

The role of the councils of national programmes of science and technology in the governance of the Colombian national system¹

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Introduction

In 1991, when the Colombian National System of Science and Technology (SNCyT by its acronym in Spanish) was created by law, the institutional set-up followed Sábato's Triangle. The composition of the decision-making bodies included representatives of three sectors: government, the academic-research community, and the productive sector. The triangle model was proposed by two Argentinians back in 1968 (Sábato & Botana, 1968)², and has been cited by many academics and practitioners. However, no other country in Latin America has explicitly applied the model in the organization of the governance system of science, technology and innovation (STI).

The focus of this research is not the content or the outcomes of STI policies but the institutional framework in which they are negotiated and implemented, which determines their effectiveness. Many factors affect the quality of policies, such as institutions and political practices, as well as history, beliefs, leadership and citizen attitudes, as Stein and colleagues say: "Policies are not adopted in a vacuum" (Stein, Tommasi, Echeberria, Lora, & Payne, 2006). The heart of the research will be the SNCyT and its decision-taking bodies, and Colciencias as the head of the system. The main objective is to analyze the impact of Sábato's Triangle model on the development of the Colombian SNCyT.

The focal point will be the Councils of National Programmes of Science and Technology (CPNCyT by its acronym in Spanish), as the principal bodies where

¹ This paper is based on Salazar, M (2010), Communication channels among the actors of the Colombian system of science, technology and innovation: a test of the Sábato's triangle model, PhD thesis, School of Communication, Simon Fraser University.

² Even if there were two authors, just one remained as the father of the proposal, that was Jorge A. Sábato (1924-1983); he was an Argentinean physicist and technologist. 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 this paper with Sábato in 1968, but science and technology did not remain his area of interest. Today he writes a column in the Argentinean newspaper *La Nación*.

the management of scientific and technological activities take place, through the processes of evaluation, selection and approval of projects. The specific objectives of this research are: 1) to elucidate the role that these programmatic councils have played in governing STI and creating linking mechanisms between the research communities and the government through the dissemination of policies; and, 2) to study the perceptions of the councillors about their role in the SNCyT.

The paper is organized as follows: firstly I will briefly describe the Colombian SNCyT, followed by the theoretical framework used in this analysis, which comprises Sábato's triangle model, innovation systems approach, and principal agent theory. In the third section I present the methodology used; followed by the findings of the web survey. I conclude the document highlighting the main results and setting up a research agenda.

1. The Colombian National System of Science and Technology

The Colombian agency in charge of S&T promotion, known as Colciencias, was created back in 1968, originally as a fund (granting agency) depending on the Ministry of Education. Later in 1990 it was transformed into an institute dependent on the National Department of Planning³, with clearer responsibilities regarding the formulation and implementation of STI policies. Recently (2009) Colciencias was revamped as an Administrative Department depending directly on the President.

In 1990, when Colciencias was re-organized, it was also created the Colombian system of science and technology (S&T), conceived as an open system, non-exclusionary, which incorporates all programmes, strategies, and activities performed by various agents (public and private organizations, and individuals) (Colciencias, 1992, 1991). The system is organized in three levels: national, regional and sectoral, and at each level there are councils where the coordination of STI policy should take place. All of these bodies are collegiate corps based on Sábato's Triangle model, which integrates three institutional spheres: government, academia and industry⁴. None of the agencies mentioned above constitutes in itself a new administrative structure, with the exception of Colciencias, they are only coordinating mechanisms.

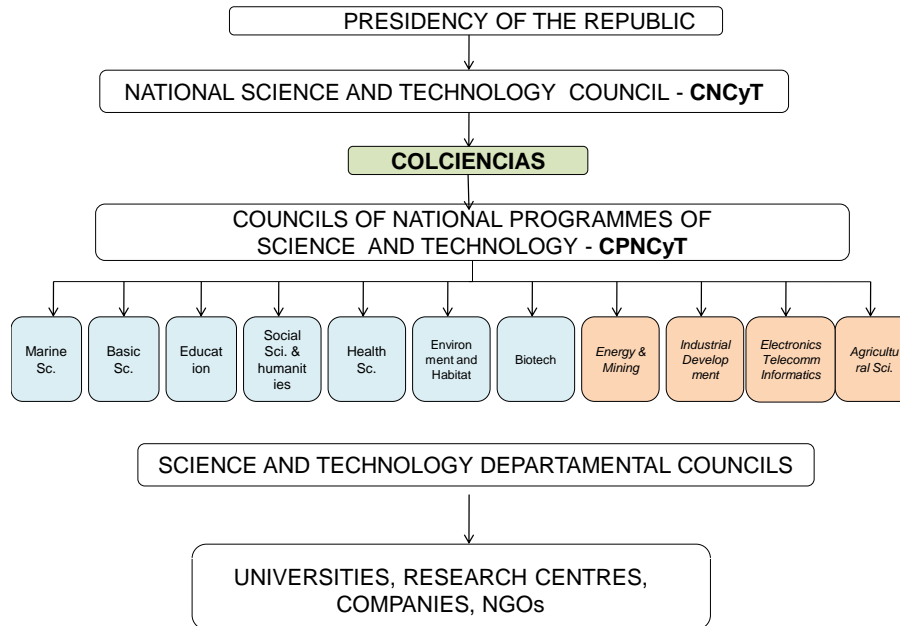
Due to the structure of the SNCyT, it is comprehensible that decision-taking bodies (the national council, the programmatic councils, and the regional commissions) are highly dependent on Colciencias because they are not formal organizations, they do not have their own personnel -except for Colciencias staff - and they do not administer money. However, the model or relationship is not problematic in and of itself, since the councillors take an oath to perform a public

³ DNP (by its acronym in Spanish) is in charge of economic and social planning and the national investment budget. It is as powerful as the Ministry of Public Finance.

⁴ 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).

function for the country, and directors of Colciencias comply with the decisions taken by the councils. This is quite unique, since councillors are not civil servants but they can allocate public resources. In view of the above, programmatic councils can certainly not be considered equal to the research councils that exist in other countries. Below a common representation of the Colombian SNCyT.

