Analysing the Differences in the Scientific Diffusion and Policy Impact of Analogous Theoretical Approaches: Evidence for Territorial Innovation Models

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ABSTRACT
The aim of this paper is to reflect on the conceptualization of three, a priori, similar territorial innovation models: the triple helix, the regional innovation systems and Sábato’s triangle. To compare their underlying theoretical foundations, we conduct a bibliometric analysis of the contributions based on the previous territorial innovation models. Following Reinert’s procedure we identify the most relevant lexical worlds in each stream of work. Our results reveal that the language of publication affects the scope and dissemination of academic works, as well as their impact in terms of policy making. The analysis also evidences the conceptual and theoretical differences among the three models. In particular, the differences in the schools of thought from which the three models emerge explain, to a great extent, the differences in the way the concepts introduced in each model are approached and applied in practice. The paper discusses how the practice of policy making tends to follow mainstream theories, approaches and methods that are not designed to transform those realities in which they are to be applied. The paper contributes to the literature with new evidence that shows how the use of non-dominant languages in scientific research does not necessarily imply that the contributions are not of interest to the world scientific and policy communities.

Keywords: Territorial innovation models, Triple Helix, Regional Innovation Systems, Sábato’s triangle, Latin America.

“No puede haber política tecnológica a contrapelo de la política económica. Es una contradicción... Absolutamente inútil será declarar objetivos tecnológicos globales magníficos si la política económica implicita o explícitamente está diciendo otra cosa en la letra chica”. [There cannot be technology policy that runs contrary to economic policy. It is a contradiction... It is totally useless to declare magnificent global technology aims if economic policy is implicitly or explicitly sending out a different message in the small print]. [1]

INTRODUCTION
The literature on territorial innovation models has introduced a multiplicity of concepts such as clusters, innovation systems, industrial districts, innovative milieus, learning regions, local production systems or new industrial spaces to explain the factors that influence and help generate the conditions necessary to support innovation. These territorial innovation models have not only had an impact on academia, but also on science, technology and innovation policy making on a global scale. In fact, most countries and regions have adopted policies to support innovation and entrepreneurship based on the previous approaches. Recently, [3] explored the extent to which territorial innovation models converge or diverge, and clarified their differences, particularities and boundaries. This paper contributes to this line of research by reflecting on the conceptualization of three territorial innovation models: triple helix, regional innovation systems and Sábato’s triangle. The rationale for focusing on these three models lies in their apparent similarities, since all of them analyse comparable elements such as the role of the state, the science and technology system, and the relevance of firms and interactions among systemic stakeholders. The analysis is novel because it brings to the fore the analysis of Sábato’s triangle, which
has been systematically ignored in non-Spanish-speaking countries.

The innovation systems approach was developed in the late 1980s[1-7] and the development of the concept of the triple helix took place in the 1990s[8,9] both in the Anglo-Saxon world. The evolution that the conceptualization of these two models has undergone was initially due to a large number of qualitative case studies which validated the first postulates that the authors in each school of thought had put forth. This later gave rise to empirical studies which were more quantitative in nature. In turn, the pioneering work of Sábato’s triangle was originated in Argentina by Jorge Alberto Sábato, an Argentinean physicist and technologist who published in Spanish his theorization on the determinants influencing local economic development and innovation in Latin American economies between the 1960s and the late 1970s.[10-12] Sábato’s triangle represents an analytical model which postulates that, for a science-technology system to exist, it is necessary that the government (as promoter, designer and executor of the policy), the science and-technology infrastructure (as a supplier of knowledge and technology) and the productive sector (representing the demand side of knowledge and technology), be strongly interrelated. More than a decade later, the triple helix model, introduced by,[8] and the literature on regional innovation systems[9] also held similar postulates, despite no reference being made to Sábato’s model. While the latter two models have been widely studied and applied in most advanced economies,[14] Sábato’s triangle still remains practically unknown, with a limited scope even in Latin America.[15] It has to be considered that despite the a priori conceptual similarity between the three territorial innovations models the policy recommendations derived from each of them are different. Hence, understanding the differences in the theoretical concepts and assumptions behind these three models is important not only for theory, but also for the practice of innovation policy making, due to the implications that the previous innovation models have for policy making. The differences in the impact caused by these three, a priori analogous, innovation models lead us to formulate the following research questions: How do the implications of these innovation modes differ in terms of design of public policy on innovation? What are the limitations of the three approaches? Can they learn from each other?

In general, Latin American economies present weak innovative dynamics[16,17] and are highly specialized in the production of raw materials and products with low value added.[10,11,12,18-20] Considering these structural characteristics is unavoidable when designing science, technology and innovation (STI) policies and defining the role to be played by science and technology institutions in the articulation of innovation processes. Thereby, the paper will contribute to the innovation policies in the Latin American context, by discussing whether the frameworks and models developed in other contexts (e.g. Anglo-saxon world) can also be extended and applied to a different institutional, economic, social and political setting. To compare the underlying theoretical foundations of each model a bibliometric analysis of the contributions based on the innovation models of the triple helix, the regional innovation systems approach, and Sábato’s triangle is carried out. Methodologically, we depart from the most cited articles that have formalized the conceptualization of each innovation model to understand the philosophies and theoretical concepts behind each. Following Reinert’s procedure,[21,22] we apply the content analysis method to this sample of articles, which allows us to identify the most relevant lexical worlds in each stream of work.

