

# A “Gold-Centric” Implementation of Open Access: Hybrid Journals, the “Total Cost of Publication,” and Policy Development in the UK and Beyond

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**This paper reports analysis of data from higher education institutions in the UK on their experience of the open-access (OA) publishing market working within a policy environment favoring “Gold” OA (OA publishing in journals). It models the “total cost of publication”—comprising costs of journal subscriptions, OA article-processing charges (APCs), and new administrative costs—for a sample of 24 institutions. APCs are shown to constitute 12% of the “total cost of publication,” APC administration, 1%, and subscriptions, 87% (for a sample of seven publishers). APC expenditure in institutions rose between 2012 and 2014 at the same time as rising subscription costs. There was disproportionately high take up of Gold options for Health and Life Sciences articles. APC prices paid varied widely, with a mean APC of £1,586 in 2014. “Hybrid” options (subscription journals also offering OA for individual articles on payment of an APC) were considerably more expensive than fully OA titles, but the data indicate a correlation between APC price and journal quality (as reflected in the citation rates of journals). The policy implications of these developments are explored, particularly in relation to hybrid OA and potential of offsetting subscription and APC costs.**

## Introduction

One important feature of the current open-access (OA) publishing environment is the coexistence of fully OA journals and “hybrid” subscription-OA journals. While the former, such as journals published by the Public Library of Science (PLoS) or BioMed Central (BMC), produce only open-access articles, the latter, now offered by most established subscription publishers, make particular articles published in subscription journals available on an OA basis,

normally on payment of a fee. Some fully OA journals also charge a per-article fee (commonly termed an article-processing charge or APC), whereas others may be funded through sponsorship arrangements. Although the majority of fully OA journals (72% in 2014) do not charge an APC, the majority of articles published in fully OA journals (59%) are APC funded (Crawford, 2015).

As many research funders, institutions, and other stakeholders adopt policies encouraging OA, and as many authors wish to make their work openly available, they are having to decide on their position in relation to the different “routes” to OA: OA publication in journals (also called “Gold” OA) and deposit in OA repositories (“Green” OA) (Suber, 2012). With regard to Gold, a key policy question faced by funders in particular is their attitude to hybrid journals (Björk, 2012; Solomon & Björk, 2012). With institutions already making substantial subscription payments to publishers, APCs for hybrid journals are often seen as a second payment to the same supplier for its content and therefore perceived to be publishers “double dipping” (Prosser, 2015; Sweeney, 2014). For this reason, a number of research funders, while offering to pay APCs as part of their funding, have excluded hybrid journals from such policies; examples include the European Union Gold OA pilot (OpenAIRE, 2015), the Norwegian Research Council (Frantsvåg, 2015), and the Netherlands Organization for Scientific Research (NWO, 2015).

However, in the UK, since 2012 in particular, many major research funders have introduced policies encouraging the adoption of OA with an emphasis on the Gold route, explicitly allowing payment of APCs to hybrid journals. Accompanying the introduction of these policies has been a set of funding streams available for institutions to pay APCs centrally, along with other OA costs. The funders include Research Councils UK (RCUK), representing major government-sponsored agencies, and major charitable medical research funders, such as the Wellcome Trust (Charities Open Access Fund or COAF; RCUK, 2013; Wellcome Trust, 2014). The UK has become, therefore, an interesting test case in the impact of a Gold-centric implementation of OA including support for hybrid journals, in which it is

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possible to track the development of APC expenditure in relation to other costs associated with journal publications, particularly subscriptions.

In this paper we report recent work carried out to examine APC expenditure in the context of subscription costs and new administrative costs, modeling the so-called “total cost of publication” for institutions, focusing on UK higher education institutions (HEIs). To carry out this modeling, we first analyze expenditure on APCs in detail, examining trends in APC expenditure over recent years and identifying the key characteristics of the APC market as it is experienced by UK HEIs. APC administration costs and subscription costs are also discussed. The analysis is then placed within an international context and its implications for future policy development discussed.

## Literature Review

Our previous study (Pinfield, Salter, & Bath, 2015) used the term *total cost of publication*, a term adopted from policy discussions. Specifically, the term was derived from comments by the then UK Science Minister, David Willetts (Willetts, 2014), in the UK government’s response to the review of the Finch report (the report that set out recommendations that have since formed the basis of the UK’s current Gold-centric approach; Finch et al., 2012). Willetts referred to the need to “develop sustainable funding models that establish a relationship between the payment of APCs (and the costs of administering them) and subscription fees for an institution” (Willetts, 2014, p. 3). The term was used in the particular context of perceived “double dipping” by publishers and related especially to new additional costs as experienced by institutions in a hybrid OA environment.

However, the term *total cost of publication* (TCP) used in this way is not without problems. It does not, for example, include all of the costs borne by HE institutions (for instance, existing administration costs associated with subscriptions). Nor does it take into account other costs, such as those of other stakeholders, notably publishers. Rather, it focuses specifically on additional costs experienced by institutions in managing open access. An alternative term, *total cost of ownership*, has also been used in this context (Lawson, 2015; Woodward & Henderson, 2014). However, we decided not to use that term because “total cost of ownership” is already widely used in the context of costing particularly information technology (IT) systems over their life cycle (Piscopo, Johnston, & Bellenger, 2008): Using the term TCO in a publishing context would cause confusion. TCP does not have any preexisting uses, reducing the possibility of confusion. Understood in the limited way it appears to have been originally intended (i.e., focusing on new institutional costs of APCs and administration in addition to subscriptions for published content), TCP is used here as a convenient label in lieu of a better term. It captures something important: the extent to which hybrid OA is impacting institutional costs in relation to the publication process.

Of the different components of the TCP (APCs, new administration costs, and subscriptions), most recent work

has been done on APCs. Several studies have provided insights into the APC market by analyzing list prices charged by publishers. Björk and Solomon (2014a), using data derived from a large sample from the Scopus database, identified the mean average APC for a number of journal types with a marked difference between them. Fully OA journals “published by ‘nonsubscription’ publishers” had a mean APC of \$1,418; fully OA journals “published by ‘subscription’ publishers” had a mean of \$2,097; and hybrid journals published by “subscription” publishers,” \$2,727. These APC prices are noticeably higher than those produced in other studies (Morrison, Salhab, Calvé-Genest, & Horava, 2015; Solomon & Björk, 2012), which have focused only on fully OA journals (based on data from the Directory of Open Access Journals, DOAJ) and excluded hybrid titles. Further work by Björk and Solomon (2015) identified a correlation between APC price and journal quality, where quality is measured by citation rates (specifically using the Source Normalized Impact per Paper, SNIP, measure). This study focused on fully OA journals but also found indications of similar segmentation within hybrid journals (with prices also varying by discipline).

Our previous work (Pinfield et al., 2015) analyzed APC prices paid by institutions from centrally managed funds based on a sample of 23 UK higher education institutions covering the period 2007 to 2013, as part of research to calculate the TCP. Centrally managed APC payments rose sharply from 2012; this was largely attributed to changes in the policies and funding arrangements of UK research funders. Based on figures from the first quarter of 2014, we projected a continued rise of central APC payments during 2014 amounting to an expected increase of more than 500% since the beginning of 2012. The mean APC paid by institutions had remained relatively stable since 2008 but there was considerable variation in APC prices paid by institutions over the period, with prices ranging from £82 to £5280. Levels of APCs charged by single publishers also varied considerably. There was a marked difference between prices charged for APCs within fully OA journals and those of hybrid journals (corroborating Björk & Solomon, 2014a). Well-established commercial publishers with large portfolios of subscription and hybrid journals had captured a significant proportion of the APC market, with eight of the top 10 publishers (who between them received 76% of all the APCs paid within the data set) being from this bracket, including Elsevier (who received more than 20% of the APC payments) and Wiley (15%).

