# Disclosing funding sources for open access publication fees: the Open APC initiative

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## ABSTRACT

Publication fees in open access publishing hold a prominent place on the agenda of researchers, policy-makers, and academic publishers. This paper contributes to the evolving empirical basis on open access funding. It describes the Open APC initiative, in which German universities and research organizations share their expenditures for publication fees. As method, the initiative uses existing open data tools to aggregate and disseminate institutional spending on open access publication fees. In total, 29 German research organizations self-reported funding of 6,279 open access journal articles, which amounted to 8,039,339 €. The average payment for each article was 1,280 €, and the median payment 1,209 €. Our data-set comprises only 53 articles in hybrid journals. With an indexing coverage of 99 %, the findings reveal that the DOI agency CrossRef provides both comprehensive bibliographic coverage of the funded open access journal literature and disambiguated names of journal titles and publishing houses. We show that authority control of these bibliographic information is particularly relevant for the comparative study of the economical effects of open access publishing.

Keywords: Open access, open access journal, scholarly publishing, publication fees, article processing charges, science policy

## INTRODUCTION

### General Background

The rise of open access journals matches the increasing relevance of publication fees in academic publishing (Davis and Walters, 2011; Laakso and Björk, 2012; Pinfield, 2015). To cover these fees, also referred to as article-processing charges (APC), authors tend to make use of funding that grant agencies or academic institutions provide (Suber, 2012). Yet, how and to what extent these research support activities are effective in terms of the number of supported articles and associated costs remains under debate.

The study of institutional spending on open access journal articles has been limited for several reasons. One is that payment on these charges is fragmented across the budgets of grant agencies, research institutions, and libraries, or is covered by personal budgets. Asking 9,645 authors from various disciplines how they financed publication fees, a comprehensive survey in 2010 revealed that the majority of the respondents had access to research funding or institutional support to cover these charges. By contrast, 12 % paid publication fees individually (Dallmeier-Tiessen et al., 2011). These findings are consistent with that of other studies, adding that sources of funding mostly exists in higher income countries, mainly to support research articles in the bio- and physical sciences (Solomon and Björk, 2011). Personal budgets, on the other hand, are likely used to cover low price publication fees (Björk, 2015; Solomon and Björk, 2011).

Another key problem in this regard is that funding for open access journals using publication fees lacks transparency because the parties involved - authors, universities, funders, publishers - neither release information on who pays for what nor the costs of publishing (Björk and Solomon, 2014), a situation similar to the lack of transparency regarding journal subscriptions (Lawson and Meghreblian, 2015). Empirical studies examining publication fees so far obtained price estimates by surveying authors (Dallmeier-Tiessen et al., 2011), or from journal websites. Using the latter method, two studies investigating journals across a broad range of disciplines calculated similar price averages that ranged

between 904 $ (Solomon and Björk, 2012) and 923 $ (Walters and Linvill, 2011), as well as considerable price variances across journals and publishers. Accordingly, Solomon and Björk (2012) suggested to cluster fully open access journal using publication fees into several groups. In descending order, these are high-impact journals, followed by biomedicine journals from commercial publishers, large multi-disciplinary journals, and mid-price journals from commercial publishers covering a large spectrum of disciplines. Lower priced journals were published by academic societies and by publishers from low-income countries.

Nevertheless, it remains unclear which factors contribute to pricing in academic publishing. Generally, these might include article processing, impact, rejection rates, management and investment, and profit margins (Noorden, 2013). While fixed prices for individual articles are common, agreements between publishers and institutions can lead to discounts, and publishers sometimes waive publication fees for authors from low-income countries (Björk and Solomon, 2012; Lawson, 2015c). Other factors leading to variable pricing schemes include submission or page charges (Björk and Solomon, 2012).

Hybrid journals substantially add to this complexity of open access funding (Björk and Solomon, 2014; Kingsley, 2014; Pinfield et al., 2015). These journals, allowing articles to be published immediately as open access after a charge was paid, rely both on subscriptions and publication fees as revenue sources. Although the uptake of open access through hybrid journals was described as lower and more expensive compared to that of fully open access journals (Björk and Solomon, 2014; Solomon and Björk, 2012), this model has gained increasing attention because of recent open access science policies, notably from the UK (Pinfield, 2015).

