Differences Between Research Projects in Computer Science Funded by Japanese and American Agencies

Emi Ishita[1]([✉]) [iD] and Tetsuya Nakatoh[2] [iD]

[1] Kyushu University, Fukuoka 819-0395, Japan
`ishita.emi.982@m.kyushu-u.ac.jp`
[2] Nakamura Gakuen University, Fukuoka 814-0198, Japan

Abstract. Understanding the relationship between funding agencies' expectations and researchers' activities in funded research projects will contribute to improved policy-making by funding agencies and better research activity by researchers. Thus, the purpose of this study is to investigate how research project size, international collaboration, and publication in international journals of articles resulting from funded research projects in Japan have progressed over the last decade. We focused on publications resulting from research projects funded by the major grants agencies in Japan and the USA using bibliographic data for computer science papers published from 2011 to 2020. Based on the numbers of authors of published journal articles and conference papers, the results showed that the size of projects funded by the National Science Foundation has been growing. In terms of international collaboration, both countries have increasingly collaborated with China, and researchers involved in research projects funded by the Japan Society for the Promotion of Science have increasingly published in English-language journals with less diverse audiences.

Keywords: Bibliometrics · Structure of funded research projects · Funding agencies

1 Introduction

Researchers' activities and research topics are often based on their own interests and preferences, although researchers may also be influenced by social expectations, the expectations of institutions or funding agencies, and current research trends. One of those trends is international collaborations, which have developed in numerous disciplines and countries over recent years. González-Alcaide, et al. [1] examined international collaborations of research papers in a specific field from 1980 to 2016 [1]. Of the total number of papers published in the periods 1980–1989 and 2010–2016, 19.1% and 32.5%, respectively, involved international collaborations. McManus et al. [2] analyzed international collaborations by Brazilian scientists and found that the number of papers published with foreign partners increased between 2004 and 2019. In Japan, the Japan Society for the Promotion of Science (JSPS) administers grant programs such

as the "Fund for the Promotion of Joint International Research" and "Enhancement of International Dissemination of Information" [3], the title of which indicate that funding agencies encourage researchers to engage in international collaborations. Another trend is growth in research project size. This can be explained by the emergence of Big Science, which is characterized by "large-scale instruments and facilities, supported by funding from government or international agencies, in which research is conducted by teams or groups of scientists and technicians" [4]. For example, the Japan Science and Technology Agency (JST) has called for research proposals for its JST-Mirai Program (Large-scale Type) [5]. In Japan, researchers have been used to presenting their contributions to and building their communities in Japanese academic associations, and thus Japanese academia has become well-developed. However, as noted above, funding agencies are increasingly expecting researchers in Japan to conduct large-scale research and engage in international collaborations, although these expectations are rarely made explicit.

In this study, we investigated how researchers working on funded research projects reacted to these expectations by focusing on the size, internationalization, and presence of research project funding based on published literature. We examined the number of authors in relation to project size, the combination of authors' countries regarding internationalization, and popular journals regarding the presence of funding contributions. There are numerous ways to measure their reactions, but publications are one of the main avenues. We also examined changes over a decade using publications from the last 10 years. Understanding these researchers' activities will help research funding agencies to develop future funding policies, while also enabling researchers to develop research proposals that lead to better outcomes.

Our main focus is funded research projects in Japan, but we also examined funded research projects in the USA for comparison. The JSPS [6] was selected as the main research funding agency in Japan, while the National Science Foundation (NSF) [7] was selected as the main funding agency in the USA. We examined funded computer science research projects from 2011 to 2020 because the research groups in this field were in a dynamic state of change. Japanese researchers in computer science are expected to publish in international journals and at international conferences, which facilitated this analysis. The data used in this study were obtained from the Scopus database. If researchers' projects are funded by grant agencies, they are strongly advised to include information regarding this funding in their acknowledgments. Therefore, the Scopus database enabled us to obtain a list of publications funded by grant agencies.