Figure 1: Representation of the Colombian SNCyT



Source: Colciencias, 2008.

The system is structured around S&T programmes, which are understood as broad areas of scientific and technological problems and are considered the main components of the system. The domain of the national programmes is either a field of S&T or an economic sector. In 2010, the eleven programmes are: basic sciences, social sciences and humanities, health, education, agriculture, biotechnology, environment, energy and mining, industry, and electronics, telecommunications and informatics.

The CPNCyT have between seven to ten members, of which three to five are researchers, at least two are from the business sector, and two to three are from government. Councillors from the research community and the productive sector are appointed by the National Council of S&T, after presentation of candidates selected by Colciencias. These people do not act in representation of any institution or region; they are elected on the basis of merit, not nominated by universities, research and development centres, academies of science, or producers associations, etc. Their selection is an acknowledgement of their careers. Councillors are *ad hoc* positions and they work *ad honorem*.

The main tasks of the councils are: 1) definition of plans and policies for their sector or field; 2) project funding; and, 3) articulation of financial resources. The programmes are the axis of the whole SNCyT, and Colciencias' organizational set-up follows the S&T programme dimension. Therefore, the management of STI activities in Colombia is framed by these programmes.

Let me discuss briefly the STI policy-making process; national policy is formulated by Colciencias and then ratified by the national council; sometimes converted into a CONPES⁵ document⁶. No big changes or differences between policies formulated by different administrations can be seen. The translation of this policy into specific recommendations for particular sectors and scientific fields is in the hands of the programmatic councils. Colciencias, as the head of the system, enforces the policies with a great deal of success due to the prior debate process which legitimizes the policies. The legitimization process consists of accepting the policies and rules of the game formulated by Colciencias, building collective arrangements, and achieving social consensus, especially on how decisions are made (Villaveces & Forero, 2007).

2. Theoretical framework

Different models have been proposed to study science, technology and innovation 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, 1997b; 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)⁷.
- 'Mode 2' type of knowledge production (see Gibbons, et al., 1994; Nowotny, Scott, & Gibbons, 2001).

These models are mainly used to explain processes related to the generation and diffusion of knowledge, and the formulation and implementation of policies. In general, they can also describe how crucial information is disseminated

⁵ The CONPES (National Council of Economic and Social Policy) is headed by the President, the Secretariat is held by the DNP, and all Cabinet Ministries participate. It is considered a central policy forum and decision-taking instance within the Colombian State. However, CONPES documents are not binding.

⁶ See for instance, CONPES 2739/1994, national S&T policy 1994-1998; CONPES 3080/2000, national STI policy 2000-2002; and CONPES 3582/2009, current national STI policy. These documents can be downloaded from www.dnp.gov.co.

⁷ In the 1975 book Sábato compiled many of the contributions to the Latin American School of Thought, included a revision of his article with Botana.

within the systems. All attempt to understand the relationships between three types of actors: industry, academia and government. Generally speaking, the approaches 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 primary 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).

For the purposes of this paper, the first three models are essential because they all focus on tripartite relations. In Colombia, Sábato's Triangle model and the National Innovation System approach were adopted for the organization of the SNCyT. This literature will grant me with the analytical and normative frameworks to explain the organization and representation of the Colombian SNCyT. Besides, the principal-agent theory will provide the basis for understanding the relations between institutions and individuals, institutions being Colciencias and the Councils of National Programmes of Science and Technology (CPNCyT), and individuals being the councillors, either researchers or entrepreneurs, who have a central role in the SNCyT.

2.1. Sábato's Triangle model

In Latin America, a school of thought on science, technology and development emerged in the 1950s, which was based on practice rather than theory or a particular discipline. Máximo Halty, Jorge Sábato, Marcelo Alonso, Amílcar Herrera, Francisco Sagasti, Miguel Wionzcek, and Carlos Martínez-Vidal⁸ are emblematic of this school (Casas, 2004; Jaramillo, Botiva, & Zambrano, 2004; Martínez-Vidal & Marí, 2002). It is important to mention the closeness of these thinkers to international agencies; for instance, Halty and Alonso were the directors of a regional S&T programme of the Organization of American States (OAS), and Sagasti was the coordinator of a programme known as "Science and Technology Policy Instruments" (STPI)⁹ funded by the International Development Research Center of Canada (IDRC) and the OAS.

This school of thought formulated a research and innovation policy which was advanced for its time, because it went beyond the traditional supply and demand perspective and was critical of the linear model (Casas, 2004). The main proposals were that autonomous technological development was possible, and that it was crucial for endogenous and integral development, incorporating social

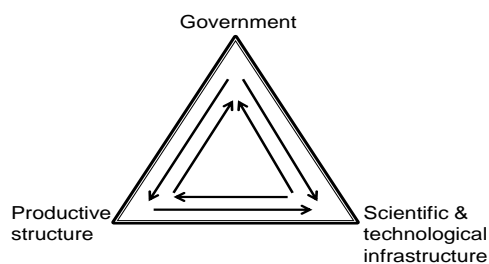
⁸ Their country of origin is varied: Argentina, Peru, Brazil, Uruguay, and Mexico.

⁹ This programme was highly influential because it provided an interesting benchmarking and learning platform for the developing world. Countries from very different regions were involved, such as Colombia, Macedonia, Korea and India.

concerns and looking at the relations between S&T and society. In this sense, there are clear connections between the formulations of this school and “dependency theory” developed within the United Nations Economic Commission for Latin America and the Caribbean (ECLAC). It is also remarkable that in those early writings innovation, and not just scientific research, was clearly stated in the discourse. However, technological development and innovation were timidly addressed by national policies and few industries were involved in those activities (see for instance Dagnino, Thomas, & Davyt, 1996; Katz, 1984, 1987).

The S&T school for development was mainly directed towards S&T policy rather than S&T institutional arrangements; however, most of the national S&T agencies in Latin American countries were created between the fifties and the seventies, under the influence of this school and some multilateral agencies. This school had clear ideas about research and innovation strategies, and the diverse groups of actors that should come together to make them happen. This is where Sábato’s Triangle comes into play. It offers a simple but clear figure to depict the three elements or groups of actors that have historically been fundamental in the development of science and technology: government, the productive structure, and the scientific and technological infrastructure, as they have been called by Sábato and Botana. 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). Subsequently, many authors proposed more sophisticated diagrams¹⁰.

