important to mention that the majority of the experts agreed in most of the policy successes and failures and the

¹⁰ For the purposes of this study, external relationships are not crucial for explaining the social capital built around Colciencias, unless we were evaluating the overall performance of the SNCyT with regard to other countries.

¹¹ Interviewees were current and former Colciencias' directors and officials, and people very close to Colciencias and the system.

implementation of the SNCyT, however, they disagree in the balance of the performance of the national, programmatic and regional councils.

It is possible to analyze or determine the existence of the systems according to the recognition granted by the different actors. Even though Colciencias is a formal governmental organization, it was necessary to define the “rules of the game” that allow the system to function. The issue here is about legitimacy and not legality, although a legal frame may contribute to the construction of institutions. Institutions are produced in the construction and acceptance of social rules, rather than formal rules. For an institution to exist there must be recognition and a social construction, as Forero and Villaveces expressed in an analysis of the SNCyT:

“Besides the creation of formal and informal institutions, the implementation of the system was a social construction process of common understanding and collective purposes” (Villaveces & Forero, 2007).

Experts affirm that the SNCyT has an image and defined institutions, given by law and a community of researchers who recognizes it, which is not the case of the national system of innovation. The main actor of the SNCyT -the scientific community- recognizes Colciencias as the head or authority in this subject, and as the national regulating, guiding, promoting, and funding entity of science and technology. Meanwhile the main actor of the innovation system -firms- does not recognize Colciencias as the main entity. There is a large institutional fracture and no particular organization is recognized as the "regulating and promoting" entity.

Besides, it is possible to talk about two kinds of systems: one as a reality, and the other as a legal frame. The system as a reality is a natural system, where interactions among the social actors are defined by time and space. Even though the natural system may be dysfunctional, it does exist anyway. This is true both for the SNCyT and the NSI. The other system is structured based on laws, decrees, and the functioning of Colciencias, as the formal organization behind it. Interviewees argue that the Colombian SNCyT has principles, regulations, and some governing bodies which sustain it. Despite this recognition, many say the national STI policy is seen as Colciencias' policy and system's policy.

Continuity in STI policies is one of the great successes mentioned by the experts. Broad guidelines and strategies have endured during these years. Also, policies have had cumulative effects; construction has been done over what have already been constructed as Jaramillo and colleagues have stated. Successes are concentrated in five great areas: support to research groups, human resources formation, support to innovation, articulation of the system, and information development.

Successes in articulation are seen in many fields, for example in the creation of institutions transcending Colciencias; in the legitimacy obtained as a S&T national promoting entity; in the participation of many public as well as private entities; in the construction of the system, and in the adoption of the different STI policies by the different actors, independently from the financial availability. The adoption of Colciencias' policies by other entities regardless of its financial aid is a manner of legitimizing its role in the SNCyT. In this way, Colciencias has obtained legitimacy as a policymaker and not as a mere financial body, which has allowed somehow overcoming Colciencias' budgetary crises. Besides the participation of the executive branch of the state in virtually every instance of the SNCyT, has made that Colciencias gain a better status and weight within the Colombian State apparatus.

Support to research groups is considered one of the great successes, which goes hand in hand with the improvements in information systems. Funding moved from individuals towards groups, and networks (relationships between groups and organizations). This contributed to the strengthening of STI institutions. On the other hand, the fact that universities, centers, and groups would have submitted to the ranking process is a big success. This was not an easy task due to the information demands (GrupLAC), and also because there is direct incentive. The ranking has contributed to give greater international visibility and recognition to the national research groups. Today, these groups (and national academic journals) exhibit the ranking granted by Colciencias.

With respect of innovation policy and the NSI, experts consulted did not agree, some argue that it was a complete failure, others that opening the SNCyT to the productive sector and creating specific instruments to attend their needs was a success. For instance some analysts consider that the separation between S&T programmes oriented to innovation or scientific research) was unfortunate, that the chance to fully incorporate innovation in the systems, was wasted.