2   Related Works

Bibliometric studies have previously been used to investigate research trends in various fields and to understand the structure of research activities. For example, Guiling et al. [8] investigated global research trends in organizational citizenship behavior over the last two decades by analyzing the top authors, journals, institutions, and countries in the field using the Scopus database. Wang et al. [9] performed a comprehensive bibliometric analysis of uncertain group decision-making over the last four decades by analyzing factors such as publication types, the most prolific countries/regions, highly authoritative publications, the development of publications, citations, and cooperating publications, the

most prolific institutions, the countries/regions involved in institutional collaborative networks, and keyword timelines. In this study, we analyzed publications that resulted from funded research projects. Faisal et al. [10] analyzed 225 government-funded research projects on science education in Indonesia from 2014 to 2018 and identified the key topics, research context, content, and outcomes. In this study, we focused on the number of authors, the combinations of authors' home countries, and journal popularity over the last decade.

3   Data Collection

The bibliographic data used were obtained from the Scopus database using query searches. We focused on computer science publications from 2011 to 2020 using the search option "SUBJAREA(comp)" to specify the field of computer science and the search options "(DOCTYPE,"ar")" and "(DOCTYPE,"cp")" to identify journal articles and papers from conference proceedings, respectively. The search option "(FUND-SPONSOR, "National Science Foundation")" was used to identify projects funded by the NSF in the USA and the search option "(FUND-SPONSOR, "Japan Society for the Promotion of Science")" was used to identify projects funded by the JSPS in Japan. Table 1 shows the number of search results for each funding agency, publication year, and literature type. Scopus is constantly adding bibliographic data, including for previous publication years, and thus the results shown in Table 1 are those that were obtained in June 2021, when we conducted the search. Because Scopus only permitted a maximum of 2,000 bibliographic items including the abstract and other detailed information to be downloaded, when the number of search results exceeded this number, the 2,000 most highly cited papers were selected for analysis.

During data processing, we found that some studies were shown as being funded by the NSF, even though they were actually funded by the National Natural Science Foundation of China (NSFC). Therefore, we manually checked the grant name, grant number, and acknowledgment statement in papers published by authors belonging to Chinese institutions and papers with NSF or NSFC displayed in the fund-sponsor field. For example, NSF fund numbers consist of seven digits, the first two of which represent the funding year, as well as a three-letter prefix in some cases, such as CNS-1018108, while NSFC fund numbers consist of eight digits, for example, 61071061. We used this information to identify NSF-funded studies. In cases where it was unclear whether the funding was provided by the NSF or the NSFC, we looked up the grant numbers in the NSF's award database [11]. In cases where authors stated that they had received an NSF CAREER award but no award number was cited, we considered the project to be a funded project even though we were unable to ascertain when the author had received funding. Following these manual checks, we deleted any papers that did not appear to be funded by the NSF. In addition, when examining journals and conference papers, we found that some papers, for example, in Lecture Notes in Computer Science, were incorrectly indexed as journal articles, and some journal articles were incorrectly indexed as conference proceedings. We excluded IEEE/ACM/IEICE Transactions and publication titles including the word "journal" from the conference paper lists, and Lecture Notes in Computer Science from the article lists. The final numbers of papers used are shown in Table 1.

Table 1. Numbers of journal articles and conference papers used for analysis.

Year		NSF				JSPS			
		Jour		Conf		Jour		Conf	
		Result	Used	Result	Used	Result	Used	Result	Used
2011		3,264	1,975	1,053	927	723	722	774	735
2012		3,574	1,960	1,365	1,182	1,049	1,048	979	905
2013		3,756	1,950	4,942	1,924	1,198	1,197	1,501	1,445
2014		3,459	1,957	1,323	1,223	1,273	1,220	1,228	1,138
2015		3,091	1,961	2,711	1,922	1,380	1,370	1,309	1,262
2016		4,362	1,958	7,335	1,891	1,531	1,520	1,850	1,752
2017		4,898	1,964	8,654	1,886	1,803	1,800	2,777	1,911
2018		6,086	1,925	9,656	1,911	2,179	1,998	3,477	1,915
2019		6,096	1,932	11,704	1,945	1,939	1,939	3,776	1,976
2020		6,865	1,953	9,354	1,966	2,068	2,000	2,671	1,965

