Does Funded Research Have Higher Impact?

Dangzhi Zhao

dzhao@ualberta.ca
School of Library and Information Studies, University of Alberta, Edmonton, Alberta, T6G 2J4 (Canada)

Abstract
This paper reports a bibliometric study of the impact and characteristics of funded research in the library and information science (LIS) field as compared with non-funded research. It is found that the impact of funded research as indicated by citation counts was significantly higher than that of non-funded research. Funding of LIS research reported in core LIS journals was biased towards the information retrieval (IR) area, especially research on IR systems. Scholars from outside LIS contributed heavily to funded research.

Introduction
During the past three decades, public research institutions such as universities have become more and more dependent on external peer-reviewed funding from research councils (Laudel, 2006; Bourke & Butler, 1999).
Consequently, scholars "are forced into a competitive environment driven by evaluation for the allocation of these scarce funds" (Heinze, 2008, p. 302). The success in obtaining research funding has been given a lot of weight in the evaluation of university professors and researchers' work performance in general and in decisions on hiring and promotion in particular. As a result, applying for internal and external research funding has become one of the major activities carried out routinely by scholars at universities.
The amount of external research funding obtained by a university as a whole has also been used as an important indicator for ranking universities as the amount of money a university has available affects the university's ability to do things such as hiring new professors, providing access to advanced technology and equipment, and supporting graduate students. As a result, universities invest heavily in supporting funding application activities hoping for more successful applications, as indicated by well-staffed research Facilitation offices and regular workshops and consultations on funding applications among others.
The underlying rationale for this funding policy is that competition for funding helps bring out the best ideas (Heinze, 2008). An examination of funded research as to its nature, investigators, results and impact should help understand what types of research this funding policy has encouraged and whether it has been successful in achieving its goals. Studies on the impact and characteristics of funded research are largely missing although the relationship between funding and scientific productivity has been studied extensively (e.g., Prpić, 2007).

Research questions
The present study examines the case of library and information science research and explores whether funded research in this field is different from unfunded research, and what the implications are for research policy. Specific research questions are:

1. Does funded research in this field have higher impact than non-funded research?
2. What types of research and researchers have been funded?
3. What are the major funding agencies for research in this field?

Methodology
A bibliometric approach was used to address these research questions. Specifically, the Acknowledgements section of all research articles that were published in 1998 in 7 core LIS journals (Table 1) were examined to identify articles reporting funded research. The impact of

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articles on funded research as indicated by their citation counts was evaluated against that of articles on non-funded research in order to answer the first research question. The distributions of articles on funded research by various criteria (e.g., topic, affiliation, funding agency) were obtained in order to answer the other research questions.

Table 1. Seven core LIS journals examined

1. Journal of the American Society for Information Science (JASIS)	4. Information Processing & Management
2. Library Quarterly	5. Journal of Documentation
3. Library & Information Science Research	6. Library Trends
	7. College & Research Libraries

It is generally accepted that the number of citations an article receives indicates the impact of this article on subsequent research, although there are debates on whether impact reflects quality and on what effect self-citation and co-authorship have on citation counts (Avkiram, N.K., 1997; Garfield, 1986; Glanzel, W. & Schubert, A., 2001; Persson, O., Glanzel, W. & Danell, R., 2004; Rousseau, R., 1992).

The year 1998 was chosen to allow sufficient time (about 10 years) for articles to be used and cited. The 7 core LIS journals chosen here are journals in Table 11 of Nisonger and Davis (2005) that were mentioned as the top five most prestigious journals in LIS by 15% or more of the 37 Deans of LIS schools in North America. The journal Annual Review of Information Science and Technology was excluded in order to focus on research rather than reviews.

Both Web of Science and Scopus were used to obtain information on how articles have been cited as a way to verify citation data. Only Web of Science data are presented here due to page limits, except that data for Library Quarterly were from Scopus as its issue 4 in 1998 was not included in Web of Science as source papers. Scopus data will also be referred to in the discussion when appropriate. Searches for this information were done in December 2008.

Preliminary results and discussion

Impact of funded and non-funded research

Table 2 shows that, on average, 28% of the articles published in the 7 core LIS journals reported funded research. In general, the percentage of papers on funded research was significantly higher in more information-oriented journals than in more library-focused ones.

Table 2. Citations of funded and non-funded research

Journal	**funded papers**	**total # papers**	**% funded**	**citations (funded)**	**citations (total)**	**ave citations (funded)**	**ave citations (non-funded)**
JASIS	34	97	35.1	656	1663	19.3	16
IPM	16	45	35.6	266	561	16.6	10.2
J Doc	9	28	32.1	143	494	15.9	18.5
Lib & Info Sci Res	5	18	27.8	97	165	19.4	5.2
Lib Trends	4	32	12.5	33	160	8.3	4.5
Coll & Res Libraries	2	31	6.5	20	183	10	5.6
Lib.Quarterly	2	12	16.7	7	33	3.5	2.6
Total	**72**	**257**	**28**	**1222**	**3181**	**17**	**10.6**