Our attempts to model the TCP were, however, hampered by insufficiently robust data on administrative costs, which meant we could not include these costs. Further work was clearly needed in this area. Nevertheless, our preliminary calculations of TCP (excluding administration costs) based on 2013 APCs and 2013–2014 subscription data for 20 HEIs showed that subscriptions were £29.4 million (90% of TCP) and APCs £3.3 million (10% of TCP; Pinfield et al., 2015). Since then, Johnson, Pinfield, and Foschi (2015) analyzed detailed administrative costs by 29 UK HEIs, and reported a

figure of £88 per article to administer a paid-for Gold APC payment, although overall costs to institutions of implementing OA in line with policy requirements (including institutional policy development, communication and advocacy, and reporting) were considerably higher. This study therefore provides a base figure for calculating the APC administrative cost component of the TCP.

The remaining component of the TCP subscriptions, is arguably the best understood. However, there have not been many studies in the published literature specifically on subscription cost data, although the nature of pricing models have been extensively discussed, particularly in relation to the purchasing bundles of electronic titles (the “big deal”; Strieb & Blixrud, 2014). Perhaps the main reason for the paucity of empirical studies is that cost data have often been restricted because of confidentiality clauses between publishers and higher education institutions (or consortia). Interestingly, however, since our previous study (Pinfield et al., 2015), there appears to have been something of a relaxing of attitudes of libraries to sharing such data. Many UK libraries have now made their subscription information publicly available in response to freedom of information (FoI) requests (Lawson & Meghreblian, 2014b). In the United States, libraries have similarly responded to FoI requests resulting in recent analyses of their “big deal” payments (Bergstrom, Courant, McAfee, & Williams, 2014). This greater openness should continue, since many subscription deals now negotiated by consortia include clauses allowing costs to be shared for FoI enquiries (Lawson & Meghreblian, 2014a).

Using subscription and APC data gathered from UK institutions, Pinfield et al. (2015) provided a provisional analysis of the TCP. This informed policy discussions in the UK, including the Burgess Report (Burgess, 2015), commissioned by RCUK to review its OA policy. The measure also informed the stance developed by Jisc in the UK in relation to negotiation of multiyear deals with publishers on behalf of the academic community, particularly in relation to the proposal to “offset” APC payments against subscriptions as the basis for the deals (Jisc, 2015; Lawson, 2015). Finally, it has informed the ongoing debate in this area, particularly on the topic of “double dipping” (Prosser, 2015; Smith, 2014a).

The “double dipping” debate has been played out particularly intensely in the UK because of the Gold-centric nature of research funders’ OA policies, which have proved controversial (Björk & Solomon, 2014a; Crotty, 2014; Prosser, 2015; Smith, 2014a; Sweeney, 2014). Although some from the publishing community have disputed the validity of “double dipping,” arguing that APCs and subscriptions are different services and can therefore legitimately be charged for separately (Smith, 2014b), more commonly, publishers have implicitly accepted its validity in developing “no double-dipping” policies (Jisc Collections, 2014; Royal Society Publishing, 2013). At the government and funder level, there also seems to be implicit acceptance of “double dipping” as a legitimate concern (Hall, 2012; Sweeney, 2014; Willetts, 2014), particularly in the context of the appa-

rent policy-based encouragement of hybrid journals. One key issue is the extent that the hybrid model can reasonably be considered to be transitional, as proposed by Prosser (2003), and, therefore, the extent to which any additional costs associated with APCs on top of subscriptions can be considered temporary (Finch, 2014; Jubb, 2014).

Despite the controversy, UK policies appear to have encouraged uptake of OA. Recent estimates (Jubb et al., 2015) indicate that the proportion of papers produced by UK authors that are open access is greater than global averages. For papers published in 2014, 22% of papers with at least one UK author were available in an open access form immediately, compared with the global average (19%). This was 28% after 6 months following publication for UK research, compared with 23% globally. After 12 months, the UK figure was 38%, and 43% after 24 months, compared with 29% and 34% over the same timescales globally. The UK appears ahead of global averages particularly in uptake of hybrid options and also depositing articles in OA repositories and websites. UK authors’ uptake of Gold OA publishing options in particular rose by 65% between 2012 and 2014, moving from 12.6% of outputs in 2012 (slightly lower than the global average of 13.6%), to 18.2% in 2014 (above the global average of 16.6%). It seems reasonable to assume from this that the UK’s approach to OA implementation is at least a contributory factor in a greater proportion of the literature being made available in an OA form. But the question is, at what cost?

In the context of this previous work, the research undertaken in the current study had the following objectives:

- To provide a detailed analysis of the APC market as experienced by UK institutions over time, focusing on questions of institution type, disciplinary area, and publication quality, not covered in previous studies.
- To model the TCP with greater precision than previous work by including new administration costs and subscription expenditure, as well as more robust APC data.
- To determine the extent to which APCs represent additional costs to institutions, particularly in relation to hybrid journals.
- To consider the policy implications of the research particularly in relation to the future of hybrid OA.

The study therefore focuses initially on the APC data, discussing these in most detail as the newest large-scale cost area experienced by institutions, then goes on to discuss administration and subscription costs. These data are then brought together in the “total cost of publication” modeling, with the question of the additionality of costs to institutions (a question at the heart of the “double dipping” debate) covered in particular. This provides the basis for a discussion of the policy implications of the research. At the same time, the study also identifies strengths and weaknesses of the data sets currently being collected, and makes recommendations on how data quality and the availability of data could be improved.

## Methods

Data were assembled covering APCs, administration costs, and subscriptions from several sources.

Data on expenditure on APCs for 2014 were collected with Jisc during the first quarter of 2015 from a sample of UK institutions. Jisc compiled the data into a single data set. APC data were in two parts: detailed APC data (including a record of all individual APCs paid) from 24 volunteer HEIs usable in nonanonymized form comprising centrally managed expenditure; anonymized data on “headline” APC expenditure (including only total expenditure) from 23 of the same HEIs covered in previous work. The headline data from the 23 institutions were added to data collected for our previous study in order to carry out a longitudinal analysis (reported below in the first section of the Results), whereas the 2014 data for the 24 nonanonymized institutions were used for the detailed analysis of the APC market (in the remaining sections of the Results, below). Both data sets represent expenditure from institutions ranging from large research-led universities to smaller specialized institutions. There was overlap between the 24 institutions in the 2014 APC data and the 23 in the previous study. They are reported separately here because of the agreement made with the 23 institutions when the first study was carried out that their anonymity would be preserved. Data from one institution submitting 2014 data still requested anonymity, so was not included in the 2014 data analysis since the other 24 institutions have been named.

The 2014 data required considerable work. Missing publication dates were added by manually searching for each article based on DOI or title. Journal titles were manually checked to remove misspellings and abbreviations to make them consistent. Duplicate records were removed through checking of matching DOIs or article titles. Anomalous APC prices were checked with the institutions and changed where appropriate. Missing APC prices were supplied at list price based on data on publisher websites. Finally, currency conversions were carried out at 0.65 US dollars (\$) and 0.75 euros (€) to the pound (£), respectively. Figures provided include Value Added Tax (at 20%) where paid.

