

# Individual Researchers' Research Productivity: A Comparative Analysis of Counting Methods

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## Introduction

Productivity can be studied at different scales (e.g., country, organisation, author). The present work examines productivity at the researcher level, with the financial support received by researchers representing input and researchers' papers representing output. Regardless of the scale at which productivity is examined, science must be considered a collective endeavour, particularly since there is a growing trend towards more collaboration in nearly every field. Importantly though, very distinct collaboration practices exist across fields of research. For instance, over 90% of the papers in the natural sciences and engineering (NSE) are written in collaboration (more than one author), whereas this proportion is 60% in the social sciences and 10% in the humanities (Larivière, Gingras and Archambault, 2006). Whether one uses fractional or whole counts can be expected to yield hugely different productivity measures (Lindsey, 1980; Egghe, Rousseau, and Van Hooydonk, 2000; Gauffriau, M. et al., 2008). This paper examines how fractional versus whole-paper counting affects the measurement of researchers' performance in the social sciences and the humanities (SSH) versus in the NSE.

## Method

This paper uses a very large dataset comprising funding, publication and citation data of all professors and university-based researchers (hereafter "researchers") in the Canadian province of Quebec over the 2000–2007 period (1999–2006 for funding). To compile this dataset, lists of researchers (n=13,479) were obtained from Quebec's Ministère du développement économique, de l'innovation et de l'exportation, and its three research councils. Bibliometric indicators in this paper were calculated using Thomson Reuters' Web of Science database for the 2000–2007 period (n=62,026 papers). Research funding comes from the SIRU database. Statistics on output per researcher were computed for researchers with at least one paper, while those on output per research dollar were computed for researchers with at least one paper and one dollar of financial support. This was deemed necessary so that the fact that researchers in the SSH often prefer books to peer-reviewed journals could be taken into account (Larivière et al., 2006).

## Results

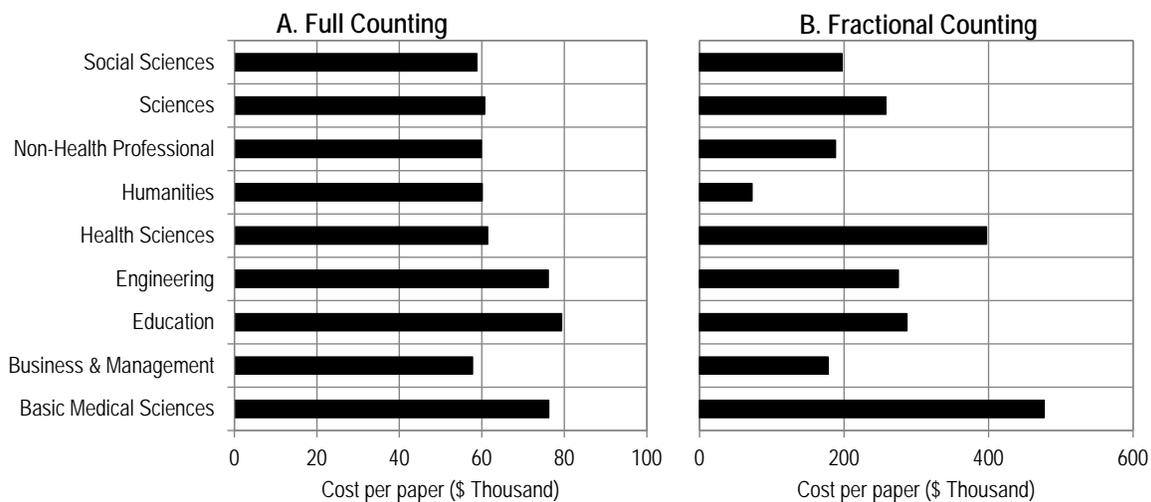
Table 1 shows that when full-paper counting is used, researchers in the basic medical sciences are the most productive, followed closely by natural scientists. Health sciences and engineering researchers follow at a certain distance, while those in the humanities and various social sciences trail noticeably. However, fractional counting evens things out in a drastic manner: productivity falls to one paper every other year, on average, in the natural sciences (i.e., 4.1 papers over the

eight-year period). Researchers in the SSH were half as productive, i.e., one full-paper equivalent every four years. Education researchers did not produce the equivalent of a full paper during the eight year period.

**Table 1. Difference in measured productivity, full and fractional counting, 2000–2007**

Field	Full counting	Fractional counting	Ratio (Full/Fractional)
Natural Sciences	17,4	4,1	4,2
Engineering	13,2	3,7	3,6
Basic Medical Sciences	20,3	3,3	6,3
Health Sciences	14,6	2,3	6,5
Humanities	2,5	2,1	1,2
Social Sciences	6,9	2,1	3,4
Business & Management	4,5	1,4	3,1
Non-Health Professional	4,4	1,4	3,1
Education	2,3	0,6	3,6

If one looks at productivity per research dollar, the results are even more striking: whereas papers in the basic medical sciences cost in excess of \$475,000 on average, researchers in the humanities produced papers for less than \$75,000 each. As previously noted, SSH researchers usually prefer to publish books instead of papers. Moreover, Thomson Reuters seriously underestimates the production of works in languages other than English, which are common in the SSH (Archambault et al., 2006). This means that productivity in the SSH is underestimated and the cost per publication in the SSH is likely substantially lower in reality.



**Figure 1. Cost per paper, fractional and full counting, by discipline, 2000–2007**

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