Journal of Scientometric Res. 2021; 10(1s): s1-s4
http://www.jscires.org

Editorial

Science, Technology and Innovation in Latin America

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DOI: 10.5530/jscires.10.1s.17

Since the middle 1960s, we have witnessed a strong and continuous growth of science, technology and innovation, as a result of the expansion of investment in both human resources and infrastructure for the sector. Nevertheless, in more recent years, the rate of this growth was affected by the financial global crisis of 2008. It is a fact that this troubled period did not strongly impact the world total R&D budget, but investments from high-income countries narrowed mostly. According to the UNESCO Science Report: Towards 2030,[1] in 2013 the world gross domestic expenditure on R&D (GERD) reached PPP$ 1,478 billion (PPP purchasing power parity – 2005), while in 2007, before the crisis, it reached PPP$ 1,132 billion. Such increase was higher than that observed for the global gross domestic product (GDP), but it was boosted by investments on R&D from upper middle-income economies, mainly China.

Past and current efforts towards the development of world R&D, however, have occurred in a context of great inequality, widening social and economic gaps not only between world regions but mainly between countries. A clear example of this scenario of inequality in science is the leadership of the "big five", that is USA, China, countries from European Union, Japan and Russia. As indicated in the UNESCO report, the group alone held 78.1% of all global investment in R&D in 2013. A similar unbalanced picture is also observed when the number of researchers is considered: the big five encompasses 72.2% of the 7.8 million researchers worldwide.

Among the continents, the report indicates a shift in the two top positions in the ranking of R&D investment: in 2007, Americas ranked number 1 with 37.1% and Asia ranked number 2 with 34%; in 2013, the two countries changed positions and Asia ranked as number 1 with 42.2. On the other side, Oceania and Africa keep on the last rank positions with respectively 1.4% and 1.3% of world investment in R&D in 2013. When looking at the distribution of researchers in 2013, Asia ranked number 1 with 42.3% and Europe ranked number 2 with 31%, while Africa and Oceania appeared again in the last positions with 1.6% and 2.4% respectively. Such gaps in investments and human resources reflect directly in the levels of scientific and technological competitiveness of the continents. As for the number of scientific publications, Europe shares 39.3% of world's publications in 2014, Americas 32.9%, Oceania 4.2% and Africa 2.6%. As for patents submitted to USPTO in 2013, Americas shares 50.2% of world's number of USPTO patents, Asia (and not Europe) displays the second highest share with 30.2%, while Africa and Oceania display the lowest, 0.1% and 0.8%, respectively.

The inequalities observed among continents reveal a division in the planet: producers of knowledge and technology on one side (north) and consumers on the other (south). This unbalanced picture led to the establishment of a collaborative model, known as North-South, where the South, that embraces consumers or peripheral countries, establishes strong links with the North, or central countries, in order to overcome its internal deficiencies in science, technology and innovation. The North-South partition is even more evident if the gaps among the Americas' sub regions are taken into account. Data included in UNESCO report, for 2013, indicate that Latin America, that is mostly located in the central and south part of the continent (the exception for Mexico), comprises the largest share of its population (58,8%), but a lower share of its R&D budget (10.5%), researchers (16.2%), publication (5.1%) and patents (0.3%)

More recently, a RYCIT report, intitled El estado de la ciencia:[2] main indicators of Ibero-American, illustrate the participation of Latin America for 2017. Despite the financial crisis in 2008, according to this report, the investments in science, technology increased almost 40% from 2008 to 2015, but since then, it has been reduced. In 2017, it represented 3.1% of all global investment while European countries invested 22.8%. As for human resource, the region has 3.7% of the world's researchers, almost ten times less that Europe that has 30%.

It is worth mentioning the region's internal inequalities in all sectors, including R&D, in which Brazil, Mexico and Argentina, in most of the times, display the best input and output indicators. As for human resources, according to UNESCO report (2019), the Latin American "big three" have the highest number of researchers: 138,653 for Brazil (refers to 2010), 51,685 for Argentina (2013) and 43,592 for Mexico (2012). But when considering the number of researchers in terms of the whole labor force, Argentina presents the highest rate, while Brazil is the third and Mexico the fifth. For R&D budget, the three countries have the highest GERD in the region: Brazil with 1.15 (refers to 2012), Argentina 0.60 (2013) and Mexico 0.53 (2014). Finally, for scientific publications in 2014, Brazil is again the top-ranked country with 37,228 publications, followed by Mexico with 11,147 and Argentine with 7,885. With such a great performance, the "big three" are responsible for the largest proportion of Latin American scientific publications, mainly devoted to the field of biological and medical sciences, mainly financed by public funds and with a low share of foreign co-authors, what may point to a high level of independence from outside. The UNESCO report also list the "big three" among the countries with the lowest average citation rate in the region, suggesting a low level of visibility of the new knowledge produced by these countries. Nevertheless, when considering the *h* index, Brazil, Mexico and Argentina are the countries with the highest indices.

