CHAPTER
13

Indicators for the assessment of excellence in developing countries

Rodolfo Barrere

Introduction

The accurate measurement of a certain phenomenon needs a concrete definition of its key characteristics and its boundaries. Measuring research excellence is therefore a major challenge because it can be defined in several ways, depending on the perspective and context. Generally, to be 'excellent' is to be superior in the achievement of a certain goal. In that sense, identifying excellence is to determine who has a better performance than others. The first step to tackle that challenge is to achieve a consensus on the goal. The second one is to find tangible expressions that can lead to its measurement. Another issue concerns the very concept of 'quality' related to excellence. The definition of quality, the criteria that express it and the indicators that would make it measurable are a theoretical problem, to which the solution is not simple. It is evident that there is no consensus about the content of the concepts of 'quality' or 'excellence' applied to research. How is quality translated into a variable that can be measured on a scale? (Albornoz and Osorio 2018).

In one way or another, scientific performance indicators are related to a concept of quality and can therefore be used to identify,

categorise and 'measure' it. However, since quality is such an ambiguous concept, we usually work with indicators that describe the object of study without adjectives and, in this way, relate their characteristics – without ignoring their differences and particularities. In this sense, since indicators produce values or scores that can help quantify something that is difficult to measure, they contribute to the project of comparing diverse analysis objects, offering a 'translation' between a complex object and others, constructed in a theoretical framework in which its measurement produces a relevant meaning for the understanding of that object (Pérez Rasetti 2010).

The assessment of research excellence in low- and medium-income 'developing' countries has to be contextual. It can be seen in terms of quality, but also in terms of pertinence. For instance, while bibliometrics are a useful standard for knowledge production, they do not inform about other activities related to science and technology that can have a clearer impact on social needs. For example, scientific services (e.g. environmental monitoring, medical laboratory activities or engineering advisory) are not covered in commonly available indicators and so are not considered by policy-makers and funding agencies at the moment of evaluating groups or institutions. Also, the experience of a research group in knowledge transfer to social groups or to the business sector is commonly out of the scope. In order to move towards the proposal of a concrete set of tools, it is possible to define two separate fields where research excellence can be measured: one inside the scientific community and one outside the scientific community.

This chapter includes three main sections. The first section describes developments in Latin America to tackle specific characteristics of research and development (R&D) performance assessments. The second section discusses the use of traditional bibliometric indicators and bibliometric databases for the measurement of research excellence within the scientific community. Limitations of the most common international data sources are analysed and proposals for fostering journals in these countries are put forward. Finally, a set of indicators for the measurement of the engagement of researchers with society will be presented as an alternative for measuring research excellence outside the scientific community.

Background

Latin American countries show very different characteristics in terms of various items, ranging from their socio-economic indicators to the degree of consolidation of their science and technology (S&T) systems, as well as the maturity of their statistical systems. A wide gradient of situations exists within the region, including countries with features similar to those of the developed world and countries with very few R&D activities and an almost complete lack of statistical information. These diversities have been reflected within the sphere of the Ibero-American Network of Science and Technology Indicators (RICYT), which has worked as a discussion forum for S&T indicators since 1995.

Latin America is a heterogeneous region: two countries have a 'very high' score on the Human Development Index, while a third of the region is in the 'medium' group. The differences are also evident in R&D capacities. Only three countries (Brazil, Mexico and Argentina) are responsible for 92% of the regional R&D expenditure. Brazil expends 1.2% of its GDP on R&D, while many of the countries spend less than 0.15%. Some countries feature developed institutional systems and a complex set of policy instruments, while others have very incipient structures (RICYT 2017a). Science and technology systems in this context are also very heterogeneous, as are the demands from their societies. It is therefore a challenge to find a single definition of research excellence, as their goals and potential are very different. Governments are the main source of funds for R&D in developing countries, with the belief that it fosters social and economic development, but – even though we have the experience and methodologies to measure inputs and outputs of research activities – we still are unable to tackle the measurement of the social impact of science.