The paper discusses the importance of academic contributions made in non-dominant academic languages, and the influences felt in the policy making sphere to follow mainstream methodologies that are, however, not properly suited to comprehend, assess and act upon existing systemic realities. As a result, the paper opens a discussion about the (political) choice to follow mainstream (scientific) models that are, nevertheless, not properly suited neither to comprehend, assess and explain, nor to act upon and transform the realities targeted by these policies.

The remainder of the paper is structured as follows. Section 2 discusses the rationales behind the conceptualization of each territorial innovation model. Section 3 presents the methodology followed in the empirical part of the paper. Section 4 presents the results of the bibliometric analysis conducted. In particular, it evidences the keywords that characterize each of the territorial innovation models considered in the paper, the distance between them and the clusters they represent based on their proximity, and the structure of the network determined by these keywords. Finally, section 5 concludes by discussing the main implications of the paper for theory and for the practice of innovation policy making in Latin America.

Review of territorial innovation models

This section presents the conceptual origins and the main contributions in each of the three innovation models analysed in the paper, namely, the triple helix, Sábato’s triangle, and the regional innovation systems approach. Figure 1 provides a graphical illustration of the three territorial innovation models discussed in the paper.

The Triple Helix

The Triple Helix of University-Industry-Government Relations was proposed by Henry Etzkowitz (1940, North American) and Loet Leydesdorff (1948, Dutch) in
The old university–industry contract was based on a linear model of innovation in which scientific knowledge was produced at universities and then transferred to firms where it was transformed into technology solutions. Possible short and long-term contributions between firms, universities and government agencies were included in the triple helix model. They were based on examples of firm creation and/or research contracts and public funding in sectors with a high demand for technology resources like biotechnology and computer science. Relationships of this type imply a spiral innovation model – hence their similarity with the DNA triple helix in genetics – to capture the multiple reciprocal links in the different stages of knowledge capitalization.

The triple helix model is therefore an analytical framework which explains joint collaboration strategies and a new division of labour which encourages collective learning as well as the creation, circulation and appropriation of new knowledge. In this manner, research results become a shared asset which allows the owners to collect incomes by selling them.

Sábato’s triangle

Jorge Alberto Sábato (1924–1983) was a renowned Argentinian physicist. His most outstanding contributions to the connection between industry and the science system were made in the Argentinian National Atomic Energy Commission after the 1950s. Convinced of the need to have an autonomous technology development system, focused on the needs of Argentina, he helped to create the Technical Assistance Service for Industry, initially in the metal and steel industry.

In the 1960s, Sábato developed the so called “Sábato’s triangle”, which is a conceptual model with a systemic approach that intended to explain the three pillars of a country’s industrial development (Figure 1b). Sábato’s triangle highlighted the links between the state, the science and technology system and the productive structure and how these interactions are key to achieving “scientific autonomy” and the endogenous development of technologies in peripheral countries.

These concepts are related to the tradition of Latin American structuralism and to the limitations encountered by industrialization processes caused by import substitution in Latin American economies in the mid-20th century. In order to fully grasp the analytical framework created by Sábato, it is therefore fundamental to understand how his logic arose in an economic context in which most Latin American economies were ‘closed’. Technology development was thus considered an endogenous process in which the state played a critical role. As we have mentioned, each vertex of the triangle represents a type of agent (i.e. a group of agents put together under one umbrella category). One of these is the science and technology infrastructure, comprised of science
and technology institutions and carriers of the creative capacity capable of developing and disseminating technology innovations. The second vertex is the productive structure which is characterized by providing goods and services to society and includes public and private firms and the future users of such knowledge. The third and last vertex would be formed by government, led by the various government agencies responsible for public policy design and which create the conditions (funding and regulation) to develop the other two vertices. In this way, three vertices form the triangle and are defined from a functional point of view, being each vertex a point where institutions and decision-making and production units converge.

State agencies play a pivotal role in this scheme as they articulate the demands of the productive system and the responses that the science and technology system can provide. The state acts as a catalyst to articulate and direct the demands of one sector to another, allocating economic and financial resources through public policies.

Sábato understands scientific production as a social process, and as such, he did not limit the scientific infrastructure only to laboratories but also included tools like human resources training needed to provide scientists, assistants, etc. It is necessary to clarify that, in Sábato’s thinking, each vertex does not represent a sole agent but rather a system of institutions that require articulation to relate to each other. Taking into account the difficulties in the relationships between the agents at the different vertices of the triangle, Sábato pointed out that “if we accept the hypothesis that the agents at both vertices have creative and business capacity, the communication channels will necessarily be open. However, if there is any indication that the agents at one vertex or another are often lacking in both qualities, the danger of isolation and dialogues of the deaf between business leaders and scientists may become an insurmountable obstacle”. In this sense, the relationships between agents can take on different forms. For instance, the cooperation levels in certain activities are satisfactory and have a positive impact on the concerned parties’ innovation and production performance while in others there may be little or no interaction.

