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The problem of credit in research evaluation – the case of Economics

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The measurement of scientific performance is usually done giving the full credit of each paper to all its authors. Aiming to analyze the impact of the number of authors on the performance, we propose an adjustment to the *h-index* that is flexible enough to allow the consideration of distinct co-authorship weighting schemes. We then evaluate the publication performance of the members of the departments of economics of the top 10 world universities. Our results show that the number of authors per paper is rapidly increasing and that this dimension measurably affects the final ranking of authors even in a subject area where the average number of authors is lower than in physical and life sciences.

Keywords: Higher education; Research evaluation; Economics; h-index; Authors

Introduction

The assessment of academic research is a fundamental element in the management and governance policies of national research systems, and to this end, the performance of institutions and authors are increasingly scrutinized. As summarized by Daraio[1] (p. 633), "besides scholars that are interested in understanding how research works and evolves over time, there are supranational, national and local governments, and national evaluation agencies, as well as various stakeholders, including managers of academic and research institutions, scholars and more generally the wider public, who are interested in the accountability and transparency of the scholarly production process". Given the importance and the consequences of such evaluation for institutions and individuals, the process must be as robust and fair as it can be.

Two key reasons explain the increasing importance of a rigorous research evaluation process[2]:

(i) budgetary constraints, putting great pressure on the efficiency in the allocation of resources;

(ii) the world-scale competition in the international research market, largely accentuated by the existence and visibility of several rankings and accreditations and their impact on institutional reputation[3].

Some few elite institutions have the best authors, and therefore, the greatest share of resources available for research and the best students, perpetuating the differences (both actual and perceived).

The tremendous pressure on scientific institutions (higher education institutions, research units) to perform better is obviously converted to author-level assessment. To promote higher levels of performance, a correct scheme of incentives must be determined and established.

In this context of analysis, we need to take into account the increase in the average number of authors per paper[4,5,6]. This phenomenon is much more pronounced in natural and life sciences, but is also evident in the social sciences.[7,8,9] This critical transformation has led to new research avenues covering: (i) motivations for collaboration; (ii) patterns of collaboration and their impact on performance[7]; (iii) differences among scientific areas[8]; and (iv) methods to divide the credit of the research papers among the authors (co-authorship weighting schemes)[10].

The current study focuses on the last dimension. More specifically, we introduce a simple method to adjust the standard bibliometric approaches to account for the effective contribution/merit of each author.

Recognizing the importance of this aspect, several weighting schemes have been proposed.[11] However, there are considerable differences between sciences regarding the importance given to this issue in performance evaluation exercises. Social sciences traditionally give lower attention to this aspect than physical and life sciences.[12,13]

We argue that because of the importance of bibliometric measures for critical decisions concerning

funding, hiring, promotions, and awards and the increasing average number of authors per paper, ignoring this dimension is hard to accept as valid.[14,15,16]

Among the vast stock of bibliometric measures available in the literature, the *h*-index[17] is by far the most diffused one. Its critical importance can be easily understood considering the words of Roberto Todeschini and Alberto Baccini[11] that the introduction of this index represents the beginning of a new era in bibliometric evaluation. However, it suffers from several important shortcomings.[18] As recognized by Jorge Hirsch (p. 2)[19], "possibly the greatest shortcoming of the h index is its inability to discriminate between authors that have very different coauthorship patterns".

This paper makes two main contributions. First, we propose an adjustment to the *h-index* to incorporate this dimension. Second, we evaluate the impact of the number and sequence of authors on publication performance considering a sample of 472 economists of top universities in the world.

Methodology

In order to empirically discuss the importance of the number and sequence of authors on performance measures, we consider the authors with primary appointments at the departments of economics of the top 10 world universities in the area of "Economics & Econometrics" according to the QS World University Ranking: Harvard University; Massachusetts Institute of Technology; Stanford University; University of California, Berkeley; Princeton University; University of Chicago; London School of Economics and Political Science; University of Oxford; Yale University; and Columbia University. Our sample includes the publications of 472 authors, including 14 Nobel laureates, corresponding to the full list of tenure-track or tenured faculty members, as defined by departmental websites in October 2018. All data were gathered from the Web of Science (WoS) database (core collection) in October and November of 2018 using the following criteria: (i) type of paper: articles and reviews; (ii) language: English.

To assure the validity of the data we conducted a detailed comparison for each of the authors included between the list of papers given by WoS and the information on individual publications retrieved from departmental and personal websites. When necessary complementary sources were also considered (e.g., Econlit). The final composition of the sample includes 15,243 papers (published between 1957 and 2018 in 709 different journals) and 1,288,803 citations.

