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Industry Interactions in Innovation Systems: A Bibliometric Study

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ABSTRACT

Assorted interactions among the agents in a territory are considered as key elements for its scientific, technological, and innovation development, thus fostering the competitiveness of its business fabric and enhancing the quality of life of its residents. In this context, this article analyses this phenomenon, specifically industry relations with innovation system players (academic, scientific, technological, financing, and facilitating agents) through a bibliometric analysis. The methodology used progresses in three stages: construction of the scientific papers search strategy (published in the ISI Web of Knowledge reference database between 2001 and 2014); its implementation; and the corresponding bibliometric analysis, using the Vantage Point® software as a support tool. Among other aspects, the findings present progress achieved in the research field, together with leading authors, organizations, and countries, as well as with cooperative efforts among them, highlighting the status of this topic in Latin America. Finally, the article concludes that industry relations in innovation systems is a topic that is steadily expanding worldwide, with large numbers of cooperative projects among countries. However, it also shows that this study theme is still incipient in Latin America, not just Brazil.

RESUMEN

Las diversas interacciones entre los agentes de un territorio son consideradas elemento clave para su desarrollo científico, tecnológico e innovador y, en consecuencia, propician la competitividad de su tejido empresarial y el incremento de la calidad de vida de sus habitantes. En tal contexto, este trabajo analiza dicho fenómeno, específicamente las relaciones de la industria con los actores de los sistemas de innovación (agentes académico-científicos, tecnológicos, financieros y facilitadores), a través de un análisis bibliométrico. La metodología empleada se desarrolla en tres etapas: construcción de la estrategia de búsqueda de artículos científicos (los publicados en la base de datos referencial ISI Web of Knowledge entre los años 2001 y 2014); su ejecución y el correspondiente análisis bibliométrico empleando como herramienta de apoyo el software Vantage Point. Los resultados presentan, entre otros, la evolución en el campo de investigación, los principales autores, organizaciones,

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países, y las colaboraciones entre ellos, haciendo énfasis en el estado del tópico en América Latina. Finalmente se concluye que las relaciones de la industria en los sistemas de innovación es un tema en continuo crecimiento a nivel mundial y con un elevado número de trabajos colaborativos entre países. Sin embargo, se demuestra que en América Latina, a excepción de Brasil, es un tema de estudio en una fase incipiente.

RESUMO

As diversas interações entre os agentes de um território são consideradas elemento chave para o seu desenvolvimento científico, tecnológico e inovador e, consequentemente, propiciam a competitividade de seu tecido empresarial, além da melhoria da qualidade de vida de seus habitantes. Em tal contexto, o presente trabalho analisa o referido fenômeno, notadamente as relações da indústria com os atores e com os sistemas de inovação (agentes acadêmico-científicos, tecnológicos, financeiros e facilitadores) por meio de uma análise bibliométrica. A metodologia empregada desenvolve-se em três etapas: a construção da estratégia de busca de artigos científicos (aqueles publicados na base de dados referencial ISI Web of Knowledge entre 2001 e 2014); a execução de tal estratégia e a análise bibliométrica correspondente empregando como ferramenta de apoio o *software* Vantage Point. Os resultados apresentam, entre outros, a evolução no campo de pesquisa, os principais autores, organizações, países e as colaborações entre eles, com ênfase no estado do tópico na América Latina. Por fim, conclui-se que as relações da indústria nos sistemas de inovação é um tema em contínuo crescimento no âmbito mundial e com um elevado número de trabalhos de cooperação entre os países. Demonstra-se, porém, que na América Latina, com exceção do Brasil, este tema de estudos está em fase incipiente.

Introduction

Innovation systems theory has been widely addressed during the past decade, as it is viewed as a rough approach for understanding innovation processes in territorial dynamics. This approach has been a matter of interest for policy-shapers, the business sector, and academics in a broad range of fields, which led to the theory of systems and its use worldwide in national, regional, and local strategies. Multiple definitions have been added to the core of the theory, one of them by Freeman (1987), who defined this as a network of institutions and the public and private sectors whose activities and interactions initiate, import, modify, and disseminate new technologies. This means that the player network is a precondition for the existence of the innovation system, whose activities spur the generation and strengthening of innovative and technological capabilities that consequently have economic and social impacts.

For authors such as Asheim and Isaksen (2002), Doloreux (2004), and Niosi (2005), the role of the production system in innovation systems is a key element for innovation performance, as affirmed by Méndez (2006), when speaking of an innovative territory. This refers directly to a production system

linked to one or several activities in which most of the existing companies strive at the technology innovation level. Similarly, Gebauer, Nam, and Parsche (2005) argued that the development of a region is encouraged by the presence of innovative industries or industries in a fast growth phase in their product life cycles, and is hampered by the presence of slow growth or declining industries.

