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Research Article

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, Sabato's triangle, Latin America.

"No puede haber política tecnológica a contrapelo de la política económica. Es una contradicción… Absolutamente inútil será declamar objetivos tecnológicos globales magníficos si la política económica implícita 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]

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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.[2] 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,[4-7] 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[13] 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 late 1990s as a model for studying knowledge-based economies.[8,9,23,24] This is an evolutionary conceptualization, not only from its conceptual genesis, but also from the academic positioning of the scholars that gave rise to its conceptual development. Summing up, the Triple Helix focuses on the forms and relationships between the key components of a system in which innovative processes are embedded.[9,25] The Triple Helix concept has also been used as an analytical model for the definition of regional development strategies and for the support of territorial (national, regional and local) policies and strategies to further the knowledge-based economy.[26] It is remarkable that years before the publication date of the seminal work by Leydesdorff and Etzkowitz.[8,9,23,24] Charles Lowe, an American paediatrician (1921, New York), in a paper entitled "The Triple Helix - NIH, Industry, and the Academic World"[27] had already identified the three pillars of their model.[1]

The name triple helix refers to each of the agents needed to articulate innovation development. One of the helices represents the science and technology system while another represents the firms that demand, generate and use innovation. Lastly, the third helix represents the government as promoter of these relationships. Beyond this agent-based view of the model, analysis of the triple helix centres on mutual relationships and interactions between universities and science environments - the first helix -, firms and industry - the second helix, - and government – the third helix (Figure 1a). Due to the interaction between agents and institutions from the three spheres of the helix, the combination of knowledge and innovative capacities, shared access to economic resources and the incentives of public innovation policies encourage innovation processes. In any case, the analysis is systemic, as it is stems from all the system agents' need to achieve innovation. However, it is the science system that is understood to be the driver.

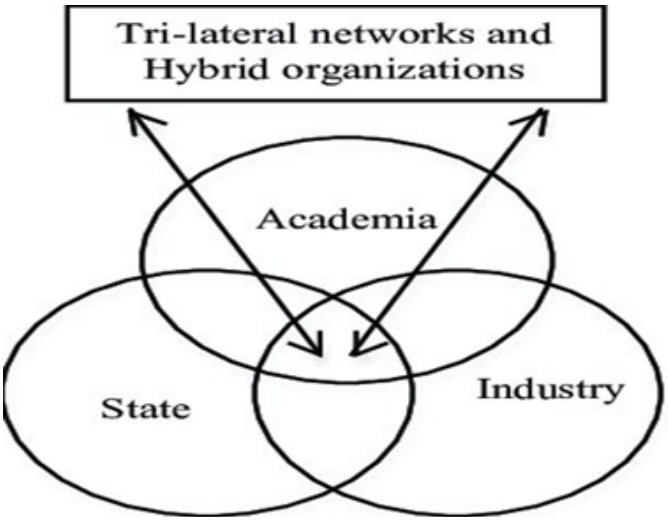

Figure 1: Territorial innovation models discussed in the paper.
Figure 1a: The Triple Helix of University-Industry-Government relations.[24]

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.[28–31] 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.[32]

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.[33,34] In this manner, research results become a shared asset which allows the owners to collect incomes by selling them.

Sábato's triangle[2]

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.[12] These concepts are related to the tradition of Latin American structuralism[18–20] and to the limitations encountered by industrialization processes caused by import substitution in Latin American economies in the mid-20th century.[16] 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.[35] 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.

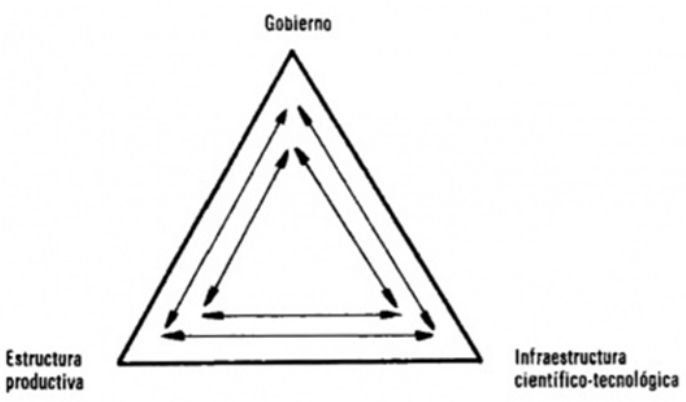

Figure 1b: Sábato's triangle.[35]

