

BRIEF COMMUNICATION

Funding Acknowledgment Analysis: Queries and Caveats

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Thomson Reuters's Web of Science (WoS) began systematically collecting acknowledgment information in August 2008. Since then, bibliometric analysis of funding acknowledgment (FA) has been growing and has aroused intense interest and attention from both academia and policy makers. Examining the distribution of FA by citation index database, by language, and by acknowledgment type, we noted coverage limitations and potential biases in each analysis. We argue that despite its great value, bibliometric analysis of FA should be used with caution.

Introduction

Acknowledgments in scientific publications express authors' gratitude to diverse entities who funded, inspired, or contributed to their research (Costas & Leeuwen, 2012; Cronin, McKenzie, Rubio, & Weaver-Wozniak, 1993; Salager-Meyer, Alcaraz-Ariza, Briceno, & Jabbour, 2011; Tiew & Sen, 2002). Though they were once called "long neglected textual artefacts" (Cronin, McKenzie, & Stiffler, 1992, p. 122), acknowledging support is becoming standard practice in

scientific communications (Cronin, 2001; Rigby & Julian, 2014). Even though acknowledgment is one corner of the "reward triangle" (with authorship and citation) (Costas & Leeuwen, 2012; Cronin & Weaver, 1995), acknowledgment analysis remained relatively underexplored for a long time because of the difficulty of collecting data (Cronin & Shaw, 2007; Cronin, Shaw, & La Barre, 2003; Giles & Council, 2004; Hyland, 2003). The problem became less of an obstacle when Thomson Reuters's Web of Science (hereinafter WoS) began systematically indexing funding acknowledgment (FA) data from August 2008 forward (Thomson, 2009). Since then, several researchers use the FA data to track research output, manage funding portfolios, and evaluate the impact of grants (Lewison & Markusova, 2010; Lewison & Roe, 2012; Liu, Hu, Tang, & Wang, 2015; Rigby, 2011, 2013; Wang & Shapira, 2011; Wang, Liu, Ding, & Wang, 2012).

Accompanying the burgeoning publications based on acknowledgment analysis, some interesting findings emerge. For example, previous research found 43% of all WoS indexed publications in 2009 report funding information (Costas & Leeuwen 2012). This percentage is even larger for selected research domains such as molecular biology and biochemistry (Costas & Leeuwen, 2012). The great variances of FA among disciplines are also reported by other scholars. Cronin et al. (1993) reported significant differences of acknowledging financial support in four humanities and social sciences disciplines. All publications in *Cell* in selected years include acknowledgments (Cronin & Franks, 2006).

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At the country level, Wang et al. (2012) reported that among the 10 most prolific countries in *Science Citation Index Expanded (SCI_E)* papers in the year of 2009, over 50% of Spanish research papers and 70% of Chinese research papers carried at least one acknowledgment of grant funding. Costas and Leeuwen (2012) also observe that China possesses the largest share of publications acknowledging research funding. Tang and Liu (2016) report that over 90% of China's highly cited research indexed in the *Essential Science Indicators* data set has reported funding agency information.

Meanwhile, concerns about analyzing FA have also been raised. For example, Rigby (2011) explicitly states that there is bias in collecting the FA information, as currently the information is confined to scientific journals only. Lundberg, Tomson, Lundkvist, Skar, and Brommels (2006) and Tang (2013) warn that an uncritical use of FA may mislead funding stakeholders and science policy makers. Costas and Leeuwen (2012) cast doubt on the algorithm that Thomson Reuters adopted to index acknowledgment information of research papers. Unfortunately, their concerns and warnings did not incur much attention. Many existing studies utilizing WoS FA information simply neglect these potential problems (Tan, Zhao, & Ye, 2012; Xu, Tan, & Zhao, 2015; Zhou & Tian, 2014). To our knowledge, no studies to date have empirically examined the aforementioned problems. This paper aims to advance our understanding of bibliometric analysis using FA by examining potential biases in the WoS practices for collecting and processing FA information. The empirical evidence is provided through both WoS query searching and manual examination of acknowledgment statements. We found that WoS indexing FA information is almost totally dependent on whether or not the article is indexed in the *SCI-E* data set. FA presence rates vary substantially among non-English papers. In addition, FA information does not report all acknowledgment contents contained in scientific articles.

Search Queries

The WoS includes three searchable field tags that provide funding acknowledgment information: acknowledgment funding organization (FO) identifies funding bodies supporting the research, funding grant (FG) provides grant numbers, and funding text (FT) contains the full text of the authors' acknowledgment section in the paper (Rigby, 2011).