4 Results

4.1 Numbers of Papers

It can be seen from Table 1 that the numbers of journal articles and conference papers resulting from NSF- and JSPS-funded research projects grew substantially over the decade from 2011 to 2020. The number of journal articles resulting from NSF-funded projects more than doubled, while the number of conference papers was nearly nine times greater. The number of journal articles resulting from JSPS-funded projects nearly tripled, while the number of conference papers was five times greater by 2019 before declining in 2020. Thus, the growth in the number of articles resulting from JSPS-funded
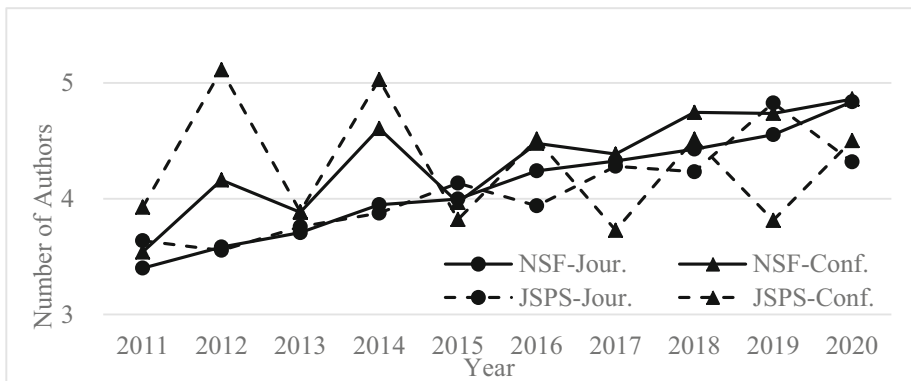
Fig. 1. Numbers of authors of publications.

research projects was less than that of articles resulting from NSF-funded research projects. As another factor, the Scopus has tried to include many publications in its database.

4.2 Numbers of Authors

Figure 1 shows the numbers of authors of published papers resulting from funded research projects. The number of authors of journal articles resulting from NSF-funded research projects (slope $= 0.15$, $p < 0.001$, $R^2 = 0.99$ by regression analysis), conference papers resulting from NSF-funded research projects (slope $= 0.12$, $p = 0.002$, $R^2 = 0.72$), and journal articles resulting from JSPS-funded research projects (slope $= 0.11$, $p < 0.001$, $R^2 = 0.78$) all increased over the decade, while the numbers of authors of conference papers resulting from JSPS-funded research projects varied considerably from year to year (slope $= -0.02$, $p = 0.70$, $R^2 = 0.02$). The number of authors of NSF-funded articles increased more than that of JSPS-funded articles, indicating that the size of NSF-funded research projects increased over the decade.

4.3 Authors' Countries

Figures 2 and 3 show the country combinations of collaborating authors of JSPS- and NSF-funded journal articles, respectively. The country names have been abbreviated using ISO 3166-1 country codes. We included all countries included in the affiliation fields from the bibliographic data, and only counted each combination once. For example, if three researchers belonged to a US institution and two researchers belonged to Chinese institutions, the combination of countries was recorded as "US & CN." It can be seen from Fig. 2 that the biggest research group consisted of authors from Japan (i.e., no international collaboration), followed by collaborative groups of authors from Japan and China. The ratio of combination of countries from only Japan was within 66.1% and 71.7%, and it has not been detected any statistically significant increase or decrease ($R^2 = 0.45$). The proportion of collaborations between Japan and China increased from 4.3% in 2011 to 7.1% in 2020 ($R^2 = 0.9044$). China was becoming a stronger partner in later years. It can be seen from Fig. 3 that in 2011, 64.9% of USA research groups were based solely in the USA, but this had decreased to 55.8% by 2020 ($R^2 = 0.93$). Conversely, the proportion of research groups based in the USA and China grew from 6.6% to 13.6% during the decade ($R^2 = 0.91$). The ratio of combination of author's countries in research groups consisting only of researchers belonging to Japanese institutions in JSPS-funded projects was higher than that in NSF-funded projects. In NSF-funded projects, the ratio of authors comprising only the USA was relatively lower, and that ratio was decreasing year by year. NSF-funded projects are more internationalized. In addition, it can be seen that both Japan and the USA are increasingly collaborating with China.

