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Overcoming the divide in SSTI: a mixed method and multi-level analysis of internationalisation in South American biomedical research

Rodrigo Liscovsky Barrera*

* rliscovs@ed.ac.uk / rodrigo.liscovsky@gmail.com

The Institute for the Study of Science, Technology and Innovation (ISSTI), The University of Edinburgh, Old Surgeon's Hall, High School Yards, Edinburgh (UK)

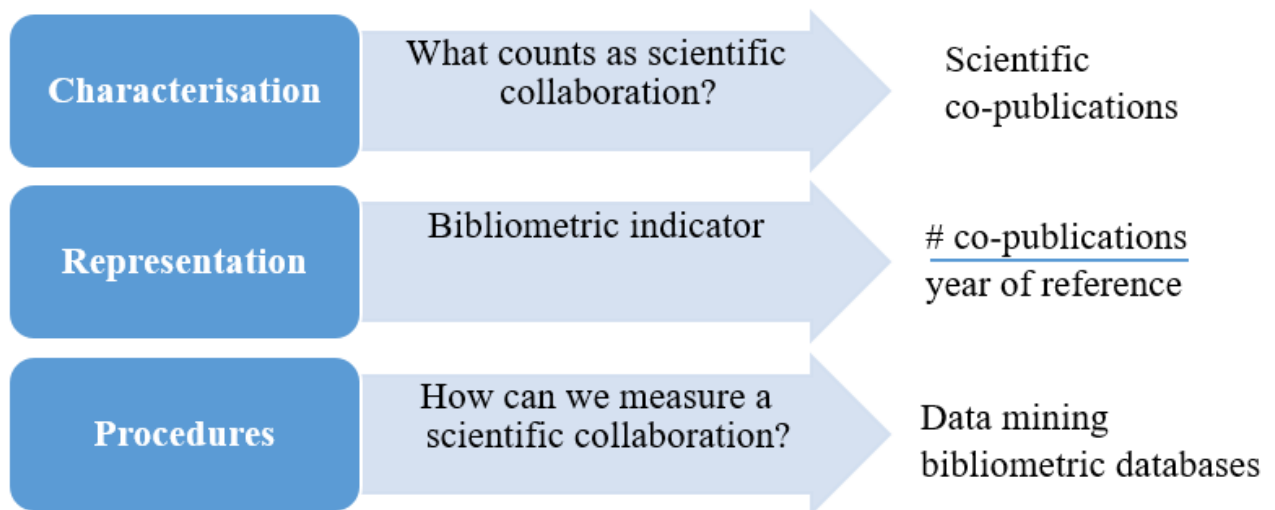
Introduction

In socially distributed models of knowledge production (Mode 2), internationalisation plays a major role in the production of scientific knowledge (Gibbons *et al.*, 1994). Although there exist profound disputes over the historical and conceptual accurateness of this model (Etzkowitz and Leydesdorff, 2000; Pestre, 2003), the increasing intensity and heterogeneity of international collaboration, a key component of internationalisation strategies, is a major point of agreement among scholars. Disagreement, however, still revolves around the methods that can be used to study internationalisation dynamics; whether they should be based on qualitative or quantitative techniques. The recent debate on the responsible use of scientometrics in research evaluation, I argue, could help shed some light into the use of scientometrics in the social study of science, technology and innovation (SSTI). More specifically, by arguing in favour of developing a multi-level analysis and a mixed method approach, I show how the study of international scientific collaboration offers an ideal setting where both qualitative and quantitative traditions can start a dialogue. This requires, nevertheless, understanding first the ontological and epistemological basis of scientometric indicators and the implications of its use in the social study of science.

What is a scientometric indicator?

At the most basic level, scientometric indicators are quantitative representations of certain scientific and technological activities (Barrere, 2010). As a measurement instrument, every indicator performs a function of *representation* which follows the *characterisation* of the concept one is trying to approach. Characterising a concept implies defining its characteristics or dimensions whereas the *procedures* (the last step) refers to the methods we employ to measure whatever it is we are trying to measure (Cartwright and Runhardt, 2015).