Figure 2: Sábato’s Triangle



Source: Sábato & Botana, 1968.

¹⁰ For instance Sagasti based on Sábato’s triangle, introduced a fourth vertex representing the financial system (Sagasti, 1983). One can argue that the Triple Helix of innovation model is a more sophisticated form of depicting the tripartite relationships, compared to a simple ‘static’ triangle; however there is no clear evidence that Etzkowitz and Leydesdorff, the originators of the Triple Helix model, knew of Sábato’s Triangle before they proposed theirs in 1996. The first time they make a proper reference to Sábato’s Triangle is in their 2000 article (Etzkowitz & Leydesdorff, 2000, p. 109). However, in an earlier article Etzkowitz, Mello and Terra make a brief mention of 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).

Each vertex also constitutes a convergence point of multiple institutions, decision agents, production units, etc. Below is my translation of the original definitions provided by Sábato and Botana (1968, pp. 3-5):

- *Government* is understood as the set of institutional roles that have the objective of policy formulation and resource mobilization from and to the vertices “productive structure” and “scientific and technological infrastructure” through legislative and administrative processes.
- The *productive structure* is defined as the set of productive sectors that provide the goods and services which a specific society demands.
- *Scientific and technological infrastructure* “is composed of a group of articulated and interrelated elements:
 - The education system, which provides the quantity and quality of ‘men’¹¹ 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.

It is interesting to note that Sábato and Botana included S&T policy-making and granting agencies as part of the scientific and technological infrastructure and not of the governmental sector. In fact most of those agencies, at least in the early years were very close to the academic and research communities, despite the policy recommendations which gave an important role to technological development and innovation activities.

What does the triangle try to show 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, as 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 do- and how they implement the strategy through the resulting relations between them. The authors were clear that

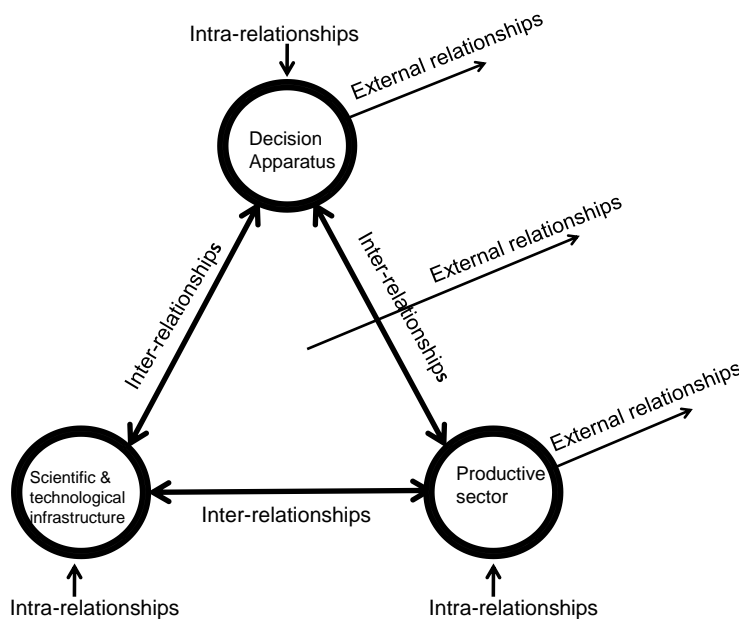
¹¹ As in the original.

it was an ideal model that was non-existent in the region at that time; basically governments did not have the capacity to formulate and execute S&T policies.

Oteiza partially reinterprets the meaning of the triangle relationships; he talks about an open or closed triangle, meaning 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).

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). The model distinguishes three levels of relations: 1) the ones established within each vertex (intra-relations); 2) the ones between the three vertices of the triangle (interrelations); and, 3) those that are established between the triangle (or between each one of the components) and the external environment (external relations).

Figure 3: Scientific and technological triangle



Source: Amaya & Alvarado, 1977

Sábato and Botana explain the objective and principal ties established or desired between the vertices. Starting with the first level, they say: “The relationships established within each vertex (intra-relations) have the objective of transforming these convergence centers into centers capable of generating, incorporating and transforming demands into a final product, which is scientific and technological innovation. In this sense, the different relationships that constitute each vertex must structure themselves in order to guarantee a specific capability” (see figure above) (Sábato & Botana, 1968, p. 6).

The interrelations between the three groups of actors are the most important for explaining and evaluating the performance of an S&T system, an integrating the triangle. It is at this level where, according to the authors, the generation of self-decision capability in the field of science and technology is placed and observed. They 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, as the former virtually depends on the deliberate action of the government, and the demand for knowledge and technology generated by the government. The government - productive structure interrelationship depends fundamentally on the capacity of both vertices to make use of existing knowledge and incorporate it into productive systems; this imply no direct government intervention or funding of the productive sector. Finally, they say that the relations between the productive structure and the scientific and technological infrastructure are the most difficult to establish and identify. The authors mention that through the interchange of personnel (occupational mobility) the two vertices can share ideas and potential mutual demands (Sábato & Botana, 1968, pp. 7-8). In a later article, Sábato says that to be able to formulate specific S&T strategies, one would need to characterize triangles for every sector (Sábato, 1973).

Regarding external relationships, Sábato & Botana state that these come from the vertices towards the exterior, rather than the opposite, that is, intervention or inputs from external or international actors. Alongside this, they argue that part of a good working triangle has the ability to export and import S&T.

The focal point of the paper is to study the impact that Sábato's Triangle has had in the development of the Colombian S&T system. Nonetheless, this model does not provide enough keys or insight to have a deep and broad comprehension of the SNCyT. Therefore other theories and approaches will be introduced in order to inform governance and networking aspects of research and innovation systems, especially looking at ways to operationalize interactions and communication channels between actors.

