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Book Reviews

The challenge of scientometrics. The development, measurement, and self-organization of scientific communications

Loet Leydesdorff

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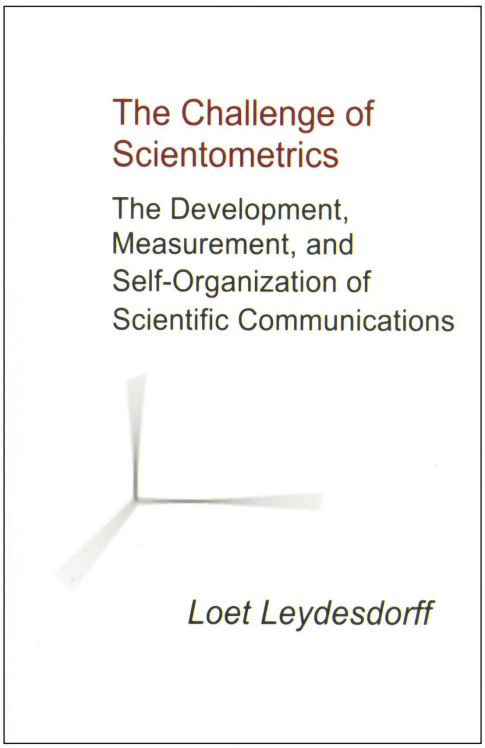
Published for the first time in 1995 by DSWO Press at the University of Leiden in Holland, this book is a second edition which, according to the author himself, is not substantially different from the first edition. Basically, some typographical errors were corrected and a new section was added to chapter 10, based on a study published after the first edition came out. The book has been translated into Japanese and Chinese, which is some kind of indication of the international influence of the author's thinking.

Loet Leydesdorff is a professor in the Communication Studies Department at the University of Amsterdam (Amsterdam School of Communications Research – ASCoR – www.pscw.uval.nl/ascor/). He is a chemist by training with Master's degrees in Chemistry and Philosophy and a PhD in Sociology. It was at the beginning of the 1970s, while still a postgraduate student in biochemistry, that he began to develop an interest in the relationship between science and society. This happened as a result of his joining one of the innovative experiences developed by Dutch universities at the time, called "science shops". These organizations emerged independently when small groups of professors and interested students decided to conduct and coordinate studies and summarize and publish the results of research on social and technological issues in response to questions and concerns raised by community groups, public interest organizations, local governments and workers (for more details of the science shops, see www.loka.org/pubs/chron.htm). In the process,



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Leydesdorff began to lean towards the social studies of science (science studies) and he went on to be one of the founders, in the 1980s, of the influential postgraduate teaching and research program in Science Dynamics at the University of Amsterdam. For reasons which it is not relevant to mention here, this unit ended up disappearing in its original incarnation, but not before the main exponents of science and technology studies, who still work on the issue today in Holland, had passed through it: Stuart Blume, Arie Rip, Rob Hagendijk, Nelly Oudshoorn, Olga Amsterdanska and, obviously, Loet Leydesdorff.

Since he began his research activities and reflections in the area of science and technology studies, Leydesdorff has published extensively in the areas of scientometrics, communication theory, philosophy of science, sociology of innovation and social network analysis (for a detailed list of his publications, see www.leydesdorff.net/list.htm). As he himself recognizes, and his list of publications indicates, during his career he has worked with numerous collaborators from the disciplines of philosophy, history and the sociology of science, including John Law, Michel Callon, Susan Cozzens and Henry Etzkowitz. But even though his work includes varied conceptual and methodological references from philosophy, history and the sociology of science, Leydesdorff calls himself a "scientometrician" (p.vii). And it was precisely in recognition of his important contribution to scientometrics that he received the Derek John de Solla Price Memorial Medal in 2003 from the editorial and consultative board of the *Scientometrics* journal.

However, Leydesdorff is not a pure scientometrician, defined as someone who analyzes science only as a relationship between inputs and outputs which respectively enter and exit a black box, where not much is known about what happens. On the contrary, Leydesdorff has a complex and systemic view of knowledge production and the focus of his research program is precisely to produce empirical evidence for his argument that "scientific developments are amenable to measurement", despite what sociologists of science from the relativist/constructivist branch say (p.3).

The argument and the focus of Leydesdorff's research program, so well exemplified in the work under consideration here, pose a massive challenge. Why? The main reason is that in this book, Leydesdorff seeks to identify the conceptual bases of scientometrics with the modern vision of the knowledge production dynamic. In other words, the author argues that the theoretical and conceptual assumptions of scientometrics are compatible with, or at least do not conflict with, the current – relativist and constructivist – trends in thinking about science.

In my opinion, it is exactly this association of scientometrics with the constructivist branch of science studies which constitutes the main challenge of the book. This is because the underlying epistemology of scientometrics is radically different from that subscribed to by participants in the programs which are aligned with the new sociology of science (the strong program, the Bath school and the laboratory studies, to mention only the most well-known). Within science studies, scientometrics really is the arena which fell heir to the quantitative dimension of Merton's work, and as a result, is today "responsible" for the ongoing support for the theoretical and epistemological presuppositions of this tradition – even though many of those who make use of scientometric techniques are not very much aware of their submission to the Mertonian paradigm.

What are these Mertonian presuppositions which are present in the conceptual base of scientometrics and how are they different from the premises and epistemology of the new sociology of science?

