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On the time evolution of received citations, in different scientific fields: An empirical study

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ABSTRACT

The time evolution of mean received citations is calculated on a sample of journals from two ISI subject categories ("Chemistry, multidisciplinary", ISI Science Edition, and "Management", ISI Social Science edition) with the use of an original methodology. Mean received citations are plotted against the time gap in years existing between publication of the cited article and received citations. For most Chemistry journals in the sample the maximum number of average received citations occurs two years after publication, and then a decrease is experimented. Some peculiar cases present a different trend. Management journals, conversely, do not present in most cases a peak of citations: average received citations instead grow from year of publication to the age of 10 years (maximum time gap studied). A subsample of journals show similar results for longer time series (up to 23 years). Medians of average received citations per year partly show a similar behavior. Results suggest that citedness follows very different trends in very different fields, and partly suggest why differences in Journal Impact Factor exist between different categories. At the end of the work conclusions are drawn, together with suggestions for future research.

1. Introduction

Received citations are probably the most common indicator used to evaluate the quality of scientific production. It is widely held that the number of citations received by a scientific product (article, book chapter, etc.) is somewhat a measure of its quality. A high number of received citations should mean higher influence on other authors, and thus a higher value in terms of novelty, quality of results, thoroughness (Garfield, 1972; see also the discussion in Bornmann, Schier, Marx, & Daniel, 2012). Nevertheless the use of citations as quality index has been questioned by many authors in the past (see for instance MacRoberts & MacRoberts, 1996, 2010).

In consequence of these facts, in the last decades, several bibliometric indicators based on the number of received citations have been devised. Such indicators are intended to help evaluating journals, single works, and even the career of scientific authors. There exists experimental evidence of the validity of citation-based indicators (see for instance Glänzel, Schlemmer, & Thijs, 2003, p. 585 and thereafter). One of the first of such metrics, and probably the most famous, is the Journal Impact Factor (Garfield, 1955; Garfield & Sher, 1963; Garfield & Sher, 1966). Notwithstanding (or possibly due to) its wide diffusion, Journal Impact Factor has received – also recently – several criticisms (see for instance Vanclay, 2009, 2012). Other metrics, like the *h*-index, have become relevant in the last years (Hirsch, 2005).

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Also the measure of the evolution with time of the distribution of received citations is a relevant topic. Its study, as also the literature overview of the present article shows, has an important space in bibliometric sciences.

The present work aims at contributing to this specific topic. It does so performing an empirical study on the number of citations received by journal articles, tackling a specific research question: do (very) different research fields present a different evolution in the trend of received citations? Is there a relevant difference between hard and social sciences? Which are the implications originating from differences and/or similarities?

In order to answer to this question the present work operates in an empirical perspective. It measures in fact the evolution of received citation from a sample of journals belonging to two distinct ISI subject categories. The two subject categories are "Chemistry, multidisciplinary" (ISI Science Edition) and "Management" (ISI Social Science edition). Time span of cited articles goes from 1999 to 2010, and that of the relative received citations goes up to 2011. Both mean citations per article and medians of citations per article per year have been taken in account, with the use of an apt methodology.

The present paper is organized as follows. Section 2 contains the overview of previous literature, mainly showing how time evolution of received citations has been studied by scholars in the recent past. Section 3 presents the methodology exploited in the present work. Section 4 presents and analyzes the obtained results, while fifth and last section discusses the results and sketches some possible future research directions.

2. Literature overview

The corpus of literature studying citedness of scientific products and its evolution is vast and composite, and it tackles research questions related to several aspects of the topic. Thus the present overview will only discuss a fraction of the most relevant works related to the specific topic of timing of received citations, which consists of a vast stream of literature in itself.[1]

Several articles tackle the topic of the time gap between the publication of a scientific work and its first received citation. This time gap is also studied as an index of quality of the cited publication: the shorter the time gap, the higher the quality. Schubert and Glänzel (1986) did introduce the "Mean response time" (MRT) as an instrument to measure the performance of journals. MRT is calculated as "the exponential mean of the first citation a set of paper receives" (Glänzel, 1992, p. 53).

A model for a first-citation distribution has then been developed by Egghe (2000) referring to Rousseau (1994) and to Gupta and Rousseau (1999). His experimental work proves a mathematical model for the cumulative distribution of first-citation times. This model combines aging rate and a Lotka's exponent. Egghe, using practical examples, is able to show that the function in question fits accurately data on first citations, both concavely or S-shaped. This result is able to offer an informetric rationale to the distribution of first citations.

By his side also Burrell (2001, 2002) developed a stochastic model for the distribution of the first and the n-th prospective (diachronous) citation. His "mixed-Poisson model with aging provides an intuitively reasonable description of prospective citation studies" (2001, p. 11).

In more recent times Bornmann and Daniel (2010a,b) and Egghe, Bornmann, & Guns (2011) have studied indexes of speed of received citations. Bornmann and Daniel (2010a) perform an experimental activity on the manuscripts accepted or rejected in a top international chemistry journal. Experimental results show that accepted manuscripts are more likely to be cited first than those manuscripts that have been rejected (but published elsewhere). This result indicates that it is meaningful to use the time up to first citation as a bibliometric evaluator.

The subsequent work (2010b) presents instead the speed of first received citation as a complement to the h-index. The citation speed index is calculated for a group of articles from the first citation time in months. An experimental activity on the same sample of the previous article shows higher indexes (and thus faster citation time) for accepted manuscripts.

Finally, Egghe et al. (2011) set out a proposal for a first-citation-speed-index (FCSI). Authors introduce an "h-index for increasing sequences" (p. 186), but nevertheless encourage the search "for other good FCSIs" (ibidem).

The study of citation distribution is indeed the most relevant topic to be reviewed in relation to the present work. Bouabid (2011) builds a model to describe citation distribution, performing a diachronous analysis. The aim is to identify the timing of the major loss of citations. The model is tested on a set of publication in ISI category 'Biochemistry & Molecular biology' from different countries. With the use of this model it is also possible to obtain the value of '*residual citations*' (p. 208) that a corpus of articles keeps after a long time from publication.

A further analysis, performed by Bouabid and Larivière (2013) studies the changes in the life expectancy of different groups of articles via the application of the model. Results show variations in life expectancy between countries and scientific fields. Moreover their results show that "life expectancy of scientific papers is lengthening with time" (p. 14).

With an original perspective Pollmann (2000) compares the processes of aging of scientific publications and of mental forgetting. To do so he performs a synchronous analysis of citations, considering references found in ISI publications in year 1984. The empirical decay of citations and data on aging in newspapers are compared. Finally, the author builds a model – based on an inversed function – for aging considering the years after year 3 from publication. There is similarity between the two considered processes.

[1] Several useful references are also found in the introduction of Glänzel (2007).