In the preliminary analysis, we also examined the combinations of authors' countries in NSF- and JSPS-funded conference papers, and the results were similar to those for journal articles.
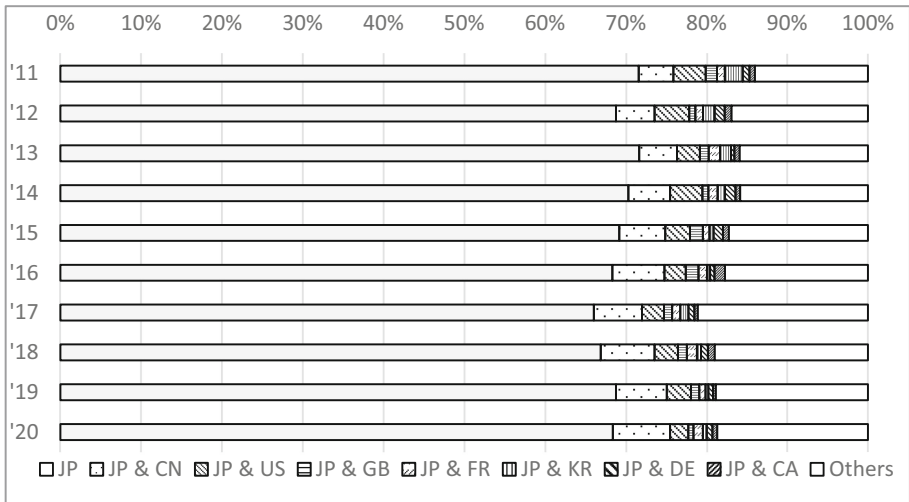
Fig. 2. Combinations of authors' countries for JSPS-funded journal articles.
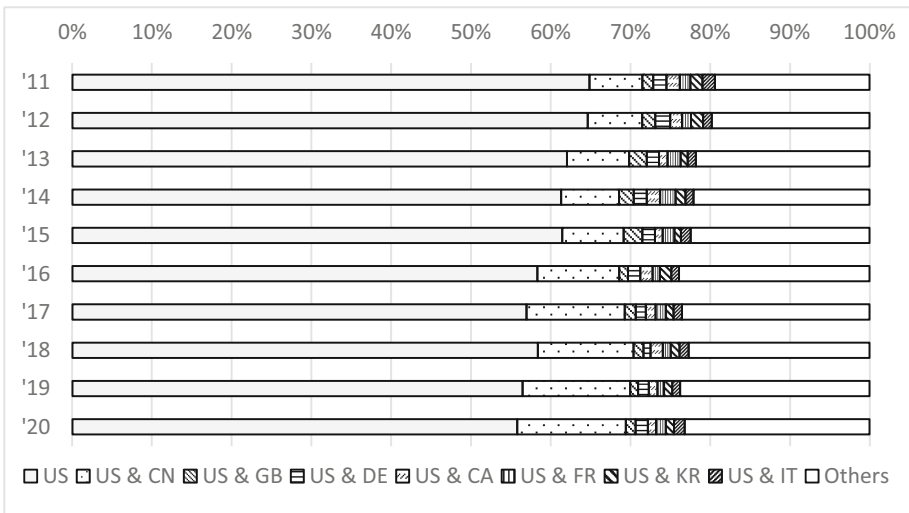

Fig. 3. Combinations of authors' countries for NSF-funded journal articles.

4.4 Journal Popularity

We counted the number of articles published in each journal in each year, and then for the three top-ranked journals in any year, we counted the number of articles in other years. Tables 2 and 3 show the numbers of journal articles resulting from JSPS- and NSF-funded research projects. The solid orange borders indicate the top-ranked journal in terms of the number of articles, the dashed green borders indicate the second-ranked journal, and the dotted blue borders indicate the third-ranked journal.