Because of the importance of the role of industry and its interactions with other agents in the territory for interactive innovation processes (Kline, 1985), a significant number of studies have explored the relationships among them, usually in isolation: government, development agencies, banks, risk capital firms, institutions of higher education, science and/or technology parks, research results transfer offices, technology centers, incubators, knowledge intensive business services, research centers, and companies (Arias, Arenas, & Camacho, 2015). However, lacunae have been identified in the literature, highlighting shortfalls in the descriptions of these relationships. Although few mentions have been found in the literature describing these relationships, Stone, Benjamin, and Leahy (2011) affirmed that very little is known about the interconnected groups in the systems and the associated influences that are part of the innovation process, while Martin (2013) stated that there are no explanations of how interactive processes are organized among the sectors, what players are involved, and where they are located in terms of the others. This is how this article intends to highlight the existence of literature that has helped deepen studies of relationships among these players through bibliometric indicators, specifically addressing relationships among industrial companies and the wide variety of innovation systems agents (Kline, 1985).

This article is structured as follows: the methodology is outlined next, together with the characteristics of the data used. Section 3 opens with an overview of the general results, the characteristics of the status of research in Latin America and the quantification of the study inputs on relationships in the industry and other players found in papers addressing the innovation systems theory. Finally, the conclusions are presented, with the main findings, future surveys, and limitations of this research project.

Methodology

The methodology used for this survey is bibliometrics, which was a concept introduced by Garfield (1995); Cadavid, Awad, and Franco (2013); and subsequently defined by Durieux and Gevenois (2010) as a technique that clusters together a set of mathematical and statistic methods used to analyze and measure the quantity and quality of books, articles, papers, and other types of publications whose findings may steer decisions. This methodology has been used for some innovation systems theory studies, such as works by Uriona-Maldonado, Santos, and Varvakis (2012), who conducted a

bibliometric analysis of innovation systems theory through 2009; Perruchas, Yegros, Castro, and De Lucio (2005), who analyzed the progress of innovation systems research over time; and D'Allura, Galvagno, and Li Destri (2012), who analyzed joint mentions of authors of the innovation systems theory.

During the initial phase of the survey (study identification), a research equation was prepared encompassing the title, abstract, and keywords fields. Papers were collected whose review fields contained the following terms: *innovation system* and *industry*, including possible variants and synonyms of the entry keywords. This survey was conducted in the ISI Web of Knowledge database, which is rated as the most important source of bibliometric analysis data on social sciences (Uriona-Maldonado et al., 2012). The survey results were screened by language and year.

The fields of the papers identified during the search were exported in *.txt format to the Vantage Point® specialized software for subsequent analyses, which began with the chronological listing of the most important papers, authors, scientific journals, organizations and countries, the main topics addressed, and the key industries encompassed by the study. The papers were then classified by country and the set of articles from Latin American countries, using the same analysis criteria. Finally, studies were identified that focused on the theory at the regional level, meaning regional innovation systems, for which the specific inputs were quantified from interactions among different agents in the innovation system and industries.

General results

There are 751 papers on innovation systems that explore the participation of industry between 2000 and 2014, with 1307 authors involved in their production, together with 690 institutions and 83 countries. In 2014, the number of papers mentioning the innovation systems theory rose to 1849, indicating that just more than 40% considered the production sector as one of the research items in these scientific works. The uptrend in the number of papers published in this field has continued to rise, peaking in 2011 with 92 papers (Figure 1), indicating that this is an area of rising interest for the scientific community. Moreover, an increasing tendency was identified based on the number of authors, organizations, and countries in the research area.

As shown in Table 1, only three authors had written at least 10 papers, coherent with Lotka's law, which forecasts that only a small number of authors in any field will produce a large number of papers, while the output of most of them is lower. Lotka called the system for ranking authors by the number of works published a "productivity index" and divided it into three tiers: small, medium, and large producers (Perruchas et al., 2005). As a result, we found that more than 80% of the authors in this field are small producers, and less than 1% are rated as large producers, meaning that they are eminent

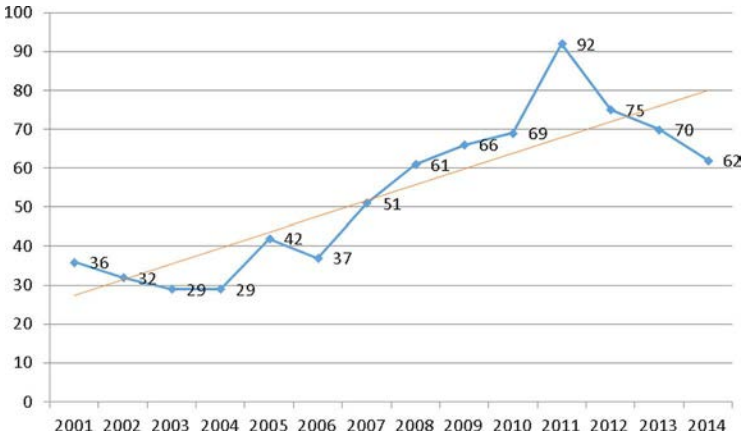

Figure 1. Evolution of scientific output. *Source*: ISI Web of Science.

in the field, as in general it may be affirmed that there is a strong link between the eminence of scientists and their productivity (Gonzalez, Moya, & Mateos, 1997).

Figure 2 shows that Klerkx, Leydesdorff, and Todtling are the main authors in the study of the innovation systems theory production system, with Cooke (the father of the regional innovation systems theory) ranking between sixth and eighth, with a total of seven products; the studies by Klerkx focus on the

Table 1. Distribution of authors by paper production.