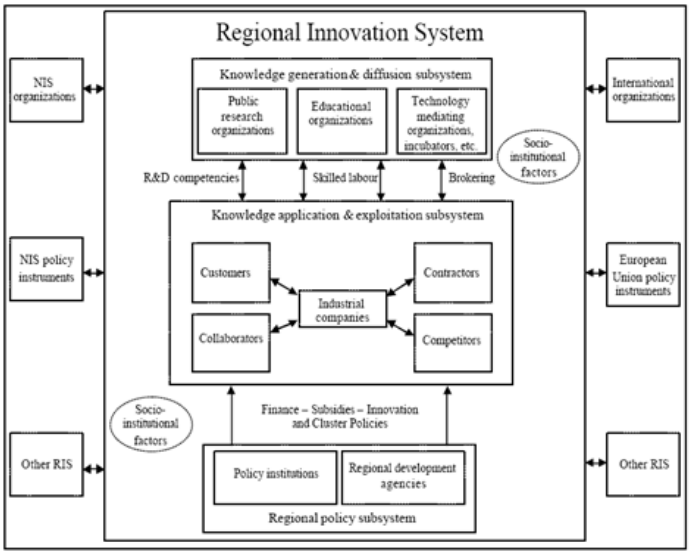

Figure 1c: The regional innovation systems approach.[64]

The institutions that make up the science and technology infrastructure are responsible for creating the domestic technology supply and form a resource base that nurtures the productive fabric. This vertex is where an economy's creative capacity is concentrated, and is an attribute that is crucial to sustaining development processes over time. The science and technology infrastructure ranges from laboratories or specialized institutions to R&D efforts made by the firms themselves. The creation of skilled human resources is also a relevant function. The academic sphere is an important space for training scientists, technicians, operators, administrators and other professionals who work in the different areas of the economic system.

The productive fabric is formed by a diverse group of goods and services producers, both public and private. This vertex plays major role in decision-making on productive transformations. In this regard, firms develop a business capacity to manage technology or administrative changes and other relevant functions within their organizations and interact with the other vertices of the triangle.

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".[12] 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,[36] accumulative and interactive[4] concept with a marked social nature.[37] 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.[38] 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 centres on technology change and entrepreneurs' search for individual[41] or collective[42] quasi-rents, which is based on a process of competition and creative destruction.[43]The role of institutions is remarkable in this model, in addition to the learning process that they can carry forward[7] in the same way as firms and institutions' absorptive capacity for innovation.[37] Absorptive capacity is understood as the firm's potential to make use of that knowledge and transform it into changes.[44,45] Not all firms have the same capacity to bring in this knowledge and absorption will depend, to some extent, on the firm's investment in research and development[46] and the learning it has acquired through experience. In this regard, the literature points to two main innovation and learning modes, that which is based on scientific knowledge (i.e. the Science, Technology and Innovation mode), and experience-based learning (i.e. the Doing, Using and Interacting mode) Figure 1c.

Innovation is a product of collective learning in which the role of collaboration is evident in relationships and links, as a "creative process",[2,47] 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.[49] Collective and interactive learning is one of the key factors in innovation processes.[50]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 Léxèmex Cooccurents dans les Enoncés Simples d'un Texte'), which is implemented through the Iramuteq software.[3] 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.[53,54]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.[4] The following criteria were used for each case:

- Sábato's Triangle: the available articles and books that listed Jorge Sábato 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 by authors Etzkowitz and Leydesdorff 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.[55] 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.[56,57] 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.[56,60] This methodology had already been tested in previous works,[61] 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[5]

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

Figure 2: Dendogram of Sábato's Triángle.