Several issues arose in processing the data that are indicative of important aspects of the current APC market as experienced by HEIs. First, it was apparent that institutions were reporting some very low APC prices. These were normally explained by discounts often linked to prepayment deals. For example, one institution recorded 40 APC payments made to a single publisher, Elsevier, averaging less than £40 each: this following a one-off deal with the publisher. There was also widespread use of schemes such as the Royal Society of Chemistry Gold4Gold scheme which resulted in some £0 being recorded (because subscribers were given vouchers enabling some APCs to be free). Such “free” or highly discounted APCs were normally part of wider deals with publishers (including some early offsetting arrangements) and so therefore need to be considered in this context of total costs to institutions (hence the importance of considering the

TCP, below, rather than just APC expenditure in isolation). These low costs were checked where possible and corrected (if an error was identified) or accepted (where a low or zero APC payment was verified). This research aimed to analyze what institutions were actually paying not simply list prices and, therefore, APCs were recorded at the discounted rate (not the list price).

Second, there was evidence of splitting of APC payments, normally between two funders. For analysis, these payments were merged and the agency listed as paying the greater amount was recorded as the funder. For the few payments where there was an even split between funders, the first-named funder was recorded.

Third, some records of payments evidently included charges in addition to APCs. It was clear that color and page charges were being recorded in the same payment details as APCs and were often apparent by anomalously high APC prices. Wherever possible, these were identified and excluded from the APC figures used for analysis. The extent to which the charges should in future be incorporated into TCP modeling is, however, a moot point. If data on these costs could be systematically assembled, there is a case for their inclusion in future analyses.

Fourth, there was some inconsistency in the definition of “publication date,” that is, between when the version of record (VoR) was made public on the journal website and date when the VoR was made part of a volume and issue of a journal. There can sometimes be a considerable length of time between these two. However, it was impossible to correct this inconsistency reliably without wholesale checking of the data and it was therefore accepted as a feature of the data.

Therefore, the APC data set (now available in its “cleansed” form on Figshare; Jubb, 2015), comes with caveats. Efforts were made to check and correct obvious anomalies but such efforts did not extend to verifying every single payment. It is likely, therefore, that the data set still includes some inaccuracies and inconsistencies. Further work on standardizing data collected from institutions is clearly required.

This research included only centrally managed APC expenditure within institutions. HEIs are currently unable to report reliably on expenditure made elsewhere and so it is difficult to estimate levels of such expenditure. It is unlikely that payments of APCs outside the center would occur at significant levels for RCUK or COAF-funded research or where institutional prepayment schemes with publishers are in place, but they may occur for other research outputs, depending on institutional arrangements for funding of APCs (see below).

Analysis of the data was based on publication year as being the most easily publicly verifiable date but has the caveats outlined above. An alternative would have been to carry out analysis by date of payment, but there was insufficient data for both APCs and subscriptions to allow this. Data for calendar years, rather than financial year, were

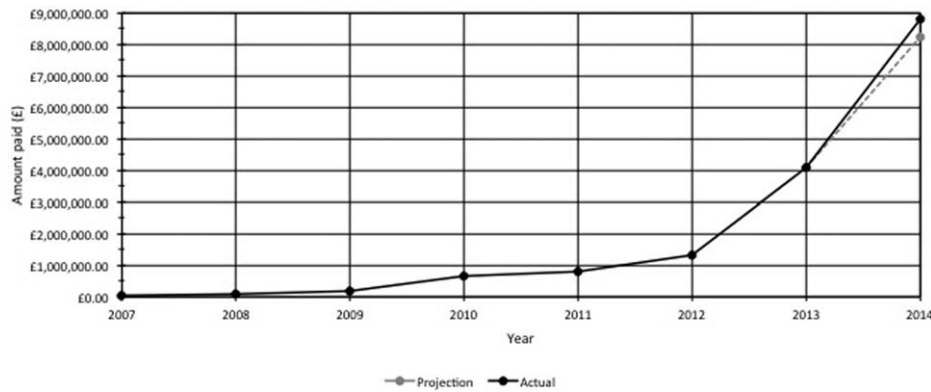


FIG. 1. Centrally managed APC payments for 23 institutions for items published 2007 – 2014 (note that the 2012 figure given is higher than in Pinfield et al. (2015) because one institution has since corrected its data).

used as this is what was available for both APCs and subscriptions.

Administration cost data used were based on estimates from Johnson et al. (2015), of an average of £88 per APC. This represents a total processing time of 134 minutes shared between faculty and support staff.

In addition to APC and administration data, subscription data used were already in the public domain (Lawson & Meghreblian, 2014b), covering seven publishers: Cambridge University Press (CUP), Elsevier, Oxford University Press (OUP), Sage, Springer, Taylor and Francis, and Wiley. We considered this a reasonable sample of subscription expenditure covering a large proportion of overall subscriptions; however, it does not provide complete coverage of institutional subscriptions. The data set includes historic data from 2010 to 2014, making comparison across years possible. Subscriptions for the 24 institutions for which APC data were gathered were available in near-complete form from 2011 to 2014 (2010 data were incomplete). These were used to analyze the characteristics of the subscription expenditure for the seven publishers during the period.

## Results

### *Centrally Managed APC Expenditure Over Time*

Previously, we reported a marked rise in centrally managed APC payments from 2012 in the 23 sample HEIs (Pinfield et al., 2015). The new data (Figure 1) from the same institutions show this rise continued in 2014 approximately in line with, but higher than, the total projected (based on the 3 months of data then available). In 2014, the same 23 HEIs spent £8,806,723 (\$13,406,739) on centrally managed APC payments. This rise is partly due to rising expenditure on APCs and partly a shift in existing levels of expenditure from distributed to centrally managed budgets in HEIs. Since Jubb et al. (2015) calculate a 65% increase in paid-for Gold OA articles (compared with this rise of more than 550%), it can be reasonably assumed that a large proportion of this rise is due to a shift in accounting in institutions from predominantly distributed payment of APCs to centrally

managed payments. At the same time, this shift has created much greater visibility of payments that are also likely to continue to increase in the next 3 years as compliance rates for RCUK and COAF-funded research outputs increase. The level of the increase may, however, vary between institutions, depending on local policies and payment methods, including whether they have also used money from other sources to pay APCs.

The APC expenditure by institution for the 23 HEIs, from 2011 to 2014, is illustrated in Figure 2 (anonymized). The APC expenditure was spread unevenly across institutions with research-intensive HEIs (e.g., 5, 8, 22) having much higher levels of expenditure. Institution 22 alone was responsible for nearly a third of all expenditure. Twenty-one of the institutions experienced a rise in payments between 2013 and 2014, and 12 of these increases were by more than 100%. The expenditure for two institutions showed a very slight decrease, although this was for a very small number of APCs.

### *2014 APC Expenditure According to Institution*

The detailed figures for APCs paid for articles published in 2014 gathered from 24 HEIs (nonanonymized) provide an interesting insight into the current APC market as experienced by HEIs. Direct comparisons cannot be drawn between this new data set and the data from the earlier study since they are from a different set of institutions (albeit with some overlap). The 2014 payments comprised 4,853 payments totaling £7,695,341 (\$11,718,427; compared with £8,806,723, or \$13,403,700, for the 23 institutions followed up from the earlier study). Payments ranged from zero (waived payments as part of deals with publishers) to £4,536 (\$6,904; mean = £1,586; \$2,415). Where £0 payments were excluded ( $n = 40$ ), the mean was £1,599 (\$2,435;  $n = 54,813$ ).