In any case, many argue that all these successes are partial by a fundamental reason, because there has not been a clear political will revealed through a stable flow of financial resources for the implementation of these policies, to fulfill long-term goals. In other words, it has not been possible to guarantee a sustained effort due to the financial ups and downs. Planning without money remains unenforced. Many analysts consider that the levels of investment oriented to S&T through Colciencias are meagre. It is recognized that the entity has done many positive things with these few resources, managing them well, based on the collegial spaces created, which give more transparency to the management of resources.

With respect of the performance of the councils we find divergent opinions, one the one side Colciencias' officials perspective, on the other the representatives of the Ministries representatives. Colciencias' officials state that the councils have not had any weight because they do not manage resources from other public agencies, and there is little coordination of public resources. Ministers as such do not attend the session of the councils and delegates do not have decision power. The lack of articulation of public resources for STI is due in part to the weakness of the National Council, despite Colciencias and the Department of National Planning attempts. Colciencias would like to centralize the administration of public funding for S&T, while the ministries' representatives consider that this is not necessary, that the articulation of criteria and policies is what counts, and that the management of resources should continue to be decentralized.

Besides the articulation of the SNCyT goes beyond the simple participation and commitment of the Ministries. Some of them do not feel part of the system, as they argue that Colciencias do not always understand how their agendas operate, and demand that Colciencias should live aside the sole representation of the organization and put on the one of the whole SNCyT.

For instance, the CPNCyT have resulted in very unequal vertices of the triangle, a very strong and participative academic sector, a practically inexistent or passive productive sector (depending on the programme), and an uncommitted State without continuity, and in some occasions, unduly represented. These councils are mainly oriented in approving projects, with no time to formulate policies –since councillors¹² have *ad hoc* positions- and they have not developed a long-term vision.

One of the problems with the programmatic and regional councils is there is no clear articulation and communication with “above” levels, that is Colciencias, and the CNCyT, meaning that the information flows in one direction (from the top), but it does not flow back. For a SNCyT to be, it is needed the triadic combination of institutions, policy and investment, as a representative of a Ministry says.

6 A RESEARCH AGENDA

As said in the beginning this is a work in progress, and several theoretical and conceptual strands will be pursued to get a better understanding and description of the Colombian SNCyT. Besides a second instrument for collection of information will be applied to Colciencias beneficiaries, more specifically the “representatives” of the research community and the innovative firms that are members of the councils. The objective of the survey is to ask these actors how they

¹² Councillors (from the academic and productive sectors) are elected on the basis of merit; they do not act in representation of any institution or region. These are *ad hoc* positions, and work *ad honorem*.

perceive their roles in the SNCyT, how they have contributed to the development of the system, and track the information they receive in the council sessions.

The theories to be considered are network theories and principal-agent. Network theories are crucial, because analyzing the functioning of the councils, in particular the programmatic and regional, they can be seen both as formal or informal organizations (Conway, 2001). From a formal point of view, they are included in the Colombian SNCyT organizational chart and they have clear tasks (mandated by law). But in practice, they seem like informal organizations, since their actions are not mediated by contracts, there is no job description, and no associated payments. Even if there are rules and norms, they behave as a social network where trust and transparency are essential, legitimizing their roles.

With respect of principal-agent theory, according to Guston, it can be applied to any situation that involves delegation, contracting, or representation (Guston, 1996). In the Colombian case, Colciencias (principal) plays different roles – policy-making and funding-, and delegates the evaluation and selection of projects to the CPNCyT (agents). But CPNCyT also act as principals in their relationships with councillors-agents (researchers and entrepreneurs) (van der Meulen, 2003). In the case of the Colombian SNCyT, there is delegation of certain functions from Colciencias to the CPNCyT and representation of scientists in the CPNCyT, where these councils seem to perform the role of mediator between government and the scientific community. Principal-agent theory is seen today as a very important analytical tool regarding S&T policy studies.

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