2.2. Innovation systems

In the late 1980s a new current emerged within science and technology policy and innovation studies: the systems of innovation approach, whose precursors were Christopher Freeman, Bengt-Åke Lundvall, and Richard Nelson. The approach was developed from historical-empirical analyses and is based on evolutionary theories of technical change, institutional economics, and the chain-link or interactive model of innovation. Several books and articles have been written based on the concept; but, as many researchers have pointed out (see Edquist, 1997a; Holbrook & Wolfe, 2000; Nelson & Rosenberg, 1993), there is still no 'formal' NSI theory. Nevertheless, theories of interactive learning together with evolutionary theories of technical change are considered to be the theoretical foundations of the systems of innovation approach (Edquist, 1997a). Nelson and

Rosenberg (1993) define an NSI as the interaction of the innovative capabilities of firms with a set of institutions that determine the firm's capacity to innovate.

Castellacci and colleagues assert that there are two traditions within innovation systems: a historical-empirical approach (NSI approach, e.g. Nelson's book) and an interactive learning-based approach (the Aalborg school) (Castellacci, Grodal, Mendonca, & Wibe, 2004). The historical-empirical branch emerged when researchers and practitioners observed how firms in different countries performed differently, recognizing, on the one hand, that national capabilities affect the performance and competitiveness of the firms. On the other hand, they also understood that firms do not innovate on their own; they rely on various supporting organizations and institutions. In this sense, innovation systems attempt to understand and "decipher" the environment that surrounds firms. This version of the NSI focuses on the institutional set-up that supports and promotes innovation activities. NSI representations (see for instance Arnold, 2004) tend to focus on formal organizations and the main functions or the infrastructure needed to foster innovation, such as venture capital and an adequate intellectual property regime, just to mention a few. It also depicts general economic conditions. The principal actors can be organized by sector (e.g. industrial, educational and political). Arnold and Kuhlman (as cited in Arnold, 2004) include in the political system, the government, the governance mechanisms and the R&D policies as such.

The approach to innovation systems is not understood as a theory in itself, but as a conceptual and analytical framework to understand the complexities of the innovation processes and the institutional arrangements that affect it. This empirical and conceptual literature uses a broad concept of system, considering first that these systems are not created on purpose, that they do not always work in a consistent and coherent manner, and that not all links between components exist at a given moment in time, so they must be constructed or facilitated (Edquist, 1997a; Nelson & Rosenberg, 1993). Earlier studies on innovation systems were highly descriptive, enumerating the agencies, their functions, and the relationships between them, similar to a checklist, as Rip and van der Meulen stated (1996). More recent studies attempt to identify gaps, breaches and bottlenecks in respect of organizations and the relationships between them.

Two features of NSI are worth emphasizing: the notion of optimality, and the debate about "creationism" or "spontaneous evolution". As Edquist notes, there are "some elements of the systems of innovation consciously designed by actors, sometimes government policy-makers, but others seem to evolve spontaneously over extended time periods" (Edquist, 1997a, p. 13). Surely, a national system could not be designed as a whole; there is not a model defined *a priori*. Moreover, the concept of optimality is absent from the system of innovation approach, since there is not an ideal system against which one can compare. Besides an innovation system if context specific. This is true for both, OECD and Latin American countries.

In analyzing the origins and development of the concept, Rodrigo Arocena and Judith Sutz, both from Uruguay, found an important distinction between developed and developing countries (Arocena & Sutz, 1999). NSI is an *ex-post* concept for developed countries, built upon empirical studies which show similar organizational patterns around innovation. The institutions already exist and work together with the firms; there are innovation networks. When scholars introduced the concept in European countries, where much of the innovation system approach was developed, the NSI were already established with working organizations and linkages between the different actors. The systems were well defined and developed. In this case the NSI approach explains how these 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 to promote innovation at the firm level, on the basis of the NSI model. They add that this is not insignificant, because in Latin American “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 these authors, 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 the concept has been used to guide the design of policies and instruments; to build and organize the system, in other words, to set up the institutional infrastructure; and, to facilitate the linkages between the different actors. In the Colombian case, for example, the model was applied when the system of innovation was formally launched in 1995, as part of the SNCyT, and the supporting institutions were created, such as technological development centres thought as intermediaries between the research system and the industry, technological parks and incubators to house start-ups and spin-offs, and venture capital funds, however no clear demand for those instruments was manifested at the moment (normative approach).

However, this literature has its limitations, on the one hand in the forms of representation. The NSI literature usually depicts the systems by differentiating among the most important actors and highlighting the central functions needed. Meanwhile, representations of the Colombian SNCyT (see Figure 1), do not display the different participating organizations, but rather the organization of the political system (especially government and governance), following 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 social networks. On the other hand, the NSI focal point is enterprises, and the focus of the research is a governmental agency and its relationships with different communities.

2.3. Principal-agent theory

Since the focus of the paper is Colombian S&T institutions and the interactions between various actors, neo-institutional theories were taken into consideration, especially when trying to comprehend the different roles that

research councils could play, and the relationships they establish with the scientific community and the government. Within institutional theories, some S&T scholars have applied the principal-agent framework for explaining S&T political and governance issues, which are central to the research.

The basic logic of principal-agent (P-A) theory is that there is an organization or actor that looks to delegate some of its functions to other actors that seem in a better position to perform them. This relationship is generally not considered from a hierarchical perspective; to a certain extent both sides are autonomous. Guston states that P-A theory is also known as ideal contracting theory. From his perspective, research grants and contracts are central to the relation between the state and scientists; therefore, this theory should be an essential analytical method for science and technology policy studies (Guston, 1996, p. 230). The basic exchange is that the principal transfers resources to the agent(s), who should do what the principal cannot.

Principal-agent theory applied to a political rather than an economic context emphasizes different aspects, even if neo-institutionalism is the origin of both. For instance, transaction costs are not crucial, but trust of the principal over the agent is vital¹², and institutional structures are essential, in this case knowing the differences between countries regarding research and innovation systems. According to Guston, P-A theory can be applied to any situation that involves delegation, contracting, or representation. In the case of the Colombian SNCyT, the P-A theory can certainly be applied, since there is delegation of certain functions from Colciencias to the CPNCyT, such as the selection of projects and funding allocation; and representation of scientists in the councils.