Levels	N° Authors	Share
Major producers ($n \geq 10$)	3	0.23%
Medium producers ($1 < n < 10$)	222	16.99%
Small producers ($n = 1$)	1082	82.79%

Source: ISI Web of Science.

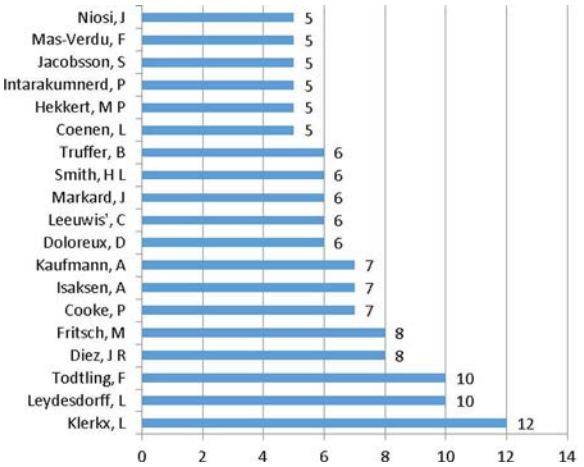

Figure 2. Authors with more than five papers published *Source*: ISI Web of Science.

agricultural sector and the innovation opportunities in its surroundings, while Leydesdorff addresses the links among the triple helix elements, including companies, as well as case studies of industries in national and regional innovation systems; in greater depth, Todtling explored the interactions among the players and the system, considering industry status at lower and higher development levels, meaning for traditional industrial systems and knowledge-intensive operations. Klerkx and Leydesdorff are also the main general innovation systems theory authors by quantity.

On the other hand, the distribution of citations by author does not result in the same ranking, as shown in Figure 3. When measured by citations, only three of the main authors by quality remained in the main players by output (number of papers) group: Todtling, Coenen, and Jacobsson, with 515, 515, and 487 citations, respectively. Although Malerba and Acs do not rank high by output quantity and quality, these are the authors with the best quality works under the average number of citations per paper criterion at 392 and 269, with Todtling ranking low for this criterion, with the largest number of citations in 10 studies, with an average of 52 citations in each paper.

The collaboration network among the main authors does not indicate associated efforts among them, as shown in Figure 4. The main researchers with the largest number of joint authorship works are Bernhard Truffer and Jochen Markard, with four collaborative projects, respectively, both linked to the Swiss Federal Institute of Aquatic Science and Technology in Zürich, Switzerland, top in the ranking of authors by number of products, with six papers on the topic, three of them co-authored. Other collaborative nodes in this network consist of Coenen and Hekkert linked to Lund University and again the Swiss Federal Institute of Aquatic Science and Technology, respectively. Other collaborative projects among the main authors do not involve more than two of them.

Representing only 1.7% of the total number of organizations, entities with more than 10 scientific products account for 20% of the papers (shown in Table 2), which are closely linked to the affiliation of the main authors and the main countries as well, as shown next. The main organization for producing papers is Lund University, with its researchers including Coenen and Jacobsson. Links among the main organizations (all universities) were stronger than among the main authors. The University of Amsterdam in

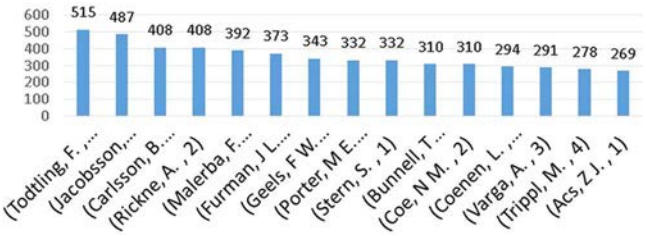

Figure 3. Main authors by citations. *Source*: ISI Web of Science.

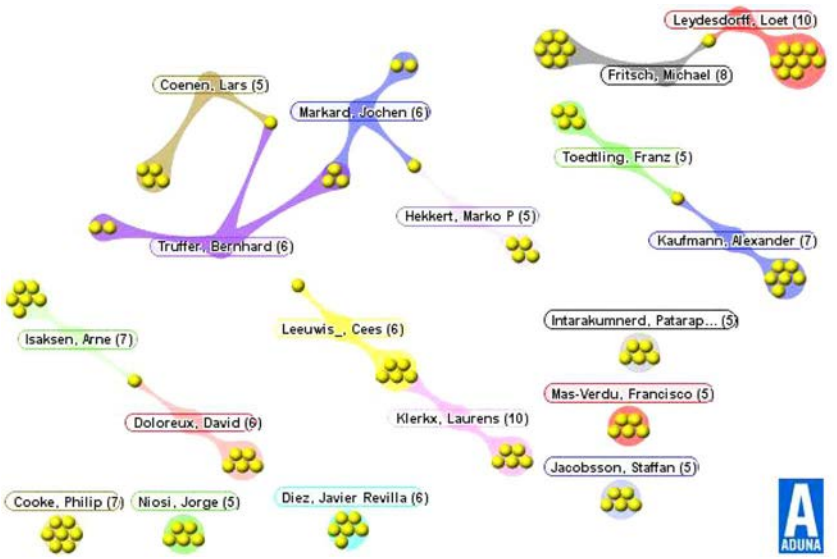

Figure 4. Author collaboration network. *Source*: ISI Web of Science.

the Netherlands is the entity with the largest number of contributions, ranked fourth by paper production and direct collaboration connections with the Friedrich-Schiller-Universität Jena, Wageningen University and the University of Sussex. Additionally, Vienna University of Economics and Business and Lund University are linked to this part of the network, which is larger.