Figure 1. Measurement process in bibliometrics



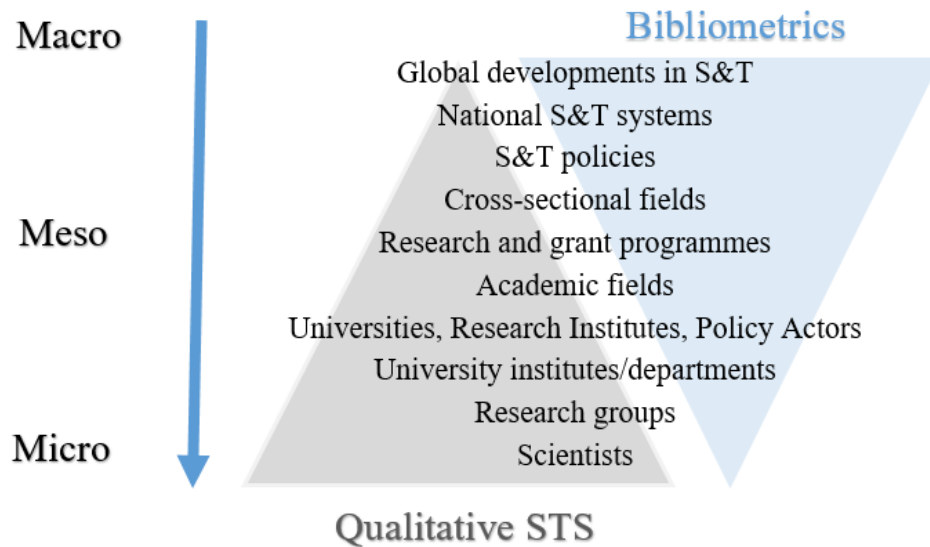
As it well-known, in the field of information, scientometric indicators are regarded as a vehicle for the efficient allocation of resources which makes them one of the most utilized tools in research management and evaluation (Clark, 1985). For van Raan (2004), a scientometric indicator must explicitly address some assumption, have a specific goal in mind and be problem driven. But most importantly, an indicator should be able to test aspects of theories and models of scientific development and its interaction with society. Consequently, indicators are not simply evaluation tools but also instruments in the study of science (Ibid).

Epistemic division in SSTI: implications for the study of scientific collaboration

This last statement is not without problems. Within SSTI, a scientometric indicator means two radically different things depending on the intellectual tradition one adopts: it can be an instrument to “discover the world” or, conversely, a barrier to answer fundamental epistemological questions. Each of these traditions relies on different assumptions, units and levels of analysis. First, a Mertonian or Institutional Sociology of Science which focused on structural phenomena such as the stratification of science and the development of specialities using quantitative methods mainly coming from scientometrics and bibliometrics. Second, the qualitative epistemology of SSTI, finds its origins in the constructivist tradition of the 1970s that emerged as a response to the normative perspective of the Mertonian Sociology of Science. The Bath School, the Strong Programme and later the post-structuralist movements are key examples of this tradition.

Figure 2. The epistemic divide in SSTI¹

¹ Adapted from Hinze and Glänzel, 2017.



The literature on the sociology of indicators further offers some insights into the ontological and epistemological foundations of scientometrics. In describing the process of designing scientometric indicators, scholars often highlight the role of the user-producer tandem (Gault, 2011; Reale et al, 2012). While the academic community can provide the conceptual basis for developing indicators, based on representations of the reality that come from theory and empirical control, in most cases it is standard practice to start without a theoretical framework (Holt, 1978). In this sense, the tasks of characterization and representation are guided by a reductionist approach which assumes that reality exists out there waiting to be discovered. It is quite common, for instance, to hear that collaboration and the international dimension are intrinsic components of science which have long existed. The role of indicators is to make them visible.

For the qualitative tradition, however, the main limitation of scientometrics and quantitative techniques is that they do not help us to answer fundamental epistemological questions, such as: *what do researchers understand by international collaboration?* or, *how and why researchers decide to collaborate across borders?* In this sense, qualitative research is capable of producing detailed narratives of collaborations, groups and institutions that provide a theoretical guide of great value for researchers. However, qualitative methods are unable to develop a systematic assessment of theories and dynamics of collaboration beyond the scope of a case study.