It is true that the "big three" concentrate most of the R&D efforts in the region and, apparently, they also promote internal inequalities. But Latin America is diverse in all sectors, including S&T, which brings together a rich plurality of institutions and personnel, who, in many cases and at different times in recent history, live in conditions of political and economic instability. So, a better understanding of the region's capabilities should consider these peculiarities in each country. Evidently that internal inequalities are of concern and the region has been looking for strategies to reduce them and, at the same time, also to reduce north-south inequalities, since these have a straight relationship with the power and well-being of nations.

In fact, for some decades, Latin American countries have been discussing strategies to overcome social and economic inequalities, which are also expressed in R&D. One of the first official meetings to discuss it took place in Santiago, Chile, in 1967, and according to Sabato and Botana,[3] the most important proposal of meeting "is that one of the decisive factors that can lead to the realization of a new type of world order in the year 2000 is the willingness of Latin American nations to achieve full participation as active subjects in the social, political and cultural development of the world of the future". For the authors, the S&T shift must go through a change "from the passive role of spectator to an active role of protagonist, trying to achieve the maximum participation".

More than fifty years after Santiago's meeting and without a real change in the world order, the countries from the region are still in search of consolidating and institutionalizing the S&T sector. One of the structuring actions is the creation of a central administrative unit that coordinates and formulates policies for the sector. In some countries this unit is organized as a Ministry of Science and Technology, as it is the case of Brazil and Argentina. Other types of organizations include National Councils (Chile, Ecuador, Mexico and Peru), National Secretaries (Panama), Administrative Departments (Colombia).

We have also seen the launch of some regional strategies to stimulate and to strength the linkage between Latin American countries. One example is UNASUR (the Union of South American Nations) that was established in 2011 with 12 members as an attempt to expand, more specifically, the South American integration, which already had, at that time, two regional customs unions, the Southern Common Market (Mercosur) and the Andean Community (CAN). Among UNASUR's structure, the COSUCTI (the South American Council of Science, Technology and Innovation) was responsible for fostering scientific co-operation in the region. Unfortunately, for political reasons, since 2018, most of the country members have left UNASUR.

The combination of a macro strategy like UNASUR with local strategies and policies led to the expansion of Latin American S&T system as a whole. One local strategy proposed by Brazil that afterwards was introduced in Argentina, Mexico and Uruguay is the sectorial funding model, which the main idea is to levy taxes from companies of specific sectors (for instance, oil, energy, tobacco, communication among others) to support R&D in the respective sectors or fields. This vertical type of funding promoted a complete change in the model of S&T financing in these countries, since it reduced the dependence of these countries on public resources and allowed, in theory, a better planning for the sector.

Despite last and recent efforts, Latin America's S&T picture still indicates a strong linkage with countries from the north. It is surprising that some experts and also some governs point out to the need to strengthen the collaborative projects already established with central countries as a way to enlarge the training for and visibility of the region's scientific and technology activities within global science. On the other hand, others draw attention that to the need for Latin American governments to seek for more internal strategies, such as the expansion of South-South relations, that may lead to a greater local and regional development as well as to a reduction of

the region's level of scientific and technological dependency and to the establishment of a common agenda focused on the peculiarities and demands of the region, especially in health sciences.

In fact, the North-South collaboration model may be considered a paradox, that is, it is at the same time a strategy for reaching S&T development and an indicative of dependence or less autonomy in S&T. Some authors go further: they sustain that such imbalanced picture is also perceived in the process of international division of scientific work. Pablo Kreimer,[4] for instance, an sociologist specialist in sociology of knowledge, science and technology, describes this collaboration model, also known as center-periphery model, as an integrative but subordinate relationship, where researchers from peripheral countries are assigned to activities with high technical and specialized content, while those from the central countries assume the technical, cognitive and conceptual definition of the studies. The social anthropologist Argentinean, Hebe Vessuri,[5] one of the most experts in Latin America S&T, states that the way scientific activity was institutionalized in the region, that is, under a structured basis of subordinate international connections, led to the adoption of an international agenda and the indefinite postponement of scientific attention to local issues. This process made it difficult to establish local agendas for S&T, an indispensable condition for reaching scientific and social development of the region.

