

Innovation, business innovation, and commercialization in Latin America:

A literature review based on bibliometric analysis

Track: Strategies for Global Competitiveness

Keywords: innovation, business innovation, commercialization, Latin America, bibliometric

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Abstract

This article presents a bibliometric analysis of research productivity in innovation, business innovation, and commercialization in Latin America. The analysis is performed by searching for bibliographic material in the Web of Science database from 1974 to 2018. The results are heterogeneous and support the development of a strong collaborative social network among authors, institutions, and funding agencies. The article develops a social network mapping of keywords leading to the most influential fields of research, and classifies them into four dominant clusters. A social network visualization of temporal concept progression shows the succession and evolution of topics for the 2011-2014 period.

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1. Introduction

Motivated by the main topic of BALAS 2019 Annual Conference: “Lighting the Future in Latin America in Times of Uncertainty: Fostering Innovation and Employability”. This article aims to investigate the research productivity in innovation, business innovation, and commercialization in the Latin America context through a bibliometric and social network analysis. Results of this analysis provides a clear view into who is leading research endeavours that have had significant influence over time. The analysis considers a wide range of issues including the most influential authors, institutions and countries, funding agencies, and subject matter research.

Innovation is getting a lot of attention from decision makers who recognize its connection to research & development (R&D) and its impact on regional and global economies (Merigo et al., 2016). It is evident that innovation, business innovation and commercialization play a major role in the development of Latin America countries. There is a need for practitioners, academicians, and authorities to collaboratively work towards the development and improvement of innovation programs in the Latin America context. Merigo et al. (2016) ranked the leading countries in innovation between 1989 and 1993 based on journals productivity. Their worldwide study ranked the first appearance of a Latin America country in 33rd place. An encouraging result was 22nd place for the first appearance of a Latin America country for period 1994-1998. However, the successive rankings were 22nd, 28th, and 31st, for periods 1999-2003, 2004-2008, and 2009-2013, respectively.

Developed countries understand the value of R&D to boost the development of their economies. Therefore, they support a broad infrastructure of research centres and people doing R&D, including innovation. The Latin America countries face giant challenges for developing a R&D infrastructure. Economic and political issues interfere with and slow the progress of R&D efforts. Furthermore, it is common for Latin America countries to lose their top researchers who may prefer to immigrate to developed countries to work in more competitive institutions (Merigo et al., 2016).

This paper is organized as follows. The next section provides a description of materials and methods. Results including basic statistics, leading authors, universities, countries, and leading agencies are presented in Section 3. The analysis of main topics and concepts is developed in Section 4. Finally, Section 5 concludes the study with conclusions and future research.

2. Materials and Method

This research uses Clarivate Analytics' Web of Science as its data source. The conference topic focuses on fostering innovation and employability in Latin America. Therefore, the following phrases were utilized to identify the research articles: "Latin America" AND "Innovation" OR "Business Innovation" AND "Commercialization". The search identified a total of 714 research articles across a span of 45 years. The first paper where the search phrases were identified is from 1974. The number of papers in the field has steadily increased since then.

There are numerous examples of innovation studies applying bibliometric analysis in literature reviews (Toivanen and Ponomariov, 2011; Albort-Morant et al. , 2017; Marzi et al., 2017; Chatterjee and Sahasranamam, 2018). What makes this paper unique is the topic of innovation, business innovation, and commercialization in the Latin America context.

Bibliometrics was originally a method for capturing text and information in academic journal citations and was introduced by Garfield in 1972 (Garfield, 1972; Narin et al., 1994). Modern bibliometrics uses automated methods and applications to explore, organize, and analyse large volumes of historical data that can be used in strategic decision-making processes (Bonilla et al., 2015). Information such as authors, affiliations, citations, patents, and publications are traced and aggregated to generate intelligence. Bibliometrics is a research field that studies bibliographic material quantitatively by analysing a research area and identifying its leading trends (Bonilla et al., 2015).

Bibliometrics can be employed in a wide range of contexts including the analysis of a research topic (Coupé 2003), journals (Cobo et al. 2015), institutions (Çakır et al. 2015), and countries (Bonilla et al., 2015). More recently, citation networks studies using social network analysis (SNA) have become popular, and provide an understanding of compelling dynamics such as collaboration among researchers and emerging knowledge trends within disciplines (Lee et al., 2014; Lampe and Hilgers, 2015; Emrouznejad and Marra, 2017).

Since 1988, social networks have been the subject of study in various research domains under the assumption that interpersonal ties and links among organizations or countries are relevant and impactful. Social analysts believe that each tie

transmits or transfers behaviour, attitudes, information, or goods. Social network analysis is a method of studying and analysing social relationships. Its primary goals are to monitor and interpret patterns of social connections among actors. It allows analysts to visualize how individuals in a group relate to each other and then determine the types of relationships that lead to effective group functioning (Stangor 2004). The defining feature of social network analysis is its focus on the structure of relationships, ranging from casual acquaintances to close bonds. Social network analysis assumes that relationships are important. It maps and measures formal and informal relationships to understand what facilitates or impedes the knowledge flows that bind interacting units (Serrat, 2017).

