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Are the authors of highly cited articles also the most productive ones?

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ABSTRACT

Ever more frequently, governments have decided to implement policy measures intended to foster and reward excellence in scientific research. This is in fact the intended purpose of national research assessment exercises. These are typically based on the analysis of the quality of the best research products; however, a different approach to analysis and intervention is based on the measure of productivity of the individual scientists, meaning the overall impact of their entire scientific production over the period under observation. This work analyzes the convergence of the two approaches, asking if and to what measure the most productive scientists achieve highly cited articles; or vice versa, what share of highly cited articles is achieved by scientists that are "non-top" for productivity. To do this we use bibliometric indicators, applied to the 2004–2008 publications authored by academics of Italian universities and indexed in the Web of Science.

1. Introduction

In recent decades, the development of the so-called knowledge economy has led many governments to undertake policies and initiatives intended to improve the effectiveness and efficiency of their domestic higher education systems. In particular, there has been increasing implementation of national research assessment exercises, essentially with aims of allocating resources according to merit and stimulating increased levels of research productivity from the funding recipients (Geuna & Martin, 2003; Hicks, 2012). Historically, the conduct of these evaluation exercises has been founded on peer-review methodology, applied to a subset of the overall scientific production that is achieved by the research organizations evaluated. This is the case, for example, of the forthcoming UK's Research Excellence Framework[1] (as well as an earlier series of "RAEs"[2]), which will examine a maximum of three or four of the highest quality works produced by the top scientists selected by the research institutions. A hybrid peer-review/bibliometrics method was adopted in the latest Italian assessment exercise, the 2004–2010 VQR,[3] in which universities were required to present, for each of their professors, the best three research works from the period under observation. The formulation of these two assessment exercises, while apparently quite similar, in reality overlies policy objectives that are different, with the first being intended

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[1] http://www.ref.ac.uk/pubs/, last accessed on September 27, 2013.
[2] http://www.rae.ac.uk/, last accessed on September 27, 2013.
[3] http://www.anvur.org/sites/anvur-miur/files/bando_vqr_def_07_11.pdf, last accessed on September 27, 2013.

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to stimulate excellence among the few, while the second is for upgrading of all. Thus the definition and the measurement of scientific excellence leave space for different formulations and indicators of measure, according to the intended objectives.

In general, scientific excellence of an institution is a multi-dimensional concept (Tijssen, 2003). Its measurement can be conducted through two distinct approaches: from the perspective of the quality of the research products or of the research staff. One example of the first perspective is seen in the so-called Excellence Rate, an indicator used by SCImago in its regular World Report,[4] which indicates the percentage of an institution's overall scientific output falling in the set of 10% most-cited papers in the respective scientific fields. Bornmann and Leydesdorff (2011) have used this indicator to locate centers of excellence at the European level. This perspective in analyzing excellence has also stimulated numerous studies focused on specific sub-fields, both in the hard sciences (for example environmental sciences, Khan & Ho, 2012; or urology, Hennessey, Afshar, & MacNeily, 2009) and in social sciences (psychology, in Cho, Tse, & Neely, 2012; law, Shapiro, 1991). According to Zitt, Ramanana-Rahary, and Bassecoulard (2005) "highly cited articles" is one of the most frequently used indicators for measurement of excellence.

The second perspective instead approaches evaluation from the point of view of the evaluating the research staff of the organizations, meaning that centers of excellence in a field are then recognized for their relative numbers of top scientists in the field (Abramo, D'Angelo, & Di Costa, 2009); and that two institutions can be compared in terms of productivity of their respective research staff (Abramo, Cicero, & D'Angelo, 2011). The literature on research excellence is particularly rich and can be segmented in at least three groups of contributions. The first area in fact concerns the bibliometric indicators proposed for the evaluation of performance in general, and in consequence for the identification of top scientists (Abramo, Cicero, & D'Angelo, 2013; Baccini, Barabesi, Marcheselli, & Pratelli, 2012; Bornmann, Mutz, & Daniel, 2007; Egghe, 2006; Hirsch, 2005; van Raan, 2006). A second group of works concerns the study of the determinants of performance, particularly the personal and contextual variables that can make a researcher a top scientist (Abramo, D'Angelo, & Caprasecca, 2009; Abramo, D'Angelo, & Solazzi, 2011; Costas, Van Leeuwen, & Bordons, 2012). Finally, a third group of works concerns analysis of the role that top scientists have or should have within their institutional contexts (Prpic, 2011; Silversides, 2010; Ioannidis, 2010; Goodall, 2006).

The question of the definition of excellence comes up again at the level of the individual scientist: is an excellent scientist the one who produces highly cited articles or the one that has an overall impact on the advancement of knowledge greater than his or her colleagues in the same field? To the best of our knowledge, there seems to have been no exploration of the convergence of these two perspectives of excellence: as defined in terms of individual research products or as defined in terms of the performance of scientists. The current work responds to this gap in the literature by attempting to clarify if the most productive scientists are also those that produce the best articles or if there are meaningful differences between the two perspectives. In fact if they were divergent, then the decision maker would have to be more cautious and precise in choosing how to weigh the concept of excellence, according to the policy objectives being sought.

To provide an exhaustive response, we consider every university researcher active in the hard sciences in Italy. In the Italian academic system, each professor is classified in one and only one research field. There are a total of 370 such fields (scientific disciplinary sectors, or SDSs[5]), grouped into 14 disciplines (university disciplinary areas, or UDAs). For each individual we measure the scientific productivity, through a bibliometric indicator based on their publications indexed in the Thomson Reuters Web of Science (WoS). The comparison of the value of the productivity indicator measured for all the researcher in a given SDS then permits identification of the so-called top scientists (TSs), for that SDS. At the same time, by counting the citations of the publications authored by Italian university professors, and comparing to world publications of the same year and subject category, we identify the highly cited articles (HCAs). Given this basis, we can advance the following research questions:

(i) *Who produces HCAs?* We provide an overall view of who (in terms of TSs and non-TSs) produces HCAs, highlighting potential differences between the fields.
(ii) *What is the correlation between research productivity and production of HCAs?* For each researcher, we measure the correlation between their scientific productivity and their production of HCAs.
(iii) *What is the distribution of HCAs among Italian scientists?* We analyze the distribution of HCA production per decile and quartile of the researchers, as classified for their scientific productivity.
(iv) *Are there differences across academic ranks?* We attempt to understand if the answer to the first research question is different for full, associate and assistant professors.

2. Methodology

2.1. Identifying excellence among research results

In the hard sciences, the prevalent form of codification of research output is publication in peer-reviewed journals. For this reason we assume that excellent results are observable in the form of excellent publications. The excellence of a publication

[4] http://www.scimagoir.com/pdf/sir_2012_world_report.pdf, last accessed on September 27, 2013.
[5] The complete list is accessible at http://attiministeriali.miur.it/UserFiles/115.htm, last accessed on September 27, 2013.