**Regional innovation systems**

For regional innovation systems (RIS), analysis centres on the systemic vision of innovation in a regional context. Similar to the triple helix, RIS is also an evolutionary approach in which innovation is understood as a non-linear, accumulative and interactive concept with a marked social nature. Organizations that interact (system) and the creation of technology and organizational improvements (innovations) based on capacity development are also necessary. A third and
no less important component is the system’s strong geographic, cultural and idiosyncratic roots.[13] This will determine the kind of institutions found in the region. And it is these institutions that explain, to a great extent, the differences in innovative performance between territories.[34] Understanding RIS from an evolutionary perspective is based on the idea that the innovative phenomenon is a systemic process in which organizations interact and co-evolve.[39,40] builds on the concept of innovation in Schumpeterian terms. This is reflected in his understanding that the capitalist dynamic of institutions is remarkable in this model, in addition to the relationships and links, as a role of collaboration is evident in relationships and links, as a key factor in innovation processes.

Innovation is a product of collective learning in which the role of collaboration is evident in relationships and links, as a “creative process”.[2,4] between different institutions or even between departments in the same firm.[48] It is therefore the region that sets the rules, standards and structure of those relationships.[46] Collective and interactive learning is one of the key factors in innovation processes.[40] Lastly, the concept of “environment” implies that the analysis centres on one type of organization (i.e. the firm) while the other organizations are taken into account by the extent to which they affect its performance or interact with it.[51] In this respect, environment is understood to be all the public and private institutions which affect the innovative dynamic of firms at a given time and place. It therefore does not mean society as a whole, but rather, in the broad sense, those institutions that affect the system’s innovative dynamic.[5,6,52]

**METHODOLOGY**

This section presents the basis of the methodology followed in the empirical part of the paper. We apply the Alceste methodology (‘Analyse des Léxèmes Cooccurents dans les Enoncés Simples d’un Texte’), which is implemented through the Iramuteq software.[2] This methodology was developed by the statistician Reinert[21,22] and it allows the treatment of large corpus of texts based on the lexicometry of the text corpus.[39,50] As already stated, we conducted a bibliometric analysis of the contributions related to the previous territorial innovation models. For the construction of each corpus, all the textual material of the articles and books was taken (eliminating graphics and footnotes). A similar series of contributions ($n=10$) was selected for each of the models studied to ensure comparison criteria between them. The following criteria were used for each case:

- **Sábatos Triangle:** the available articles and books that listed Jorge Sábatos as the first author were examined. It is worth noting that most of the works were from the 1970s. Due to the difficulty of accessing historical documents from the period of conceptual development, the decision was made to use 5 articles and books available in Google Scholar.
- **Triple Helix:** the ten articles/chapters of books most cited under the search term “Regional Innovation Systems” in the titles of articles from 1990 to 2012 on Google Scholar were selected.
- **RIS:** the first 10 articles/chapters of books most cited under the search term “Regional Innovation Systems” in the titles of articles from 1990 to 2012 on Google Scholar were selected.

It is worth noting that this article does not follow the classic “brute force” methodology used in scientometric and bibliometric works which apply one specific method for the entire scientific base found in a certain time period.[58] This approach was discarded in our case as the aim of the work is to determine the theoretical fundamentals that underpin each model in its genesis to discern the similarities or differences between them.

By applying the textual statistics method to these articles, we identified the most relevant lexical worlds in each stream of work. This allowed us to identify lexical worlds and find relevant themes and words in each of the models. Semi-automatic analysis was used to find the structure of the discourse in each model according to the profiles of words that are most repeated.[55,57] Based on identification of the key concepts, a corpus with the selected texts on each of the conceptualizations was elaborated.

Frequency distribution was used to build a descending hierarchical classification of words in accordance with the position and repetition of words in the text.[58] They were shown in a dendogram, which makes it possible to identify lexical worlds.[59,60] This process identifies the main words that give meaning to the discourse used in each document, analysed in text segments of 4 to 20 words. If the word forms part of a lexical world, the above methodology identifies and regroups it. It is shown graphically in the factor analysis, in
which its distance or proximity can be observed. Organizing the words in this manner allows to identify the strength of a word in a lexical world. This methodology had already been tested in previous works, and was demonstrated to be effective when identifying different lexical worlds from a certain discourse.

**RESULTS**

### Textual Statistics

The result of the statistical text analysis of each corpus elaborated is shown below.

**a. Sábato’s Triangle**

The results shown in the dendogram resulting from analysis of the literary corpus of Sábato’s Triangle identify five lexical worlds, of similar weight, in which the most relevant words in each one emerge (Figure 2). Thus, lexical world 1 (red) highlights words related to the agriculture and fishing sector like “production”, “technology”, or “agriculture”, differentiating them from the other lexical worlds that refer to industry-related issues. These special features may be related to the structuralist legacy that underpins the approach of Sábato’s Triangle, in which Latin American economies are described as a dual-interaction system between the primary and industrial goods sectors (see Section 2).

Lexical worlds 2 (grey) and 3 (green) are more closely related to each other and describe the components that make up the model itself through words like “vertex”, “science”, “infrastructure”, “government”, “policy”, “strategy” or “cooperation” and which show the relationship between government organisations and the science and technology system. On the other hand, lexical worlds 4 (blue) and 5 (violet) depict word associations that describe the specific features of the links between the productive fabric and the science and technology system. Thus, words like “factory”, “laboratories”, “research”, “importation”, “investment” or “transnational” are highlighted and represent essential characteristics of the triangle proposed by Sábato.

Proximity or distance of the lexical worlds is one of the remarkable aspects of this analysis. Figure 3 is revealing in this aspect as worlds 2 to 5 are close to each other and have common discourses and themes that intermingle. These lexical worlds identify the central themes that we have underscored and each one represents a vertex of the triangle. On the other hand, lexical world 1 is the most distant from those mentioned above, and, as we have noted, is the world linked to the agriculture and fishing industry.