To address these problems of fragmented spending on publication fees and of in-transparency about what was being paid, some European research funders and research performing institutions have recently begun to disclose their payment for publication as open data. To our knowledge, the first research funders providing such data were the Wellcome Trust (Kiley, 2014) and the Austrian Science Fund FWF (Reckling and Kenzian, 2014). The not-for-profit company Jisc followed by collecting data from UK universities (Lawson, 2015b). Disclosed as publicly available spreadsheets, these data-sets self-report expenditure along with bibliographic information, including title, journal and publisher, and a persistent identifier to the publisher's version. Curatorial efforts focused on the disambiguation of publisher and journal titles as well as on detecting duplicates and persistent identifiers to the full text including the Digital Object Identifier (DOI) (Neylon, 2014; Woodward and Henderson, 2014). Parts of Jisc's cost data was examined by Pinfield et al. (2015). Although the average spending on publication fees remained stable across the universities, they found large price variances, as well as a varying number of articles UK universities supported between 2007 - 2014, being consistent with earlier studies that collected price information from journal websites (Solomon and Björk, 2012).

## Central funding for publication fees in Germany

This paper focuses on how much German universities and research organisations spent on open access publication fees. In Germany, the Deutsche Forschungsgemeinschaft (DFG), the largest German research funder, has strongly influenced how universities manage institutional support for these charges. Before the DFG started to pay for centrally funded publication fees on a pro rata basis through its "Open-Access Publishing" program in 2011, only a few central funds existed (Eppelin et al., 2012). This is similar to the situation described in Canada (Hampson, 2014) or the UK (Pinfield and Middleton, 2012). The DFG has enforced a set of criteria grantees have to comply with (Fournier and Weihberg, 2013), leading to related implementations for open access supporting across German universities. These criteria exclude sponsoring of articles in hybrid journals, and the funding of articles whose publication fee exceeds 2,000 €[1]. Grantees agree not only to pay for APCs, but also to find ways to improve the handling of those financial transactions. This includes central invoicing schemes and memberships, among others, agreed between university libraries and publishers that often lead to a discount on publication fees (Fournier and Weihberg, 2013).

Non-university research organisations, mainly those institutes organised in the Fraunhofer-Gesellschaft, Helmholtz-Gemeinschaft, Leibniz-Gemeinschaft, and Max-Planck-Gesellschaft, are not eligible for this DFG funding program. But in response, some organisations have adopted similar processes to support authors. The Max-Planck-Gesellschaft operates their long-lasting open access activities, including handling spending and publisher agreements centrally, through the Max Planck Digital Library (MPDL) (Schimmer

[1] Guidelines for the funding program can be found here: `http://www.dfg.de/formulare/12_20/`

et al., 2013; Sikora and Geschuhn, 2015), while the Leibniz-Gemeinschaft set up a dedicated open access fund in 2016.

The evolving institutional support structures to cover open access publication fees has led to calls for an unified approach towards supporting open access journal publishing in Germany. The MPDL called for re-allocating subscriptions in favour of financing open access charges in 2014 (Schimmer et al., 2015). The Allianz der Wissenschaftsorganisationen[2], a science policy board representing all major research organisations in Germany, marked price transparency as one way to sustain an "adequate open access publication system" (Bruch et al., 2015). Reflecting Austrian and UK initiatives to share institutional spending on open access publication fees as open data, as well as professional discussions on open access publishing, Bielefeld University Library began to openly share its payment of publication fees in May 2014. After engaging with the working group "Electronic Publishing" of the Deutsche Initiative für Netzwerkinformation (DINI)[3], other German institutions joined under the umbrella of the Open APC initiative soon after (Apel et al., 2014–2014 - ).

### Research question

The aim of the study was to examine how much German universities and research organisations spent on open access publication fees until 2015. Using self-reported cost data from the Open APC initiative, the analysis focused on the amount that was being spent on publication fees, and compared these expenditure with data from related Austrian and UK initiatives, both in terms of size and the proportion of articles being published in fully and hybrid open access journals. We also asked how thoroughly self-reported articles were indexed in Crossref, a DOI minting agency for scholarly literature, and analysed how the institutional spending was distributed over publishers and journal titles.