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

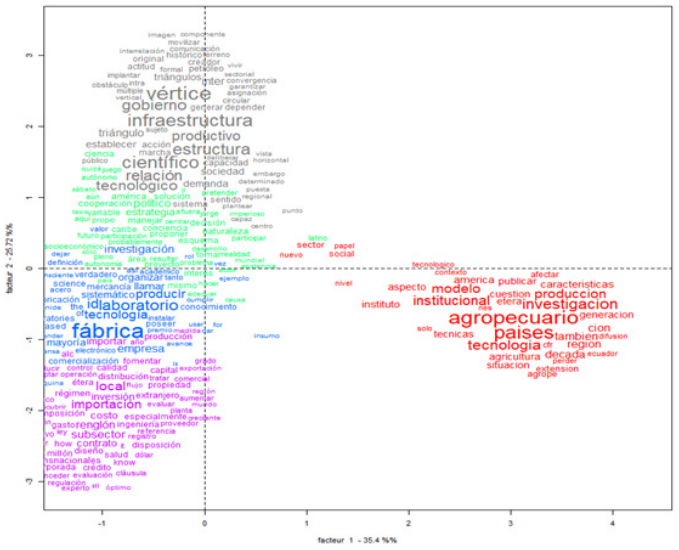

Figure 3: Factor analysis of Sábato's Triangle.

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

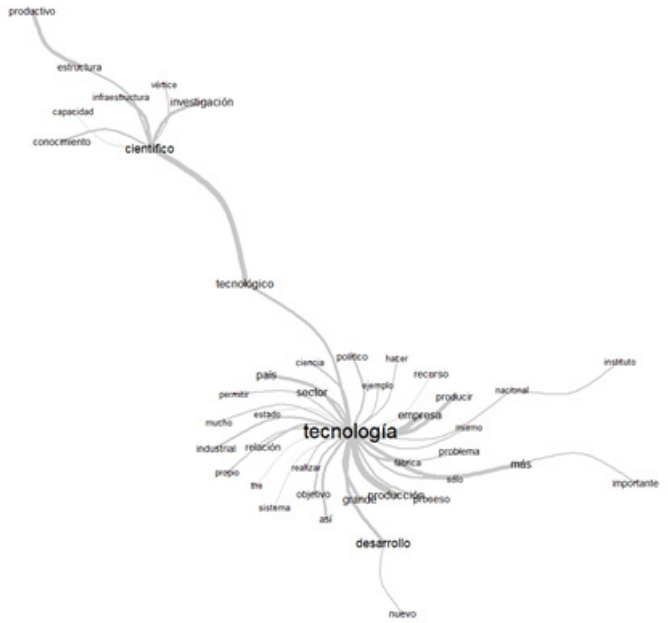

Figure 4: Similitude analysis of Sábato's Triangle.

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

Figure 5: Dendogram of the Triple Helix.

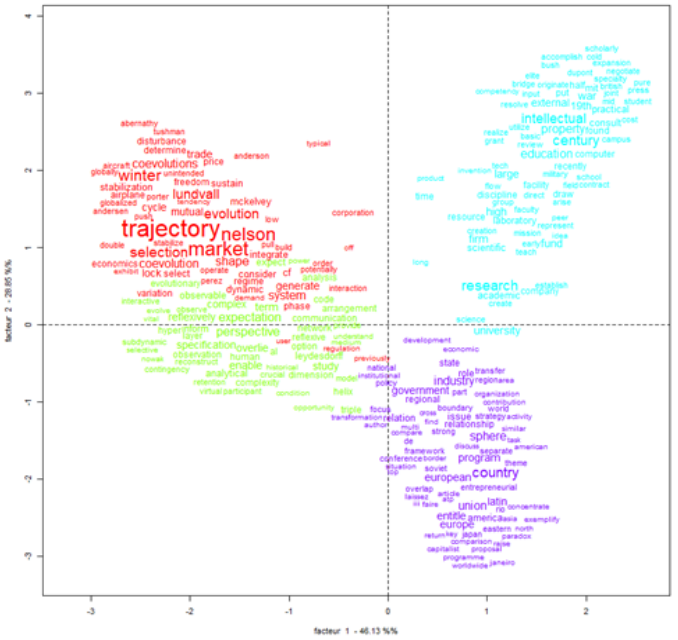

Figure 6: Factor analysis of the Triple Helix.