First of all, scientometrics, like the social system of science defined by Merton, sees science as an input-output process. Certain resources – in this case, human and financial resources, equipment, laboratories, libraries and buildings – are fed into a "black box" and certain products emerge from the box as outputs. The new sociology of science, in turn, considers this way of viewing science to be very simplistic, and believes that it ignores the most interesting and crucial part of the problem: the processes which happen inside the black box and which transform inputs into outputs.

Scientometrics also takes its definition of the goal of science from the Mertonian tradition, in other words, the production of certified scientific knowledge. Also embedded in this vision is the idea of the autonomy and neutrality of science, concepts closely linked to the Mertonian paradigm in the sociology of science, as well as the idea that the researcher who goes in pursuit of other goals (for example, contributing to the resolution of practical problems) is not really practising science. All of these ideas are strongly refuted by the new sociology of science.

In line with the premise above, scientometrics assumes, like Merton, that the scientific product and its quality are entirely reflected in the formal written instruments of scientific communication, particularly in articles published in scientific journals. From the point of view of scientometricians, scientists are rewarded for the original contributions they make to the progress of scientific knowledge through the esteem and recognition they receive from their peers. This recognition includes the various eponymic practices, the awarding of honorary prizes and the number of citations of the work published by the various researchers in the scientific literature. Merton suggests that the adequate recognition of a discovery is a necessary condition for maintaining "communalism", since without recognition scientists would not have incentives to publish and science would not be maintained as an institutionalized and universal public activity. And it is exactly this universality of scientific publication as a means of communicating new research results that enables scientific analysts to evaluate science without necessarily having recourse to scientists – it is enough to analyze what they published, where they published it and who they referred to.

The new sociologists of science, on the other hand, consider that formal publication is just one of the types of science communication available – less significant than and radically different from informal channels – and therefore believe that it makes little sense to derive quantitative measurements from scientific literature. They argue that tacit knowledge – for example laboratory techniques learned during training and the processes of "negotiation" between colleagues – is a constitutive part of science which, by definition, cannot be described in the scientific literature. To ignore these informal communication channels, as conventional quantitative indicators do, is more than a simple choice of analytical technique; it represents the perpetuation of an excessively rational account of scientific processes, which systematically obscures the fundamental characteristics of knowledge production.

As well as tacit knowledge, other types of knowledge which are generated by research may not reach the published scientific literature for a series of reasons which might be called social: lack of motivation due to the system of rewards in place; difficulty in access to scientific periodicals; a confidentiality clause imposed by the institution, and so on. Even ignoring these objections, in order to transform a publication tally into a measure of the knowledge generated, it is necessary to accept that each article makes the same contribution to knowledge – despite this being a highly implausible assumption. Without a doubt, empirical studies have demonstrated that the scientific literature is not made up of articles of equal quality.

In short, by offering an objective overview of science "as it is", scientometrics implies an unsuitably positivist and realist approach. This approach has been strongly criticized by the new sociology of science. Therefore, to align the conceptual premises of scientometrics with the modern vision of science upheld by the new sociology of science does really represent a massive challenge, even for Leydesdorff, who, as mentioned above, is not a pure scientometrician.

In light of this, it is relevant to ask how the author fares in the face of the challenge he poses to himself. He does in fact develop convincing arguments based mainly on the idea that certain Mertonian premises, such as the separation between cognitive and social factors, although not "true", have huge validity for analytical purposes. But he does not resolve the matter and one arrives at the end of the first part of the book with the impression that, despite his efforts, the author ends up giving in to a Mertonian vision of the operations of the scientific system.

Despite this, the author's efforts to develop innovative dimensions of the quantitative study of science are noteworthy. For example, he introduces three different dimensions of the communication of knowledge – authors, texts and cognitions. He deals with these dimensions from a multidisciplinary perspective particularly in the first part of the book, which also includes the theoretical and conceptual discussion mentioned above.

Part II – methodological studies using information theory – is definitely the central part of the book. Here Leydesdorff develops the procedures and methodological tools to deal with the issues and concepts related to the structure and dynamics of science. The statistical techniques used are relatively simple, but efficient for studying some characteristics of scientific information. In Part III – communication, probabilistic entropy and self-organization – the notion of information systems under development more clearly appears as the focus of attention. For this purpose, he develops sophisticated mathematical models and applies them to some groups of publications.

The author's intention was certainly not to write a scientometrics textbook, and some basic references therefore do not make an appearance. Even so, the book includes a huge number of footnotes (132) and references (308), an indication of the authors and topics covered.

The book is organized in 13 chapters which are based on 15 key articles and another 18 additional articles produced by the author since the end of the 1980s. Even though it is based on published articles, the book was certainly considerably rewritten because it does not come across as a collection of articles, and can be read as a monograph. Despite this, it is not an easy read for beginners. Leydesdorff develops sophisticated reasoning (since he has a background in philosophy) and includes references which are not commonly used by the community of pure scientometricians, nor by people without knowledge of science studies. In addition, he makes use of advanced mathematical techniques, further reducing the roster of potential readers.

Perhaps this short review does not do justice to the intellectual depth of the author nor to the implications of the new concepts presented by him, as well as the ways of quantifying them. It is important to stress the significant contribution of the author and this book not just to scientometrics, but also to the advance of ideas about scientific information. The conceptual problems discussed in the first part of this review are relatively minor in the context of the contribution he makes. Perhaps the broader question, for science on the periphery, as in Brazil, is to what extent we can make use of the approaches, concepts and techniques presented in this book to study the production and communication of knowledge in our conditions.