## METHODS AND MATERIALS

We analysed self-reported cost data released by the Open APC initiative on May 13, 2016,[4] to assess institutional spending on open access publication fees in Germany. In addition to administrative data about the amount paid per article including value added tax, the reporting institution, and the year of invoicing, we used information about whether an article was published in a fully open access journal or in a hybrid journal as well as the DOI reported in the data-set.

We fetched bibliographic metadata for each article from Crossref on May 19, 2016, on the basis of the reported DOIs. Although the Open APC initiative gathered metadata representing publishers and journals from Crossref as well, this information was retrieved at the time when the participating institutions submitted their expenditure. The Open APC initiative kept track of the date when these data-sets were submitted with Git, a version control system, increasingly used for enabling reproducible research (Ram, 2013), and made this information available via GitHub to be transparent over time. However, during these data collection activities Crossref had regularly updated metadata to represent ongoing mergers of publishing houses. A prominent example in this regard was the merger of the two large publishing houses Springer Business + Media and Nature Publishing Group announced on May 6, 2015, that operated as Springer Nature at the time of our study. To reflect these dynamics in academic publishing, we decided to retrieve updated bibliographic metadata from Crossref, and to merge these records with the administrative information instead of re-using the historical publisher and journal information contained in the Open APC data-set.

As a client, we used the R package rcrossref (Chamberlain et al., 2016), developed and maintained by the rOpenSci initiative[5], to access Crossref's REST API[6]. We requested the XML-based format `application/vnd.crossref.unixsd+xml` in which full and abbreviated journal titles as well as the ISSN media types, the International Standard Serial Number used to identify journals, were distinguished. It also contained normalised publisher information, thus avoiding confusion about naming of publishing houses other studies were faced with when working with self-reported data (Woodward and Henderson, 2014). In cases where no bibliographic information could be obtained, we used the Open APC values. Because Crossref was not the only registration agency for DOIs, but also the agencies DataCite

[2] `http://www.dfg.de/en/dfg_profile/alliance/index.html`
[3] `http://dini.de/english/ag0/e-pub0/`
[4] `https://github.com/OpenAPC/openapc-de/tree/v2.4.3`
[5] rOpenSci: `https://ropensci.org/`
[6] `https://github.com/CrossRef/rest-api-doc/blob/master/rest_api.md`

and Medra minted DOIs for scholarly work, we furthermore obtained the DOI agency for each article with the help of the rcrossref client.

Data collection also involved obtaining cost data from related open data initiatives. To compare self-reported spending on open access journal articles by Germany universities and research organisations with that of other initiatives, we consulted the openly available data-sets from the the Austrian Science Fund FWF (Reckling and Rieck, 2015; Rieck et al., 2016), Jisc (Lawson, 2015a, 2016) and the Wellcome Trust (Kiley, 2015, 2016). For analysis, we obtained the overall publication fee spending on both fully and hybrid open access journal articles. In the case of FWF, we gathered the cost information from the accompanying spending reports. We used the spreadsheet data to calculate Wellcome Trust's and Jisc's spending, and converted the prices from GBP to Euro in accordance with the average foreign exchange reference rates provided by the European Central Bank. Our comparison of the open data initiatives focussed on the last two years 2014 and 2015. Because Wellcome Trust's spending was reported for the fiscal periods 2013 - 2014 and 2014 - 2015, we referred to the average exchange rates of the full two-year period as we could not determine the actual invoicing dates from the data. We excluded articles from the analysis for which information about the cost or the journal type was missing. In the case of Jisc's 2014 data (Lawson, 2015a), for instance, we excluded spending on 2,812 publications that amounted to 4.861.772 € from the analysis because no publication type was given in the data-set.

Data curation activities of the Open APC initiative and those of the other initiatives differed in some aspects. For instance, whereas the DOI was a mandatory element in the Open APC data template that the participating institutions were required to report, in case of the Wellcome Trust spending data, DOIs were also being identified by automated compliance checks. Our first screening of the data-sets revealed that some articles published in Crossref-indexed journals lacked a DOI. Because of these different methods to curate the cost data, and as our main focus was institutional funding for publication fees in Germany, we decided to only compare German APC spending with that reported by other initiatives. We, therefore, did not analyse the distribution of spending over publishers and journal titles, or the indexing coverage in Crossref for the Austrian and UK spending data.