Figure 5 shows that the United Kingdom is the main producer of articles exploring the role of industry in innovation systems, followed by the United States, the Netherlands, and Germany, with more than 50 products. The ranking of authors producing more than 10 papers includes countries in Europe, Asia, America, and Oceania.

The collaboration network among countries has resulted in a large number of joint projects. The top producer, the United Kingdom, is connected mainly

Table 2. Organizations by paper production.

	Organization	No. articles
1	Lund University	19
2	University of Manchester	18
3	Universiteit Utrecht	16
4	University of Amsterdam	14
5	Wageningen University	13
6	University of Sussex	12
7	University of Cardiff	11
8	Universitat Politècnica de València	11
9	Friedrich-Schiller-Universität Jena	10
10	Université du Québec	10
11	University of Toronto	10
12	Vienna University of Economics and Business	10

Source: ISI Web of Science.

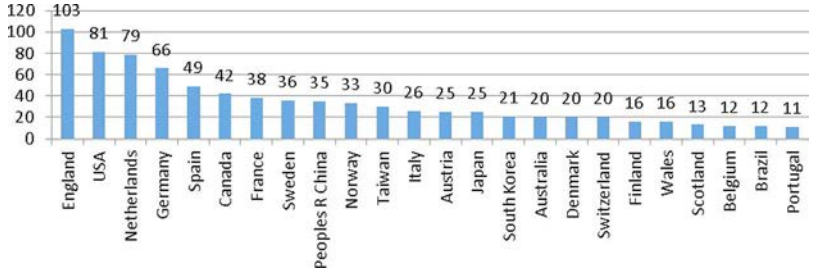

Figure 5. Main producer countries. *Source*: ISI Web of Science.

with Taiwan; followed by the United States, which is linked to China and Japan. Although the systems theory inputs are not evenly balanced for all of them, due to their own specific economic, political, and social characteristics, it is, nevertheless quite clear that industry has played a key role worldwide, which has been addressed for territorial development.

On the other hand, 18 journals are the main sources of products with more than 10 papers, with the most important being *Research Policy*, as shown in Figure 6. This journal empirically and theoretically examines interactions among innovation, technology, or research on the one hand, and economic, social, political, and organizational processes on the other (Elsevier, n.d.). Ranked next with a similar approach are *European Planning Studies, Regional Studies*, and *Technological Forecasting and Social Change*, which are among the leading sources in the fields of innovation systems and technology management.

The most important papers are "Firms' Knowledge-Sharing Strategies in the Global Innovation System: Empirical Evidence from the Flat Panel Display Industry," (Spencer, 2003) with 97 citations and "Science-Industry Interaction in the Process of Innovation: The Importance of Boundary-Crossing Between Systems," (Kaufmann & Tödtling, 2001) with 94 citations. In the former, Spencer (2003) concluded that companies that design strategies for sharing technological expertise with their competitors and those sharing knowledge with other agents in their innovation system achieve higher innovative yields

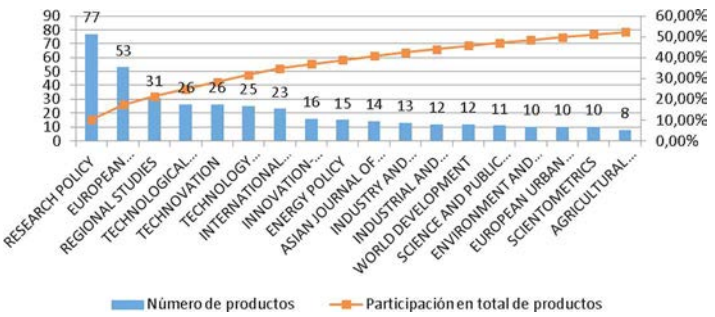

Figure 6. Main journals. *Source*: ISI Web of Science.

than nonsharers. Similarly, Kaufmann and Todtling stressed the importance of associations in innovation systems, showing that scientific allies are more important than clients for introducing new products to the market.

These studies involving industrial system participation have been linked to the many adaptations the innovation systems theory had during the 1990s and early XXI century, as shown in the list of keywords in Figure 7: national innovation systems (Freeman, 1987; Lundvall, 1992; Nelson, 1993), which was the first to be acknowledged by the scientific community; technology systems (Carlsson & Stankiewicz, 1991), sectoral innovation systems (Breschi & Malerba, 1997), and regional innovation systems (Cooke, Uranga, & Etxebarría, 1997). Additionally, other key terms appearing frequently in the reviewed studies were identified: "technology transfers," which take place as relationships progress; and "patents" generated in relationships; "innovation networks" resulting from interactions; and "open innovation" as one of the types of collaborative innovation. Further, keywords are also involved, related to system agents: "triple helix," "university," and "cluster." Terms such as "system innovation policy" and "biotechnology" were also frequent, as one of the leading sectors for collaborative technology development.

