Journal of Informetrics 12 (2018) 249–258

Contents lists available at ScienceDirect

Journal of Informetrics

journal homepage: www.elsevier.com/locate/joi

Who benefits from a country's scientific research?

Giovanni Abramo[a,*], Ciriaco Andrea D'Angelo[b]

[a] Laboratory for Studies in Research Evaluation, Institute for System Analysis and Computer Science (IASI-CNR), National Research Council of Italy, Via dei Taurini 19, 00185 Rome, Italy

[b] Department of Engineering and Management, University of Rome "Tor Vergata" and Laboratory for Studies in Research Evaluation, Institute for System Analysis and Computer Science (IASI-CNR), Via del Politecnico 1, 00133 Rome, Italy

ARTICLE INFO

Article history:
Received 7 July 2017
Received in revised form 9 January 2018
Accepted 9 January 2018

Keywords:
Knowledge flows
Comparative advantage
Specialization index
Bibliometrics

ABSTRACT

When a publication is cited it generates a benefit. Through the country affiliations of the citing authors, it is possible to work upwards, tracing the countries that benefit from results produced in a national research system. In this work we take the knowledge flow from Italy as an example. We develop a methodology for examination of how the knowledge flows vary across fields, in each beneficiary country. We also measure the field comparative advantage of countries in benefiting from Italian research. The results from this method can inform bilateral research collaboration policies.

1. Introduction

The essence of scientific activity is information processing. Scientists talk to one another, read each other's papers, and most important, they publish scientific papers. The science system consumes, transforms, produces, and exchanges "information". The aim is to produce new knowledge. Knowledge has several peculiar features compared to other goods. Knowledge is intangible, as its essence is information. It is cumulative, which means that the present global stock and level of knowledge is the direct result of scientific advancements achieved by past generations. Knowledge does not wear out physically, and can be used unlimited times without diminishing its substance: it is "infinitely expansible without loss of its intrinsic qualities, so that it can be possessed and used jointly by as many as care to do so" (David & Foray, 1995). The available stock of knowledge serves as the basis for creating new knowledge and allows for the regeneration of the existing stock, through combinations in new applications and products (Griliches, 1990). Because knowledge accumulates continuously, existing knowledge becomes obsolete and the stock must be maintained regularly.

In the current knowledge-based economy, the ability of national science systems to keep abreast and produce new scientific and technological advances is of paramount importance for sustaining domestic industrial competitiveness and socio-economic development. Access to new knowledge takes place via the channels that the scientists use to offer and disseminate it. Because the scientists' principal goal is to produce new knowledge and diffuse it, they typically encode it in publications. New knowledge spreads internationally through scientific and technical literature, seminars and conferences, and personal communication between researchers. In addition to publications, the literature recognizes social networks (Sorenson & Singh, 2007), research collaboration (Onyancha & Maluleka, 2011) and mobility of skilled persons (Kyvik & Larsen, 1997; Trippl, 2013) as important modes of knowledge transfer. The ever-growing scale and rate of dissemi-

* Corresponding author.
E-mail address: dangelo@dii.uniroma2.it (G. Abramo).

https://doi.org/10.1016/j.joi.2018.01.003
1751-1577/

nation beyond national boundaries stems from the ease of knowledge transmission. Owing to the rapid development of ICT, particularly the Internet, global knowledge flows have become faster, cheaper and easier than ever before.

In this work, we investigate the geographical flows of knowledge,[1] particularly from the perspective of a single country. The question we wish to answer is epitomized in the title: who benefits from a country's scientific research? While the transnational exchange of goods can be measured by the underlying monetary transactions (balance of payments), as also for the exchange of technologies ("technology balance of payments"), a problem arises when it comes to measuring knowledge flows, which do not entail commercial transactions. In this case, bibliometrics can help to overcome the problem. From the author affiliations of a publication, one can easily identify the country/countries that produced the new knowledge, and in the case of a citing publication, the country/countries that benefited from it.