Payments by institution are shown in Table 1 by institutional “mission group”: Russell Group (large research-intensive institutions), “Pre-92” institutions (other research institutions), “Post-92” institutions (teaching-led institutions), and “Specialist” HEI. There were marked differences in numbers of payments made, from less than 10 (three

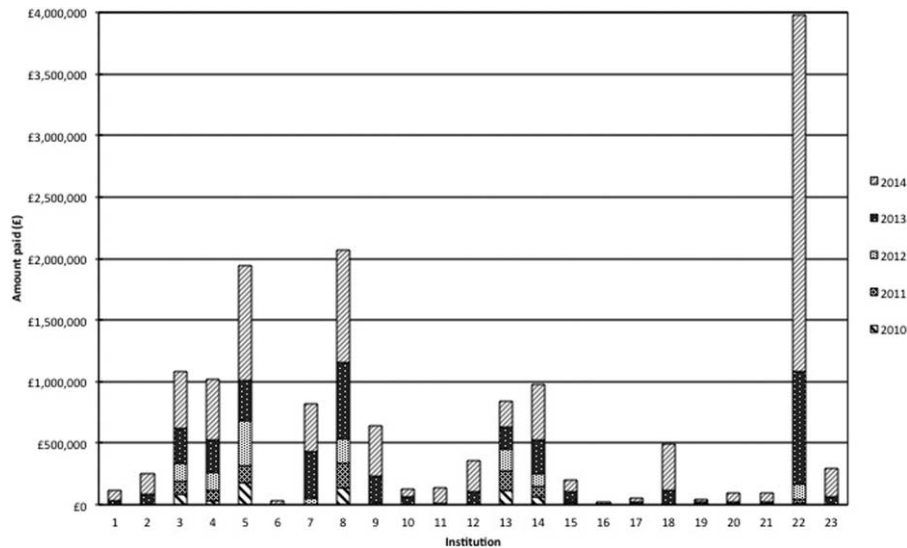


FIG. 2. Centrally managed APC expenditure by institution, 2010 – 2014.

institutions) to approaching 2,000 (UCL). These differences, in many respects, reflect the research intensity of the institutions and, therefore, the numbers of research outputs they produce. There were, however, evidently differences of policy between institutions that were reflected in the structure of their expenditure.

Institutional differences were further explored with the 2014 APC data being normalized by the number of

research-active staff to examine whether expenditure patterns were reflecting institutional research income or different approaches between HEIs (Figure 3). The numbers of research-active staff were taken as those identified as such by the institutions themselves in their submissions to the 2014 Research Excellence Framework (REF) assessment exercise (labeled “Category A” staff). The REF (previously known as the Research Assessment Exercise, RAE) is a UK-

TABLE 1. Centrally managed APC expenditure by institution for articles published in 2014.

Group	Institution	Mean	N	Minimum	Maximum	Sum	Median
Russell Group	Birmingham	£1,387	334	£0	£3,780	£463,221	£1,481
	Bristol	£1,792	277	£115	£3,780	£496,467	£1,800
	Durham	£1,492	99	£500	£2,797	£147,660	£1,560
	Glasgow	£1,638	237	£200	£3,600	£388,180	£1,500
	Imperial	£1,844	495	£205	£3,958	£913,017	£1,800
	Liverpool	£1,783	145	£210	£3,780	£258,466	£1,656
	Newcastle	£1,892	236	£240	£4,248	£446,503	£1,800
	QMUL	£1,322	70	£0	£3,780	£92,549	£1,394
	Sheffield	£1,556	243	£0	£3,780	£378,153	£1,500
	UCL	£1,451	1995	£0	£4,536	£2,893,864	£1,500
	Warwick	£1,823	127	£356	£3,884	£231,461	£1,753
Overall	£1,576	4258	£0	£4,536	£6,709,542	£1,502	
'Pre-92' Universities	Bangor	£1,939	42	£431	£3,360	£81,424	£1,924
	Bath	£1,529	112	£0	£3,900	£171,243	£1,500
	Cranfield	£1,857	19	£842	£2,340	£35,274	£2,084
	Lancaster	£1,465	45	£480	£3,780	£65,945	£1,500
	Leicester	£1,743	70	£552	£3,810	£122,030	£1,644
	Loughborough	£1,413	57	£0	£3,331	£80,567	£1,462
	RHUL	£1,379	7	£785	£2,026	£9,654	£1,243
	Salford	£1,894	18	£600	£2,407	£34,088	£2,146
	Sussex	£1,926	41	£293	£3,780	£78,952	£1,907
	Swansea	£1,647	45	£817	£3,780	£74,129	£1,500
	Overall	£1,652	456	£0	£3,900	£753,305	£1,620
'Post-92' Universities	Plymouth	£1,641	8	£514	£2,934	£13,131	£1,754
	Portsmouth	£1,599	9	£962	£2,245	£14,390	£1,590
	Overall	£1,619	17	£514	£2,934	£27,521	£1,728
Specialist HEI	LSHTM	£1,680	122	£789	£3,808	£204,972	£1,721
Overall (all institutions)		£1,586	4853	£0	£4,536	£7,695,341	£1,502

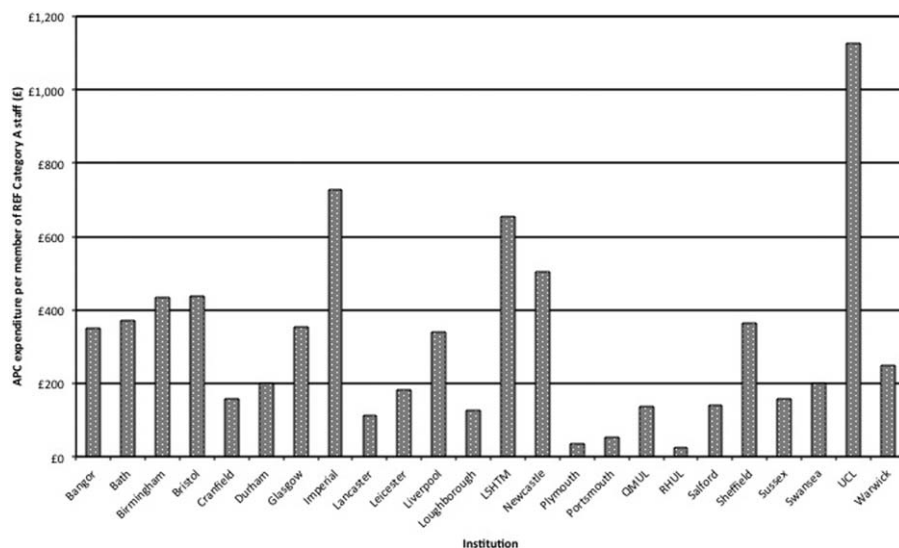


FIG. 3. 2014 APC expenditure per member of research-active staff (submitted as “Category A” i.e., “research-active” staff for REF2014).

wide exercise undertaken every 5 to 7 years that has important implications for levels of institutional funding. The large research-intensive institutions, UCL and Imperial College, with highest total expenditure levels, also had a higher mean expenditure per member of research-active staff. The London School of Health and Tropical Medicine (LSHTM), a smaller more specialized institution, had relatively high mean expenditure. There is some variability among other research institutions (e.g., Newcastle and Warwick), with post-92 institutions with lower levels. A combination of factors might explain this, including varying institutional policies and practices (where certain institutions may actively promote and support Gold OA compared with others), different disciplinary make-up of institutions (particularly where institutions have large medical schools, use of Gold OA may be higher, see below), and possible differences in REF inclusion criteria. It may be important that both UCL and Imperial were among the small number of institutions using internal funding for centrally managed APC payments as well as external grants, indicating an institutional policy to encourage Gold OA. In contrast, Glasgow has in place a policy explicitly favoring Green OA where possible in preference to Gold, with only external funds being used to fund APCs (Ashworth, McCutcheon, & Roy, 2014). The data for funding source were, however, incomplete, with only 3,285 of the 4,853 records including a funding source. Of these, 2,152 (65% of those recorded) cited the funder as RCUK, 500 (15%) Wellcome, 249 (8%) COAF, and 288 (9%) internal institutional funds. The remaining 3% were smaller amounts for a variety of funders. Centrally managed payments were, therefore, largely being generated by external grants designed specifically to fund APCs, with internal funds being used less commonly. With funder preference for licenses that allow for liberal reuse (including commercial exploitation), it is unsurprising that 89% (1,909) of APC records in the data set with the license field completed (2,146 (44%) of the 4,853 total) were listed as having a CC

BY license (one of the Creative Commons licenses allowing most extensive reuse).