It is interesting to note that different authors do not have a unique perception of who is the principal and who is the actor in the field of S&T. With respect to S&T policy, the principal could be a ministry, a research council, a funding or granting agency, or a mission oriented agency, which perform similar functions but their portfolio changes and, of course, their position within the government apparatus is different. Moreover, some include a third agent that can be either an intermediary between the principal and the agent, or simply a third party. Below, I present a summary of some of these perspectives.

¹² Generally speaking, these authors emphasize the trust dimension in science from different angles: in the P-A relation, in the peer-review process, and as part of the scientific ethos.

Table 1: Principal-agent viewpoints

Authors	Principal	Agent	Intermediary or Third party
Braun 1993	State	Research agency	Scientists
Guston 1996	State	Science	
Van der Meulen 1998	Research funding agencies	Scientists	
Van der Meulen 2003	Policy-maker	Scientists	Research council or funding organization
Braun 2003	Policy-makers	Scientists	
Caswill 2003	Ministry	Research actors	Research funding organization
Gulbrandsen 2005	Research council	Research community	
Slipasæter, Lepori & Dinges, 2007	Government	Research council	
	Research council	Institutions of science	

Source: Prepared by the author.

In the Colombian research system, van der Meulen's (2003) proposal seems to be the most adequate, since there are three actors: Colciencias, the CPNCyT and researchers (or in general beneficiaries of public funding), where the councils seem to perform the role of mediator between the government and the scientific community. In Colombia, Colciencias (principal) plays different roles – policy-making and funding-, and delegates the evaluation and selection of projects to the CPNCyT (agents). But the programmatic councils also act as principals in their relationship with researchers and entrepreneurs (agents). In the words of van der Meulen (2003) “the research councils in our case can be seen as a link in a chain of principal-agent relationships”.

Research councils perform different roles: 1) they can access and integrate knowledge more easily because they are closer to the scientific community; and, 2) they allow government to reduce transaction costs by implementing policies. Braun also argues, that the “triadic” structure (principal, agent and third party) establishes improved communication channels between the political and the policy system (Braun, 1993). The question is whether research councils are due to government or scientists, or whether they are the object of political interests or captured by scientific elites¹³. Van der Meulen proposes three types of relations among principal, intermediary and agent, depending on the transfer of task and the control over the resources. The control could remain in the government if the intermediary is close or dependent on government; or in scientists if the intermediary is very close to the research community (van der Meulen, 2003).

¹³ It is worth recalling Salomon (1977), who said that organizations concerned with S&T policy were set up with the purpose of associating the advice of scientists to political decisions, and that they should perform at least three functions: information, consultation and coordination. In this sense, problems associated with these relationships seem unavoidable.

The theoretical and conceptual framework presented in this section provides the basis for explaining how institutional and individual actors of the Colombian SNCyT establish relationships and constitute networks, the interaction mechanisms they use, and how information is exchanged between them. To summarize Sábato's Triangle and the NSI supply the normative framework to explain the Colombian SNCyT, showing the central actors and functions necessary for STI development. Principal-agent theory provides the basis for understanding the relationships between government (Colciencias), the programmatic councils and the councillors.

3. Methodology

The methods used were literature review, regarding the history of Colciencias and the Colombian SNCyT, and S&T policy literature; and the field work consisted on an electronic survey applied to the representatives (current and former) of the research community and the productive sector that are members of the programmatic councils. The objectives pursued were to study how they perceive their roles in the SNCyT, how they have contributed to the development of the SNCyT, and to track the information they receive in the council sessions.

A preliminary list of around 220 councillors was built (covering the period 1991-2010); although not all the former councillors were traceable. The survey was sent to 186 people, and 74 responded, equivalent to a 40% response rate (see table 1 for basic demographic data of respondents).

The participation by gender (73% men and 27% women) in the survey follows the pattern of national data regarding female participation in STI activities. Based on the S&T indicators published by the Colombian Observatory of Science and Technology (OCyT by its acronym in Spanish), the distribution of the total number of active researchers in Colombia is: 62% male, 38% female (OCyT, 2009a, 2009b).

Table 2: Respondents by gender and type of councillor

	Gender		Total	Type of councillor	
	Male	Female		Researchers	Entrepreneurs
Total surveyed	137	49	186	127	59
Respondents	54	20	74	61	13
Rate of response (%)	39	41	40	48	22

Source: Councillor survey.

The number of councillors per programme is not equal, on average there are five councillors from the academic/research community and two from the private productive sector. The distribution of the people surveyed by type of councillor, did

