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The influences of counting methods on university rankings based on paper count and citation count

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ABSTRACT

In an age of intensifying scientific collaboration, the counting of papers by multiple authors has become an important methodological issue in scientometric based research evaluation. Especially, how counting methods influence institutional level research evaluation has not been studied in existing literatures. In this study, we selected the top 300 universities in physics in the 2011 HEEACT Ranking as our study subjects. We compared the university rankings generated from four different counting methods (i.e. whole counting, straight counting using first author, straight counting using corresponding author, and fractional counting) to show how paper counts and citation counts and the subsequent university ranks were affected by counting method selection. The counting was based on the 1988–2008 physics papers records indexed in ISI WoS. We also observed how paper and citation counts were inflated by whole counting. The results show that counting methods affected the universities in the middle range more than those in the upper or lower ranges. Citation counts were also more affected than paper counts. The correlation between the rankings generated from whole counting and those from the other methods were low or negative in the middle ranges. Based on the findings, this study concluded that straight counting and fractional counting were better choices for paper count and citation count in the institutional level research evaluation.

1. Introduction

In recent decades, scientists have intensified research collaboration. Consequently, counting co-authored papers has constituted a methodological problem in informatrics based research evaluation. Previous studies have addressed the problems and influences of counting methods in country-level research evaluation (e.g., Gauffriau & Larsen, 2005a, 2005b; Gauffriau, Larsen, Maye, Roulin-Perriard, & von Ins, 2007; Gauffriau, Larsen, Maye, Roulin-Perriard, & von Ins, 2008; Huang, Lin, & Chen, 2011; Larsen, 2007a, 2007b). But how counting methods affect institution level research evaluation has hardly been reported in existing literatures. This study addresses the knowledge gap by testing four different counting methods on a large bibliometric dataset to see how university rankings are influenced by counting method choices.

University ranking is a quantitative style of university performance evaluation (Huang, 2011). Today, several large-scale university ranking programs exist. Most of them rely partly or wholly on bibliometric measures (Aguillo, Bar-Ilan, Levene, & Ortega, 2010). Paper count and citation count are respectively the two most basic bibliometric indicators for assessing research productivity and impact. The invent of the measures for research evaluation may be attributed to the

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groundbreaking work of Eugene Garfield, who envisioned the use of objective and countable citations as the basis for studying research impact in 1955, and who later materialized Science Citation Index (SCI), Social Science Citation Index (SSCI), and other tools since 1958 that made the analyses possible (Garfield, 2006; Garfield & Sher, 1963).

Today, few ranking programs employ such simple and primitive indicators as the sole basis for measuring research performances. But paper count and citation count continue to be the foundation for the more sophisticated measures (Academic Ranking of World Universities [ARWU], 2011; Higher Education Evaluation and Accreditation Council of Taiwan [HEEACT], 2010; Leiden Ranking, 2012; NTU Ranking, 2012). As such, the original numbers of papers and citations may still influence performance rankings. In a previous study, we tested three counting approaches on a large dataset to observe their influences on the country-level rankings (citation temporarily removed for review). In this study, the counting methods were again tested to see how institutional level rankings were influenced accordingly. The focus of this study is not to evaluate the research performance of the universities included in our data, but to observe how the selection of counting methods influence the paper counts and citation counts for the universities and how rank positions of the universities are changed by that.

Our data were the paper and citation records in the field of physics between January, 1989 and August, 2008 as indexed in Thomson Reuter's Web of Science (WOS). We focused on 300 universities which have excelled in physics research. One problem with the use of WOS data in institution level analyses is that, over years, authors' institutions have been indexed inconsistently in the database. The "unification of institution names" (Van Raan, 2005) must be conducted before the data can be used for analyses. We employed the concept of "authority control" (Taylor, 2004) on the original WOS records to ensure the data accuracy. The procedures for the authority control work will be reported in Section 3.

2. Counting methods for university rankings

The ways in which collaborative papers are counted can affect the numbers of papers and citations attributed to a university. Huang et al. (2011) summarized three different counting approaches. The first is *whole counting*. Depending on the level of evaluation, each unique collaborating institution or country receives one full credit (Gauffriau et al., 2007, 2008). It is also the de facto method for several well-known global university ranking programs (ARWU, 2011; Quacquarelli Symonds [QS], 2011; HEEACT, 2010; NTU Ranking, 2012).

The second approach is *straight counting*. Only the most prominent collaborator receives one full credit, and the others receive none. *First author counting* and *corresponding author counting* are characteristic of this approach. Both have been used in previous biblimetric studies (Gauffriau & Larsen, 2005a, 2005b; Larsen, 2007a, 2007b). The idea behind the two highly similar methods was the same, i.e. to credit the main leader only. The SCImago Group therefore used the term "leadership" for this type of counting (SCImago Journal & Country Rank [SJR], 2012).

The third is *fractional counting*. One credit is equally or proportionally shared by the collaborators (Gauffriau & Larsen, 2005a; Gauffriau et al., 2007, 2008). The Leiden Ranking by the Centre for Science and Technology Studies (CWTS) in Leiden University, Netherlands, is a current university ranking program that supports fractional counting (Leiden Ranking, 2012).

All of these counting methods are simple and straightforward enough to be used in large-scale ranking programs. But whole counting unavoidably generates larger numbers than the other methods; the sum of each university's paper and citation count by this method also exceeds the total number of papers/citations there actually are. In other words, whole counting inflates paper and citation counts. Huang et al. (2011) found that, in the country level research evaluation, certain countries have systematically benefited from such inflation and received better ranking positions from using it. By the same token, we can expect to see some universities benefit from whole counting in institution level evaluation.

However, Huang et al. (2011) also found that, at the country level, country rankings from different counting methods were highly correlated, which suggests that counting methods were of minor influence on the overall ranking results. But at the institution level, counting methods are more likely to have a stronger impact on ranking because the difference between two universities' papers and citation numbers are usually smaller than those of two countries. As such, altering counting methods may change two universities' rank positions. Moreover, the number of universities in the world is much larger than the number of countries. There are more universities having similar quantity of papers and citations, and their collaboration with other institutions may vary. Consequently, we may predict that more counting method-induced rank changes will occur at the institution level.

We thus tested four counting methods on a large bibliometric dataset to see whether the prediction holds. Our research questions included whether different counting methods generate alternative university rankings as well as how and to what extent the ranking results vary. We focused only on the rankings of universities and excluded independent research institutions. The counting methods we tested included:

a. Whole counting (W): each collaborating university of a paper receives one full credit.
b. Straight counting using the first author (SF): only the first author's university receives one full credit, and the other collaborating universities receive none.
c. Straight counting using the corresponding author (SC): only the corresponding author's university receives one full credit, and the other collaborating universities receive none.
d. Fractional counting (F): each collaborating university of a paper equally shares one credit.