The proximity or distance of the lexical worlds can be identified more clearly in Figure 3. In other words, it shows how they are spatially distributed and the links between them, as well as the most significant words in each one. Whereas lexical worlds 2, 3, 4, 5 show a certain proximity and overlap, world 1 is spatially separate and in turn, has fewer links with the rest of the lexical worlds.

Lastly, Figure 4 shows the network of word associations from the previously mentioned corpus. In Sábato’s Triangle, there are three keywords that give the network its structure: Technology as the central node, science as a satellite network node and technology as the connection between the two. A group of words related to the industrial sector, science, economic development and the state’s role are connected from the central node. However, the satellite network, grouped around the word “science” is related to words associated with knowledge, research and capacity, which are closely linked to
the vertex called science and technology infrastructure in the approach.

**Triple Helix**

As can be observed in Figure 5, the dendogram of the Triple Helix yields 4 lexical worlds. Unlike the previous case, such separate lexical worlds are not observed, although their weights are differentiated. Lexical world 4 (lilac) has a greater weight with 34.5% of the total corpus, followed by lexical world 2 (green) with 28.3%, successively, lexical world 3 (blue) with 23.5%, and lastly, lexical world 1 (red) with 13.7%. As regards the relationship between word clusters, lexical worlds 3 and 4 share certain attributes, with words like “sphere”, “research”, “intellectual property”, “industry”, “education”, “government”, “university” and “firm” standing out. These words describe the Triple Helix model through its components and focus on agents like universities, industry and government. In turn, words like “Europe” or “union” “European”, which are associated with the initial geographic problems that inspired the approach, are highlighted. Lexical worlds 1 and 2 are associated with the neo Schumpeterian roots of the approach, as authors like “Nelson”, “Lundvall” or “Winter” have demonstrated, and the systemic and evolutive outlook through terms like “complex”, “network”, “perspective” and “co-evolution”, which gave rise to this analytical approach.

The factor analysis graph (Figure 6) shows the distances between the lexical worlds mentioned and the weight of the words in each one. As can be observed, lexical worlds 1 and 2 are closely related while worlds 3 and 4 are more distant from each other. World 3 (blue) is particularly distant from lexical worlds 1 and 2, with little interaction between the word clusters.

In the illustration shown below (Figure 7), we observe a network of associations organized by a group of node words: “university” as a central node that connects words like “technology”, “knowledge”, “development”, “industry” and “government”; “system” as a satellite node that connects words like “dynamic”, “network” and “complex”; and node words with a narrower scope like “innovation” and “triple” “helix” “model”. This structure demonstrates that the approach clearly emphasizes the role of universities as a distinctive aspect but
highlights the systemic complexity of the links between the agents that make up innovation processes.

Regional Innovation Systems

Lastly, analysis of the RIS corpus yields a dendogram in which 5 lexical worlds can be identified, divided into two groups (Figure 8). The first comprises worlds 1 (red) and 4 (blue), and the second comprises worlds 2 (grey), 3 (green) and 5 (violet). The weights of the lexical worlds in the first group are relatively similar while the second group is divided into two subgroups. Worlds 2 and 3 share the first subgroup and have similar weights, being world 5 the one which forms the remaining subgroup with the lowest weight between the word clusters from the corpus we analysed.

In the first group, formed by worlds 1 and 4, words like “government”, “firm”, “sector” or “laboratory” are highlighted. They indicate issues typical of firms (i.e. high sector, size, manufacture, product), the role of public policy and agents like universities and laboratories. In the first subgroup (worlds 2 and 3) of the second group, words like “system”, “context”, “innovation”, “institutional”, “economic”, “governance”, “regional” or “path” stand out. They evidence the specific features of the network of links between agents such as their organizational makeup, hierarchical structure, territorial definition, the institutional and cultural context and function as a system that leads to innovation processes. World 5 therefore describes the interchange and characteristics of the knowledge that flows within the RIS, highlighting words like “knowledge”, “tacit”, “codify”, “learn” and “process”. These are concepts taken from the neo-Schumpeterian literature and from aspects of innovation systems.

The factor analysis of the RIS corpus shows that worlds 2, 3 and 5 spatially overlap and are distant from the rest of the lexical clusters. Worlds 1 and 4 are more distant from each other and have few connections. World 4 (blue) is the word cluster which is most isolated from the rest of the lexical worlds of the RIS literary corpus Figure 9.

Finally, Figure 10 shows the network of relationships between words that emerge from the analysis of the RIS literary corpus. The main node of the network revolves around the term “innovation” from which auxiliary nodes centred on words like “firm”, “regional”, “system”, “knowledge” and “research” emerge. In the literature on RIS we therefore observe that there is a strong focus on postulates on innovation processes which emerge from systemic and interactive links functioning between agents in a certain environment.
Comparative analysis

Section 2 contains a detailed explanation of the essential characteristics that justify the genesis of each of the models analysed. Based on the results of the bibliometric analysis presented in section 4.1, this section aims to provide a comparative analysis of the three models, demonstrating the similarities and differences between them.