# RESULTS

## Cost Data

After excluding payments being made for non-journal articles as well as articles invoiced in 2016, we retrieved 7,417 open access journal articles 30 German universities and research institutions financially supported between 2005 and 2015. As illustrated in Figure 1, payments made for open access journal articles increased over the years. While one institution supported 5 articles in 2005, most institutions included in our study shared their expenditure from 2013 onwards. With 1,999 articles, the year 2015 was best represented. However, at the time of analysis, not all, but 27 institutions contributed cost information, suggesting a time lag between payments made and reporting these spending to the Open APC initiative.

**Figure 1: Growth of Open APC Initiative**

Among all articles, fees amounted to 9,627,537 € including VAT, the average payment was 1,298 € and the median value 1,231 € . Figure 2 presents the distribution of institutional spending on publications. We observed that 6,996 (94%) of the publication fees were paid in accordance with the DFG price cap of 2,000 €. Most payment on publications ranged between 1,000 - 1,250 €.

**Figure 2: Distribution of institutional spending on publication fees by German research organisations**

**Figure 3: Institutional spending on publication fees by German research organisations per year**

Figure 3 presents institutional spending per article and year. Large price variations could be observed. Publication fees that were paid by the German universities and research organisations ranged between 40 € and 7,419 € (SD 486). However, the average price paid varied somewhat during the period 2011 and 2015 (1239 - 1423 €).

The number of APC payments per institutions varied considerably (see Table 1). With 2,856 reported articles, the Max Planck Society contributed 39 % of the overall article volume. By contrast, for several universities that only recently begun to set up centrally managed open access funds to cover publication fees we observed a lower number of support for open access journal articles.

**Table 1: Institutional spending on open access publications (in €)**

## Comparision of related cost data-sets

Table 2 compares Open APC spending data with that of the Austrian FWF, as well as with Jisc's and Wellcome Trust's expenditure. Prices were converted according to the average Euro exchange rate of the examined periods, and gathered for both fully and hybrid open access journals. The comparison revealed that the Open APC initiative lacked cost information about hybrid journals, whereas the related Austrian and UK open data initiatives reported a large share of spending on these journals between 2014 and 2015. Over the years 2005 – 2015, 3 out of 30 German universities and research institutions reported 60 hybrid journal articles to the Open APC initiative, representing 0.81 % of the overall supported article volume. In terms of the number of supported articles and the amount being spent on publication fees, by contrast, the Open APC data-set provided the most comprehensive price information for fully open access journals compared to what the Austrian and UK initiatives had reported.

Comparison of average prices suggests that publishing in hybrid journal was more expensive than in fully open access journals. Price differences between these two categories were also reported earlier, indicating that prices for fully open access journals were on average lower (Pinfield et al., 2015; Solomon and Björk, 2012). In 2014 and 2015, the mean price for fully open access journals calculated from all data-sets was below the DFG price cap of 2,000 €.

## Crossref indexing

To identify publication fee spending on the article-level, as well as to gather bibliographic metadata, DOIs were a mandatory part of the Open APC initiative's data collection activities. The participating institutions reported DOIs for 7,373 out of 7,417 articles. Using these DOIs, we retrieved additional metadata from Crossref for 7,346 publications, representing 99 % of the total article volume. Articles for which no metadata could be obtained, were registered with the DOI agency DataCite (10 articles) or Medra (two articles). For eight articles, our parser could not gather the XML resource, although these publications were registered with Crossref at the time of our study. Seven DOIs reported to the Open APC initiative did not resolve.

## Cost data by publisher and journal

We used the DOI to automatically fetch publisher and journal names for each article from the Crossref REST API. Table 2 shows the top ten publishers in terms of payments made. They represented 92 % of the overall spending on publication fees. In total, payments were made to 139 publishing houses. In comparison with data from the UK, a greater share on total spending of some open access publishers could be observed. Pinfield et al. (2015), for instance, reported remarkably lower numbers for the open access publishers MPDI, Copernicus, and Hindawi.

