Are there factors that influence the quality of funding acknowledgements in publications?

Torger Möller*, Barbara Scheidt** and Andreas Meier***

*moeller@dzhw.eu, ORCID: 0009-0003-9753-8295
German Centre for Higher Education Research and Science Studies (DZHW), Germany
** b.scheidt@fz-juelich.de;
Juelich Research Center, Central Library, Germany
*** a.meier@fz-juelich.de
Juelich Research Center, Central Library, Germany

It is crucial for funding acknowledgement analyses that the funding data in the bibliometric databases is of high quality. One factor for data quality is to what extent the funding recipients fulfill their obligations and acknowledge the funding in their publications. This question has hardly been investigated to date. A data set of 32,640 publications from final reports of research projects of the German Research Foundation (DFG) was used to investigate the factors that influence the quality of funding information. Some of the factors are personal characteristics of the applicants (age, first application), number of co-authors, international collaborations, affiliation, discipline, open access status, PP top10%, length of the funding text and publication year. The results show that more than 90% of publications correctly named the DFG as the funding body, while the correct project number is less named (66%). However, the quality of funding increases over the years (2012-2020).

1. Introduction

Research is supported to a large extent by third-party funding.[1] In some countries, more than 10% or even 20% of domestic publications can be traced back to a single research funder (Möller 2019). Although we know that research funding plays an important role in publication output, it is unclear whether the bibliometric data adequately reflects the level of funding. Do funding organizations have an even greater influence on publication activity? To what extent do the grantees acknowledge the funding in their publications? Do they meet the requirements of the funding organizations to indicate the funding source? And are there any factors that influence the funding acknowledgement (FA) practices? The answers to these questions are of crucial importance for assessing the overall quality of bibliometric funding acknowledgement analyses but have hardly been investigated so far. The reason for this is that these questions cannot be answered purely bibliometrically, but only by using additional data that needs to be collected from other sources.

One possibility is to ask researchers about their funding acknowledgement practices. In 2016, the German Center for Higher Education Research and Science Studies (DZHW) conducted an online survey of German academics (n=4,844, Neufeld and Johann 2016). The result is that most researchers always (79%) or usually (15%) mention the funding source in their publications. Only six percent state that they rarely (4%) or never (2%) do so. According to this finding, the data basis for the bibliometric funding acknowledgement analyses appears to be not perfect, but nevertheless good. However, it is known from bibliometric studies that grantees use a variety of spellings of the research funder's name that do not correspond to the official names (Álvarez-Bornstein and Montesi 2021). This makes it difficult to identify the funded publications in the bibliometric databases.

---

[1] Own calculation based on the databases of the German Competence Network for Bibliometrics (https://bibliometrie.info/en/, snapshot July 2023).

For instance, in one year, more than 6,000 spellings were found for the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) in the funding organization field of the Web of Science (Möller 2019; Sirtes 2013). Apart from the official German and English names, the DFG has many other variants, e.g. "German Research Council", also combined with various names of funding programs. In addition, the grant numbers also differ substantially. The example shows that even if the researchers assume that they have claimed the funding source correctly, this does not always correspond to the requirements of research funders. The diversity of the funding acknowledgements leads to a data collection challenge for bibliometric studies.

Another approach to obtain information on the quality of funding acknowledgements is to examine publications that were the outcome of funded projects, e.g. from the final reports submitted by the grantees. Such an approach was pursued over ten years ago with data from the Austrian Science Fund (FWF) (Costas and Yegros-Yegros 2013; van Wijk and Costas-Comesaña 2012). The FWF provided 3,198 bibliographic records with publication year between 2009-2010. 2,437 publications could be identified in the Web of Science (WoS) and 72% of them had an FWF-funding acknowledgement (Costas and Yegros-Yegros 2013). Therefore, no FWF funding could be found for 28% of the publications. Compared with the findings of the online survey above, this is a less good result. However, a comparison is difficult as both the research approach and the period of investigation (2009-10 and 2016) are different. In particular, the funding acknowledgement coverage in WoS has improved significantly in recent years (Clarivate 2022).

A central aim of this paper is to provide new insights into the quality of the funding acknowledgment in publications based on more recent and more comprehensive data. To what extent is the research funder as well as the grant number mentioned in the funding text of the WoS? Are there factors that influence the quality of the funding acknowledgements and grantees' compliance with funders' requirements?