To the best of our knowledge, there are very few studies on the geographic flows of "public" knowledge produced by countries. Moreover, they are very limited in scope. Rabkin, Eisemon, Lafitte-Houssat, and McLean Rathgeber (1979) explored world visibility for four departments (botany, zoology, mathematics, and physics) of the universities of Nairobi (Kenya) and Ibadan (Nigeria), measured by citations in the Science Citation Index (SCI) for the years 1963–1977. They assessed the distribution of the author-country citing publications among five macro-regions (OECD, Eastern Europe, Africa, Latin America, and Asia), with specific attention to Great Britain, given its historic relations with Kenya and Nigeria. Their findings suggested high rates of domestic visibility for scientists in the two universities, mainly in botany and zoology, which are evidently locally oriented disciplines. However, not just for these two specific disciplines, the expectation was that in general, the main recipients of new knowledge produced by a country would be domestic scholars themselves. In fact the social links between the researchers of an individual country are on average stronger than those between researchers of different countries (Bozeman & Corley, 2004), as is confirmed by observations that rates of collaboration are higher domestically than internationally (Abramo, D'Angelo, & Murgia, 2013). At the level of the single field, Stegmann and Grohmann (2001) measured knowledge "export" and international visibility, through analysis of publication and citation data for the thirty journals listed in the Dermatology & Venereal Diseases category of the 1996 CD-ROM Journal Citation Reports (JCR) and in seven dermatology journals not listed in the 1996 JCR. Finally, Hassan and Haddawy (2013) mapped knowledge flows from the United States to other countries in the field of Energy over the years 1996–2009.

In this work, we extend the scope of previous studies, investigating the domestic and transnational flows of scientific knowledge produced in Italy, how these vary across fields, and the sectoral specialization of the countries benefiting from Italian research. The same methodology could also be applied for other countries.[2] (For the record, as of 2016, Italy ranked sixth in the world by number of publications and for number of citations.)[3]

In the next section we present the data and method of analysis. Section 3 provides the results from the elaborations. Section 4 closes the work with our considerations on the relevance of the study and its possible future developments.

2. Data and method

To answer the questions of who benefits from a country's scientific research, and whether differences occur across fields, we need to measure the flows of knowledge produced in the country. To this purpose, we adopt a bibliometric approach. All limitations and assumptions typical of bibliometric analyses then apply. Furthermore, from a geographical perspective, we define a publication as "made in" a source country if at least 50% of the institutions authoring it belong to that country.[4] When a publication is cited, it is conventionally understood that it has had an impact on scientific advancement because other scholars have drawn on it, more or less heavily, for the further advancement of science. We can then say that it has given rise to a "benefit". The number of "benefits" deriving from a publication equals the number of citations, and if the citing publication is co-authored by one or more foreign countries, the benefit has crossed an international boundary. In the case of a citing publication by multi-country authors, the same benefit (citation) is "gained" contemporaneously by n different countries, so we can say that it has given rise to n equal "gains", one for each country. Operationally, we assign a gain to each country listed in the affiliation list of the citing publication: thus, if a citing publication has three authors, two with Italy affiliations and one with France, the gains are equally assigned to both countries, independently of the number of authors in each. In theory, the total number of gains generated by a publication could be as many as the total countries in the world. A publication could be cited by m publications. In this case, the publication would give rise to m benefits and m x n gains. The geographical reach of a publication is measured by the total number of countries n that cite it (which is lower than or equal to m x n). Of course, i) the larger a country in terms of number of researchers; ii) the more productive; and iii) the more scientifically advanced in terms of domestic stock and level of accumulated knowledge, the higher the chances that it can gather benefits from new knowledge produced elsewhere.

[1] The knowledge investigated is that encoded in publications, intentionally made available by the authors. We do not investigate flows of proprietary knowledge, such as that encoded in patents, utility models and similar, which is examined in a vast literature.

[2] We plan to extend the analysis to other countries in the future. The reason why we started with Italy is that, apart from being our own country, we have Italian citing-cited publication data readily available through a license agreement with Clarivate Analytics.

[3] Latest data available from http://www.scimagojr.com/countryrank.php?year=2016&order=ci&ord=desc, last accessed 9 January 2017.

[4] It could be more correct to consider the number of authors rather than institutions, but developing appropriate algorithms would be much more complex. Alternative conventions, such as the affiliation of the corresponding author,or first and last authors in non-alphabetically ordered bylines, could be adopted as well.