**Table 2: Publication fees paid per publisher (in €)**

Most of publication fee spending in Germany was on articles published in Springer Nature journals, likely profiting from the merge with the open access publisher BioMed Central in 2008, and that between the well-established publishers Springer Science + Business Media and Nature Publishing Group in 2015. Using the Crossref-Member-ID instead of the publisher name, we were able to differentiate between journals formely published by Springer Science + Business Media and Nature Publishing Group. In terms of articles, the majority of payments made were for publications in journals formerly associated with Springer Science + Business Media. Springer Science + Business Media journals accounted for 2,027 articles, representing 94% of the overall Springer Nature article volume recorded by the Open APC initiative, and 92 % in terms of the amount being spent. Median publication fee spending slightly differed between Springer Science + Business Media (1,355 €) and Nature Publishing (1,386 €). However, price variation was higher for Nature Publishing journals (SD = 848€) compared with that of the former Springer Science + Business Media titles (SD = 313 €).

In contrast to Springer Nature, other well-established publishing houses such as Elsevier and Wiley-Blackwell ranked lower in our analysis.

**Table 3: Publication fees paid per journal (in €)**

Prices also varied within journals. Based on the number of articles paid for, Table 3 illustrates the top ten out of 732 journals. We normalised PLOS journal titles, because the name chnages from "PLoS" to "PLOS" was only partly represented in the Crossref metadata at the time of our study. Payments to the top ten journals represent 45 % of the overall expenditure. The multidisciplinary journal PLOS ONE and the journals New Journal of Physics, Atmospheric Chemistry and Physics Discussions and Frontiers in Psychology, all of which publish contributions from all branches of their respective discipline, were also

well represented in the Open APC data-set. In general, an estimated 14 out of more than 10,000 journals registered in DOAJ in 2015 accounted for up to 15–20 % of all articles published in fully open access journals (Björk, 2015) In the case of Atmospheric Chemistry and Physics Discussions, the large price range can be explained by the fact that this journal charges per page and also takes the submission's file format into consideration.

## DISCUSSION

In Germany, institutional spending on publication fees charged by open access journals has increased over the years. These findings are consistent with the general trend of publication fees as revenue source for open access publishing (Davis and Walters, 2011; Laakso and Björk, 2012; Pinfield, 2015). They also reflect the evolving institutional support to cover these charges in Germany (Fournier and Weihberg, 2013). Similar to investigations of the expenditure on publication fees at an institutional level in the UK (Pinfield et al., 2015), spending size varies across the German universities and research organisations included in the Open APC initiative. With a proportion of 39 % of the overall article volume, the Max Planck Society, a large non-university research organisation, supported most open access journal publications. This likely reflects the centralised library support at the Max Planck Society where the Max Planck Digital Library has managed large open access agreements with publishers over the last decade (Schimmer et al., 2013, Sikora and Geschuhn (2015)). This presumably not only resulted in a large number of supported articles, but also contributed to an advantage in monitoring and thus being able to report on this data. Many universities and research organisations, on the other hand, reported a remarkably lower number of supported articles.

To answer data curation issues while unifying UK spending data (Neylon, 2014; Woodward and Henderson, 2014), re-using DOIs to gather bibliographic metadata from Crossref is a promising approach. In our study, Crossref thoroughly indexed open access journal articles disclosed in the Open APC data-set, providing publisher and journal titles for 99 % of the overall article volume. Making use of metadata from Crossref, therefore, reduces the extensive validation work of bibliographic information provided that the DOI is made available in the cost data. DOI availability is a requirement needed to be addressed in other fields of the quantitative study of scholarly communication as well, such as in altmetrics to deal with heterogeneous data (Haustein, 2016). Drawing on Crossref has the potential to increase the comparability of cost data to prepare future negotiations with publishers on open access agreements, because Crossref's metadata reflects the current landscape of academic publishing in terms of ongoing mergers of publishing houses. Future comparative studies of publication fee spending using data on the article-level also benefit from such an approach.