A new index to account for the number and sequence of authors

A scientific paper is the result of the effort and the merit of its authors. The reasons, advantages, and costs of scientific collaboration have been extensively discussed in the literature.[8,20,21] Our focus in the present study concerns the identification of the credit that should be given to each author. In fact, when there are two or more authors, a key question emerges: what is the real contribution of each author? The answer is subjective and in fact only the authors know it.

However, recognizing the importance of this issue, many co-authorship weighting schemes have been suggested.[16,22] They seek to infer the contribution of the author from his/her position in the author's list of the paper. One exception is the standard counting scheme (full credit to all authors), in which the credit received by each author is independent of the number of authors and of their specific position. This is inherent to the *h-index*, and one of its critical drawbacks.[19] Other popular weighting schemes include uniform counting and proportional counting. Let us define the position of the author in the paper's list of authors as k ($k = 1, 2, \ldots, K$) and the weight given to each author as $p(k)$. In the uniform counting, $p(k) = 1/K$, $\forall k$ while in the proportional counting $p(k) = 1/k$, therefore considering not only the number of authors but also their position. Other schemes follow a more extreme solution, giving the full credit of the paper to only one author.[23]

Given the importance of this topic, some measures have been suggested aiming to adjust or to complement the *h-index*. Erika Crispo proposes a complementary index – the *AP-index* – accounting for the average position of the author in the group of papers that compose the *h-core*.[24] Recently, Jorge Hirsch[19] introduces the h_α*-index* aiming to measure the degree of scientific leadership. Other measures opt to adjust the *h-index*. This can be done through a cut in the total number of papers (e.g., the *paper fractional h-index*, proposed by Leo Egghe[25], a cut in the total number of citations (e.g., the *weighted h-index* suggested by Ash Abbas[26]), or through adjustments in the *h-index* after its calculation, such as those suggested by the *pure h-index*[27] or the *complementary h-index*[28].

We follow this last option but suggest an even simpler way to adjust the *h-index*. This new measure (h^**-index*) corresponds to the proportion of the total

merit/performance of the author (defined by h) that can be assigned to him/her, as defined by the weighting scheme used:

$$h^* = int[\sum_{p=1}^{P_H} p(k)] \quad (1)$$

in which p represents papers and P_H are the last paper included in the *h-core*. h^* is rounded to the lower value. When $p(k) = 1$ for all papers, $h^* = h$. In the remaining cases, $h^* < h$.

Analysis

We start our empirical analysis with the issue of the author's position in the list of authors. While in some cases it reflects a different role in the paper's conception and production, in some sciences the common practice is to follow the alphabetical order of the names. When this occurs, a scheme that considers the sequence of authors should not be used. We test this aspect for the 15,243 papers of our sample and verify that alphabetical order is followed by 91.38% of the multi-authored papers, which is in line with previous evidence by Annke Kadel and Andreas Walter.[29] Therefore, the uniform counting scheme will be adopted as reference.

The 15,243 papers were produced by a total of 34,710 authors, corresponding to an average of 2.28 authors per paper. The number of authors ranges between 1 (4,014 papers) and 255 (a paper by David Laibson published in *Nature* in 2016). Table 1 presents key evidence concerning the evolution of the number of authors per paper throughout the period considered.

The results clearly demonstrate a strong increase of scientific collaboration in economics, in which we highlight: (i) the increase of the average number of authors per paper, from 1.397 during the period 1957-1970 to 2.893 in the current decade; (ii) the dramatic reduction of single-authored papers, from 65.44% of the total in the first period to only 14.74% today.

The impact on performance measures depends on the distribution of this variable (number of authors per paper). Figure 1 shows this evidence, highlighting the existence of remarkable differences among the authors.