Each tradition has its strengths and limitations and the challenge is to understand how a dialogue between these two traditions can be developed within SSTI.

Responsible use of scientometrics

In his study of scientific collaboration, Shrum (2007) proposes to develop an inter-language between quantitative and qualitative traditions in order to construct a sort of ‘hybrid tradition’ in SSTI. This solution, however, fails to recognise the ontological opposition between these two epistemic worlds and, as a result, it does not establish a distinction between micro and macro levels of analysis. Recent contributions to the discussion about the responsible use of scientometrics in research evaluation, nevertheless, could help inform prospects for developing mixed methods approaches in SSTI.

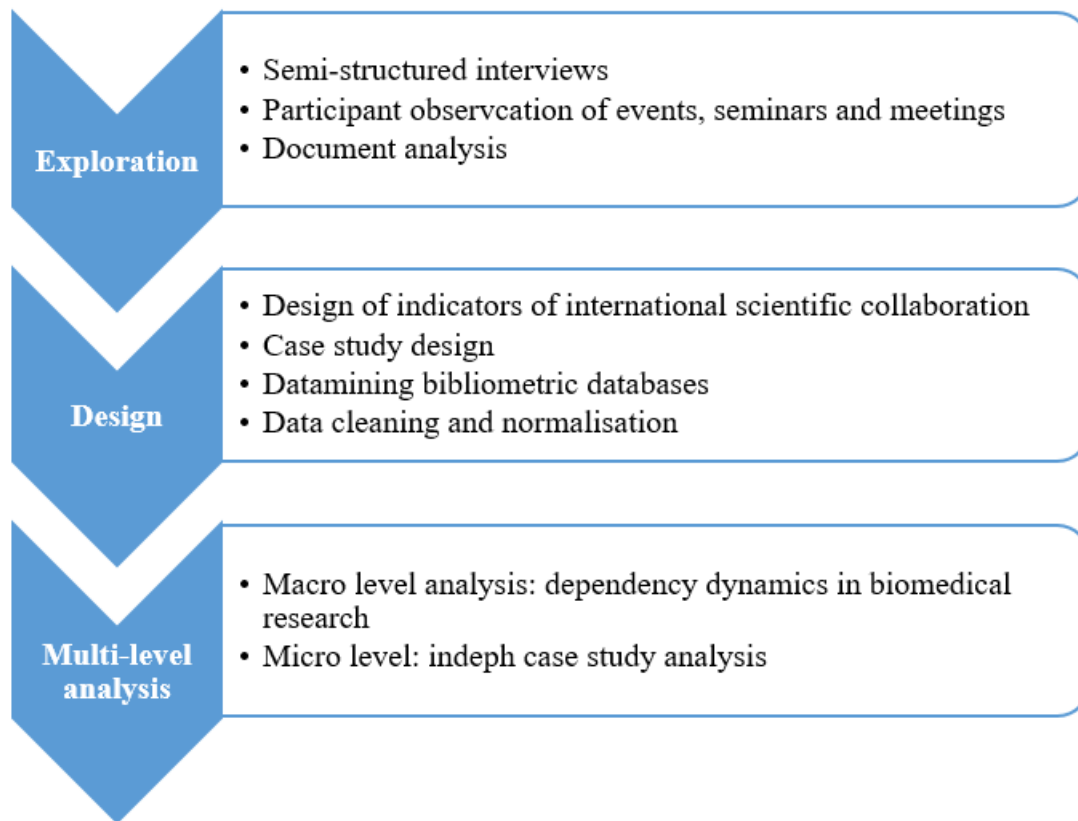
As noted before, in scientometrics indicators ‘define the world’ but the validity of such representation depends on the level of analysis the evaluation is being conducted. Waltman (2018) argues that at the macro level, indicators should guide the evaluation while at the micro level there exist particularities which require a combination of quantitative and qualitative methods. At the macro level, experts view the world through indicators, thus they not only support the evaluation but they make it possible. In other words, they define the phenomenon. Furthermore, according to Leydesdorff (2018), in order to improve research evaluations, experts should be informed not only by the level of analysis but they should also be ‘theoretically informed’ which requires opening the black box of the system under study. This constitutes a key step forward in the ontological and epistemological bases of scientometrics which should be applied in SSTI so that indicators perform their role described by van Raan (2004), that is: becoming effective research tools for the social study of science.