2. Method and Data
The analyses are based on publications (2012-2020) from funded projects, which were reported to the German Research Foundation (DFG) by the funding recipients in their final reports. To gain access to bibliometric funding information, these publications were matched with the Web of Science (WoS)[2]. As the aim of the project was to investigate the acknowledgement practices of researchers, only publications with funding information were considered. The majority of publications were matched by the DOIs. In a considerable number of publications from the final reports the DOIs were missing. For those a step-by-step comparison of the titles in combination with the source information led to further hits. A total of 47,838 publications from the final reports of DFG projects were found in the WoS. As some publications are the result of research collaborations between DFG projects, the total number of publication-project links is 52,313 (Meier et al. 2023). In this paper, we focus on a subset of 32,640 publication-project links of the DFG's standard funding program ("Sachbeihilfe"), as the data quality and richness are significantly better than in the overall publications set and the results are therefore more reliable.[3]

---

[2] WoS database dump in the infrastructure of the Competence Network Bibliometrics dating from April 2022: Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI), Arts & Humanities Citation Index (AHCI), Index to Scientific & Technical Proceedings (ISTP) and Index to Social Sciences & Humanities Proceedings (ISSHP).

[3] This is around 46 percent of the 70,055 publications from all final reports of the hole sample.

We developed a funding acknowledgment Quality (FA Quality) indicator. It measures the extent to which the funding recipients have complied with the DFG requirements for funding acknowledgment. Since 2006, the DFG has been asking grant recipients to acknowledge the funding in their publications. From 2011, the form of DFG funding acknowledgement became mandatory and was further specified in 2015 ("funded by the German Research Foundation (DFG) – project number(s)"). The funding acknowledgment quality indicator distinguish between two dimensions and three quality classes in our analysis: i) the naming of the DFG as a research funder and ii) the naming of the project identifier, hereinafter referred to as grant number. Each dimension is analyzed separately. The three quality classes are:

- compliant naming,
- non-compliant naming,
- not mentioned.

DFG
The official German and English names of the DFG ("Deutsche Forschungsgemeinschaft" and "German Research Foundation") are classified as compliant names. The use of the acronym DFG was also classified as compliant. It was checked whether the abbreviation DFG could refer to another international funding body or another research program. The non-compliant naming includes, on the one hand, non-official spelling variants of the DFG, such as "Deutsche Forschungsgesellschaft", "German Science Foundation", "German Research Council" or "German Science Society". If neither a compliant nor a non-compliant entry could be found, the category "not mentioned" was assigned.

Grant Number
It is considered as "compliant" if the grant recipients have indicated at least one of the two possible correct DFG grant numbers of their project.[4] If there are clear deviations from the DFG specifications in the alphabetical or numerical part of the grant number, the category non-compliant naming was assigned. If no valid DFG grant number is provided that refers to the respective funded project, the category "not mentioned" was assigned.

3. Results

3.1 FA quality – descriptive analysis
The above FA quality indicator were applied to the 32,640 project-publications.[5] The two dimensions (naming the DFG as the funder and the grant number of the respective project) and the three quality classes (compliant naming, non-compliant naming, and not mentioned) result in a nine-field matrix that shows the various possible combinations (Table 1). The blue bars show how the individual combinations are distributed. The summed row and summed column results (bold) indicate that the DFG (90.6%) was named compliant more frequently than the grant numbers (65.6%). It seems to be more difficult for grantees to correctly state the grant number. This may also be due to the fact that there were two different grant numbers: alphanumeric numbers in particular are more prone to errors than the nine-digit grant numbers introduced since December 2015. In 8.4% of the cases the grant numbers were classified as non-compliant. In just around a quarter of cases (26.1%), no grant number was given.

---

[4] There are two different project identifiers for the investigation period: the personal reference number (2011-2015), consisting of letters, numbers, and symbols and a nine-digit project number (introduced in the end of 2015).
[5] Methods from the field of natural language processing (including regular expression (regex)) were used. The programming was done in Python.

Table 1: Occurrence of DFG and grant number in publication data set
(Percentages of total, n = 32,640)

		grant number			
		compliant	non-compliant	not mentioned	sum
DFG	compliant	64,1%	8,0%	18,5%	**90,6%**
	non-compliant	1,3%	0,2%	0,3%	**1,9%**
	not mentioned	0,1%	0,2%	7,3%	**7,6%**
	sum	**65,6%**	**8,4%**	**26,1%**	**100,0%**

Figures 1 and 2 show the overall results from Table 1 over time. While the respective FA quality shares for naming the DFG are relatively stable, albeit with slightly increasing values, there is a substantial increase in the compliant naming of the grant number from around 60% (2012) to 80% (2020).