Although the North-South collaboration model is very well documented, the recent history shows that countries from the south may objectively assume the role of knowledge producers, in other Sabato and Botana's words,[3] they turned to be active subjects, protagonists. An example is the global public health crisis of Zika that has reinforced the strategic character of the global system of science, technology and innovation in the production of quick and joint responses. In this context, Latin American countries, especially Brazil, played an important role as a producer of knowledge. According to Araujo *et al*.[6] Brazil was the number two in the world ranking of number of publications about the disease, behind only the USA. In addition, Brazilian researchers were also responsible for several discoveries on the disease infection and control, including the relationship between microcephaly and congenital Zika virus infection (DE ARAUJO *et al*.[7] and the possibility of transmission of the virus by the mosquito culex.[8]

Similarly, during the COVID-19 pandemic, Latin American competences also flourished, changing the producer-consumer model and highlighting the scientific competence of the region's institutions and researchers. Such contribution is evidenced in the article by Espinosa *et al*. that sought to map and characterize the contribution of Latin American and Caribbean countries in the research on Covid-19. The authors identified a total of 1,291 scientific publications from January 1 to July 31, 2020, being Brazil (43.9%), Mexico (9.14%) and Colombia (7.98%) the most productive countries. Considering only the original articles (n = 236), Brazil (40.7%), Mexico (12.2%) and Colombia (5.5%) are still the leaders. Belli *et al*.[9] have map the 15 top institution and countries in the research on Covid-19 over time, but also in 2019-2020. They found a diverse list of countries, including many peripheral countries, as Brazil, the only Latin American country listed. Among the main findings, we highlight the percentage of international collaboration within Brazilian publication (31.8%) that was considerably lower than that observed for center countries, such as USA (41.4%), Germany (63.9%), United Kingdom (64.7%) and (64.8%).

These examples illustrate the Latin American human and institutional capabilities to respond quickly to emerging problems as well as to assume as a main actor in the process of producing new knowledge and be recognized as an indispensable player. Hence, taking into account the relevance and strong potential of Latin America within global science, technology and innovation, we present this special issue of the Journal of Scientometric Research, which sought to welcome studies with a focus on Latin American S&T. In a first call, we received 32 abstracts, a significant number of proposals. After evaluation by the two guest editors, twelve manuscripts were selected to continue the process of publication flow. At the end, ten manuscripts were accepted and are now included in this special issue.

This special edition encompasses the contribution of Latin American researchers, with a strong participation of authors from Brazil and Uruguay, but also authors from Mexico, Colombia and Ecuador. In addition to local participation, this special issue has also contributions of authors from countries outside the region, such as the Netherlands, UK and Spain, with and without collaboration with Latin American authors.

Regarding the five main subjects indicated in the first call for this special issue, they are all covered by the ten articles, as following. In the subject 1 - ST&I indicators, there are two manuscripts one in the field of health sciences and another one in an emerging theme, named *Cancer Research in Latin America, 2014-2019, and its disease burden* and *Global trends, local threads. The thematic orientation of renewable energy research in Mexico and Argentina between 1992 and 2016*. In the subject 2 – ST&I policies, there is one conceptual manuscript about ST&I policy in different Latin America and Iberian countries and second one about three territorial innovation model, including one from a Latin American author, named: *Contesting the Mainstream Narrative? A Conceptual Discussion on the Politics of Science, Technology, and Innovation from the Periphery* and *Analysing the differences in the scientific diffusion and policy impact of analogous theoretical approaches: evidence for territorial*

innovation models. In the subject 3 – Scientific collaboration, there are two manuscripts devoted to investigate collaboration in articles or patents named *Patent Collaboration Networks in Latin America: extra-regional orientation and core-periphery structure* and *Transformations in the Ecuadorian scientific landscape: a bibliometric analysis of the main publication trends and the role of the scientific networks and the public international scholarship program*. This subject also includes a manuscript about mobility of Mexican researchers, named National Systema of Researchers of Mexico in their academic training in Latin America. In the subject 4 – Open access, Consolidation of local or regional databases, Multilingualism, among other topics, there are two manuscripts, both using data extracted from local sources, named: *The relationship between the language of scientific publication and its impact in the field of public and collective health* and *Health research networks based on national CV platforms in Brazil and Uruguay*.[10] Finally, in the subject 5 - Alternative indicators, there is one comprehensive manuscript about the Latin American research on altmetric, named: *Ten years of Altmetrics: a review of Latin America contributions*.

We understand that the set of manuscripts selected for this special issue helps to better understand some dimensions of Latin American scientific production as well as offering theoretical and methodological perspectives of great relevance for strengthening the fields of Bibliometric and Scientometric in the region.

We wish you all a great reading!

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