A proposal to overcome the divide: a mixed methods and multi-level study of internationalisation in South American biomedical research

This research project aims to understand contemporary dynamics of international collaboration in biomedical research in South America. The project is structured in three phases. In the first exploratory phase, I make use of a combination of qualitative methods to understand how international collaborations for knowledge production are initiated, organised and how researchers in this field understand such processes. In the second phase, I rely on the results from the first phase to inform the tasks of characterisation, representation and the procedures to study contemporary dynamics of international scientific collaboration. In the third and final phase, I conduct a multi-level analysis.

At a macro level, I seek to test theories of international collaboration based on bibliometrics and social network analysis techniques. At a micro level, I also rely on these techniques to analyse specific cases in more detail in combination with findings derived from qualitative research. The main aim is not to develop an inter-language between the two epistemic traditions as suggested by Shrum (2007), but to ‘let each method speak for itself’ which implies acknowledging their constitutive ontologies and considering how procedures vary depending on the level of analysis one is conducting.

Figure 3: Project’s phases



Some of the preliminary findings from the first phase include:

- The strategic meaning of international collaboration for South American researchers: researchers resort to international collaboration to avoid local restrictions which increase the costs of research (both financially and time).
- International mobility plays a key role in the training of researchers and facilitates the establishment of collaboration networks upon their return.
- Well-established authorship norms: being listed as “correspondence author” is associated with the ownership of research line. Middle positions are left for more technical or marginal contributions.
- In biomedicine, alternative animal models such as zebrafish, are becoming increasingly popular among South American laboratories given its low cost of maintenance as compared with traditional experimental models such as rats or mice.
- The use of this model in the region has been possible given the international mobility of pioneering researchers who established regional networks upon their return to promote its use and encourage collaborations.

As a result, a multi-level analysis of the dynamics of internationalisation in biomedicine is conducted:

At the macro level the aim is to study the dynamics of international collaboration of South American biomedical researchers. I seek to test theories of scientific internationalisation referred to dependency dynamics in knowledge production (Kreimer, 2006; 2013; 2015) by looking at percentage of South American researchers listed as correspondence and last authors in internationally co-authored papers. This allows observing the distribution and origin of research lines in international collaborative research. Moreover, based on social network

techniques, I examine the position of South American laboratories in the global research network, their evolution and their centrality.

At a more micro level, I focus on a group of researchers using zebrafish as an alternative animal models. A priori this animal is thought to increase the autonomy of local laboratories to conduct research (and thus reduce their dependency with the ‘outside world’) as they are less cost-intensive when compared with other models. Based on semi-structured interviews and document analysis, I seek to understand how the choice for this model has shaped researcher’s perceptions of collaboration. In addition, based on a bibliometric and social network analysis, I intend to map the international mobility of these researchers (as registered throughout their publishing careers) to study the formation of resource-based collaborations (Van Rijnsoever et al., 2008) (e.g.: who they collaborate with and whether they occupy middle or corresponding author positions). I also analyse differences between local, regional and international collaborations as well as with other traditional animal models in biomedical research.

Figure 4. Sample of a social network of collaboration in scientific publications in biomedicine (macro level)