When RICYT was created, the availability of S&T information in Latin America revealed a problematic situation: most of the countries lacked reliable and comparable information. The initial feature of the network was to bring together two heterogeneous sets of actors: on the one hand, national S&T agencies, which are simultaneously producers and users of information and, on the other hand, researchers devoted to studying the relationships between science, technology and society,

as well as experts in indicators. This duality conditioned both the focus and the agenda: it was a matter of generating indicators for policies and exploring new dimensions.

Producing indicators in Latin America is a task that involves not only transposing the methodological norms applied in developed countries, but also generating discussions in order to achieve consensus about which should be the more adequate indicators according to the intrinsic features of Latin American countries, without leaving aside international comparability. This involved two parallel tasks in the early years of RICYT. On the one hand, the OECD's methodological manuals were disseminated, with the aim of promoting international comparison. On the other hand, a discussion was generated around which necessary adjustments should be made to the manuals, in accordance with the idiosyncrasy of the region's countries. The debates referring to the more adequate methodological definitions for constructing input indicators, as well as the discussions on innovation studies, are clear examples of this situation. Nowadays, RICYT has developed a wide and active network that discusses methodologies and produces statistical information as inputs for decision-making and evaluation. That experience, in the diverse context of Latin American countries, is a good basis for the development of new tools for the assessment of research excellence in developing countries.

Excellence inside the scientific community: Bibliometrics

The use of quantitative indicators of research performance, especially those derived from bibliometric methodology, has become increasingly common for the evaluation of the scientific productivity of institutions and researchers, even in developing countries. The expansion of access and the facilitation of the use of these analytical tools and resources have generated a qualitative change in evaluation mechanisms. The possibility of, to a certain extent, automating evaluation through the use of bibliometric indicators is a temptation for those responsible for this activity, both because of its lower cost and easy management and to avoid overloading the researchers themselves.

Bibliometric indicators of knowledge production and utilisation processes – either research publications (publication output measures) or the citing of publications (citation impact measures) – are useful to measure the quality of research within the scientific community because the system of peer review (the assessment of colleagues themselves) guarantees its functioning. The scientific publication system, in addition to functioning as a reservoir of knowledge, is a prestigious distribution mechanism. In this sense, researchers seek to make their work known as widely as possible, using for that the most widely read (and cited) journals. The phrase 'publish or perish' is an adequate reflection of this phenomenon. In this context, prestige is an attribute that gets its meaning with regard to the work of colleagues; the peers in charge of the review will not recommend the publication of works that do not meet a minimum of quality and relevance.

This dual accountability mechanism ('publish or perish' and peer review) guarantees that the statistical analysis of scientific publications takes place in the context of the production of knowledge in an environment validated by the scientific community itself. The introduction of these assessment techniques, however, generates uncertainties about their influence on the behaviour of researchers (Hansson 2010), for example, on how researchers establish their research priorities and whether the choice of their line of work is conditioned more by the agenda of the high-impact factor of journals, rather than the relevance of the topic (at either the institutional or local level). In that sense, the most debatable issue is not the application of bibliometric techniques in developing countries, but the representativeness of the bibliographic databases on which those techniques are applied.

A common objection against the use of bibliometric indicators is related to a supposed weakness of international bibliographic databases with regard to their representation of scientific production in developing countries. The most common databases used in bibliometric analysis, such as the Web of Science (WOS) and SCOPUS, are multidisciplinary databases that are meant to be sufficiently representative of the mainstream of international science. The scientific, scholarly and technical journals indexed in those databases publish