One similarity between the three analytic schemes is that they involve the science system, the productive fabric and policy makers. These models intend to explain the fundamentals for science and technology pioneering that allow territories to develop. A priori, this leads us to think that the models are based on the same logic and pursue similar aims. However, as described in the previous sections, each of them shows differences in the arguments concerning innovation processes, generation of new knowledge and technologies, and particularly the agents’ role and the importance of territorial issues. The differences are revealed in the theoretical analysis as well as the empirical results presented in the textual statistics. Table 1 shows the key aspects of these differences.

As regards the differences that we can point out between Sábato’s model and the Triple Helix, the former’s understanding of capitalism is based on the problems typical of peripheral underdeveloped economies, in which government is positioned as the indispensable agent and articulator of the parties analysed to achieve technology development. This analytical framework is based on a situation in which each of the parties fulfills a specific and not very dynamic function, thus requiring government action not only to catalyse innovation but also to articulate between agents. On the other hand, the concept of the Triple Helix model emerged from the problems of more developed economies and it maintains that universities have the necessary tools to drive innovation processes hand in hand with government agencies. These agencies are engaged in creating an appropriate regulatory framework to facilitate the link between university and industry.

In the genesis of thought on RIS, firms were considered to be the key agents in moving learning and innovation processes forward. The interactions that firms establish with

| Table 1: Comparative chart and conceptual differences. |
|--------------------------------------------------------|
|                        | Triple Helix | Regional Innovation Systems | Sábato’s Triangle |
| **Innovation catalyst** | University   | Industry                    | Government        |
| **Government’s role**  | Participate through legislation, fiscal instruments and incentives to promote relations between university and industry | Set the regulatory framework and incentives | Promote demands and act as the key agent in articulation between the science and technology system and the productive fabric |
| **Role of the science system** | Universities play an essential role in achieving innovations | Source of external knowledge for firms in innovation processes | It is the agent with “creative” capacity and a key role in innovation processes |
| **Industry’s role**    | Interact with universities, communicating their needs | Articulate the other agents in order to integrate innovations into the economic system | This is the agent with the “business” capacity to adapt or revolutionize productive processes |
| **Systemic vision**    | The university plays a leading role in the interaction of the three sectors by articulating between industry and government | The many different ways in which links between system agents can be formed are pivotal to boosting the development of innovative processes | Innovation processes are a product of interaction within and between sectors |
| **Capacities**         | Shared knowledge and capacities boost innovation processes | The central role of firms’ absorptive capacities | “Business” and “creative” capacities are decisive in opening up communication channels between the parties |
| **Territorial issues** | They are not included | Territory as container of the system | Peripheral economies |
other agents are necessary for these processes, in which government agencies and the technology system play a major role. The scarcity of links between agents and the systematic weakness of firms as catalysts of structural transformations and innovative synergies are demonstrated in Sabato’s Triangle. This is a structural feature of Latin American economies. For this reason, these processes need encouragement from the state to boost innovation through promotion and funding of R&D projects and the articulation of education, science and technology institutions with the productive fabric.

CONCLUSION

This paper aimed to reflect on the conceptualization of three, a priori, similar territorial innovation models: the triple helix, the regional innovation systems approach and Sabato’s triangle. On the one hand, the analysis provides evidence of the conceptual and theoretical differences among the three models. In particular, the differences in the schools of thought from which the three models emerge explain to a great extent the differences in the way the concepts introduced in each model are approached and applied in practice. This implies that beyond the language in which academic contributions are made, it is important for policy makers to follow those methodologies and approaches that are best suited to comprehend, assess and act upon existing systemic realities. However, the practice of policy making often tends to follow mainstream theories, approaches and methods that are not designed to transform those realities in which they are to be applied.

On the other hand, the bibliometric analysis we have conducted also reveals that the language of publication directly affects the scope and dissemination of academic works, as well as their impact in terms of policy making. The fact remains that English is the prevalent language in scientific literature, and facilitates the diffusion and application of the concepts published in mainstream journals. However, the use of non-dominant languages in scientific research does not necessarily imply that the contributions are not of interest to the world scientific community. As the study on Sabato’s triangle proves, it has not been pursued, unlike the innovation systems or the triple helix models. The academic modifications and contributions made in these two areas have allowed the elaboration of an increasingly rich, transversal and complex corpus. Likewise, the case studies conducted on different environments and contexts, as well as the application of these two models globally, have not only led to validation of the fundamentals they introduced but have also allowed them to be enriched. However, Sábato’s triangle has not had the necessary continuity for the elaboration of a theoretical corpus that captures the complexity of the subject of study (i.e. innovation and technological and social progress). In part, this explains why policy makers from Latin American countries have anchored their science, technology and innovation policies in models like the triple helix or innovation systems instead of relying on models like Sábato’s.

Accordingly, for policy makers to apply certain concepts and theories upon which a particular policy is to be framed, the contextual circumstances in which these concepts and theories emerge also need to be considered. In Europe, for example, there is a common community policy. In spite of territorial differences between countries and regions, the science, technology and innovation policies adopted by the various member states are similar, as they are influenced by the European context. However, the contextual conditions in Latin America vary widely, even within the same country. As a result, the policies are more focused on local development.