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

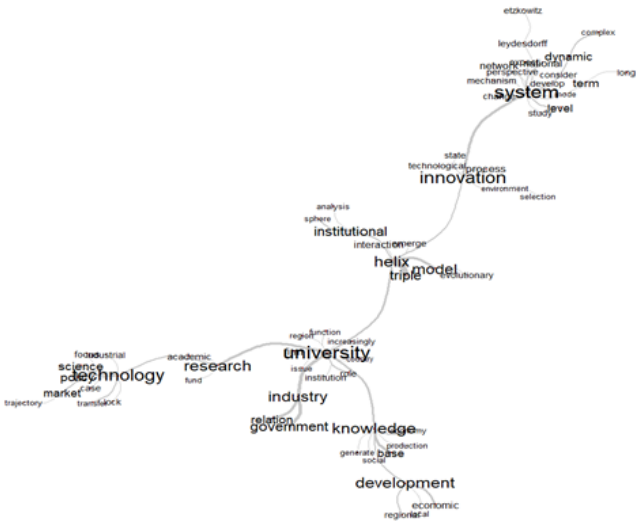

Figure 7: Similitude analysis of the Triple Helix.

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

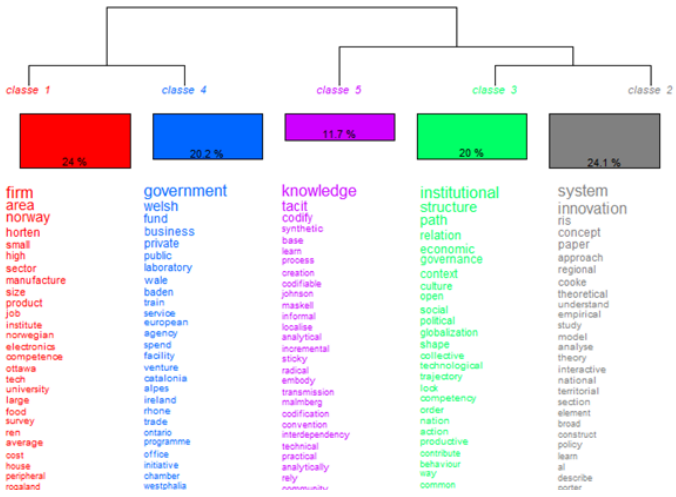

Figure 8: Dendogram of Regional Innovation Systems.

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.

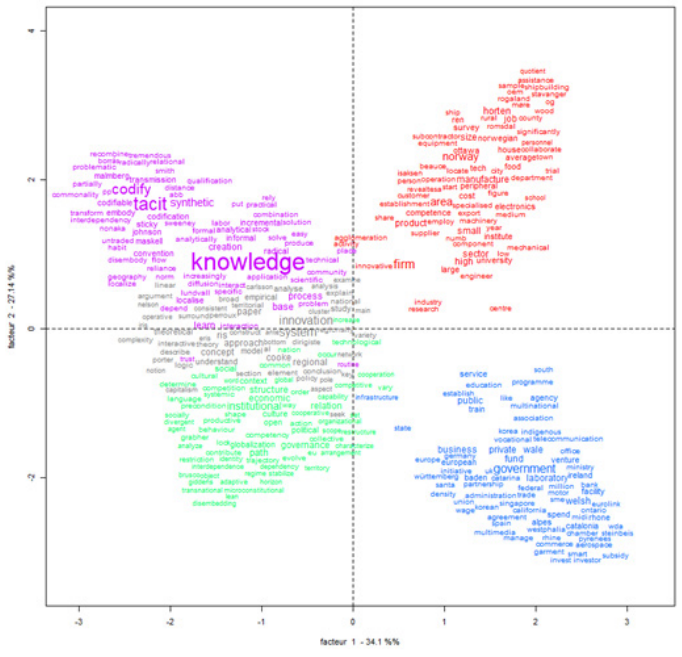

Figure 9: Factor analysis of Regional Innovation Systems.

Figure 10: Similitude analysis of Regional Innovation Systems.

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 fulfils a specific and not very dynamic function, thus requiring government action not only to catalyse innovation

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

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

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 Sábato'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,[62-64] 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.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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(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.

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 Sábato, Natalio Botana	Arbor, 575, 21-44.	1993
2	Bases para un régimen de tecnología	Jorge Sábato	Redes, 4(10), 119-137	1997
3	Desarrollo tecnológico en América Latina y el Caribe	Jorge Sábato	Revista de la CEPAL, 10	1980
4	El pensamiento latinoamericano en la problemática ciencia-tecnología-desarrollo-dependencia. Introducción	Jorge Sábato	Book	1975
5	Empresas y fábricas de tecnología	Jorge Sábato	Book	1972

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 Introduction to the special issue	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-JoachimBraczyk, 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