To retrieve a complete set of funding records in the WoS, after rounds of trials and errors, we used the following Query #1 searching in the *funding text* field. In order to study data for several full years, we limited our search to publication years 2009 through 2014.¹

Query #1 FT=(A* OR B* OR C* OR D* OR E* OR F* OR G* OR H* OR I* OR J* OR K* OR L* OR M* OR N* OR O* OR P* OR Q* OR R* OR S* OR T* OR U* OR V* OR W* OR X* OR Y* OR Z* OR 0* OR 1* OR 2* OR 3*

OR 4* OR 5* OR 6* OR 7* OR 8* OR 9*) AND PY=(2009–2014)

Query #1 improves on the search statements used by Wang et al. (2012) and Xu et al. (2015) in the *funding organization* field. Although their query can capture records with any words beginning with any of the 26 letters of the alphabet or the numerals of 0–9 in the *funding organization* field, records with only grant number but no funding organization will not be retrieved. For robustness check, Queries #2 and #3 were also conducted.

Query #2 FO=(A* OR B* OR C* OR D* OR E* OR F* OR G* OR H* OR I* OR J* OR K* OR L* OR M* OR N* OR O* OR P* OR Q* OR R* OR S* OR T* OR U* OR V* OR W* OR X* OR Y* OR Z* OR 0* OR 1* OR 2* OR 3* OR 4* OR 5* OR 6* OR 7* OR 8* OR 9*) AND PY=(2009–2014)

Query #3 FG=(A* OR B* OR C* OR D* OR E* OR F* OR G* OR H* OR I* OR J* OR K* OR L* OR M* OR N* OR O* OR P* OR Q* OR R* OR S* OR T* OR U* OR V* OR W* OR X* OR Y* OR Z* OR 0* OR 1* OR 2* OR 3* OR 4* OR 5* OR 6* OR 7* OR 8* OR 9*) AND PY=(2009–2014)

Our results show that Query #1 (searching the FT field) returned 4,610,481 records, whereas Query # 2 in FO and Query #3 in FG captured 4,591,259 and 3,171,084 records, respectively.² We further found that 98 record hits retrieved in FT could not be covered by the combination of FO or FG (#1 not [#2 or #3]), and only 4 out of 4,610,387 hits returned by FO or FG are not covered by FT ([#2 or #3] not #1). Thus, unless otherwise specified in this paper, Query #1 searched in the FT field has been used to retrieve WoS funding acknowledgment information.

Citation Index Database Bias of FA Information

The Web of ScienceTM Core Collection contains three journal citation databases spanning over 250 disciplines: *Science Citation Index Expanded (SCI-E)*, *Social Sciences Citation Index (SSCI)*, and *Arts & Humanities Citation Index (A&HCI)*.³ In 2015, 620 *SSCI* journals and 68 *A&HCI* journals were also covered by *SCI-E*.⁴

We applied the Query #1 search to *SCI-E*, *SSCI*, and *A&HCI* separately. Table 1 documents the returned hits and calculated FA presence rates. The coverage biases in the WoS FA information are clearly evidenced by the frequency of funded publications indexed in different citation indices. As shown within the 2009–2014 time band, 9,747,715 publications are indexed in *SCI-E*, among which 4,608,632 records contain funding acknowledgment with an FA reporting rate of 47%. This differs from Rigby's (2011) finding that FA information was available only for the papers

²Only three journal citation databases (*Science Citation Index Expanded*, *Social Sciences Citation Index*, and *Arts & Humanities Citation Index*) are included.

³For more details please refer to http://wokinfo.com/products_tools/multidisciplinary/webofscience/.

⁴Source : <http://ip-science.thomsonreuters.com/mjl/>.

¹All queries were searched by using the WoS on December 4, 2015.

TABLE 1. Citation index bias.

Searching set	<i>SCI-E</i>	<i>SSCI</i>	<i>A&HCI</i>	(<i>SSCI</i> or <i>A&HCI</i>) NOT <i>SCI-E</i>
Total records (TR)	9,747,715	1,540,644	730,918	1,504,352
Records with FA	4,608,632	248,856	9,045	2,382
Records with FA/TR (%)	47.28	16.15	1.24	0.16

Note. Data source: Thomson Reuters WoS. Time span: 2009–2014.

TABLE 2. Language bias.

Language	Total records	Records with FA	FA presence rate (%)
English	9,446,993	4,592,697	48.62
German	78,616	34	0.04
French	48,898	32	0.07
Spanish	42,954	64	0.15
Chinese	41,743	15,246	36.52
Portuguese	32,220	44	0.14
Polish	12,225	12	0.10
Japanese	8,909	3	0.03
Russian	7,756	0	0.00
Turkish	6,265	5	0.08

Note. Data source: Thomson Reuters WoS-*SCIE*. Time span: 2009–2014.

indexed in *SCI* (p. 366). We do observe that articles indexed in *SSCI* and *A&HCI* also report FA data. But their FA presence rates are extremely low, almost one third and one fortieth that of *SCI-E*.

A further Boolean examination of (*SSCI* or *A&HCI*) NOT *SCI-E* shows that only 2,382 out of 1,504,352 records contain FA⁵. The FA reporting rate of WoS papers not indexed in *SCI-E* dips to 0.16%. The extremely low FA reporting rate suggests that only FA of publications indexed in *SCI-E* are systematically recorded. This at least partially accounts for the low FA rates for humanities and social sciences in addition to disciplinary nature and cultural factors suggested by Costas and Leeuwen (2012).