We can infer possible public policy recommendations for Latin American countries from the analysis conducted on each analytical framework. From the triple helix point of view, publicly funded aid is channelled to universities for promotion of R&D projects, promotion of knowledge and technology transfer and creation of technology-based firms within the university sphere. In Latin America, university-business relationships have been weak and scarce, despite this interaction is understood as a synergistic opportunity capable of enhancing development processes. These policy recommendations could contribute to improving the relationship between universities and firms. From the perspective of Sábato’s triangle, the possible recommendations point to re-creating an innovation system under government leadership. Innovation processes are driven by state agencies in those economic sectors that lack agents with sufficient technology capacity and learning to carry out these processes. Lastly, from the RIS approach, public funding and incentives for the private sector are pivotal in encouraging the development of capacities to achieve positive effects on firms’ innovative performance. In particular, these recommendations aim to strengthen the demand for technological knowledge and improving the absorption capacity of the productive sector.

The methodological approach used in the article could be complemented in future research. For instance, the analysis was based on the 10 most representative works of each of the three perspectives studied as the aim was to determine the theoretical fundamentals that underpin the genesis of each model. In this respect, future research could conduct a complete bibliometric analysis of all the literature published on these innovation models (e.g. [3]), to search for possible cross citation between the innovation models. Another potential research avenue could explore the backward and forward citations of the scientific evidence found in each stream of thought, so as to understand the philosophies and theoretical concepts behind each model.
Finally, and from a political perspective, it might be worth studying why Latin American policy makers may be interested in applying concepts that are not well suited to transform their territories (e.g. the triple helix, the regional innovation systems) due to the structural differences between their territories (i.e. Latin America) and those from which these concepts emerge (i.e. mainly European countries), instead of applying other concepts that are better suited to their local economic circumstances (e.g. Sábato’s triangle). A potential explanation may be related to the need to legitimize certain policy decisions. Another may be given by the role played by supranational institutions such as the World Bank, the United Nations Industrial Development Organization, the Inter-American Development Bank, or the Organization of Ibero-American States, which rely on mainstream scientific concepts, and follow one-size-fits-all logics, rather than promoting initiatives that help to better characterize and diagnose the territories for which the policy is intended, using the knowledge available in the local context.

ACKNOWLEDGEMENT

The authors are grateful to the editor and the two anonymous reviewers for their feedback and the comments provided on earlier versions of the paper. Jon Mikel Zabala–Iturriagagoitia would like to recognize Professor Ignacio Fernández de Luccio for being a true inspiration in his professional career, for acting as a second father in his personal life, and for introducing him to the works by Jorge Sábato when Jon Mikel was still a PhD candidate. Jon Mikel Zabala–Iturriagagoitia also acknowledges financial support from the Basque Government Department of Education, Language Policy and Culture (IT 885-16).