The units of measure in this study are individual articles indexed in the Web of Science. This includes published and print ahead articles only. Book reviews, comments to the editor, and similar articles are excluded from the analysis. The data was collected from October 22nd to October 26th, 2018.

The software platforms utilized were Bibliometrix (Aria and Cuccurullom 2017) and VOSviewer 1.6.5 (Van Eck and Waltman, 2009, 2010, 2011; Zhao and Strotmann, 2015; Appio et al., 2017). Bibliometrix is a tool for quantitative research in scientometrics and bibliometrics. It provides various routines for importing bibliographic data, performing bibliometric analysis and building data matrices for co-citation, coupling, scientific collaboration analysis and co-word analysis. VOSviewer enables the analysis of bibliometric networks. In this work it was used to study keyword networks for clustering analysis, taking into account all publication's keywords for the period studied.

There are a wide range of methodologies that can be employed when developing a bibliometric review. This study focuses on a general overview which presents a range of indicators such that each reader can reach his or her own understanding of the bibliometric data (Bonilla et al., 2015).

The use of these materials and methods forms a general picture of research topics in Latin America. The results illuminate influential authors, institutions, countries, funding agencies, keyword occurrence clusters, and temporal concept progression during the period studied.

3. Results

3.1 Basic statistics

The 714 articles have generated 32,180 cited references which correspond to an average of 731.36 citation per year and 45.07 cites per paper. Furthermore, the statistics show that teams of researchers have explored the topics of innovation, business innovation, and commercialization in Latin America. The average research team corresponds to 2.51 authors per paper and confirms an expected significance of social networks in the studied research (Table 1).

Total Number of Articles	714
Cited References (total)	32180
Citations per year	731.36
Cites/Paper	45.07
Author/paper	2.51

Table 1. Demography of annual articles documented in the Web of Science between 1974 and 2018.

3.2 Leading authors, universities, and countries

The top 25 leading authors, by number of documents published, are listed in Table 2. The top author is Albert N. Link who is professor of economics at the University of North Carolina at Greensboro. The second author is John T. Scott who is professor of economics at Dartmouth College and had collaborated with Albert N. Link. The collaborative work between Link and Scott highlights the importance of social research networks. These authors are an example of a strong social network relationship, which assumes that relationships are important to facilitate knowledge flows among researchers (Silva et al., 2018). After Link and Scott there are five authors with four publications each.

Rank	Author	<i>n</i>	% of 714
1	Link, A.N.	7	0.98
2	Scott, J.T.	5	0.70
3	Brooks, S.M.	4	0.56
4	Felzensztein, C.	4	0.56
5	Landini, F.	4	0.56
6	Sutz, J.	4	0.56
7	Urbano, D.	4	0.56
8	Aguilar, J.M.P.	3	0.42
9	Audretsch, D.B.	3	0.42
10	Ciravegna, L.	3	0.42
11	Hellin, J.	3	0.42
12	Natera, J.M.	3	0.42
13	Ogliastri, E.	3	0.42
14	Palma, A.P.	3	0.42
15	Perez, L.R.V.	3	0.42
16	Pietrobelli, C.	3	0.42
17	Aboal, D.	2	0.28
18	Alvarez, A.L.	2	0.28
19	Amoros, J.E.	2	0.28
20	Arcenas, A.	2	0.28
21	Arza, V.	2	0.28
22	Bennett, D.	2	0.28
23	Brenes, E.R.	2	0.28
24	Cabannes, Y.	2	0.28
25	Cancino, C.A.	2	0.28

Table 2. Leading publishing authors

Rank	University/Organization	n	% of 714
1	Consejo Nacional de Investigaciones Cientificas y Tecnicas Conicet	19	0.98
2	Universidade de Sao Paulo	18	0.70
3	University of London	18	0.56
4	University of California System	14	0.56
5	Universidad Nacional Autonoma de Mexico	13	0.56
6	The World Bank	12	0.56
7	Fundacao Oswaldo Cruz	11	0.56
8	University of North Carolina	11	0.42
9	University of The Republic Uruguay	11	0.42
10	Universidade Estadual de Campinas	10	0.42
11	State University System of Florida	9	0.42
12	Universidad Adolfo Ibanez	9	0.42
13	University of Buenos Aires	9	0.42
14	University of The Andes Colombia	9	0.42
15	Autonomous University of Barcelona	8	0.42
16	Harvard University	8	0.42
17	Universidad de Chile	8	0.28
18	University of North Carolina Greensboro	8	0.28
19	University of Sussex	8	0.28
20	Pan American Health Organization	7	0.28
21	Pontificia Universidad Catolica de Chile	7	0.28
22	Pontificia Universidad Catolica del Peru	7	0.28
23	Tecnologico de Monterrey	7	0.28
24	Columbia University	6	0.28
25	Incae Business School	6	0.28