Figures 1 & 2: Occurrence of DFG and grant number in publication per year (2012-2020)
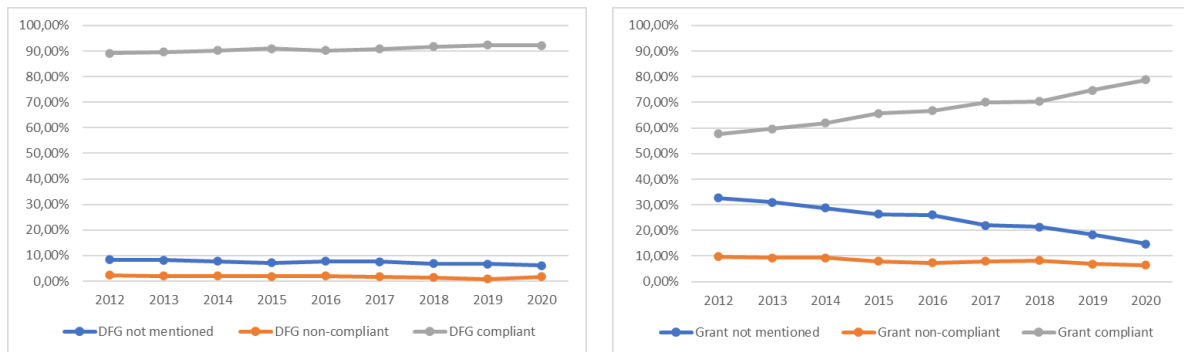
As already explained, the requirements for funding acknowledgement have been modified by the DFG over the years. Whether these changes have had an impact on the naming of the DFG as a funder has been examined with three temporal considerations, the year in which funding began, the year of publication and the year from which the final report dates. 98% of publications have a start date for project funding from 2006 onwards. While the FA quality 'compliant' for the DFG naming has remained stable at around 90.5% since 2006, the proportion of compliant mentions of the grant number is significantly lower with an average of 65.8% but has improved over the years with some fluctuations from 59% in 2006 to 69% in 2015 (Figures 1&2). Due to very low publication numbers, the analysis shows strongly deviating shares of the respective FA quality for the year of the start of funding in 2018 compared to the trends of the other years and has therefore been excluded from the analysis. Depending on the publication year, the FA quality of the grant number also improved considerably over the time: since 2012, the proportion of compliant mentions has increased from 58% to 79% (2020). At the same time, the proportion of publications without naming a grant number at all has decreased from 33% in 2012 to 15% in 2020. Looking at the FA quality from the perspective of the years of the final reports, a similar development can be observed (albeit at a somewhat lower level): the proportion of compliant naming of grant numbers improved from 54% in 2012 to 69%, while at the same time the proportion of publications without mentioning a grant number fell from 30% to 22%.

In the DFG's four scientific disciplines, the compliant naming of the DFG ranged from 90% in the Life Sciences to 91% in the Natural Sciences, Humanities and Social Sciences and 92% in

the Engineering Sciences. The compliant naming of the grant number is lowest with 64% for the Natural Sciences, and best for Humanities and Social Sciences with 72%.

The analysis of a total of 14 subject areas reveals that the compliant naming of the DFG is lowest in the humanities (85%) and highest in mechanical and production engineering (94%), thermal engineering/process engineering and materials science and engineering (93% each). With a remarkable proportion of 74%, the social and behavioral sciences have the highest proportion of compliant naming of the grant number, with the lowest proportion mechanical and production engineering (31%).

The younger the applicants are, the better the quality of the FA, both in terms of compliant naming of the DFG and the grant number but the FA quality of naming the DFG does not improve for the first-time applicants. 17% of the publications in our data set were done by first-time applicants. Regarding the grant number the compliant rate is 70% for first-time applicants and 60% for non-first-time applicants. Open Access status of a publication hardly influences FA quality. The type of institution (university, non-university research institution, companies etc.) reveals little differences on the FA quality in naming the DFG. Only universities have a higher proportion for the compliant naming of the project number.

The existence of international co-publication partners decreases the FA quality, and other funding organizations mentioned in the funding section also have a negative influence, at least regarding the compliant naming of the grant number. As the number of authors increases, the compliant naming of DFG and grant number decreases. If the applicants of a DFG-funded project are co-authors of the publications the proportion of compliant naming of the DFG and the grant number is higher.

3.2 FA quality – regression model
Figure 3 shows the various factors already discussed above in an ordinal regression model. The negative impact of international collaborations is evident in naming the DFG and the grant number. The less compliant acknowledgment of DFG might be due to a lack of knowledge or miscommunication among the (international) co-authors.