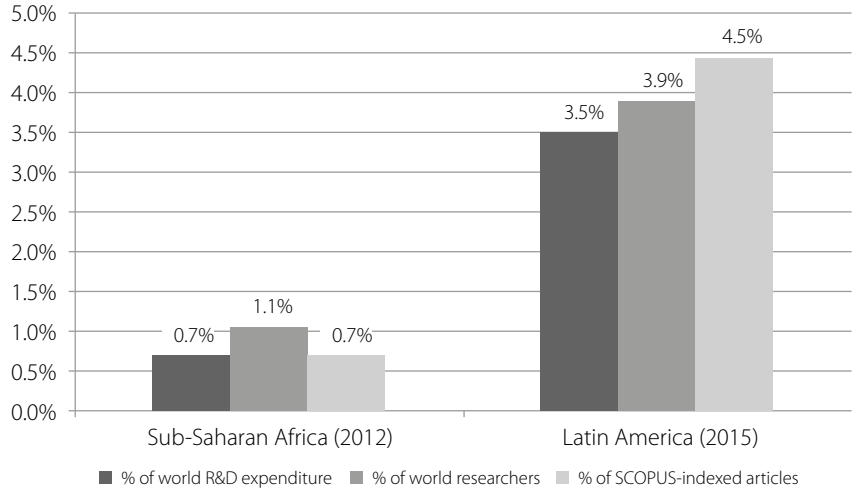
research on a range of subjects of interest at the international level and often include applications of common scientific techniques.

Nevertheless, a comparison between bibliometric indicators and statistical information generated by international organisations on the basis of national surveys of R&D activities shows a remarkable convergence. Sub-Saharan Africa (SSA) is responsible for 0.7% of global expenditure on R&D and has 1.1% of the researchers (see Figure 1). At the same time, 0.7% of the total articles indexed in SCOPUS are from SSA. In Latin America, the total expenditure on R&D represents 3.5% of global expenditure and the region has 3.9% of the world's researchers. Representation on SCOPUS is 4.5%. The comparison using WOS produces an equivalent outcome.

In this context, developing countries' contributions to mainstream science seem not to be under-represented. Nonetheless, the issues covered in indexed journals may not be the most important for developing countries. In that sense, there is a lack of robust bibliometric sources for a broader coverage of the scientific production of developing countries. There are no bibliographical bases capable of covering the entire scientific production of a country, which affects the possibility of using these sources for evaluation. This implies that the topics that interest the mainstream will be represented, while others will almost never appear. This phenomenon strongly affects developing countries, whose research topics, in some disciplines more than others, may diverge from those studied in leading countries.

The option of accessing regional bibliographic databases with a greater coverage of developing countries would allow a better representation of local research. Some Latin American initiatives aim to remedy this situation, such as the medical science database LILACS, developed by BIREME, and the CLASE and PERIODICA databases from Mexico's UNAM. SCIELO and REDALYC initiatives also offer encouraging prospects. However, there is still a long way to go. The statistical information available based on these regional initiatives still shows inconsistencies with the remaining available indicators, such as investment and human resources in R&D. Some countries are still over-represented, and others are under-represented in these regional data sources.

Figure 1: Percentage of global R&D expenditure, researchers and SCOPUS indexed articles



Sources: RICYT, UIS-UNESCO and World Bank (2014)

In conclusion, bibliometrics is a good methodology for measuring excellence within the scientific community, drawing on the need among researchers to publish and offering the quality assurance system through a strict peer review of submitted manuscripts. However, this assessment mechanism is only possible if journals meet the strict standards of editorial quality. In that sense, scientific journals which comply with editorial quality are valuable tools for the management and evaluation of S&T systems in developing countries. High-quality scientific journals help bring communities together and define agendas. However, most developing countries lack consolidated public policies for the support of fostering scientific journals. In Latin America, the few countries that have carried forward this type of policy, such as Brazil and Chile, are also the countries that have grown the most in their contribution to international science as measured in international bibliographic databases.

Beyond these general considerations, bibliometric indicators have broader limitations in measuring scientific production. Bibliometrics

can only address the scientific aspect, while other activities and aspects, notably those of a technological, educational and social nature, must be studied by other indicators and information sources (Bordons 2001).

Excellence outside the scientific community: Engagement indicators

During the last decades there has been a growing demand from many governments – both in high-income 'developed' countries and other 'developing' countries – for academia to play a more active role in supporting economic growth and development. Universities, for example, are seen as key actors in their societies, because of their role in teaching, research and extension activities. These organisational missions have become part of the normative model of the 'modern university' in Latin American countries, but variations in the historical development of this model have produced different types of universities, each with their own specific profile, and operating in very diverse regional contexts.