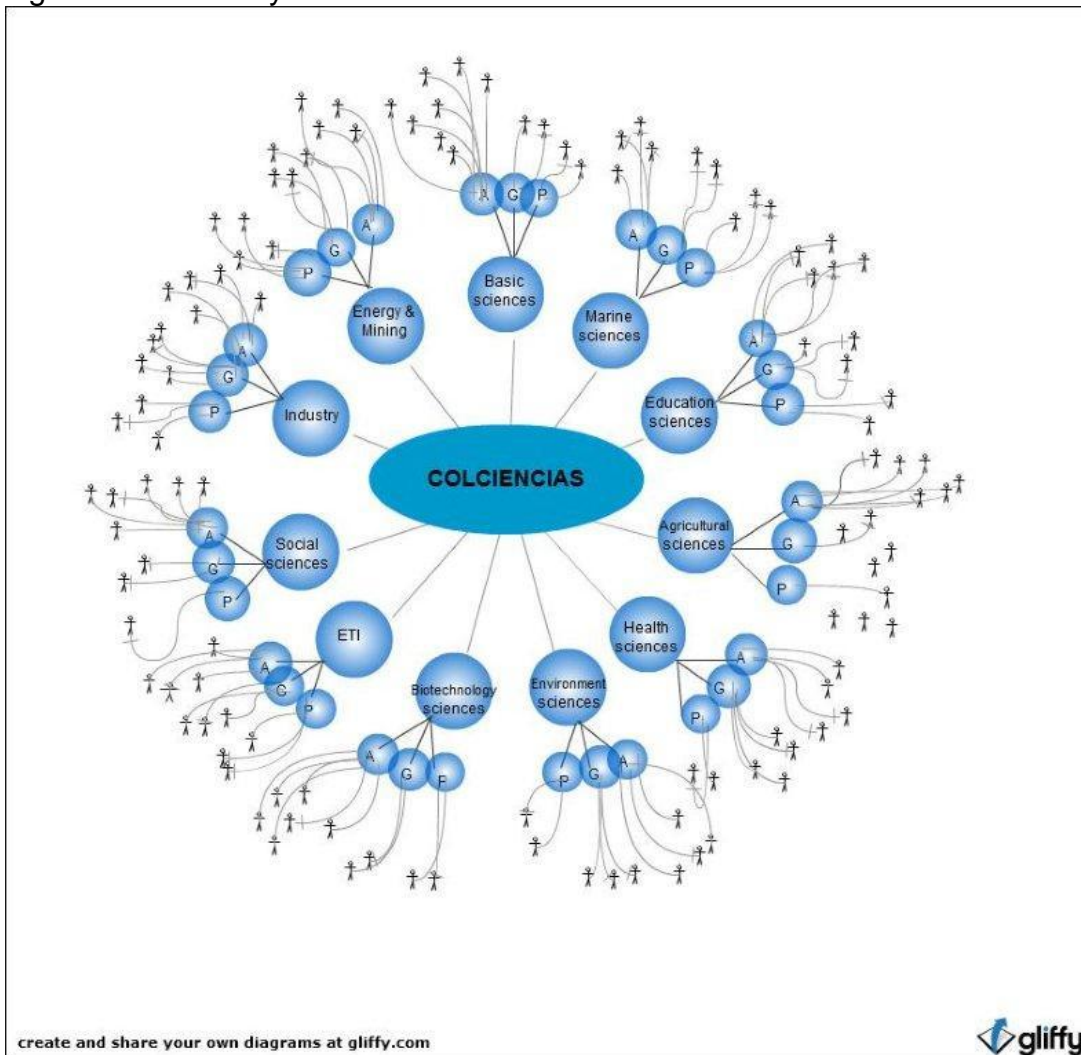
not keep the pattern of the current distribution: representatives of the productive sector account for 18% of responses, and the academic/scientific community for 82%. In 2010 the members of the CPNCyT were 52 researchers (67%) and 26 entrepreneurs (33%). Certainly, part of the problem is that former councillors from the productive sector were very difficult to find.

4. Survey results

The role of the programmatic councils was analyzed around three core issues: 1) circulation of information: ideas and policies; 2) the council's tasks; 3) the tripartite representation in the councils.

The organizational chart of the Colombian SNCyT is usually presented in a hierarchical way (see Figure 1). However, keeping in mind that the system is composed of various networks, such as the CPNCyT, the system could be represented differently, depicting every member of every council (see diagram below). This type of map illustrates the idea that CPNCyT are a mechanism for the circulation of ideas, people and policies, showing the large number of agents that help to disseminate Colciencias initiatives.

Figure 4: The SNCyT as a network



Source: Prepared by the author. Notes: A. Academia; G: Government; P: Productive sector; ETI: Electronics, telecommunications and informatics.

Several questions on the survey were designed to illustrate the communication aspect. Firstly, the question regarding the benefits they perceive as a councillor, 40 out of 74 (54%) chose “acquire and transmit valuable information”, the second most frequent option. Secondly, councillors were asked with whom they share the information they receive in the council meetings, and the use they give to that information; 84% responded that they share it with colleagues within their organizations, and 53% with colleagues outside their organizations. Finally, with respect to the use they give to that information, 81% use it to strengthen their academic discipline, and 68% use it to formulate research or innovation projects. It is worth noting that councillors do not influence their organizational environment (18%) as much as their academic discipline.

Based on the responses, it seems that being in the “inner circle” of the SNCyT -i.e. the CPNCyT- it is a privileged position that helps the councillors and

their closer contacts (ties) present R&D projects and take advantage of that position. In addition, it seems that the councils are a suitable mechanism for disseminating information from Colciencias to other actors of the system. Councillors state that they share information with their (supposedly) closer ties, which are their colleagues.

4.1. The council's tasks

There are contradictory opinions regarding policy-making as one of the council's functions. Some councillors surveyed affirm that councils contribute to STI policy-making in their respective area, but others say that they do not have enough time for it and that when they make proposals they are not taken into account. Generally they view their contribution as setting priorities via the selection and funding of projects.

Councillors were asked about the real key functions of the programmatic councils (see Table 3). 62 out of 74 (84%) choose "to approve or recommend project funding"; 43% "to define funding priorities" and, 35% "to formulate research and innovation policy for the programme". It is interesting to note that sharing information between diverse actors is not considered a central function of the council (selected only by 3 people), but rather a by-product of their activities, as most say that they share the information they receive in the council's meetings, rather than keeping it for themselves.

Table 3: Key real functions of the CPNCyT

What are the key real functions of the programmatic councils? (two most important)	Responses	%
To approve or recommend project funding	62	84%
To define funding priorities	32	43%
To define main research lines or topics of the Programme	1	1%
To formulate research and innovation policy for the Programme	26	35%
To coordinate S&T policies with other policies	6	8%
To share information between diverse actors of the SNCyT	3	4%
To discuss national priorities	6	8%

Source: Councillor survey.

The open questions regarding satisfactory and unsatisfactory aspects of their role also tell us something about their functions. The most satisfying things for councillors are: to participate or contribute to the formulation of plans and policies, to know about the SNCyT, the national policies, what is being investigated in the

country, and the research communities. Meanwhile, many councillors (46%) point out that one of the frustrations or difficulties they face is lack of time to formulate policies or design implementation strategies. Councils do not meet very often, every three to four months, the sessions are not long enough, and there are usually projects to be considered. The most frustrating thing or difficulty they perceive, is that their policy recommendations are not taken into account, that there is no communication or articulation with “higher” levels, that is, the General Director of Colciencias and the national council; which means that the information flows in one direction (top-down), but not upwards. In addition to the top-down communication problems, there are also lateral problems, as mentioned by one of the people surveyed, referring to the fact that there are no relationships between programmatic councils.