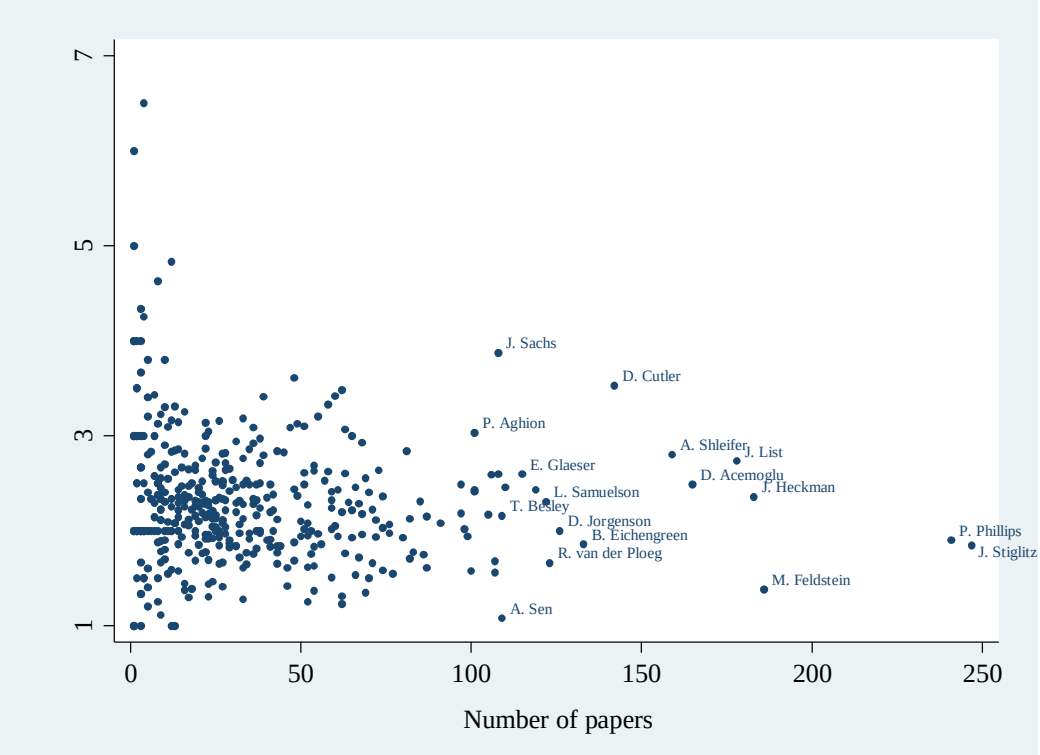
These results demonstrate that co-authorship is an important issue that must be addressed by the standard performance metrics since the lack of its consideration can lead to biased conclusions, with important individual and institutional implications. Our evidence clearly illustrates this aspect. For example, we have 19 authors with $h^* = 10$ but their original *h-index* range between 12 and 35. The same happens for instance in the case of the authors with h^*= 20. The seven authors with this adjusted score have values of the *h-index* between 29 and 43.

Figure 2 presents the link between the average number of authors per paper (in the *h-core*), *h*, and h^*. Authors represented more to the left in panel (2a) and more to the right in panel (2b) are those with the best scores in *h* and h^*, respectively.

Comparing the top 10 obtained with the two measures, we conclude that 7 authors belong to the top in both cases (Andrei Shleifer, Joseph Stiglitz, James Heckman, Peter Phillips, Robert Barro, Daron Acemoglu, and John Campbell) but significant modifications occur. Andrei Shleifer occupies the 1st position of the ranking based on the *h-index*, but due to his high number of co-authors per paper when compared to the average (the 2nd highest in the top 10), ranks only 6th according to h^*. The first position in this measure belongs to Joseph Stiglitz (the author with most papers in the whole sample and the 3rd in the *h*-ranking). The most noticeable increases are seen for Amartya Sen (from 12th to 2nd) and Martin Feldstein (from 12th to 4th), which is explained by the fact that these authors register the lowest values of average number of authors per paper (in the *h-core*) among all included in the top 30 of h (1.12 and 1.31, respectively).

Table 1—Number of authors per paper

Period	No. of authors per paper			% of papers		
	Average	Standard deviation	Maximum	Single author	≥5 authors	≥10 authors
1957-1970	1.397	0.600	4	65.44%	0.00%	0.00%
1971-1980	1.469	0.634	8	58.42%	0.15%	0.00%
1981-1990	1.700	0.719	7	42.92%	0.05%	0.00%
1991-2000	1.928	1.021	29	32.54%	0.77%	0.13%
2001-2010	2.273	1.251	26	21.35%	3.33%	0.37%
2011-2018	2.893	5.871	255	14.74%	7.51%	0.86%



Note: The figure excludes one author with an average number of authors per paper of 16.1.

Figure 1—Publications and scientific collaboration

Note: See note for Figure 1. Numbers between brackets correspond to the ranking position of the author.

Fig 2—Publication performance measured through h and h^* indexes

Conclusion

The stock of evidence presented in this study makes it clear that measuring scientific performance using the most standard approach ($\bar{h}$-*index*) may produce biased conclusions since it lacks the consideration of one critical dimension – the number of authors – and that this problem is now much more important than in the past, even in social sciences, since scientific collaboration has increased rapidly throughout the last decades. This is also the case of economics. Therefore, obtaining fair decisions based on rankings of publication performance critically requires the use of performance measures that capture this dimension, such as the one suggested in this study (h^*-*index*). This is vital to avoid the individual and institutional consequences of wrong decisions based on inadequate measures.

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