Table 3. Leading published universities

Many institutions have a great deal of influence in the research stream. Usually, the leading institutions are those who employ the leading authors. Occasionally, some institutions benefit from associations with a wider range of leading authors, making them even more influential. Table 3 shows the leading published universities. The top two universities are from Latin America, and 14 out of the top 25 are Latin American institutions. Ten institutions are from English-speaking countries and three are European institutions. In this case, the university associated with the most influential author occupies the 18th rank. The gap in the number of publications between institutions is minimal.

Another interesting metric to consider is the classification of countries by numbers of publications during the study period. Figure 1a shows the publication productivity of countries in the research stream. The countries are ranked by total number of articles published. The most productive country is the United States of America with 209 publications. There is a significant gap with the next country, which is Brazil. After Brazil the productivity by country decreases. Figure 1a shows 20 countries of which nine are Latin American, eight are European, and one is Asian. The languages in Latin America are Spanish and Portuguese, eleven out of twenty top-producing countries are either Spanish or Portuguese speaking.

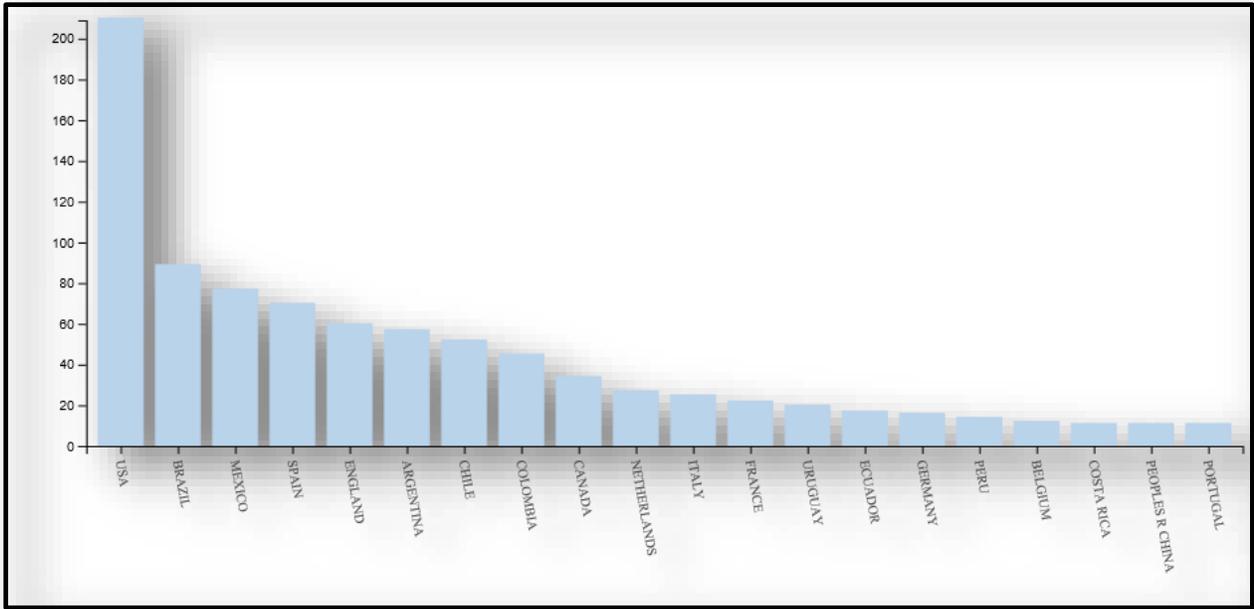


Figure 1a. Leading Web of Science publishing countries

Figure 1b shows the tree map from Figure 1a. The first column of countries (USA, Brazil, and Mexico) are American countries. The first two European countries arise in the second column of the map. It is interesting to observe at least one Latin American country in each column (vertical segment) of the map, which illustrates the heterogeneity of the research endeavors carried out in Latin American institutions.



Figure 1b. Leading Web of Science publishing countries between (Tree Map)

3.3 Leading funding agencies

Government have organizational units that promote and support cooperative research between universities and industry, stimulate international scientific and engineering efforts, and prompt educational activities at every academic level through various funding agencies. National funding agencies promote research and education in many fields. They facilitate this through grants, cooperative agreements with universities, formal and informal science organizations, and other research organizations throughout their countries. Additionally, they support graduate and postdoctoral fellowships. A grant is one of the avenues that government agencies use to promote ideas and projects that will provide public services and stimulate economic return. Grants provide significant support to critical recovery initiatives and innovative research.