There was a wide variation in APC prices paid by the different HEIs (Figure 4). The “Tukey” boxplot distinguishes the majority of payments from outliers and extreme values. The highest payment for a single APC was £4,536 (\$6,903), while several institutions recorded £0 APC payments. There is, nevertheless, a relatively clear “band” of payments across institutions indicated by the interquartile range (IQR, the boxed area).

The journals for which APC payments were made were mapped against the broad subject panels used in the 2014 REF using subject classifications from Scopus in order to assess their broad disciplinary coverage (Table 2). For 4,710 of the 4,853 payments that could be matched and verified (97% of the records), there is a clear predominance evident for Health and Life Sciences (REF Panel A) (>60% of the articles and spend). This is higher than the proportions of all papers by UK authors in Scopus (including all organization types, HE and others) which, in 2014, was 49% for Panel A (Health and Life Sciences), 32% for Panel B (Science and Engineering), 14% for Panel C (Social Sciences), and 6% for Panel D (Arts and Humanities). APC payments for Health and Life Sciences were, therefore, disproportionately high, and Social Sciences and Arts and Humanities, disproportionately low. Science expenditure was approximately in proportion to its overall outputs. The predominance of Health and Life Sciences in take up of Gold OA is evident in other studies (Björk et al., 2010; Gargouri, Lariviere, Gingras, Carr, & Harnad, 2012; Kurata, Morioka, Yokoi, & Matsubayashi, 2013).

#### 2014 APC Expenditure According to Publisher

Centrally managed APC payments were made to 128 publishers. However, over 70% of the numbers of payments were made to the top 10 publishers (Table 3), with Elsevier

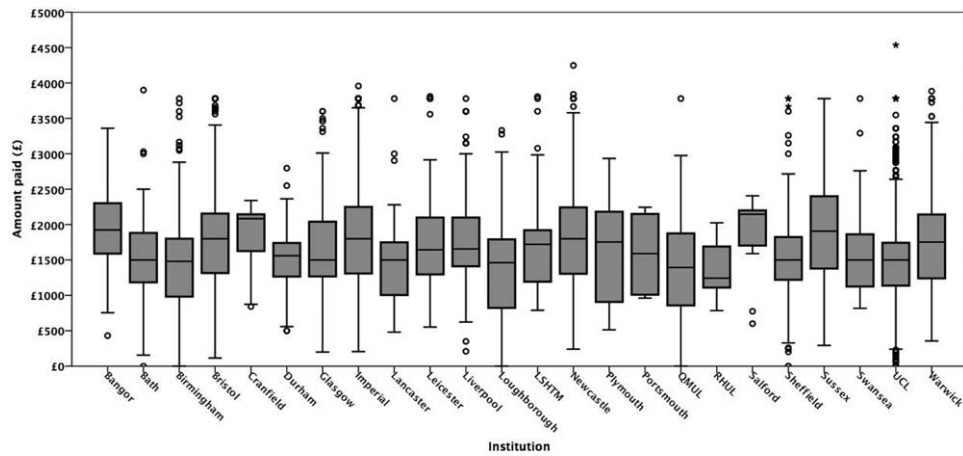


FIG. 4. The range of APC prices paid by institution for articles published in 2014.

and Wiley receiving 19% and 15% of payments, respectively—very similar proportions to those reported in Pinfield et al. (2015). More than three-quarters of the payments (76%) were made to hybrid journals. Of the top-10 publishers, three were fully OA publishers: PLoS, BMC, and Frontiers, compared with two (PLoS and BMC) in the previous study. BMC has been treated as a separate “fully OA publisher” because various factors, not least of all price, justify a distinction from its parent company, Springer; but it is a debatable point how long such a classification will remain valid. Payments were made to a wide range of journals, with only three titles accounting for more than 1% of all the payments by number: *PLoS ONE* (5.3%), *BMJ Open* (1.5%), and *Nature Communications* (1.4%).

Most publishers charged a relatively wide range of different APC prices. Figure 5 illustrates the price range of APC payments for the top-10 publishers. It is noticeable that payments to Nature and Elsevier cover a wide range, including very low levels for Elsevier due to one-off discounts included in deals with HEIs. There is also a marked difference in the median price among the different publishers. Two publishers had median APCs below £1,000: Frontiers, £902 (\$1,373) and PLoS, £972 (\$1,479). Two publishers had median APC levels above £2,000: OUP, £2,100 (\$3,195) and Nature, £3,360 (\$5,109).

Analysis of the APC expenditure by journal type shows a marked difference between the mean APC charged by hybrid journals and OA journals, with hybrids considerably more expensive (Table 4), consistent with previous studies (Björk & Solomon, 2014a,b; Pinfield et al., 2015). There is also a difference between fully OA journals produced by publishers who also publish subscription titles and those who publish only fully OA titles (previously observed by Björk & Solomon, 2014a,b). The hybrid mean APC is 58% higher than the mean of fully OA journals from “nonsubscription” publishers. However, journals may offer different levels of service and may deliver different products (most hybrids, for example, deliver their product in paper and electronic format, whereas fully OA journals do not). These points (as well as price) need to be considered in any holistic comparison. Nevertheless, the price differentials are considerable.

An interesting question arising from this relates to the relationship between price and quality. To address this, the APC price data were matched against Field Weighted Citation Index (FWCI) scores derived from Scopus to test whether there was a correlation between APC price and citation impact, using citation impact as a proxy measure of quality. Initial analysis of the journal types in Table 4 shows a correlation between price and citation impact (“Ave.

TABLE 2. APC payments matched to broad subject area (REF panel) from Scopus, 2014 ( $N = 4,710$ ).

Data for the 24 UK HEIs	Panel A: Health and life sciences	Panel B: Physical sciences and engineering	Panel C: Social sciences	Panel D: Arts and humanities	Total (de-duplicated)
Total spend*	£5,526,217	£2,757,244	£620,368	£115,216	£7,596,649
No of articles*	3337	1701	428	88	4710
Mean	£1,656	£1,621	£1,449	£1,309	£1,611
Min	£0	£0	£71	£71	£0
% spend	61.3%	30.6%	6.9%	1.3%	100%
% articles	60.1%	30.6%	7.7%	1.6%	100%
% of all papers by UK authors	49%	32%	14%	6%	100%

\*Sum of the panels add up to more than the total as some journals are classified in more than one REF panel.



TABLE 3. Frequency of articles in OA and subscriptions journals among top-10 publishers, 2014 based on APC payments made, with OA breakdown.