Languages Bias of FA Information

Diaz-Faes and Bordons (2014) reported that the WoS captures and processes only FAs that are written in English and that inclusion relies on the assistance provided by Thomson Reuters's technical support team. We are curious whether publications in languages other than English with FAs are also indexed in the WoS. We therefore tested the FA presence rate by language of publication.

We applied Query #1 and confined our search to *SCI-E*. About 9.45 million English publications were identified, and 4.59 million included FAs when all document types considered (Table 2). The FA presence rate of the English-language publications indexed by *SCI-E* is 49%. Unlike Diaz-Faes and

Bordon's (2014) study, we found that publications written in other languages also have their FA data collected. However, the FA presence rates are extremely low for most other languages. One exception is Chinese—over one third of Chinese articles also report FA information. Table 2 lists the top 10 languages for the period of 2009–2014 based on the quantity of *SCI-E* papers. As shown, papers in Chinese, which is the fifth most frequent language in *SCI-E*, report significantly larger FA presence rate than publications in the more common German, French, and Spanish languages.

Acknowledgment Type Bias of FA Information

Researchers acknowledge support in their paper for a variety of reasons. Previous studies have categorized acknowledgments into different types: moral support; financial support; access to facilities, data, etc.; clerical support; technical support; and peer interactive communication (Cronin, 1991; Cronin, McKenzie, & Rubio, 1993). The WoS name for this field, *funding text*, intuitively delivers the message that the acknowledgment is about financial support of the research. Yet it remains unclear if all types of acknowledgment are systematically collected in the WoS. No research has examined this issue with one exception: Costas and Leeuwen (2012) manually checked the acknowledgments of their own publications and found that the WoS did not include the acknowledgment texts of papers that did not contain funding acknowledgment (p. 1650). To explore this question, we chose a journal and downloaded the full texts of all its articles published in 2014 and manually examined the acknowledgment sections. Following the common practice of selecting top-ranking journals suggested by previous studies (Bazerman, 1994; Connor, 2004; Cronin, McKenzie, & Rubio, 1993), we purposely chose *Journal of the Association for Information Science and Technology* (JASIST)⁶, a leading journal in library information science (LIS) and computer science indexed in both *SCI-E* and *SSCI*. Our manual analysis shows that 215 papers⁷ were published in JASIST in 2014, with 116 containing acknowledgments sections. We applied Query #1 in the WoS but restricted searching to JASIST in the year of 2014, and the search returned only 83 hits. This left 33 JASIST acknowledgment-bearing articles which could not be retrieved by searching the FT

⁵The following three steps were taken in order to get the records which are indexed by *SSCI* or *A&HCI* but not by *SCI-E*. a) Retrieve records indexed by *SSCI* or *A&HCI* (#1); b) Retrieve records indexed by *SCI-E* (#2); c) Combine sets using the Boolean operator (#1 NOT #2) from the Advanced Search page.

⁶JASIST was changed to its current name from *Journal of the American Society for Information Science and Technology* in 2014.

⁷These 215 papers consist of 183 original articles, 15 book reviews, 8 letters, 2 reviews, 2 editorial materials, 4 biographical-Item, and one correction.

field in the WoS. Without exception, these articles' acknowledgment sections do not contain research funding information. This finding provides further evidence supporting the claim of Costas and Leeuwen (2012) that only acknowledgments with funding information are collected in the WoS.

Conclusion and Discussion

Funding acknowledgment (FA) is an increasingly institutionalized practice across scientific fields. Previous studies have proposed caution regarding FA analysis: misspellings and variants of funding organizations' names (Lewison & Roe, 2012; Tang, 2013; Wang & Shapira, 2011), ghost and gift funding organizations (Claxton, 2005; Giles & Council, 2004), and unconsciously over- or under-reported financial supporting information (Costas & Leeuwen, 2012; Tang, Shapira, & Youtie, 2015). In addition to those pitfalls, the inherent biases in Thomson Reuters's practices for collecting FA information should also be clear for future research.

This study provides empirical evidence of the limitations in the WoS FA information collection. We found that the WoS database records an acknowledgment only if it contains funding information, and thus it is not recommended for analyzing other types of acknowledgment without complementary information. For WoS databases, only FAs in journals indexed by *SCI-E* are systematically recorded. In other words, the WoS FA data are not suitable for analyzing social science and humanities research. In addition, the WoS records FA information almost exclusively for papers in English and for those in Chinese with English FAs, so the data are not recommended for analyzing publications written in languages other than English and Chinese.

To conclude, although FA analysis opens a wide range of possibilities for linking scientific input and output (such as the correlation between funding with collaboration and research performance), we argue that the pitfalls and potential impacts on the results of bibliometric analysis of FA should be taken into account when undertaking this type of analysis. These caveats are particularly important when using bibliometric analysis to make comparisons across different countries and research disciplines.

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