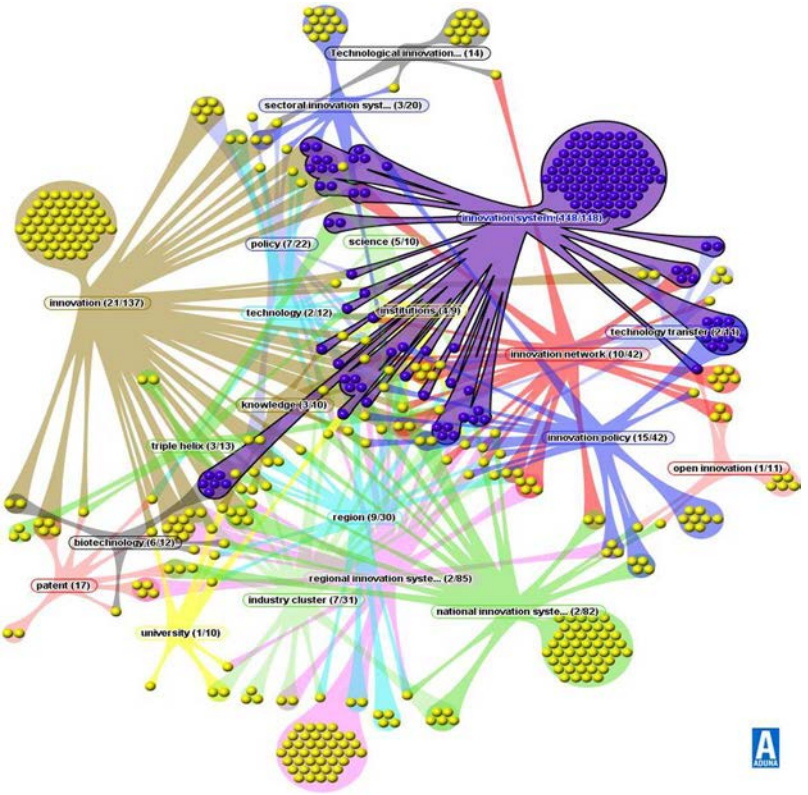

Figure 7. Links among keywords. *Source*: ISI Web of Science.

Table 3. Main industries studied in regional innovation systems literature.

Industry	Frequency	Share
Biotechnology	13	11%
Food and nutrition	7	6%
Photovoltaic	6	5%
ICT	6	5%
Medical devices and materials	5	4%
Forestry	5	4%

Source: Prepared by the authors.

From the total number of studies, 122 mentioned a specific analysis of an industry, with Table 3 listing those studied in the greatest depth within the innovation systems context. The main share was held by the biotechnology segment, which some studies rank among the leaders for strategic alliances (Mora, Martinez, & Camacho, 2014), because this sector has been identified as having the largest number of alliances, with solid inter-company cooperation (Rothaermel & Deeds, 2004), in addition to being one of the most competitive and knowledge-intensive sectors of the economy (Gay & Dousset, 2005). From among those listed in the Table 3, biotechnology, photovoltaics, information and communication technologies, and medical materials and devices are taken under consideration using Pavitt's (1984) taxonomy and its updates (Bogliacino & Pianta, 2010) as science-based, which corresponds to the classification of industries into four groups, based on the type of technological changes, production process characteristics, market structures, and others. The food, forestry, and dairy industries are classified as dominated suppliers; in contrast, they are less knowledge-intensive.

Results for Latin America

The number of papers published during the 13 years covered by the study reflect the limited input from the Latin American scientific community to the study industry in innovation systems. During this period, only 26 papers were found and, despite a general uptrend in publications over time, this output has varied widely, as shown in Figure 8, with these studies accounting for only 3.5% of all those registered in the database and located by the search equation.

At the Latin American level, three authors are identified with more than one paper published: Costa, Gadelha, and Maldonado, each co-authoring two papers, and are affiliated with Brazilian organizations. All the Latin American authors in this field rank low on the Lotke Productivity Index. The most mentioned are Almeida and Etzkowitz, together with Dalco and Silvestre, with these pairs co-authoring papers, as shown in Figure 9.

The main Latin American producers are listed in Table 4, with more than one paper. Most of them (five out of seven) are entities in Brazil, similar to many of the authors ranking high for number of articles and mentions.

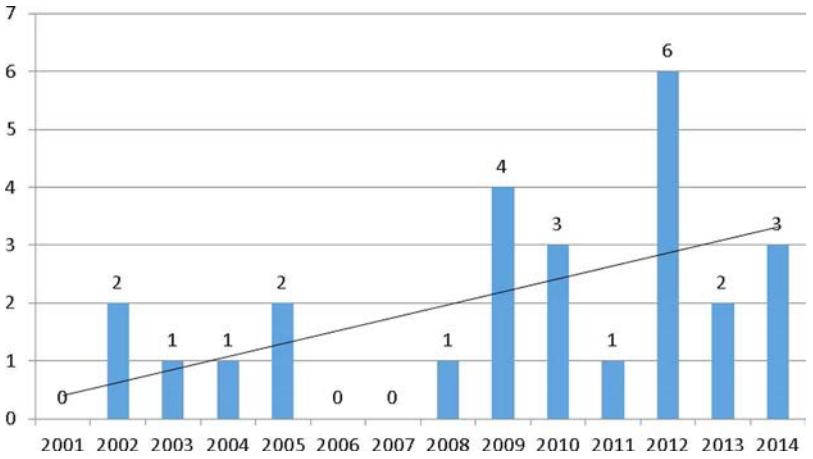

Figure 8. Progress of scientific output. *Source*: ISI Web of Science.