The impact of articles reporting funded research as indicated by citation counts was about 65% higher than that of non-funded research. A higher impact of funded research is seen in all

individual journals except Journal of Documentation. Interestingly, the difference in impact between funded and non-funded research appears to be larger in "L" journals than in "I" journals according to Web of Science data (i.e., excluding Library Quarterly in Table 2), and is the largest in the journal Library and Information Science Research (about 3 times higher).
Many factors may have played a role in producing the higher impact of funded research. The quality of the research may have been enhanced because the funding may have helped the investigators to allocate more time for the research, to hire excellent research assistants, and to gain access to better data and technology. The dissemination of research results may have been widened by the funding (e.g., attending more and international conferences), which normally results in a higher level of awareness of the results. The level of co-authorship of funded research may have been higher as collaborative research projects are perceived favourably by many funding agencies and as a result are more likely to get funded. Indeed, our data shows that the average number of authors per paper on funded research is larger than that of all papers in LIS (slightly more than 2 vs. slightly less than 2), but this difference alone is not sufficient to account for the large difference in citations received between funded and non-funded research.
We examined the Journal of Documentation more closely to find out why it is the only journal in which articles on funded research have lower impact than those on non-funded research. This statistical anomaly was caused by Peter Ingwersen's article "The calculation of Web impact factors" which was not funded but extremely highly cited (159 times). If this article were excluded from the calculation, the average citation counts of articles on non-funded research would be 10.7 in this journal, resulting in a pattern similar to the other journals.
This outlier reminds us that non-funded research can also have extremely high impact. Ground-breaking research like Ingwersen's in particular, be it in theory or in methodology, may happen before becoming fundable under current funding policy, or before a funding proposal can go through. Nevertheless, the data in the present study show that funded research in general produces significantly higher impact than non-funded research.
We are in the process of examining the distribution of citations to funded and non-funded research papers by year to see if there is any difference in how these papers have been used over time. Results are expected to be presented at the conference.

Characteristics of funded research

Table 3 shows clearly that most funded research was in the information retrieval (IR) area, especially the IR-systems area, followed by library science, and Scientometrics. This is consistent with findings above that a larger percentage of funded research was reported in "I" journals than in "L" journals, and with findings below that scholars in the computer science research fields contributed heavily to funded research reported in these core LIS journals.

Table 3. Distribution of articles on funded research by topic

Topic	#papers	Topic	#papers
Information retrieval (IR) system	33	Medical informatics	3
Library Science	9	Science mapping	3
IR interaction	5	Image retrieval	2
Scientometrics	5	Scholarly communication	2
User studies	4	Others (metadata, OPAC, research methods, etc.)	6

Studies (Zhao & Strotmann, 2008) have shown that IR system is just one of the many research areas even in just information science. While IR is one of the two camps of information science, most LIS scholars study user interactions with IR systems rather than IR

systems themselves. This picture is obviously very different from what is seen here in funded research, about 40% of which was on IR systems. This shows that funding of LIS research was clearly biased towards system-oriented research.

Most authors of articles on funded research were from universities (including university libraries and research centers) and only a few from research institutions. Table 4 shows that scholars from a range of departments published articles on funded research in the 7 core LIS journals including psychology and communication studies, although most of them were from either LIS or computer science fields. About 60% of the papers on funded research in the 7 core LIS journals were contributed by scholars from departments other than LIS or libraries. In part this was probably due to the fact that both IPM and JASIS publish articles in both LIS and CS fields as well as other related areas such as MIS. In fact, IPM is cross-listed in the Social Sciences and Computer Science categories in the ScienceDirect database.

Table 4. Distribution of funded research by author affiliation type

Department/School/College	#papers	Department/School/College	#papers
LIS	26	Science & Technology Studies	3
Computer Science (CS/EE/HCI/DL)	24	Psychology	2
MIS	6	Med Informatics	2
Academic and research libraries	5	Others (Business, Cognitive Sci, Ergonomics & HCI, etc.)	5
Communication Studies	3		

Table 5 shows that scholars from many countries reported funded research in these 7 core LIS journals. Those in the United States contributed more than half of the articles on funded research, followed by United Kingdom and Canada.

Table 5. Distribution by country

Country	#papers	Country	#papers
United States	41	Belgium, Germany, Italy, Japan, Netherlands	2
United Kingdom	10	Australia, Austria, Denmark, Finland, Israel, South, Korea, Spain, Switzerland, Taiwan	1
Canada	7		

Table 6 presents external funding agencies that were acknowledged in more than 2 articles on funded research. It shows that the US National Science Foundation (NSF) was the top external funding agency, followed by the European Union, the Social Sciences and Humanities Research Council of Canada, and the British Library Research and Innovation Centre. Industry funding appeared to be rare in this field. It appears that LIS research was mostly funded by public funds for research in general administered by a federal or European Union government funding agency. The United Kingdom was one of the very few countries where major funding for LIS research was from a LIS-specific organization.

The pattern of English-speaking countries dominance is probably related to the fact that many LIS studies, especially library-oriented ones, are focused on national concerns, such as studies on national cataloguing rules and classification standards. These types of studies tend to be published in local languages in local or national journals whereas the 7 journals top-ranked by the deans of LIS schools in North America are all English language publications.

This pattern may also have to do with other factors (e.g., different university systems in these English-speaking countries and in other countries). We are in the process of exploring this further, with the plan to present results at the conference.

Table 6. Funding agencies

Funding Agency	#papers
US National Science Foundation (NSF, NSF/ARPA/NASA, NSF/CISE)	16
European Union (EU)	8
Social Sciences and Humanities Research Council of Canada (SSHRC)	6
British Library Research and Innovation Centre	5
UK Joint Information Systems Committee (JISC)	3
AT&T Foundation	3
Disclosure, Inc.	2
US National Center for Supercomputing Applications (NCSA)	2
German Federal Ministry for Education and Research	2

Conclusions

The present case study of LIS research shows that funded research did, indeed, have significantly higher impact than non-funded research, at least in LIS. This indicates, in a sense, that the funding policy and practice were working quite well. Future studies are required to see if this pattern also exists in other research fields.

Although funding was found to be biased towards research on IR-systems when contributions by computer scientists were included, there appeared to be a balance between the "I" and the "L" sides of LIS among the funded research contributed by LIS scholars.

In most countries, external funding for LIS research came from a federal government (or the EU) funding agency for sciences or social sciences in general, but in a few countries from a LIS-specific organization.

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