Latin American public policies aimed at boosting economic growth, social development and increasing the efficiency of public management have placed the focus on innovation. This is underpinned by the understanding that innovation is the result of a synergistic engagement and action involving several organisational actors – including universities and other public research centres – to transfer knowledge, skills and other capacities to society. Universities are seen as key players in innovation systems.

The experience of RICYT with its Bogotá Manual, which is focused on innovation, shows that a typology of Latin American firms is different from that of European firms and the industrialised world in general. Likewise, available indicators highlight that the role of universities in the production of knowledge is central in Latin American countries, in comparison with other regions, in which the impulse of the business sector predominates. For example, in Latin America, 75% of the total researchers are based in universities, compared to only 39% in the European Union. Regarding universities' share in

SCOPUS-indexed research articles, in Brazil, Chile and Colombia, for instance, this is near 90%, while in European countries it is usually less than 70% (OEI 2018).

The high percentages of poverty in Latin American countries also present a picture of social demands; this challenges academia in a different way than in countries with a higher degree of development. In this context, many Latin American countries and governments have implemented policies to encourage collaboration between academia and the business sector, as well as initiatives to finance scientific infrastructures, with the purpose of contributing to the transfer of research results to the whole society. To monitor and manage this process, there is a need to design, develop and implement a system of indicators capable of reflecting a wide range of interactions through which academia relate to their socio-economic environment. Following this requirement, RICYT sought to provide an answer. From its beginnings, in 1995, RICYT had in the foreground the challenge of measuring the social impact of science and technology. In these discussions, the link between academia and the socio-economic environment has repeatedly appeared as one of the mechanisms through which this impact is made effective. The *Ibero-American Manual of Engagement Indicators of the University with the Socioeconomic Environment* – the Valencia Manual (RICYT 2017b) arose as a result of a long process of reflection that sought to respond to a demand for accurate and comparable information regarding the influence of the universities on the socio-economic environment. The initiative was driven by the Ibero-American Observatory of Science, Technology and Society (OCTS) of the Organization of Ibero-American States (OEI) and RICYT, with the support of Centro REDES in Argentina and INGENIO (CSIC-UPV) in Spain.

Opting for the university as an observation point and unit of analysis is related to the above-mentioned role of these institutions in the various research systems in Latin American countries. The proposal also includes the possibility of observing engagement patterns at the level of the academic groups at the base of the university organisational pyramid; that is, the possibility of analysing the behaviours of

academics in terms of their links with external actors and detecting non-institutionalised linkages.

To define the scope of the Manual, 'engagement activities' are understood to be those related to the following:

- The generation of knowledge and the development of capacities in collaboration with non-academic agents and the elaboration of legal and cultural frameworks that guide the opening of universities towards their environment; and
- The use, application and exploitation of knowledge and other capacities existing in the university outside the academic environment, as well as training, sales of services, advice and consultancy, carried out by the universities in their environment.

The indicators proposed in the manual are, in general, quantitative measures, although in some cases qualitative descriptions are used to facilitate the interpretation of the development of the engagement activities within the environment of each institution.

The set of proposed indicators is grouped into three categories:

- *Institutional characterisation:* these indicators refer to aspects indirectly related to the engagement activities that facilitate and condition their existence and development in the institution (such as the history of the institution, its size and its profile of academic specialisation), which are relevant in characterising the institutional context and appropriately contextualising the activities of engagement;
- *Indicators based on the capacities for the engagement activities:* the engagement activities of each institution are based to a large extent on the use of the available capacities. These indicators account for the stock of knowledge, as well as the capacities associated with the physical and organisational infrastructure of each institution. Some examples are intellectual property rights, infrastructure marketing and spin-offs and start-up creations; and
- *Indicators based on the engagement activities themselves:* although knowledge of the characteristics of the institutional organisation

and of the available capacities is central to understanding the link between the university and the environment, the intensity with which these activities take place in the institution is observed directly in the range of engagement activities carried out. This group of indicators is meant to capture the effective realisation of these activities, and the results obtained from them. Examples include the number of contracts in collaboration with different sectors, capacity-building activities developed, extension activities and the social communication of knowledge.