This study is limited in some respects. One is that we cannot assess whether publishers and journals granted publication fee discounts because the Open APC initiative uses a minimal data scheme to make self-reporting easy, and, therefore, does not track this kind of information. However, large price ranges of particular journals suggests that varying pricing schemes are in place, an observation also made earlier (Solomon and Björk, 2012, Pinfield et al. (2015)). Adding to this complexity, it is likely that some institutions only paid parts of the publication fee. Take for instance the journal Nature Communication. Charges reported to the Open APC initiative ranged between 2000 €, the DFG price cap, and 4.403 €. Although such payments made from several budgets are a proposed strategy to sustain publication funds at German universities (Fournier and Weihberg, 2013), these pro rata amounts cannot be identified as such within the Open APC data, leading to a possibly flawed representations of publication fee spending in Germany. In another case, one university included its contributions to the SCOAPˆ3 consortia and presumably divided the sum by the articles published by their authors in SCOAPˆ3-covered journals.[7] This is very arbitrary, since the mean APC for an institution can only be determined after the end of a full 3-year funding cycle. Other factors affecting price variations are currency movements over the years, and different tax rates in Germany. For instance, the Max Planck Society has a limited input tax reduction. The refund of input value added tax for publication fees is 20%. Local and payment currency, as well as taxes, as suggested by Pinfield et al. (2015) to increase the transparency of publication fee spending, were not disclosed in the Open APC initiative's data-set at the time of our study.

It must also be noted that reporting to the Open APC initiative is voluntary. Therefore, not all institutions in Germany that provide central funding of publication fees contribute cost data to this

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initiative. In a qualitative survey, asking why German institutions are reluctant to share their cost data through the Open APC initiative, one institution feared that an increase in transparency would allow publishers to adjust prices in their favour. Others pointed out that the workload to produce such a data-set could be too extensive (Deppe, 2015). As no reliable registry of institutional open access funds or similar support structures in Germany exists, we cannot assess the number of non-participants in Germany.

Our analysis of how institutional spending per articles was distributed over publishers and journal titles indicates that open access publishing is heterogeneous and concentrated at the same time. While we were able to identify 139 individual publishing houses that were supported by the German universities and research organizations, the distribution is highly skewed. Ten publishers collected 92 % of open access publication fee spending, being consistent with an observed high concentration of few publishers in current academic publishing (Larivière et al., 2015). However, our study could not confirm that publications in open access journals owned by traditional publishing houses account for most of the spending on publication fees as observed by Pinfield et al. (2015). Rather, open access publishers such as Public Library of Science (PloS), Copernicus or MPDI rank higher in our study than in the analyses of cost data in the UK.

One possible explanation why traditional publishers are less well represented in our study, is the lack of cost information about hybrid open access journals. 99 % of the overall article volume German universities and research organisations financially supported were published in fully open access journals. This presumably reflects the DFG funding policy that excludes the support of articles published in hybrid open access journals. However, while reviewing self-reported cost data from funders or countries that also support hybrid open access journals, there are smaller proportions of payment on articles in fully open access journals. Because open access publication fee spending is fragmented and often in-transparent, it remains open to speculation whether authors affiliated with German universities and research organisations avoid opting for open access when publishing in hybrid journals, or simply use other budgets that are not covered by the Open APC initiative.

## CONCLUSION

Our study reveals the size and extent of spending on open access journals using publication fees in Germany. Drawing on self-reported cost data from the Open APC initiative, payments from German universities and research institutions have grown over the years. Comparing these expenditure with those from Austria and the UK, German open access funding is mostly focussed on fully open access journals, raising important questions about the role hybrid open access journals play as publication venue for researchers affiliated with the institutions included in our study. Given our findings and the general discussion on funding policies concerning hybrid open access journals, questions about if and to what extent science policy interventions, as well as the availability of institutional support, influence how researchers publish are of particular concern.

Using self-reported data and gathering publisher and journal information from Crossref, our study extends methods and improves data collection activities for researchers and practitioners alike, as well as contribute to a better understanding of factors affecting the analysis of publication fees in open access publishing. In this regard, our research highlights large variation in the distribution of spending that needs to be taken into consideration when studying payment on publication at the institutional level. We have also confirmed previous studies showing large price variations across publishers and open access journals that need to be better understood in future.

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