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. Sábato JA. Propuesta de política y organización en ciencia y tecnología. Centro de Participación Política de la UCR, Encuentro Nacional de Ciencia, Tecnología y Desarrollo. Buenos Aires; Unión Cívica Radical; 1983;39-46.
2. Moutaert F, Sekia F. Territorial innovation models: A critical survey. Regional Studies. 2003;37(3):289-302.
3. Doloreux D, de la Puerta JG, Pastor-López I, Gómez IP, Sanz B, Zabala-Iturriagagoitia JM. Territorial innovation models: To be or not to be, that’s the question. Scientometrics. 2019;120(3):1163-91.
4. Freeman C. Technology Policy and Economic Performance: Lessons from Japan. London; Pinter; 1997.
5. Lundvall BÅ. editor. National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning. London; Pinter Publishers; 1992.
6. Nelson RR, editor. National Innovation Systems: A comparative Analysis. New York; Oxford University Press; 1993.
7. Edquist C. editor. Systems of Innovation: Technologies, Institutions and Organizations. London; Pinter; 1999.
8. Etzkowitz H, Leydesdorff L. Introduction to special issue on science policy dimensions of the Triple Helix of university-industry-government relations. Science and Public Policy. 1997;24(1):2-5.
9. Etzkowitz H, Leydesdorff L. The endless transition: A “triple helix” of university-industry-government relations: Introduction. Minerva. 1998;36:203-8.
10. Sábato JA, Botana N. La ciencia y la técnica en el desarrollo futuro de América Latina. Revista de la Integración. 1986;13(1):15-36.
11. Sábato JA. El pensamiento latinoamericano en la problemática ciencia – tecnología – desarrollo – dependencia. Buenos Aires; Editorial Paidós; 1975.
12. Sábato JA. Ensayos en campa. Primera edición. Buenos Aires; Juárez Editor; 1979.
13. Cooke P, Uranga MG, Extebarria G. Regional innovation systems: Institutional and organizational dimensions. Research Policy. 1997;26(4-5):475-91.
14. Jacob M. Utilization of social science knowledge in science policy: Systems of Innovation, Triple Helix and VINNOVA. Social Science Information. 2006;45(3):431-62.
15. Albornoz M. La política científica y tecnológica en América Latina frente al desafío del pensamiento único. Redes. 1997;41(0):95-115.
16. Katz J, Kossoff B. Aprendizaje tecnológico, desarrollo institucional y la microeconomía de la sustitución de importaciones. Desarrollo Económico. 1998;37(148):483-502.
17. Yoguiel G, Robert V, Erbes A. Capacities, innovation and feedbacks in industrial firms in Argentina. Economics of Innovation and New Technology. 2010;19(9):719-41.
18. Prebisch R. Growth, disequilibrium and disparities: Interpretation of the process of economic development. In: Economic survey of Latin America, 1949-ECN. 12/164/Rev. 1-1951. 1949;3-85.
19. Fajnzylber F. Industrialización en América Latina: de la caja negra a la ciencia. Comparación de patrones contemporáneos de industrialización. Cuadernos de la CEPAL, Naciones Unidas Comisión Económica para América Latina y el Caribe (CEPAL); Santiago de Chile; 1990.
20. Bielschowsky R. Sesenta años de la CEPAL: Estructurismo y neoestructurism. Revista Cepal. 2009;97:173-94.
21. Reinert M. Un logiciel d’analyse lexicale: ALCESTE. Les cahiers de l’Analyse des Données. 1986;11(4):171-84.
22. Reinert M. Les «mondes lexicaux» et leurs «logiques» à travers l’analyse statistique de divers corpus. Langage et Société. 1993;66(1):5-39.
23. Leydesdorff L, Etzkowitz H. Emergence of a Triple Helix of university—industry—government relations. Science and Public Policy. 1996;23(5):279-86.
24. Etzkowitz H, Leydesdorff L. The dynamics of innovation: From National Systems and “Mode 2” to a Triple Helix of university—industry—government relations. Research Policy. 2000;29(2):109-23.
25. Etzkowitz H, Leydesdorff L.A. Universities and the global knowledge economy: A triple helix of university-industry-government relations. London; Pinter; 1995.
26. Ranga M, Etzkowitz H. Triple Helix systems: An analytical framework for innovation policy and practice in the Knowledge Society. Industry and Higher Education. 2013;27(4):237-62.
27. Lowe CU. The Triple Helix–NIH, Industry, and the Academic World. The Yale Journal of Biology and Medicine. 1982;55(3-4):239-46.
28. Kline S. Innovation is not a linear process. Research Management. 1985;28(4):36-45.
29. Kline S, Rosenberg N. An overview of innovation. In: Landau R, Rosenberg N, editors. The positive sum strategy: Harnessing technology for economic growth. The Washington DC: National Academy Press; 1986:275-366.
30. Godin B. The linear model of innovation: The historical construction of an analytical framework. Science, Technology, and Human Values. 2006;31(6):639-67.
31. Arza V, Vázquez C. Interactions between public research organisation and industry in Argentina. Science and Public Policy. 2010;37(7):498-511.
32. Etzkowitz H. Academic-industry relations: A sociological paradigm for economic development. In: Leydesdorff L, van den Besselaar P, editors. Evolutionary Economics and Chaos Theory: New Directions in Technology Studies. London. Pinter; 1994;139-51.
33. Etzkowitz H, Webster A, Gebhardt C, Terra BRC. The dynamics of innovation: From National Systems and “Mode 2” to a Triple Helix of university—industry—government relations. Research Policy. 2000;29(2):109-23.
34. Balconi M, Laboranti A. University–industry interactions in applied research: A paradigmatic case study of microelectronics in Italy. Research Policy. 2000;29(2):109-23.
35. Sábato J, Botana N. La ciencia y la tecnología en el desarrollo futuro de América Latina. In: Sábato J, editor. El pensamiento latinoamericano en la problemática ciencia-tecnología-desarrollo-dependencia. Buenos Aires; Paidós; 1975;215-34.
36. Deza XV. Economía de la innovación y del cambio tecnológico. Una revisión crítica. Madrid: Siglo Ventiuno Editores; 1995.
37. Sábato JA. Ensayos en campera. Primera edición. Buenos Aires; Juárez Editor; 1979.
38. Sábato JA. El pensamiento latinoamericano en la problemática ciencia – tecnología – desarrollo – dependencia. Buenos Aires; Editorial Paidós; 1975.
39. Taylor MZ. The Politics of Innovation. Why Some Countries Are Better Than Others at Science and Technology. New York: Oxford University Press; 2016.
40. Robert V, Yoguiel G. La dinámica compleja de la innovación y el desarrollo económico. Desarrollo Económico. 2010;50(199):423-53.
41. Lundvall BÅ. National innovation systems—analytical concept and development tool. Industry and Innovation. 2007;14(1):95-119.
42. Schumpeter JA. The theory of economic development. Leipzig: Duncker and Humblot; 1912.
43. Schumpeter J. Creative destruction. Capitalism, socialism and democracy.
APPENDIX

Selection of articles for the analysis of the corpus of Sábato’s triangle

| #  | Title                                                                 | Author(s)                  | Journal/book       | Year |
|----|----------------------------------------------------------------------|----------------------------|--------------------|------|
| 1  | La Ciencia y la tecnología en el desarrollo futuro de América Latina | Jorge Sábado, Natalio Botana | Arbor, 575, 21-44   | 1993 |
| 2  | Bases para un régimen de tecnología                                | Jorge Sábado                | Redes, 4(10), 119-137 | 1997 |
| 3  | Desarrollo tecnológico en América Latina y el Caribe               | Jorge Sábado                | Revista de la CEPAL, 10 | 1980 |
| 4  | El pensamiento latinoamericano en la problemática ciencia-tecnología-desarrollo-dependencia. Introducción | Jorge Sábado                | Book               | 1975 |
| 5  | Empresas y fábricas de tecnología                                  | Jorge Sábado                | Book               | 1972 |

ENDNOTES

1  [27] (p.239) already indicated that “American biomedical research organizes around a triangle of interests formed by industry, universities, and government... I have chosen to call this biomedical research complex a triple helix, borrowing from the language of cell biology. The analogy seems serviceable for it suggests that the triple helix, like the double helix, has both structural and functional attributes”.