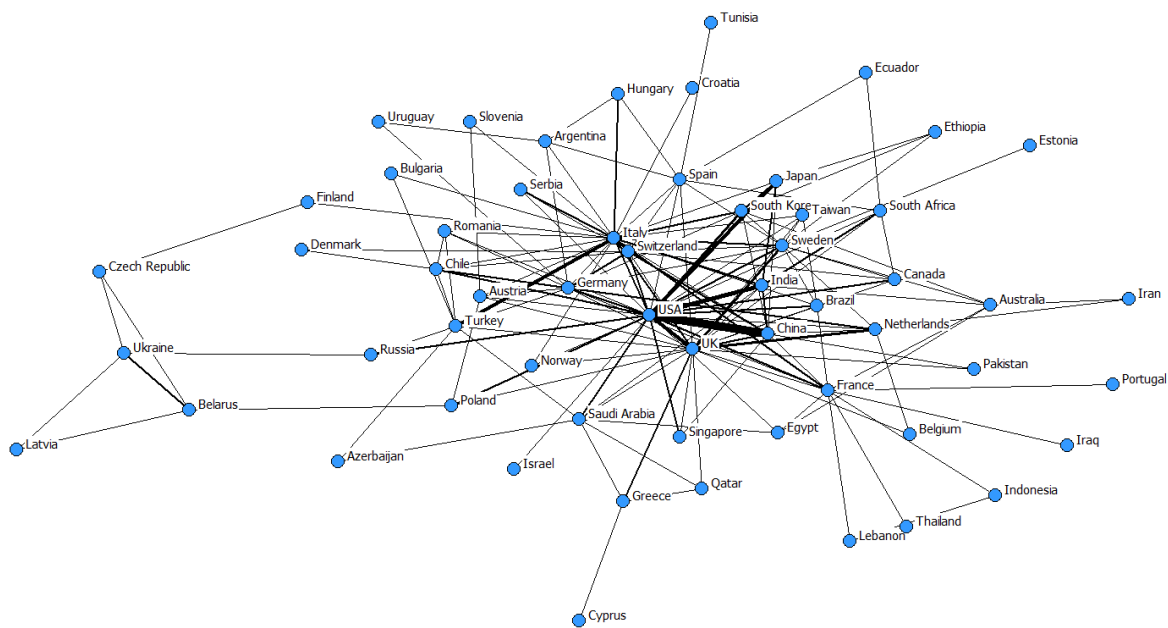
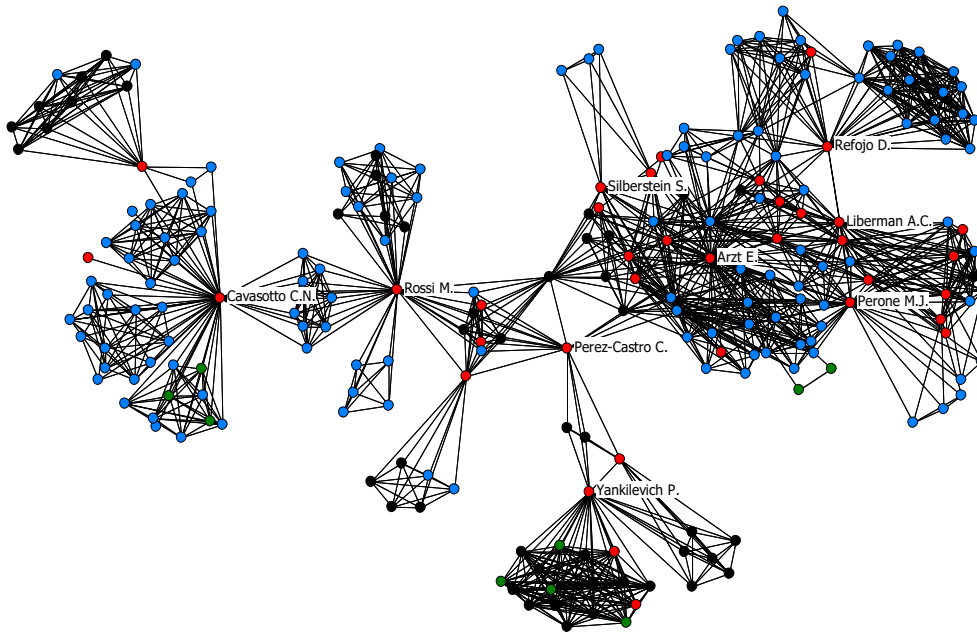


Figure 5. Sample of social network of collaboration in scientific publications of a group of Argentine researchers working in biomedicine (micro level)



Impact:

This project currently is undergoing its second phase of research. It nevertheless seeks to contribute to theoretical discussions on scientific internationalisation, a relative novel topic in SSTI. Methodologically, this project seeks to respond to recent calls in SSTI to combine scientometrics with traditional qualitative methods. It will deliver new understandings about the scope of interactions between these two epistemic traditions which have not been explored in detail. As such, this project is viewed as an empirical setting where a discussion about the responsible use of scientometrics in SSTI can start to take place.

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