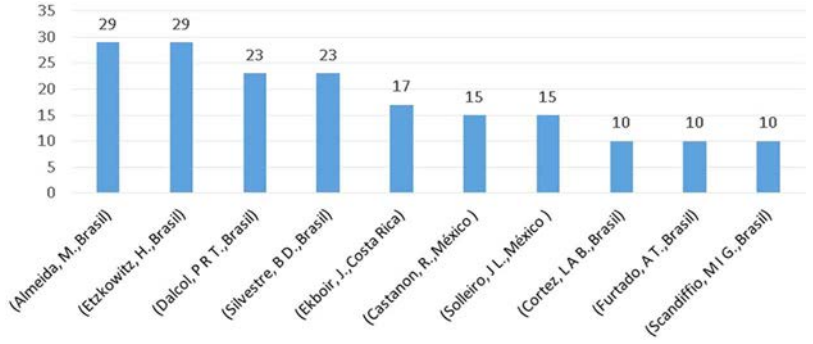

Figure 9. Main Latin American authors by citations. *Source*: ISI Web of Science.

Latin American output by country clearly indicates that it is in Brazil that the importance of industry in systems development has been most clearly defined (shown in Graph 10a), followed by Mexico, Colombia, and Costa Rica, with more than one paper, and 19% from the other countries. These four countries also rate high for competitiveness, according to the 2014–2015 Global Competitiveness Report (World Economic Forum, 2015) with the

Table 4. Organizations by paper output.

N°	Organizations	No. Papers
1	Fundação Oswaldo Cruz (Brazil)	3
2	Universidad Nacional de Colombia (Colombia)	3
3	Ministry of Health (Brazil)	2
4	Universidade Federal Fluminense (Brazil)	2
5	Universidad Federal de Minas Gerais (Brazil)	2
6	Universidade de São Paulo (Brazil)	2

Source: ISI Web of Science.

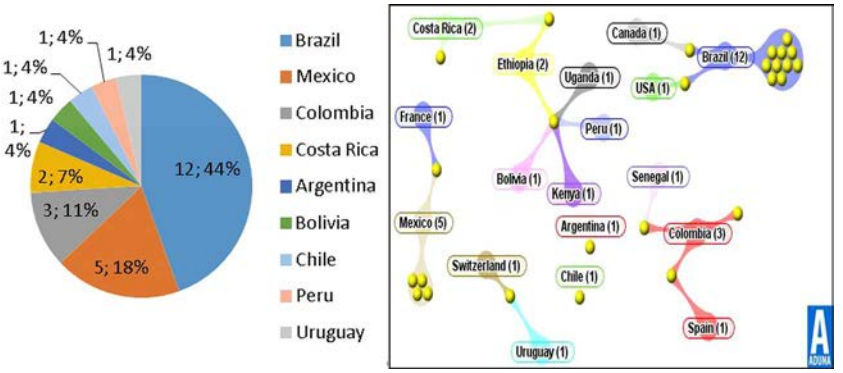

Figure 10. Main Latin American countries and their collaborations. *Source*: ISI Web of Science.

R+D investment outlays indicator for companies in Brazil ranking second, followed by Costa Rica, with Colombia in seventh place (Banco Interamericano de Desarrollo, 2010). The collaboration network (Figure 10) shows that the four main countries do not interrelate, although Brazil has co-authored papers with Canada and the United States; Mexico with France; Costa Rica with Ethiopia; and Colombia with Spain and Senegal.

There are three journals publishing more than one paper on this topic: *Revista de Saude Publica, Technovation* and *Agricultural Sistemas*. The first is backed by the University of São Paulo in Brazil, while the other two (*Technovation* and *Agricultural Sistemas*) rank among the most important in the innovation systems field in general.

Only four industries were studied in the Latin American literature on this topic: medical devices and materials; sugarcane; telecommunications; and forestry—the first three in Brazil and the last in Costa Rica. In fact, the first two are rated as science-based while the latter pair rank as supplier dominated, according to the taxonomy drawn up by Pavitt. The findings show similar behavior in terms of the general results of the main industries, with the difference that only 3.3% of the industries studied are located in these countries.

Main interactions between industry and other players in regional innovation systems

Out of 751 papers identified as addressing systems theory, 222 mention the regional innovation systems theory, while all of them refer to the role of industry in regional innovation systems. However, not all of them explore the reasons or purposes of relationships with other regional agents in any great depth. At least in the regional level, it has been shown that the relationship between industry and institutions of higher education and the government has been addressed in many papers (Table 5), which is due mainly to the progress in the triple helix theory that appeared during the 1990s.

Table 5. Relationships between industry and the other regional innovation system agents.