Publisher	Articles in fully OA journals	Articles in hybrid journals	Total (%)
Elsevier	20	906	926 (19.1)
Wiley	25	709	734 (15.1)
Springer	8	329	337 (6.9)
PLOS	322	—	322 (6.6)
BioMed Central	290	—	290 (6.0)
Oxford University Press	28	202	230 (4.7)
BMJ	80	138	218 (4.5)
Taylor & Francis	1	167	168 (3.5)
Frontiers	140	—	140 (2.9)
Nature Publishing Group	34	106	140 (2.9)
Others	232	1116	1348 (27.8)
Total	1180 (24.3)	3673 (75.7)	4853 (100)

FWCI” column). To test this further, journals were grouped in 10 different FWCI categories for analysis, with all journals covered in Scopus being ordered according to their FWCI and then ranked into tiers, each tier accounting for 10% of the total number of journals, the top tier rated 1 and the bottom tier rated 10. To provide greater granularity the top level, which accounted for 38% of articles, was further divided in two, with the top 5% rated 1 and second 5% rated 1.5, making a total of 11 tiers. For each tier, Table 5 shows the numbers of journals and of articles for which APCs were paid from the sample. The proportions of those journals and articles for the whole sample are also given. For example, for Tier 1, APCs were paid for 954 articles in 266 different journals, which constitute 15% of the journals and 20% of the articles covered in the sample. For each tier the weighted average and unweighted average FWCI are also shown.

There was a strong correlation between APC price and FWCI (Figure 6): 90.4% of the variation in mean APC was explained by mean FWCI. This is consistent with another recent study of APC list prices (Björk & Solomon, 2015) which also found that highly cited journals charge higher APCs using different citation indexes and based on list prices. Highly cited journals charging higher APCs may, of course, be explained in different ways. High-FWCI titles

tend to be more costly to produce (with, e.g., higher rejection rates and more rigorous editorial standards): higher APC prices may therefore reflect higher costs. Conversely, authors clearly value publication in highly cited titles more and may be prepared to pay higher APCs. Higher APCs may, therefore, reflect the fact that the market will stand higher prices. It is possible that both of these factors may be important. Further work could investigate this correlation, including more detailed comparisons of hybrid journals and fully OA journals with similar FWCI scores, and further work could examine value and cost (not just price).

#### “Hidden” Article-Specific Costs

As already observed, the APC data reported by institutions and used in this study include centrally managed payments only. While this can be reasonably assumed to encompass most RCUK and COAF-funded APCs, other APC payments may in some institutions occur outside the center. Reliable data on this, however, are not available. Nevertheless, estimates of the central-distributed expenditure balance can be made in at least two ways: first, “top down,” from the UK-wide data based on Scopus, and second, “bottom up,” based on estimates at the institutional level. Both are briefly presented here.

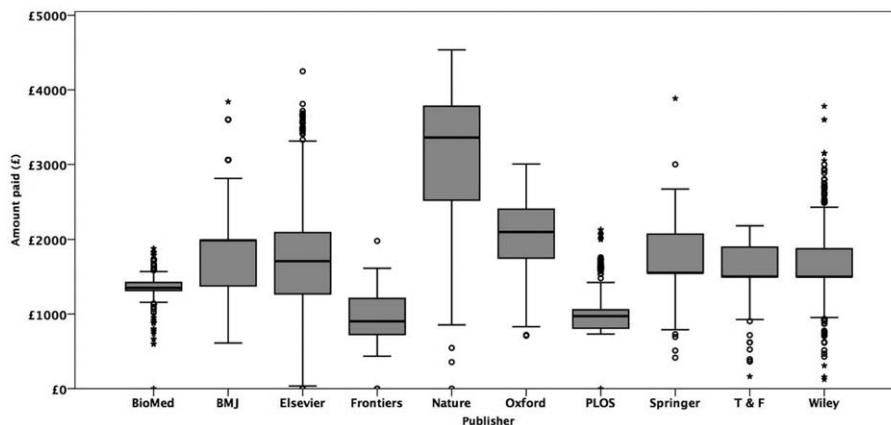


FIG. 5. Range of APC payments for the top-10 publishers measured by receipt of APC payments.

TABLE 4. APC payments by journal types, 2014.

Publisher type	Mean	Number of journals	Number of articles	Sum	Min	Max	Median	Ave. FWCI
Hybrid journals— published by subscription publishers	£1,725	1613	3673	£6,337,723	£0	£4,536	£1,680	1.78
Fully OA journals— published by subscription publishers'	£1,311	74	306	£401,149	£0	£3,810	£1,229	1.49
Fully OA journals— published by nonsubscription publishers	£1,094	181	874	£956,469	£0	£2,960	£1,071	1.29

FWCI, Field-Weighted Citation Index derived from Scopus.

Based on Scopus data, the number of UK OA articles for which an APC was paid rose from the 15,444 in 2012 to 25,001, a rise of 65% (Jubb et al., 2015). Our sample of 24 universities produced 4,853 articles in 2014 for which centrally managed APCs were paid, part of the steep rise in centrally managed payments (as reported previously). However, based on estimates derived from Scopus of the total paid-for Gold outputs of the institution, we estimate that APCs paid from centrally managed budgets rose from 20% of the estimated total APCs paid by the institution (747 of the 3,786 Gold articles) to 78% in 2014 (4,853 of the 6,250 Gold articles). This is a considerable shift in favor of centrally managed funds but one that shows that 2014 data presented here is likely to represent a large proportion of the overall payments made by HE concerned, with noncentrally managed payments being 22% of the total.

Two of the Russell Group institutions from our sample also provided estimates of expenditure from noncentrally managed budgets based on an analysis of expenditure recorded in their institutional financial system. Both insti-

tutions identified records of APC expenditure in their institution outside the centrally managed funds for a sample of publishers corresponding to the top-10 publishers identified by this study (Table 3). One institution reported that total expenditure from noncentrally managed budgets was as high as 31% of the whole, whereas the other reported just 14%. Such differences may be due to different institutional policies and varying publicity about the availability of centrally managed funds. It is interesting that the second institution with a lower level of expenditure from noncentrally managed funds is one where internal institutional funding has been added to the central fund, allowing authors to pay APCs even where they do not have a grant from an external funding body. This is not the case for the first institution and may mean that users there have less opportunity to use the central fund.

These estimates compare with those made by Pinfield and Middleton (2016) of numbers (rather than value) of APC payments made from noncentrally managed budgets to seven publishers (BMJ, Elsevier, Oxford University Press,

TABLE 5. APC prices paid and Field-Weighted Citation Index values (based on Scopus data).