In terms of journals publishing JSPS-funded articles, *IEICE Transactions on Fundamentals of Electronics, Communications and Computer Sciences* published the most articles in the first five years, while *International Journal of Molecular Sciences* published the most articles in the final four years. *IEICE Transactions on Information and Systems* maintained its fourth-placed ranking throughout. IEICE stands for the Institute of Electronics, Information and Communication Engineers, which is a Japanese academic association that publishes journals and transactions in English, as well as in Japanese. Several Japanese groups have begun to publish papers in English, but they tend to choose international journals published by Japanese associations. Thus, researchers might choose a Japanese association publisher as the first step toward publishing in international journals. *International Journal of Molecular Sciences*, which is an international open access journal, was also the top-ranked journal in some years, and some researchers prefer to publish in open access journals. It can be seen from Table 3 that *Journal of Computational Physics* was ranked first or second in terms of the number of articles published from 2013 to 2017, *Journal of Chemical Theory and Computation* was ranked first or second from 2017 to 2020, and five of the eight most popular journals were published by the IEEE. No journal maintained its top ranking throughout the decade. The rankings of journals publishing NSF-funded articles were even more inconsistent, with no journal maintaining a high ranking throughout the decade. This indicates that NSF-funded projects are more varied. *IEEE Access* was the only journal ranked in both groups. Journal articles resulting from NSF-funded research projects appeared in a more diverse range of publications than those resulting from JSPS-funded research projects.

We also examined the number of conference papers published as a result of JSPS- and NSF-funded research projects. Most papers resulting from JSPS-funded research projects were published in *Lecture Notes in Computer Science*, followed by *Proceedings of SPIE*, which publish the proceedings of various international conferences. Papers were also published in *Procedia Computer Science*, the *ACM International Conference Proceeding Series*, *Leibniz International Proceedings in Informatics*, and *CEUR Workshop Proceedings*. The Scopus database is not as useful for the analysis of conference proceedings because of the aggregation across publishers. Thus, we did not undertake any further analysis of conference proceedings.

Table 2. Most Popular Journals for JSPS-funded Articles.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
IEICE Trans. Fundamentals	35	44	53	55	73	52	56	35	65	51
IEICE Trans. Inf. & Syst.	22	31	36	37	61	65	72	59	71	79
Int. J. Mol. Sci.	5	25	39	26	49	60	102	148	180	212
IEICE Trans. Commun.	27	34	25	19	32	26	24	33	43	23
IEEE Access	NA	NA	NA	3	10	13	41	60	120	123
Applied Sciences	NA	NA	NA	NA	2	8	22	65	64	92
Total	722	1048	1197	1220	1370	1520	1800	1998	1939	2000

Table 3. Most popular journals for NSF-funded articles.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
IEEE Trans. Inf. Theory	124	86	59	41	40	40	47	22	28	35
IEEE Trans. Signal Process.	85	65	38	43	40	48	56	42	41	18
J. Comput. Phys.	77	46	66	99	92	76	65	50	38	53
PLoS Comput. Biol.	49	65	72	72	97	72	41	33	28	26
J. Chem. Theory Comput.	13	32	61	75	65	69	66	63	61	65
IEEE Trans Smart Grid	11	26	17	19	24	25	29	61	43	53
IEEE Internet Things J.	NA	NA	NA	2	1	7	34	31	62	46
IEEE Access	NA	NA	1	4	7	20	43	37	58	44
Total	1975	1960	1950	1957	1961	1958	1964	1925	1932	1953

5   Conclusion

We analyzed the number of authors, combinations of collaborating authors' countries, and popular journals in relation to the publication of journal articles and conference papers resulting from funded research projects. The results showed that the numbers of authors jointly publishing journal articles resulting from JSPS-funded research is increasing, but this is not the case for conference papers. Thus, this requires further analysis. Regarding the combinations of collaborating authors' countries, we found that authors participating in JSPS-funded research projects are increasingly collaborating with China, and are increasingly tending to publish in a diverse range of English-language journals published by Japanese associations. From these results, Japanese-funded research projects are reacting to the part of fund agency expectations.

In this study, we used Scopus bibliographic data, and conducted data cleaning as described in Sect. 3. These data might still contain errors, however, we intend to make these data available to the public to the extent that this does not breach the Scopus guidelines.

The results of this study raise several questions regarding the funding of research projects that are worthy of further investigation. For example, the influence of gender on research projects and publications [12] would be interesting to examine if such data are available, and it would also be worth investigating the differences between various types of research funding. We are also interested in exploring the research topics that various funding agencies are focused on, regardless of whether they express their interest implicitly or explicitly. The analysis of research topics between both funded research projects over the decade would be a next step. We plan to conduct topic analysis in an effort to identify the major research topics in Japan and the USA. Previous studies have conducted topic analyses using topic modeling [13–15]. Our aim is to apply the latent Dirichlet allocation model to titles and abstracts of publications to enable a more in-depth analysis.

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