2  This section is based on the work “Ensayo en campera”, originally published in 1979 [12] and re-edited in 2004, based on Jorge Alberto Sábato’s memoirs and stories.

3  Free software developed by the university of Toulouse. Available: http://www.iramuteq.org/

4  See the Appendix for the full list and year of publication for each of the contributions analysed.

5  Please note that the content of the articles and books by Sábato were all written entirely in Spanish. As a result, the figures included in this subsection also capture the Spanish words that the author used in his key contributions. These Spanish words have been kept in the analysis to provide a better characterization of the original works by Sábato, instead of translating them into English.
### Selection of articles for the analysis of the corpus of the Triple Helix

| #  | Title                                                                 | Author(s)                                      | Journal/book                                  | Year |
|----|-----------------------------------------------------------------------|-----------------------------------------------|-----------------------------------------------|------|
| 1  | Emergence of a Triple Helix of University-Industry-Government Relations | Loet Leydesdorff, Henry Etzkowitz             | Science and Public Policy, 23, 279-86          | 1996 |
| 2  | The Triple Helix -- University-Industry-Government Relations: A Laboratory for Knowledge Based Economic Development | Loet Leydesdorff, Henry Etzkowitz             | EASST Review, 14(1), 14-19                    | 1995 |
| 3  | The Triple Helix as a model for innovation studies                    | Loet Leydesdorff, Henry Etzkowitz             | Science and Public Policy, 25(3), 195-203     | 1998 |
| 4  | The Future Location of Research and Technology Transfer               | Henry Etzkowitz, Loet Leydesdorff             | Journal of Technology Transfer, 24, 111-123   | 1999 |
| 5  | The dynamics of innovation: from National Systems and “Mode 2” to a Triple Helix of university–industry–government relations | Henry Etzkowitz, Loet Leydesdorff             | Research Policy, 29, 109–123                  | 2000 |
| 6  | The triple helix: an evolutionary model of innovations                | Loet Leydesdorff                              | Research Policy, 29, 243–255                  | 2000 |
| 7  | The Triple Helix of University-Industry-Government Relations: Implications for Policy and Evaluation | Henry Etzkowitz, Loet Leydesdorff             | Issues in Linking RIT Evaluation With Policy  | 2012 |
| 8  | Triple Helix indicators of knowledge-based innovation systems         | Loet Leydesdorff, Martin Meyer                | Research Policy, 35, 1441–1449                | 2006 |
| 9  | The Triple Helix of University-Industry-Government Relations          | Loet Leydesdorff                              | Book chapter, in Elias Carayannis (Ed.) Encyclopedia of Creativity, Innovation, and Entrepreneurship. New York: Springer. | 2013 |
| 10 | Universities and the Global Knowledge Economy: A Triple Helix of University-Industry Relations | Henry Etzkowitz, Loet Leydesdorff             | Book                                           | 1997 |

### Selection of articles for the analysis of the corpus of Regional Innovation Systems

| #  | Title                                                                 | Author(s)                                      | Journal/book                                  | Year |
|----|-----------------------------------------------------------------------|-----------------------------------------------|-----------------------------------------------|------|
| 1  | Regional governance structures in a globalized world                  | Hans-Joachim Braczyk, Martin Heidenreich      | Book chapter, in Hans-Joachim Braczyk, Philip Cooke, Martin Heidenreich (Eds.) Regional Innovation Systems. The role of governances in a globalized world. London: UCL Press, pp. 414-440 | 1998 |
| 2  | Regional Innovation Systems: Competitive Regulation in the New Europe | Philip Cooke                                   | Geoforum, 23(3), 365-382                      | 1992 |
| 3  | Regional innovation systems: Institutional and organisational dimensions | Philip Cooke, Mikel Gomez Uranga, Goio Etxebarria | Research Policy, 26, 475-491                  | 1997 |
| 4  | Enterprise-University Co-operation and the Role of Public Research Institutions in Regional Innovation Systems | Micheal Fritsch, Christian Schwirten          | Industry and Innovation, 6(1), 69-83         | 2013 |
| 5  | Location, agglomeration and innovation: Towards regional innovation systems in Norway? | Bjørn T. Asheim, Arne Isaksen                  | European Planning Studies, 5(3), 299-330     | 1997 |
| 6  | Regional Innovation Systems: The Integration of Local ‘Sticky’ and Global ‘Ubiquitous’ Knowledge | Bjørn T. Asheim, Arne Isaksen                  | Journal of Technology Transfer, 27, 77–86    | 2002 |
| 7  | Knowledge bases and regional innovation systems: Comparing Nordic clusters | Bjørn T. Asheim, Lars Coenen                   | Research Policy, 34, 1173–1190               | 2005 |
| 8  | The Geography of Innovation: Regional Innovation Systems              | Bjørn T. Asheim, Meric S. Gertler             | Cook chapter, in Jan Fagerberg, David C. Mowery (Eds.) The Oxford Handbook of Innovation. Oxford: Oxford University Press, pp. 291-317. | 2006 |
| 9  | Regional Innovation Systems in Canada: A Comparative Study            | David Doloreux                                 | Regional Studies, 38(5), 479-492              | 2013 |
| 10 | Strategies for Regional Innovation Systems: Learning Transfer and Applications | Philip Cooke                                   | Prepared for UNIDO World Industrial Development Report | 2001 |