Universities show a significantly positive influence on the naming of DFG. Most of the DFG funding is directed towards universities, therefore a well-established practice of funding acknowledgment might be the case. First time applicants show slightly better results than experienced applicants. New compliance guidelines might be more present for first-time applicants. Funding acknowledgment of the DFG is also better when several funders are mentioned while the quality of the grant number decreases under these circumstances. Multiple funding might increase the awareness of naming all funding organizations but lead to neglect further details like the grant numbers. Disciplines show little to no differences on the FA quality.

Age shows a significant influence on the naming of DFG and grant numbers: The youngest cohort tends to mention funding more frequently than the oldest cohort. If the applicants are also co-authors, the FA quality in naming the DFG and the grant number is significant higher. It seems that the funding acknowledgement compliance is more important for the applicants than for the researchers, who are employed in the project. However, the findings may also indicate a communication problem between the principal investor and employees. The regression analysis also shows little to no influence of the open access status. An increasing

number of authors has a negative impact on the acknowledgment: this fact indicates that there might be some communication issues between the authors.

An interesting finding is the negative influence on the naming of DFG and grant numbers of publications with a higher citation impact. The length of the funding text seems to have a positive influence on the mentioning of the grant number but not necessarily on the naming of DFG.

Figure 3: Ordinal regression – Coefficient plot
(dependent variables FA quality in naming the DFG and the grant number)
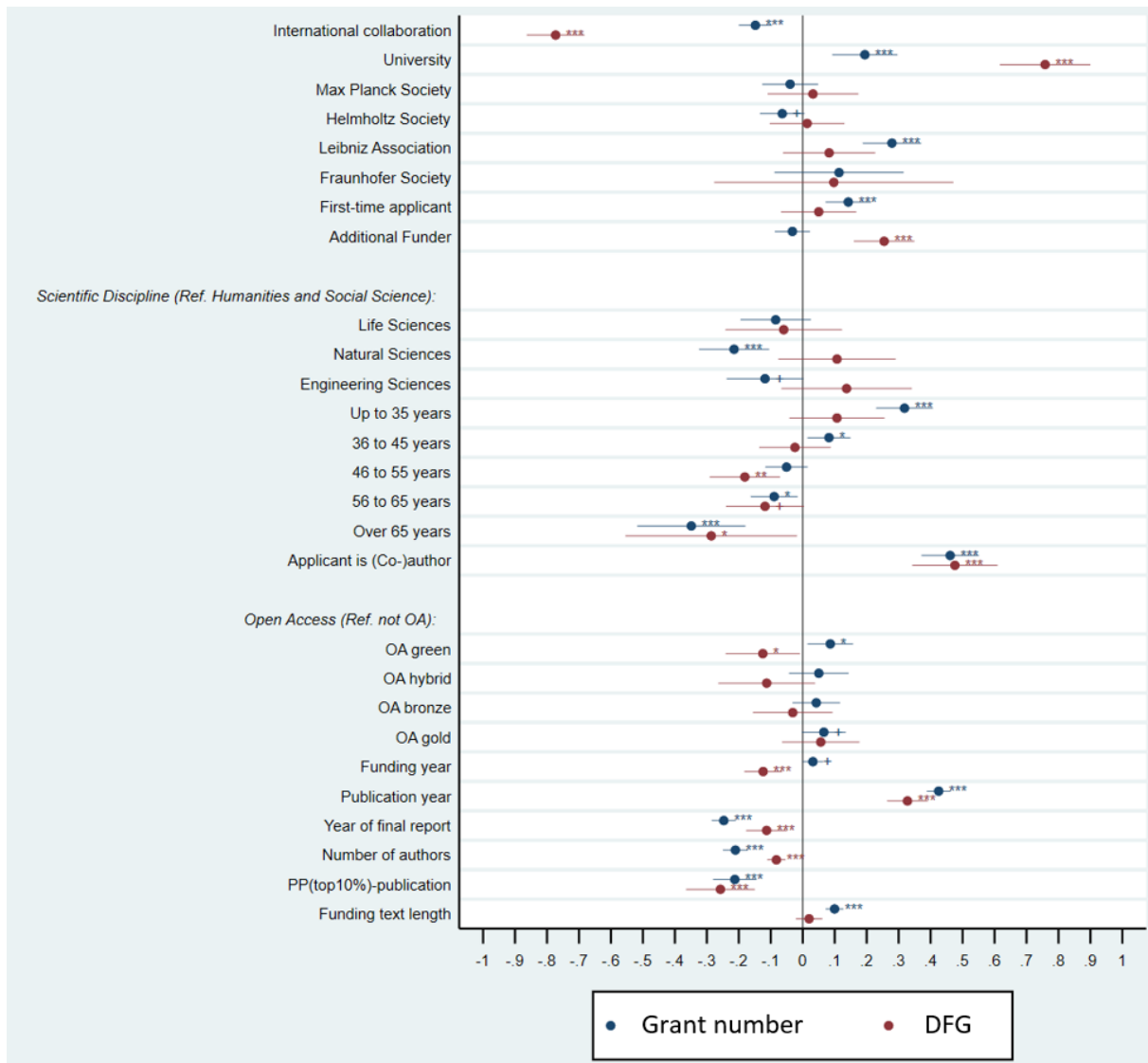
4. Discussion