Type	Relation Players	Total	Latin America
1	Industry—Government	16	2
2	Industry—Development agencies	4	–
3	Industry—Banks	2	–
4	Industry—Venture capital firms	4	–
5	Industry—Higher education institutions	31	2
6	Industry—Scientific and/or technology parks	2	0
7	Industry—Research results transfer offices	4	–
8	Industry—Technological centers	2	–
9	Industry—Incubators	3	2
10	Industry—Knowledge intensive business services,	3	–
11	Inter-companies in the industry	6	–
12	Companies in different industries	6	–
13	Inter-companies in the industry	6	–
14	Industry—Research centers	8	–

Source: Prepared by the authors.

Fewer studies have been conducted of relationships between industrial companies and other players in innovation processes, as shown by the shortage of these works in Table 5. These players are development agencies, banks, risk capital firms, science and/or technology parks, research results transfer offices, technology centers, incubators, knowledge intensive business services research centers, and other companies in different industries.

As shown in Table 5, the results are somewhat insignificant for the number of articles submitted by authors affiliated to organizations in Latin America. It indicates that the industries that they study, or perhaps for which they draft policies, are wagering on interactions with the Government, Institutions of Higher Education, and incubators, leaving aside other organizations that intervene in innovation processes as facilitators or playing a more active role. This input comes from Brazilian universities, with no other country in the region participating. The institutions involved are the University of Campinas and the Rio de Janeiro State Engineering and Architecture Institute.

Conclusions

The gap mentioned by some authors has been pinpointed in the innovation systems literature, with few contributions to the study of relationships among innovation systems players and industry. This need is met through this article, grounded on a bibliometric study of published papers in one of the leading databases on this topic (ISI Web of Knowledge) between 2001 and 2014. It was apparent that exploring the relationship between industry and innovation systems is a topic that is expanding steadily worldwide, prompting a significant number of papers addressing the role of industry in innovation systems, examining in greater depth some of the specific relationships among the various agents in this field. However, these contributions are largely stand-alone, and no studies were identified that systematized the inputs from authors on this topic.

The authors of the papers come from many fields of knowledge in Asia, the Americas, Europe, and Oceania; the output of most of them is limited, with low collaboration rates, mainly through co-authorship. In contrast, the cooperative network among the many nations clearly shows large numbers of joint projects among them, with the United Kingdom and the United States as the main producers of these studies, focused mainly on analyzing the biotechnology industry, which is rated as knowledge-intensive due to its innovation processes, characterized by broad-ranging alliances between companies.

Of note, adaptations of the theory of innovation addressing studies of the industry included those in national innovation systems, regional innovation systems, technology systems, and sectoral innovation systems. For the first two—national and regional—it was apparent that the strongest and best-developed relationships of industrial companies reached out to universities and government entities.

In the Latin American countries, relationships between the industries and other agents has received little attention, compared with the global results of other studies, clearly reflected in the limited number of papers and authors, accounting for only 3.5% of all the database records found by the search equation. All the Latin American authors are small producers with little collaboration among them. A significant number of papers, authors, and organizations studying this topic was found in Brazil, but with no collaboration noted with other countries in the region. Only four industries were addressed by studies, three of them Brazilian, and two of which are rated as science-based. Moreover, the results show that this topic is still largely incipient in Latin America, except for Brazil, and that the countries in this region must encourage industry to participate in regional dynamic processes, thus generating endogenous capabilities that will endow them with a keener competitive edge and enhance the quality of life.

Due to the number of scattered studies with few links among them, it is recommended that a review of the literature be conducted to consolidate the characteristics of the interactions immersed in this web of players, explaining how they occur and the roles of the participants, bearing their different contributions in mind. Further, it is recommended that the study be replicated with local sources of information that might include other works not addressed by this research project because, despite the importance of the database used, inputs not included in its records were not encompassed by this survey.

References

Arias, C., Arenas, P., & Camacho, J. (2015). *La influencia científico-tecnológica de la industria del petróleo de Santander en sus sistema regional de innovación. Proyecto de investigación de maestría. Universidad Industrial de Santander, INNOTEC.* Colombia: Bucaramanga.

Asheim, B. T., & Isaksen, A. (2002). Regional innovation systems: the integration of local "sticky" and global "ubiquitous" knowledge. *Journal of Technology Transfer*, *27*, 77–86. doi:10.1023/A:1013100704794

Banco Interamericano de Desarrollo. (2010). *Banco Interamericano de Desarrollo*. Retrieved from http://idbdocs.iadb.org/wsdocs/getdocument.aspx?docnum=%2035691608

Bogliacino, F., & Pianta, M. (2010). Innovation and employment: a reinvestigation using revised pavitt classes. *Research Policy*, *39*(6), 799–809. doi:10.1016/j.respol.2010.02.017

Breschi, S., & Malerba, F. (1997). Sectoral innovation systems, techno-logical regimes, Schumpeterian dynamics and spatial boundaries. In C. Edquist (Ed.), *Systems of innovation: technologies, organizations and institutions* (pp. 130–156). London: Pinter.