In principle, information that leads to a global characterisation of the institution is requested. This includes the interaction with the environment carried out by its different academic units, which reveals institutional patterns in terms of the type of activity, financing methods, resources generated and socio-economic sectors with which it is linked. Having specific information and dedicated indicators on such university–society interactions is of fundamental importance, on the one hand, in order to provide academic institutions with instruments to measure their own engagement activities and, on the other hand, to provide governments with instruments that allow them to design public policies and define the strategic allocation of associated resources that accompany them. Also important is the use of information by different economic and social actors to guide their strategies for finding links with universities and academic groups. It is also necessary that such indicator systems take into account the specificity of the social and productive landscape of developing countries and the characteristics of their universities and public research centres. The decentralised nature of university engagement activities within the socio-economic environment poses a significant challenge to the collection of information. The need to have an adequate information system on these activities is thus a fundamental step for the development of a system of indicators that is broad enough to cover the greatest number of aspects related to the link between the university and the environment in the specific context of each institution.

A pilot study was carried out in six universities in five Latin American countries. Although it was exploratory work which had

the objective of perfecting the methodology, the results offer some interesting clues about the links in the universities of the local region, which should be deepened in later studies (Estébanez 2016). Findings indicate that both the execution and the management of the engagement activities take place in multiple institutional spaces within these universities. Each case shows different patterns in terms of the efforts made in the engagement activities, with varying degrees of importance in relation to other activities, such as R&D.

The most standardised management modality of engagement activities is the contract. In this regard, very diverse activities are carried out, some involving the generation of new knowledge and others that are routine services. There are contracts for research, training of human resources, technological development and technology licensing.

In addition to producing a preliminary diagnosis of engagement activities in regional universities, the application of the pilot study yielded a series of conclusions regarding the methodological strategies to be implemented in future surveys, and associated possibilities and limitations in data collection. The development of engagement indicators will be of great interest to better understanding relationships between universities and wider society. One of the main methodological and analytical challenges was the difficulty in capturing linkages at the research group level; such activities are usually very rich, but often not registered at higher levels within the university. Next year's OCTS is planning to apply a massive regional online survey that targets academic authors in order to gather this 'micro-level' information in a comparative way.

General conclusions

In the context of S&T systems management, and for the allocation of resources, research excellence cannot be defined in a single way. This complex concept depends on desired results and impacts. However, it is possible to define different domains of application where excellence can be defined and measured, each domain with its own logic and quantitative aspects. As was discussed previously, one possibility

is to separate excellence measurements inside and outside the scientific community.

Looking at research excellence from the perspective of the scientific community, bibliometric indicators have proved to be valuable analytical tools with consolidated methodologies that nowadays have permeated research activity itself. The available information sources and international databases are sufficiently accurate to measure the contribution of developing countries to mainstream science, but additional databases are needed, or need to be developed, for a broader measurement of knowledge production that also captures local and regional dimensions. To make that possible, it is also necessary to develop a strong scientific journal system, which includes more local and regional journals, compliant with high-quality editorial standards. This is a public policy vacancy in most developing countries.

Measures of research excellence should also include university–society engagements; this is where significant impacts of R&D investments are to be expected. That is an important challenge, as links have very different forms and are not always recognised in the institutions. The Valencia Manual methodology is an interesting collective experience to tackle that challenge.

These different dimensions of measuring excellence, and many others that can be defined, are by no means mutually exclusive. They offer complementary approaches that provide a broader landscape in which the results and evaluation of research activities can be viewed. The ideal research project is one that can show excellence in many dimensions, depending on the goals established by funders, donors or policy-makers.

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Statistical sources

Ibero-American Network on Science and Technology Indicators (RICYT): http://www.ricyt.org
UNESCO Institute for Statistics (UIS-UNESCO): http://uis.unesco.org/