When asked about changing the functions of the councils, 54% of the councillors say that they should be changed to include policy-making and 46% say that they should not be changed. Many acknowledge that what the law stipulates is correct, that what needs to be changed is the operation of the councils, making better use of their advice. Even if more councillors would like the functions to be changed, the changes proposed aim to formalize the formulation of policies, which is a task already included.

4.2. Tripartite representation in the Councils

Sábato’s Triangle model seems adequate as an operating arrangement. It includes the three institutional sectors that should participate in the orientation of STI policies and strategies, although in Colombia it is not a representative stakeholder scheme. One could say that if the councils are to be changed, three different aspects should be considered: functions, representativeness and election mechanisms, and their relationships with the government, specifically Colciencias (principal-agent issues).

Some analysts argue that the CPNCyT conceived as triangles of interaction has resulted in very unequal vertices: a very strong and participative academic sector, a practically inexistent or passive (depending on the program) productive sector, and an uncommitted state without continuity and, on some occasions, underrepresented, due to the delegation in medium to low-ranking government officials. This will mean to rethink the programmatic councils, since it seems that the mechanism has been exhausted.

The councillors’ perspective is different; they think that the councils work, despite the lack of time to formulate policies. They believe that the council’s composition is correct, 77% say that the composition should not be changed, and that the election mechanisms should not be modified (68%). Some say that the articulation of the three sectors is an advantage. Not many explicitly identify Sábato’s Triangle but some (16%) state that the most satisfying things are: the possibility of sharing experiences and points of view, and relating and communicating with others who are different from them.

Based on a variety of different views, it seems that the tripartite participation in the programmatic councils is adequate, in the sense, that it provides a space for interaction, coordination and articulation, even if no formulation of policies and plans actually happen. As different interest groups get together and take decision jointly (on projects approval), a common space is facilitated for discussion and negotiation. Most of the criticisms are either related to operative aspects (routine tasks and lack of time) or to principal-agent conflicts and tensions; mainly due to the disrespect to the functions and roles assigned to the councils (agents) by Colciencias (the principal). The structure-agency dichotomy, when analyzing the CPNCyT seem not be solved; taking into consideration that the structure provided by the legal framework is very powerful regulating actors, but certainly in the everyday practice and the setting up social norms and rules councillors and Colciencias' officials recreate what the law says.

5. Concluding remarks

The findings will be organized around the theories and approaches used for understanding the governance of the Colombian SNCyT. Generally speaking, governance involves the interaction between formal and civil society institutions. The governance of an STI system involves interaction between formal organizations (research councils, government agencies, companies, universities, R&D centres, etc.) and researchers, entrepreneurs, and society in general. The governance of STI institutions in Colombia was certainly affected by law 29, which created the SNCyT as an open, participatory system, based on merit. The implementation of the law produced: 1) the framework for the development of STI in Colombia; 2) the development of new policy instruments; and, 3) the formalization and strengthening of an institution that is socially recognized and legitimized, which is the SNCyT.

Based on systems' literature, a system consists of components and the relations among them¹⁴. The Triple Helix and Sábato's Triangle models state that interactions among actors are what make them function. Therefore, the existence of a system is confirmed if organizations and individuals interact purposely, in other words, if there is a network. In the development of these relationships, institutions and practices are recognized and legitimized, or not. Sábato & Botana proposed a series of inter-relationships between the vertices, which after the analysis of the Colombian case could be complemented as shown in the table below.

¹⁴ The main components are formal organizations and informal institutions. Relations in a research and innovation system can be described and measured through information and knowledge circulation as well as financial flows.

Table 4: Categories for the analysis of inter-relationships – Sábato's Triangle

<i>Inter-relationships</i>	<i>Sábato & Botana</i>	<i>Newcategories based on the case study</i>
Government - Academia	Resource allocation Demand of knowledge and technology	Funding (transfer of resources) Transfer of tasks (P-A delegation) Adoption of policies Application of research results in the design of policies
Industry - Academia	Interchange of personnel	Demand of knowledge Sharing of ideas Interchange of personnel Alliances
Industry- Government	Both, to make use of existing knowledge produced by academia	Funding Adoption of policies

Source: Prepared by the author.

Some analysts state that the SNCyT has functioned by inertia, thanks to Colciencias. On the contrary, I think the SNCyT functions despite Colciencias. If we look at the SNCyT and the tripartite relationships at the system's level, certainly Colciencias has been crucial for making those interactions happen. But going to the level of the programmatic councils, and considering the PNCyT the axis of the SNCyT and Colciencias, the picture changes. In this case, I think that Colciencias has not favoured the development of the CPNCyT. Councillors know their role and the faculties and functions mandated by the law, although Colciencias does not allow them perform all of them. In this sense, they are limited by Colciencias, which provides the norms and rules, and determines when and for what purposes they will meet. In this sense, the dealings between Colciencias and the CPNCyT are flawed, since it seems that Colciencias does not really know what it wants the councils to do.