Various factors influencing funding acknowledgement quality were examined using an ordinal regression model. In particular, the influence of the applicants has been evident: both the age at the time of application is relevant (the younger, the better the FA quality of the funding number) and the involvement in the publication process (if applicants are also co-authors). The overall number of authors or international collaborations have a negative influence on the naming of project number. Differences between the disciplines are less apparent, except for the natural sciences with a significantly lower FA quality of the grant number. The descriptive analysis of

the 14 subject areas shows some differences in the quality of FAs. First-time applicants and younger applicants tend to comply better than older applicants.

Some findings of the regression analysis, such as the significantly negative influence of the funding year (naming DFG) and the year of the final report (naming DFG and grant number), are unexpected and require further investigation. Especially since the DFG has more specific guidelines for funding acknowledgment developed over the last years.

Overall, the results show that the quality of the funding acknowledgement in the bibliometric database WoS is relatively good regarding the naming of the research funder itself. The DFG was compliant and non-compliant named as the funding body in 93,4% of publications. However, the compliant and non-compliant naming of the grant number is considerably lower (73,9%), but a positive trend can be observed from 2012 to 2020. The finding indicates that bibliometric analyses of funding acknowledgements are becoming more and more reliable.

Open science practices
One of the sources that was used in this study was GEPRIS[6] which is open database on research funding of the DFG. Nevertheless, the data was complemented with personal data and is therefore not publicly available due to data protection. Web of Science is another source that was used. The data is proprietary and therefore not publicly accessible without a license. The report provided to the DFG is publicly accessible (see Meier et. al 2023).

Author contribution
The funding acquisition, conceptualization, investigation, analysis, visualization, and writing (draft, review, and editing) were performed by all three authors.

Competing interests
The authors have no competing interests.

References
Álvarez-Bornstein, B., & Montesi, M. (2021). Funding acknowledgements in scientific publications: A literature review. *Research Evaluation*, 29(4), 469–488. https://doi.org/10.1093/reseval/rvaa038

Clarivate Analytics (2022): Web of Science™ Core Collection. XML User Guide.

Costas, R., & Yegros, A. (2013). Possibilities of funding acknowledgement analysis for the bibliometric study of research funding organizations: Case study of the Austrian science fund (FWF). *Proceedings of ISSI 2013 - 14th International Society of Scientometrics and Informetrics Conference 2*, 1401-1408.

---

[6] https://gepris.dfg.de

van Wijk, Erik, and Rodrigo Costas-Comesaña (2012). *Bibliometric Study of FWF Austrian Science Fund 2001-2010/11*. Zenodo. doi: 10.5281/ZENODO.17851.

Meier, Andreas, Bernhard Mittermaier, Torger Möller, Matteo Ottaviani, Barbara Scheidt, and Stephan Stahlschmidt. 2023. *Publikationen aus DFG-Geförderten Projekten – Praxis und Nutzbarkeit von Funding Acknowledgements*. ssBonn: DFG. https://www.dfg.de/resource/blob/328034/97029dd115220cea690ad66bd4172e30/studie-funding-acknowledgements-data.pdf

Neufeld, J., & Johann, D. (2016). Wissenschaftlerbefragung 2016. Methodenbeschreibung und Fragebogen. Hannover/Berlin: DZHW.

Möller, T. (2019). The Impact of Research Funding Agencies on the Research Performance of five European Countries – A Funding Acknowledgements Analysis. *Proceedings of the 17th International Conference on Scientometrics & Informetrics (ISSI)*, 2279–2287.

Sirtes, D. (2013). Funding acknowledgements for the German Research Foundation (DFG). The dirty data of the web of science database and how to clean it up. *Proceedings of the 14th International Society of Scientometrics and Informetrics Conference*, 1, 784–795. http://www.forschungsinfo.de/publikationen/Download/SIRTES_ISSI_2013_DFG_FUND_ACK.pdf