Journal of Informetrics 9 (2015) 629–641

Contents lists available at ScienceDirect

Journal of Informetrics

journal homepage: www.elsevier.com/locate/joi

Contributory inequality alters assessment of academic output gap between comparable countries

Nils T. Hagen

Faculty of Biosciences and Aquaculture, University of Nordland, N-8049 Bodø, Norway

ARTICLE INFO

Article history:
Received 21 February 2015
Received in revised form 29 May 2015
Accepted 1 June 2015

Keywords:
Coauthor credit
Harmonic formula
Bibliometric bias
Publication metrics
Inequality

ABSTRACT

An elite segment of the academic output gap between Denmark and Norway was examined using harmonic estimates of publication credit for contributions to *Science* and *Nature* in 2012 and 2013. Denmark still leads but the gap narrowed in 2013 as Norway's credit increased 58%, while Denmark's credit increased only 5.4%, even though Norway had 36% fewer, and Denmark 40% more, coauthor contributions than in 2012. Concurrently, the credit produced by the least productive half of the contributions rose tenfold from 0.9% to 10.1% for Norway, but dropped from 7.2% to 5.7% for Denmark. Overall, contributory inequality as measured by the Gini coefficient, fell from 0.78 to 0.51 for Norway, but rose from 0.63 to 0.68 for Denmark. Neither gap narrowing nor the positive association between reduced contributory inequality and increased credit were detected by conventional metrics. Conventional metrics are confounded by equalizing bias (EqB) which favours small contributors at the expense of large contributors, and which carries an element of reverse meritocracy and systemic injustice into bibliometric performance assessment. EqB was corrected by using all relevant byline information from every coauthored publication in the source data. This approach demonstrates the feasibility of using EqB-corrected publication credit in gap assessment at the national level.

1. Introduction

The main objective of this work is to use recent advances in bibliometric credit allocation to gain new insights into the academic output gap between two comparable countries, in this case Denmark and Norway. Previous studies invariably rated the academic output of Denmark above Norway (e.g. Glänzel, 2000; Research Council of Norway, 2014; Schneider, 2010; van Leeuwen, 2012), but all gap size estimates based on conventional bibliometric methods are inaccurate because they do not adequately account for the size of each country's contribution to internationally coauthored publications.

Almost 200 countries contribute to the global production of academic publications and the output of many is changing rapidly (National Science Board, 2014). Everyone, therefore, wants to know how well they are doing in relation to others and their shared concern is to avoid being misguided by inaccurate information. Such concern over perceived academic output gaps between countries has fuelled research policy debate for nearly two centuries, and the concept of academic productivity as an input/output ratio has evolved in a context of international comparison (Godin, 2006, 2009; Nowotny, 2007). An early example is Charles Babbage's concern about the decline of science in England relative to Germany (Babbage, 1830; Foreigner, 1931); a concern quantified by Edward Frankland in 1871 (Devonshire, 1872, p. 371:5866) (cf. Braun, 1993;

E-mail address: Nils.Hagen@uin.no

http://dx.doi.org/10.1016/j.joi.2015.06.002
1751-1577/

Cardwell, 1972; Nye, 1984), and echoed in the modern debate about the same topic 150 years later (Martin, 1994). On a broader scale, the dynamic nature of international science today is reflected in current trends suggesting that the academic pre-eminence of the US may be surpassed by China in the foreseeable future (Leydesdorff, 2012).

The global growth in academic output has been accompanied by an unabating increase in international collaboration (Aksnes, Frølich, & Slipersæter, 2008; Leydesdorff & Wagner, 2008). More than a quarter of all publications in the world are produced by multi-national teams, and several smaller countries produce more than half of their research papers in collaboration with international partners (Royal Society UK, 2011). Collaboration has many benefits, is often encouraged by policy makers and funding agencies, and is considered essential for groundbreaking research where the required effort is beyond the capacity of a single nation (Bidault & Hildebrand, 2014; Sonnenwald, 2007). Participation in international top-level research is therefore regarded as an indication of national competitive ability and academic achievement.

But in conventional measures of academic output, collaboration is a major source of inaccuracy. The routine approach is to inflate publication counts by issuing full publication credit to every country included in the list of author affiliations. The other conventional approach is to divide one unit of credit equally among a paper's coauthors, and then tally the fractions for each country. Such fractional publication counting corrects for inflationary bias, but not for the equalizing bias (EqB) which is the inevitable consequence whenever the coauthors of a paper have not contributed equally.

EqB skews bibliometric assessments and accounts for a massive shift of credit from primary to secondary authors. As a result, biased equal credit scores produce distorted publication performance rankings that are fundamentally different from rankings obtained from estimates of actual coauthor credit (Hagen, 2014a). Furthermore, the powerful distortional effect of EqB is inevitably compounded in derived bibliometric indices and indicators. EqB may also provide an incentive for unethical behaviour, including unwarranted claims for honorary authorship or gift authorship.

The key to more reliable publication counting is to ensure accurate accreditation of coauthors by including all relevant byline information. This bottom-up approach is facilitated by the harmonic formula, which provides equitable distribution of coauthor credit for scientific papers with a hierarchical byline structure (Hagen, 2008, 2013). It also accommodates additional byline information which, for instance, may indicate the equality of some or all coauthors, or the presence of a senior author. Recent studies of field specific publication patterns have used the harmonic formula to partially eliminate EqB (Fernandes, 2014; Walters & Wilder, 2015), but future studies must also include additional byline information about equality or seniority in an effort to completely eliminate EqB.

Here, I use an evidence-based informetric approach to estimate the effect of international academic collaboration on measurements of publication output for two comparable nations, Denmark and Norway. First, I address the need for improved accuracy by portraying how the combination of increased output and increased international collaboration over the past four decades has generated a widening zone of overlap between the upper and lower boundaries of the two countries' total publication output. Second, I provide a close-up of the academic output gap between Denmark and Norway, by analyzing in detail their scientific contributions to the two top-tier journals *Science* and *Nature* for the years 2012 and 2013. Third, I quantify the inequality profile of each country's contributions, and provide new information about the relationship between contributory inequality and cumulative top-level output. And finally, I conclude by demonstrating how EqB altered the perceived direction of annual change in the top-level academic output gap.

2. Background: accounting for coauthorship in publication counting

The use of publication counts as a quantitative base for research policy was pioneered by Frankland's testimony to the British Royal Commission in 1871, when he used publication counts for the year 1866 to provide a quantitative assessment of the alledged academic performance gap which showed Britain lagging behind Germany (Cardwell, 1972; Devonshire, 1872, p. 371:5866). At the time coauthorship was not a confounding issue but inaccuracy due to international collaboration had already entered the picture. It was Frankland who pointed out that the count for Britain underestimated the gap because it included publications from German scientists residing in Britain who had received their training in Germany.

2.1. *Inflated publication counting*

Inflated publication counting was initiated in 1917, when S.I. Franz (Franz, 1917, p. 202, footnote 1) decided to assign full value publication credit to both individuals of a joint publication (cf. Godin, 2006). This approach provided a strong incentive for joint authorship which expanded seamlessly to multiple authorship. Inflated counting has dominated quantitative research output analysis ever since.

But inflated publication counting is confounded by two separate sources of bias. Inflationary bias, generated by issuing one full unit of credit repeatedly to each coauthor or participating country; and equalizing bias (EqB), generated by ignoring differential contribution (Hagen, 2008).

2.2. *Fractional publication counting*

Nearly 50 years ago, as multiple authorship became increasingly common, Price and Beaver (1966) introduced the practice of fractional counting in an influential paper which set a longstanding, unintended precedent for using fractional counting in