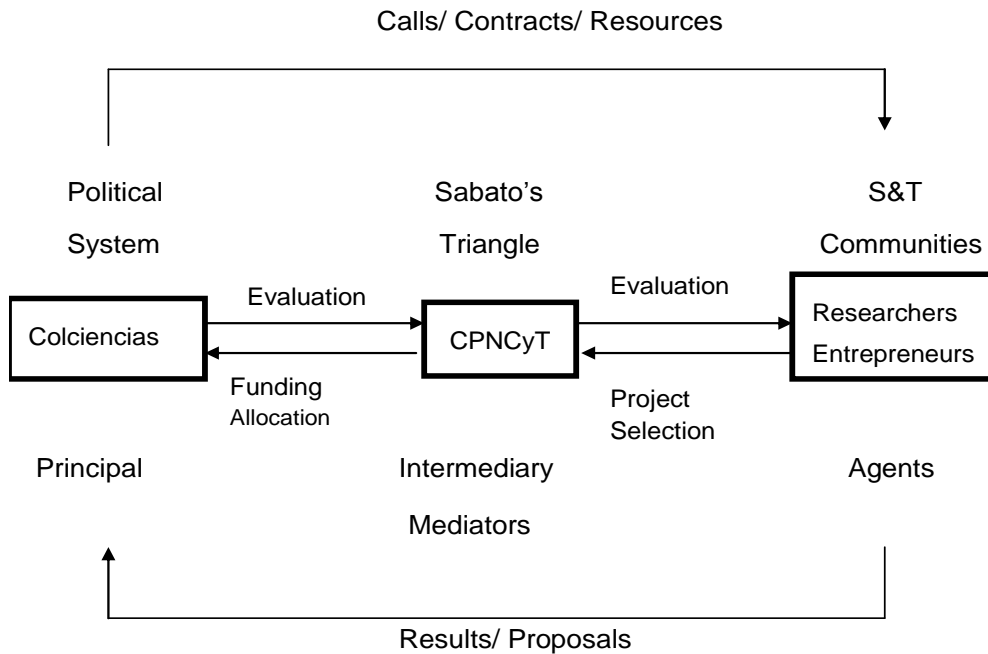
The councils of the Colombian SNCyT can undoubtedly be understood as policy-networks, considered as either a form of governance or an interest intermediation mechanism (Borzel, 1997). In the case of the CPNCyT, on the one hand, policy formulation is one of the council functions regardless of how effectively it is performing it; in addition, all other functions related to the management of STI activities as such (i.e. evaluation, selection and approval of projects) are also key to the governance of science. On the other hand, regarding interest intermediation, there are unquestionably many interests (public and private) that intervene in the council, which by default produce tensions and conflicts, as the objectives and goals pursued are different and sometimes divergent. Clearly if Colciencias recognizes and accepts the different interest groups present in the councils, conflict could be managed.

The CPNCyT bring together various 'interest groups', and as such, these groups will try to take advantage for their own benefit. Certainly, any individual councillor has interests, and he/she tries to "represent" his/her discipline, organization and region, but very few of them acknowledge this situation.

Current and former Colciencias officials consulted would like councils to discuss policy but, as councillors say, Colciencias does not provide the time and space to do so. I wonder, then, if Colciencias really expects CPNCyT to formulate STI policies in their own field, or only implement and apply national guidelines and strategies to the specific area? Certainly councillors claim to be allowed to design policies and strategies, even if some of them give importance to the selection and approval process. Representatives of the ministries argue that if the CPNCyT dedicate themselves only to project approval, the ministers will never get involved. They propose that the councils should be focused on negotiating resources, calls for tenders, and policies with other public and private entities.

As Braun and Guston say, **principal-agent** theory provides a useful insight into the relationships between government and the scientific community, and the third party or intermediary that many identify with granting councils (Braun & Guston, 2003). I think that the P-A configuration of the Colombian SNCyT is quite balanced, where scientists play an important role, but the principal (Colciencias) in reality maintains the control over the resources (financial and human) and does not transfer them to the intermediary (CPNCyT). Even if it is a balanced configuration, councillors do not question Colciencias' rules and norms; they just criticize the operational aspects. In this sense, councillors sometimes feel that the project approval process within the councils is a "ritual passage", like one more step, which they feel instrumental but not essential. Following this idea, one could represent the P-A model with three actors, with the CPNCyT as intermediary agents, but the direct relationship is between Colciencias and the STI communities, or final beneficiaries of Colciencias' action (see figure below).

Figure 5: The triadic structure of the P-A model in Colombia



Source: Prepared by the author, based on Braun, 1993.

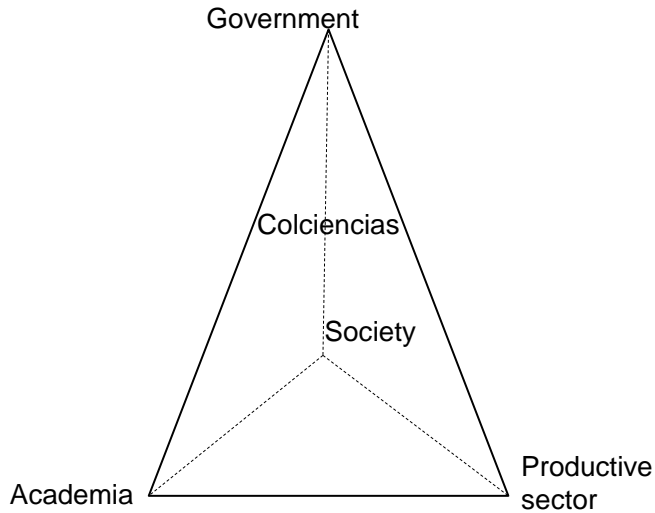
For the sake of building a stronger SNCyT, and more effective relationships between Colciencias and the CPNCyT, the functions of the councils should be clarified and their scope of action clearly defined. As said before, the councils are adequate mechanisms for the governance of STI, so the national government, based on Colciencias as the head of the system, should make a better use of them to formulate effective policies, having at hand high level advisors, strategic partners and enablers of social capital.

6. Future research

Few analysts, or none at all, would disagree that tripartite relationships are not essential for defining research and innovation strategies, but these interactions are neither easy to achieve nor developed automatically; actions need to be taken to facilitate them. Some scholars and activists are arguing that a fourth sector should be included: civil society (see for instance Guston, 2004; Guston & Sarewitz, 2002; Hennen, 1999; Jasanoff, 2004). Certainly the incorporation of the civil society is key for the democratization of STI policy, but this is simpler to say than to achieve. In this sense, I am proposing a new representation of these interactions for the Colombian SNCyT, including the fourth sector, and putting Colciencias in a different position, as neither part of the scientific and educational infrastructures, as Sábato and Botana proposed, nor in the government vertex, but

in the middle of a pyramid, articulating and facilitating the interactions of all sectors. In Colombia, Colciencias is the boundary organization facilitating the relationships, but in other countries could be S&T ministries, agencies or councils.

Figure 6: Pyramid of STI relationships



Source: Prepared by the author.

The inclusion of society in these models, as either a fourth vertex, helix or pillar, challenges us, first of all, to establish when in the processes of formulation, negotiation or implementation of policies society must intervene and, secondly, to propose innovative forms for their representation in this pyramidal relationship model.

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