Based on all journals		Based on journals in which 24 UK universities published APC articles in 2014						
Distribution of all journals	Quality tier (by FWCI)	No. of journals with APC articles (from 24 UK HEIs)	No. of articles with APCs (from 24 UK HEIs)	Proportion of journals	Proportion of articles	Weighted mean FWCI	Mean FWCI	Mean APC paid (£) including VAT if charged
5%	1.0	266	954	15%	20%	2.92	3.11	£1,936
5%	1.5	288	864	16%	18%	1.88	1.90	£1,713
10%	2.0	475	1603	27%	34%	1.36	1.37	£1,503
10%	3.0	321	663	18%	14%	0.99	0.99	£1,449
10%	4.0	182	322	10%	7%	0.76	0.76	£1,472
10%	5.0	125	169	7%	4%	0.55	0.56	£1,371
10%	6.0	47	68	3%	1%	0.41	0.40	£1,459
10%	7.0	24	34	1%	1%	0.26	0.25	£1,325
10%	8.0	14	17	1%	<0.5%	0.16	0.15	£1,352
10%	9.0	12	13	1%	<0.5%	0.03	0.04	£1,102
10%	10.0	3	3	<0.5%	<0.5%	0.00	0.00	£1,237

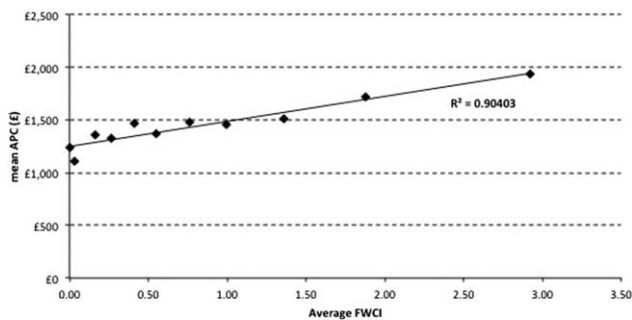


FIG. 6. Mean APC against average Field Weighted Citation Index score for journals, 2014.

Nature, Taylor and Francis, Springer, and Wiley) at the University of Nottingham over the lifetime of its APC central fund (2006 to 2014) of 17% of total APC payments. Pinfield and Middleton (2016) discuss the complexities and caveats of such analyses, which mean that such figures can only currently be regarded as approximations. What is clear, however, is that current data sets of centrally managed APC payments underrecord total payments made by the institution as a whole, a fact which needs to be taken into consideration in the TCP modeling below.

Anecdotal evidence indicates that well-established fully OA publishers that do not have prepayment deals in place with institutions may receive a much greater number of non-centrally managed payments than hybrid publishers. Fully OA journals may have established relationships with authors and the comparatively low prices charged for APCs mean that authors are willing to pay from local funding sources. Hybrids, on the other hand, tend to be paid centrally to a greater degree. However, such observations are very impressionistic and need further testing. In contrast, it is clear that other costs of publication, e.g., color and page charges, might also arguably be included in the total cost of publication: these tend to be distributed around institutions and are therefore often difficult to identify (Gray, 2015).

### Subscription Expenditure

Subscription data for 24 UK higher education institutions were available in useable form for the period 2011–2014 for seven major publishers: Cambridge University Press (CUP), Elsevier, Oxford University Press (OUP), Sage, Springer, Taylor and Francis, and Wiley (Lawson & Meghreblian, 2014b). Figure 7 illustrates the changes in the total subscription expenditure by the 24 sample HEIs between 2011 and 2014 for those publishers. Over the entire period (2011–2014), the overall costs for subscriptions to each of the seven publishers increased. The largest percentage change between 2011 and 2014 was for OUP, a rise of 38%. The publisher with the highest level of institutional expenditure was Elsevier, with a subscription income of £15.3 million (\$23.3 million) in 2014, 8.6% higher than the £14.1 million (\$21.45 million) in 2011.

In addition, in most cases, there was also a year-on-year increase in the aggregated subscriptions paid to publishers (Table 6). However, there was a decline for two publishers between 2012 and 2013. For a small number of the particularly smaller HEIs and in relation to the smaller publishers in the sample, there is evidence of some large percentage changes in a single year, perhaps indicating a change in titles purchased (possibly moving from purchase of individual titles to a package or vice versa). However, there are relatively few of these and in any case they represent small absolute values, so do not have a major impact on the overall averages.

Between 2013 and 2014, the aggregated subscriptions paid by the 24 institutions rose for all seven publishers. Increases ranged from 3% for Elsevier to 11.3% for CUP. These overall average increases for the 24 institutions are generally reflected in figures for the individual HEIs. Between 2013 and 2014, 21 of the 24 HEIs experienced a rise in Elsevier subscription costs; this was 22 for Wiley; 23 for Springer; 19 for Taylor and Francis; 20 for Sage; 24 for OUP; and 23 for CUP. Few institutions experienced a decline in subscriptions for any of the seven publishers between 2013 and 2014.

There is then a clear pattern of price rises for the subscription costs of the seven publishers as experienced by the 24 HEIs. This applies both in terms the entire period between 2011 and 2014 and between 2013 and 2014. These subscription figures provided by institutions can be assumed to represent the entirety of the institutions expenditure on subscriptions. In a period in which online access is predominant and site licenses the norm, it is unlikely that other subscriptions exist to any large extent in the institution apart from those paid centrally. This is different from APC data which, for reasons outlined, are likely to underrepresent institution-wide cost.

### Total Cost of Publication

Previously, we used the measure of the TCP (after Willetts, 2014) to gauge the new additional costs being experienced by institutions (Pinfield et al., 2015). The measure consists of the cost of existing subscriptions plus APCs and new administration costs, and since it was first used in the context of trying to develop an evidence base relating to perceived “double dipping” by publishers (and also concerns about rising additional administrative costs), the measure only includes hybrid journals since only these involve a business model with two income streams (subscriptions and APCs) from the same customer for publisher content. Fully OA journals might more reasonably be seen as an alternative cost to subscriptions. Use of only hybrid APCs for the modeling may also be preferable from a pragmatic viewpoint, since if it is believed that a larger proportion of fully OA APCs are paid outside the center than hybrids, then the data for hybrids are more likely to be a closer reflection of the overall institutional payments. The data now available mean that the TCP can be refined and updated using the current

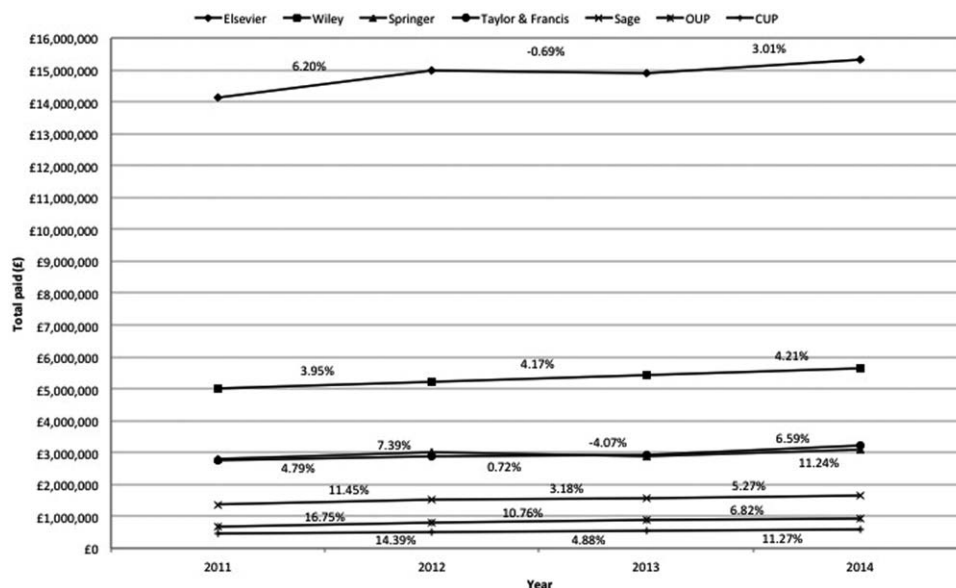


FIG. 7. Aggregated subscription expenditure for 24 institutions for seven publishers, 2011 – 2014 (including annual percentage changes).

APC data in combination with subscriptions data. These can be combined with previously calculated administration cost data of £88 per APC (Johnson et al., 2015).