Cadavid, L. C., Awad, G., & Franco, C. J. F. (2013). Análisis bibliométrico del campo modelado de difusión de innovaciones. *Estudios Gerenciales*, *28*(65), 213–236. Retrieved from http://proesa.org.co/revistas/index.php/estudios_gerenciales/article/view/1486\nhttp://proesa.org.co/revistas/index.php/estudios_gerenciales/article/download/1486/PDF

Carlsson, B., & Stankiewicz, R. (1991). On the nature, function and composition of technological systems. *Journal of Evolutionary Economics*, *1*, 93–118. doi:10.1007/BF01224915

Cooke, P., Uranga, M. G., & Etxebarría, G. (1997). Regional innovation systems: institutional and organizational dimensions. *Research Policy*, *26*, 475–491. doi:10.1016/S0048-7333(97)00025-5

D'Allura, G. M., Galvagno, M., & Li Destri, A. M. (2012). Regional innovation systems: a literature review. *Business Systems Review*, *1*(1), 139–156. doi:10.7350/BSR.A12.2012

Doloreux, D. (2004). Regional innovation systems in Canada: a comparative study. *Regional Studies*, *38*(5), 479–492. doi:10.1080/0143116042000229267

Durieux, V., & Gevenois, P. (2010). Bibliometric indicators: quality measurements of scientific publication. *Radiology*, *255*(2), 342–351. doi:10.1148/radiol.09090626

Elsevier. (n.d.). *Elsevier*. Retrieved from Research Policy: http://www.journals.elsevier.com/research-policy/

Freeman, C. (1987). *Technology policy and economic performance: lessons from Japan*. London: Frances Printer Publisher.

Garfield, E. (1995). Citation indexes for science: a new dimension in documentation through association of ideas. *Science*, *122*(3159), 108–111. doi:10.1126/science.122.3159.108

Gay, B., & Dousset, B. (2005). Innovation and network structural dynamics: study of the alliance network of a major sector of the biotechnology industry. *Research Policy*, *34*, 1457–1475. doi:10.1016/j.respol.2005.07.001

Gebauer, A., Nam, C. W., & Parsche, R. (2005). Regional technology policy and factors shaping local innovation networks in small German cities. *European Planning Studies*, *13*(5), 661–683. doi:10.1080/09654310500139301

Gonzalez, J., Moya, M., & Mateos, M. A. (1997). Indicadores bibliométricos: características y limitaciones en el análisis de la actividad científica. *Anales Españoles de Pediatria*, *47*, 235–244.

Kaufmann, A., & Tödtling, F. (2001). Science–industry interaction in the process of innovation: the importance of boundary-crossing between systems. *Research Policy*, *30*(5), 791–804. doi:10.1016/S0048-7333(00)00118-9

Kline, S. J. (1985, Julio- Agosto). Innovation is not a linear process. *Research Management*, *28*(4), 36–45.

Lundvall, B. (1992). *National systems of innovation. Towards a theory of innovation and interactive learning*. London: Pinter.

Martin, R. (2013). Comparing knowledge bases: on the organisation and geography of knowledge flows in the regional innovation system of Scania, Sweden. *European Urban and Regional Studies*, *20*(2), 170–187. doi:10.1177/0969776411427326

Méndez, R. (2006). La construcción de redes locales y los procesos de innovación como estrategias de desarrollo rural. *Revista Latinoamericana de Economía*, *37*(147), 217–240.

Mora, J., Martinez, H., & Camacho, J. (2014). *Redes inter-organizativas y su desempeño de innovación: una revisión sistemática de la literatura. Experiencias internacionalaes emergentes en gestión tecnologica y de la innovación para el desarrollo territorial* (pp. 1–15). Cartagena: Universidad Simón Bolivar.

Nelson, R. (1993). *National innovation systems: a comparative analysis*. New York: Oxford University Press.

Niosi, J. (2005). The evolution and performance of biotechnology regional systems of innovation. *Cambridge Journal of Economics*, *29*(3), 343–357. doi:10.1093/cje/bei044

Pavitt, K. (1984). Sectoral patterns of technical change: towards a taxonomy and a theory. *Research Policy*, *13*(6), 343–373. doi:10.1016/0048-7333(84)90018-0

Perruchas, F., Yegros, A., Castro, E., & Fernández De Lucio, I. (2005). La investigación sobre "Sistemas de innovación": radiografía realizada a través del análisis de las publicaciones científicas en bases de datos internacionales. *Revista Ciências Administrativas*, 11(1), 51–63. Retrieved from http://hp.unifor.br/pdfs_notitia/1378.pdf

Rothaermel, F. T., & Deeds, D. L. (2004, August). Exploration and exploitation alliances in biotechnology: a system of new product development. *Strategic Management Journal*, *25*, 201–221. doi:10.1002/smj.376

Spencer, J. W. (2003). Firms' knowledge-sharing strategies in the global innovation system: empirical evidence from the flat panel display industry. *Strategic Management Journal*, *24*(3), 217–233. doi:10.1002/smj.290

Stone, I. J., Benjamin, J. G., & Leahy, J. (2011). Applying innovation theory to Maine's logging industry. *Journal of Forestry*, 109(8), 462–469.

Uriona-Maldonado, M., Santos, R. N. M., & Varvakis, G. (2012). State of the art on the systems of innovation research: a bibliometrics study up to 2009. *Scientometrics*, *91*(3), 977–996. doi:10.1007/s11192-012-0653-5

World Economic Forum. (2015). *World economic forum*. Retrieved from http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2014-15.pdf