Table 4 shows the leading funding agencies supporting published articles during the study period. Two out of the top four are European agencies. The second and the third are Brazilian and Colombian agencies respectively. There is significant heterogeneity among funding agencies and no truly dominant funding agency. The highest frequency is four and the number of articles is 714 which corresponds to 0.56%. In fact. The top 20 funding agencies have supported just 6.3% of the publications.

Rank	Funding Agencies	<i>n</i>	% of 714
1	Economic and Social Research Council	4	0.56
2	CNPQ	3	0.42
3	Colciencias	3	0.42
4	European Union	3	0.42
5	Bill and Melinda Gates Foundation	2	0.28
6	British Heart Foundation	2	0.28
7	Capes Science Without Borders	2	0.28
8	Economy Knowledge Department Catalan Government	2	0.28
9	EU	2	0.28
10	Inter American Development Bank	2	0.28
11	International Development Research Centre IDRC	2	0.28
12	Knight Center for Journalism in the Americas at The University Of Texas At Austin	2	0.28
13	NIDDK, NIH, HHS	2	0.28
14	Social Sciences and Humanities Research Council of Canada	2	0.28
15	Spanish Ministry Of Economy Competitiveness	2	0.28
16	Administrative Department of Science Technology and Innovation of Colombia Colciencias	1	0.14
17	AHRQ, HHS	1	0.14
18	Alcúe Net Project European Union Network on Research and Innovation	1	0.14
19	Alcúe Net Project Fp7 Funded Project Latin America Caribbean	1	0.14
20	Anderson Center for the Study Of Public Policy at Occidental College	1	0.14
21	ANPCYT of Argentina	1	0.14
22	Argentina National Agency of Science and Technological Research PICT	1	0.14
23	Arid Lands Resource Science PhD Program at The University Of Arizona	1	0.14
24	ARL, NS, CTA	1	0.14
25	Asociacion Latinoamericana de Facultades y Escuelas De Contaduria y Administracion ALAFEC	1	0.14

Table 4. Leading funding agencies supporting published articles in the Web of Science between 1974 and 2018.

The final years of the study period show a marked increase in the rate of research productivity, with fully half of all published papers having been written between 2015 and 2018. Figure 3 shows the overlay visualization of temporal concept progression from 2011 to 2014. The blue nodes could be identified as the source nodes, or the starting points of multiple paths directed to the yellow nodes which are sink nodes or ending nodes. In this light, research activity in the period 2011-2014 started with topics such as *firm*, *government*, and *state*. Then it passed through *market*, *world*, and *project*. *Data*, *university*, *work*, *science*, *Mexico* are topics that followed. The final concepts emphasized in the most recent research articles are *Brazil*, *practice*, *education*, *methodology*, *literature*, *topic*, *implication*, and *practical implication*. This figure describes the path of research topics for the period 2011-2014. It is very promising and compelling to see the evolution towards implications and practical implications of innovation that the most recent articles are focused on.

5. Conclusions

This study has presented a bibliometric review of innovation, business innovation, and commercialization in Latin America. The analysis was performed by searching for bibliographic material in the Web of Science database. It includes published articles and print ahead articles from 1974 to October 2018.

Several bibliometric indicators were considered throughout the analysis including the total number of published and print ahead articles, cited references, citations per year, cites per paper, cites per author, authors per paper. The overall results indicate that A.N. Link and J.T. Scott are the most prolific authors in terms of published papers. Consejo Nacional de Investigaciones Cientificas y Tecnicas (Conicet), University of London, and Universidade de Sao Paulo are the leading published universities for the 1974-2018 period, respectively. From these results, three countries show the most significant presence in the research stream: United States, Brazil, and Mexico. The Economic and Social Research Council, a European organization, is the leading funding agency that supported published researches in the research stream.

The article also develops a social network mapping of the most frequently used keywords leading to the most influential fields of research, and classified them into four dominant clusters. Furthermore, a social network visualization of temporal concept progression shows the succession and evolution of topics for the 2011-2014 period. The results suggest an alignment with implications and practical implications of innovation research.

The overall results support the importance of a strong collaborative social network among authors, institutions, and funding agencies. A contribution of this article is a synopsis of what has been done in innovation, business innovation, and commercialization in the Latin American context. Future research streams are suggested to further expand this knowledge. Some recommendations include the creation of a social network map for authors, a content analysis combined with bibliometrics which will enhance the study of knowledge creation, and a main path analysis of innovation.

Finally, this approach is useful in obtaining a general overview, with some limitations. First, the results can change overtime, as many new issues could appear which may condition the study in the future. Second, we follow the methodology utilized by the Web of Science for classifying bibliographic material, which has limitations that affect this study.

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