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Revisiting the scientometric conceptualization of impact and its measurement

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ABSTRACT

The development of scientometric indicators and methods for evaluative purposes, requires a multitude of assumptions, conventions, limitations, and caveats. Given this, we cannot permit ambiguities in the key concepts forming the basis of scientometric science itself, or research assessment exercises would rest on quicksand. This conceptual work attempts to spell out some principles leading to a clear definition of "impact" of research, and above all, of the appropriate scientometric indicator to measure it. The aim is to stimulate a discussion aimed at a definitive convergence on the meaning and measurement of a fundamental concept of the scientometric science.

1. Introduction

"Impact", jointly with "citation", is probably the most frequent term in scientometric literature. It recurs so often that its definition is more and more taken for granted, hardly ever spelled out. Impact is often, and much more easily, defined by means of the indicators employed to measure it, rather than as a concept in itself. It is precisely the proliferation of measurement indicators, witnessed by all, that calls for a red flag and return to home base. Without this, there is serious risk that we will lose sight of what we are measuring and, above all, of what we want to measure. The obsessive pursuit of measurement—"measure all that is countable, regardless of whether it counts or not"—resembles a case of gold fever. One apparent aspect of this, which calls for remediation, is to "first measure, and then ask whether it counts". An occurrence would be the situation of the altmetric indicators, which have proliferated in the past few years. First they were constructed, and now scientometricians strive to find out what they actually measure and how they might be used (Costas, Zahedi, & Wouters, 2015; Fenner, 2014; Haustein, Larivière, Thelwall, Amyot, & Peters, 2014; Priem & Costello, 2010; Sugimoto, Work, Larivière, & Haustein, 2017; Thelwall, Tsou, Weingart, Holmberg, & Haustein, 2013; Thelwall, 2017).

The problem I see, and the point I am making, is that there cannot be different definitions of a concept that one intends to measure, nor a myriad of relevant measurement indicators. A number of scholars and organizations have advised that a clear definition of impact is required (Duryea, Hochman, and Parfitt, 2007; Grant, Brutscher, Kirk, Butler, & Wooding, 2009; Russell Group, 2009). The aim of the current work then is to revisit the scientometric conceptualization of impact and the relevant measurement indicator. The hope is that we will begin to clear the fog over the meaning and the measurement of a concept that lies at the heart of evaluative scientometric studies. A clear definition of the concept and its measurement (and the limits embedded) would also help to blunt weapons of the main detractors of evaluative scientometrics. Last but

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not least, if a convergence on the meaning of research impact and method of measurement is achieved, then scientometric studies by different researchers may be compared more accurately.

It is important to note that the argument presented in this paper depends on the perspective that one has on the definition and scope of the field of scientometrics. A number of scholars broadly define scientometrics as the quantitative study of science, implying that it can cover some of the work done in the economics of science. My own perspective reflects the current reality, whereby scientometrics is contiguous to such fields as the economics of science and the economics of innovation. Although disciplines generally present blurring boundaries and some overlapping domains, my perspective is that scientometrics does not embed the above two fields, as it lacks the "socio-economics metrics".

The following questions drive the work:

1. What do (and should) scientometricians mean by "impact" of research?
2. How then should scientometricians measure it, given the tools they have available?

The search for answers should sharpen our image of what it is we want to measure, what we can actually measure, and above all, what we do not succeed in measuring.

2. The conceptualization of impact of research

2.1. A review of the literature

In reviewing the definitions of scientometrics in the literature, Mingers and Leydesdorff (2015) find that the main themes of scientometric research "include ways of measuring the quality and impact of research". The authors distinguish quality from impact of research. I will revisit this distinction at a later stage. Talking about impact, they identify that scientometrics deals with the impact "of some thing" (research), but not "on what", leaving the latter implicit. In the scientometric literature, in addition to the "research", we often find impact associated with terms that are somewhat different: publications, journals, individual researchers, research groups, institutions and nations. In some cases, the question of "on what" can be inferred from a modifier, identifying the scope of the root word: e.g. as in "scientific, academic, scholarly" impact, "non-scholarly, educational" impact, or "economic, social (societal)" impact. "Impact" is also often modified by terms denoting the means of measurement, indicating that we in fact use scientometric tools: "bibliometric, scientometric" impact or "citation" impact.

In his book "Citation analysis in research evaluation", Henk Moed (2005, p. 221) states: "The term *impact*, coined by Garfield and later used as a key concept by Martin and Irvine, is often used, but it is suggested to use the term *citation impact*, as it expresses the methodology along which impact is measured". It is interesting to recall then what Eugene Garfield, the father of scientometrics, meant by impact. David Pendlebury, one of the earliest and closest collaborators of Dr Garfield in personal research projects, interviewed by me on the issue, states that Garfield's conceptualization of impact is "a little loose, originally, but he mentions *impact on the literature* in his 1955 paper in Science (Garfield, 1955), and then in 1963 Irving Sher and he address impact in terms of a size-independent journal measure (Garfield & Sher, 1963)". Pendlebury further adds: "And I do admit that in the internal jargon of ISI[1] over the years, we understood 'impact' to mean a size-independent measure of research performance (not productivity), in other words, citations divided by publications. This is the batting average concept. So our own definition evolved from Gene's early conception of citations as indicators of influence on the literature (and how the literature changed because of select papers, journals, etc.) to a narrow definition of a class of citation indicator (size independent). But we didn't go beyond that, by which I mean we advanced no theory or philosophy of *research impact*".

In their seminal work on assessing basic research, Martin and Irvine (1983) state that "the impact of a publication describes its *actual* influence on surrounding research activities at a given time", and further on "it is the impact of a publication that is most closely linked to the notion of scientific progress – a paper creating a great impact represents a major contribution to knowledge *at that time*". Along the same lines, Moravcsik (1977) holds that the impact of a publication lies in its influence on subsequent publications, and that such influence will manifest itself by the influenced paper citing the influencing paper.

More recently, we have witnessed a tendency to broaden the definition of research impact (Bornmann, 2014), including societal and economic impacts, and a growing pressure on scientometricians, by governments and funding agencies, to measure them. Through time, a number of scholars and practitioners have proposed their own perspectives on the meaning of impact, ending up extending the original definition and leading to the current situation where "impact" is often used in vague, generic ways; stakeholders and organizations use different definitions and think differently; they often talk past one another; review articles on impact definitions and relevant measurement have been published. Examples are the review by Penfield, Baker, Scoble, and Wykes (2014) which summarizes a wide range of definitions of impact, and Bornmann's work (2017) describing how impact is generally measured. I refer the reader to the above reviews for additional concrete examples. A convergence on the basic meaning of impact, and how to measure it is now strongly needed.

[1] The Institute for Scientific Information (ISI) was founded by Garfield in 1960.