The calculations are shown in Table 7 and Figure 8. Across the 24 institutions and seven publishers, subscriptions constituted 87% of the TCP, APCs 12%, and administration costs less than 1%. These show a slightly higher proportion of costs in the APC category than previously (Johnson et al., 2015; Pinfield et al., 2015) but are not directly comparable, since their study covered all subscriptions paid to publishers to which APCs had also been paid, and was therefore wider in its coverage.

Interestingly, only five HEIs have proportions for APCs above the mean (i.e., 11.8% of the TCP): Imperial (16.3%), LSHTM (18.4%), Newcastle (12.7%), Sheffield (12.3%), and UCL (34%). These research-intensive institutions, particularly UCL, therefore, have a major impact on the overall average. With UCL removed from the calculations, the TCP calculations change somewhat to subscriptions 91%, APCs 8%, and administration costs less than 1%.

Since it has been shown that subscription expenditure has risen for institutions in the last 5 years, it is clear that

APC costs shown here are largely *additional* costs for institutions, at least currently. There is no evidence in the data examined that subscriptions have declined commensurately as APC expenditure has increased. Moreover, APCs have been included here at discounted rates, if applicable, and therefore take into account at least some of the offsetting that occurred. The additionality of APC expenditure is also apparent because while subscription costs given can reasonably be assumed to represent the entirety of an institutions expenditure, the APC data underrepresent actual expenditure (as discussed above). The evidence therefore indicates that, currently, the APCs in the calculations here are additional costs, a situation that is likely to continue for the foreseeable future until any institution-level offsetting agreements are more widely adopted and have had time to take effect.

## Discussion

Addressing the question of the cost of Gold OA requires multiple strands of evidence and a policy response with a clear set of criteria about the value of OA (involving

TABLE 6. Total subscription expenditure and percentage changes for 24 institutions for seven publishers, 2011 – 2014.

	Total paid each year				% Change		
	2011	2012	2013	2014	2011-12	2012-13	2013-14
Elsevier	£14,116,785	£14,992,729	£14,888,816	£15,336,796	6.20	-0.69	3.01
Wiley	£5,012,723	£5,210,941	£5,427,978	£5,656,715	3.95	4.17	4.21
Springer	£2,801,861	£3,008,942	£2,886,513	£3,076,860	7.39	-4.07	6.59
Taylor & Francis	£2,759,493	£2,891,599	£2,912,432	£3,239,863	4.79	0.72	11.24
Sage*	£1,376,618	£1,534,175	£1,582,949	£1,666,361	11.45	3.18	5.27
OUP	£672,296	£784,922	£869,360	£928,625	16.75	10.76	6.82
CUP	£450,013	£514,758	£539,860	£600,681	14.39	4.88	11.27
<b>Total</b>	<b>£27,189,789</b>	<b>£28,938,065</b>	<b>£29,107,908</b>	<b>£30,505,902</b>	<b>6.43</b>	<b>0.59</b>	<b>4.80</b>

\*Excludes Imperial College for which Sage subscription data were incomplete.

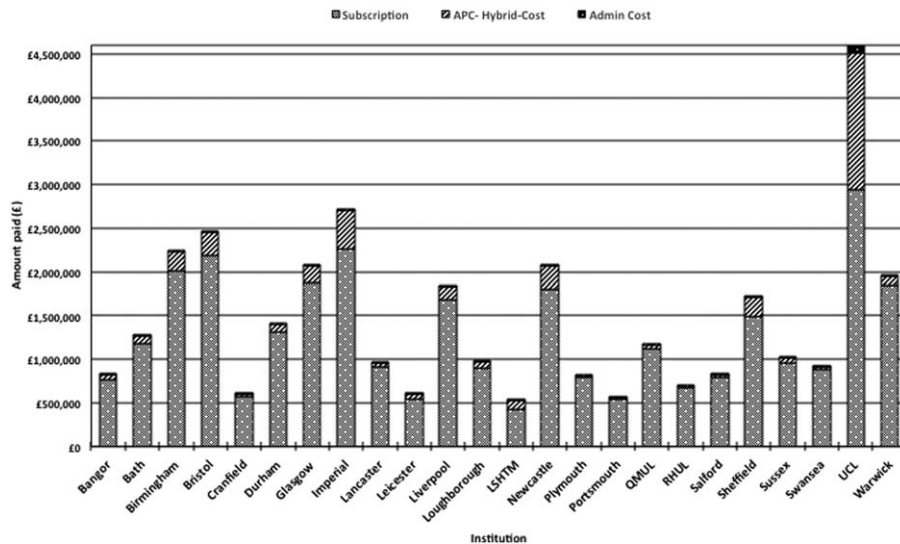


FIG. 8. TCP for seven publishers (Cambridge University Press, Elsevier, Oxford University Press, Sage, Springer, Taylor & Francis, and Wiley), 2014.

financial and other costs and benefits). Our research provides a clearer picture of the paid-for Gold OA market as experienced by UK HEIs from centrally managed funds, and shows the prominent role played by hybrid APC payments. Moreover, it shows that the 12% of APCs in the TCP were largely additional costs for institutions—additional, that is, to subscription costs, which themselves have continued to rise. Since it may be assumed in the current policy environment that APC costs are likely to rise, the policy question arises to

what extent can and should support for hybrids be sustained? Hybrid OA is adding considerably to the TCP for HEIs, and at a time of budgetary restraint in higher education, the sustainability of such a situation is a key issue, particularly as studies of overall OA costs for various scenarios tend to posit projected cost savings for the sector (Cambridge Economic Policy Associates, 2008; Swan & Houghton, 2012).

The key issue facing policymakers in particular is whether these additional costs currently faced by institutions

TABLE 7. TCP for seven publishers (Cambridge University Press, Elsevier, Oxford University Press, Sage, Springer, Taylor & Francis, and Wiley), 2014.

Institution	Subscriptions (%)		APC (%)		Admin. cost (%)		Total
Bangor	£765,872	<b>93.2%</b>	£53,607	<b>6.5%</b>	£2,200	<b>0.3%</b>	£821,679
Bath	£1,186,086	<b>93.4%</b>	£78,992	<b>6.2%</b>	£4,488	<b>0.4%</b>	£1,269,566
Birmingham	£2,004,295	<b>89.5%</b>	£222,069	<b>9.9%</b>	£14,168	<b>0.6%</b>	£2,240,532
Bristol	£2,181,422	<b>88.5%</b>	£271,226	<b>11.0%</b>	£12,408	<b>0.5%</b>	£2,465,056
Cranfield	£567,832	<b>94.9%</b>	£29,467	<b>4.9%</b>	£1,320	<b>0.2%</b>	£598,620
Durham	£1,308,700	<b>92.7%</b>	£97,268	<b>6.9%</b>	£5,456	<b>0.4%</b>	£1,411,424
Glasgow	£1,871,363	<b>90.3%</b>	£192,080	<b>9.3%</b>	£10,032	<b>0.5%</b>	£2,073,474
Imperial	£2,262,852	<b>83.0%</b>	£443,124	<b>16.3%</b>	£18,744	<b>0.7%</b>	£2,724,720
Lancaster	£919,913	<b>95.6%</b>	£40,053	<b>4.2%</b>	£2,200	<b>0.2%</b>	£962,166
Leicester	£545,000	<b>90.4%</b>	£55,058	<b>9.1%</b>	£2,552	<b>0.4%</b>	£602,610
Liverpool	£1,678,451	<b>91.6%</b>	£146,634	<b>8.0%</b>	£6,864	<b>0.4%</b>	£1,831,950
Loughborough	£903,882	<b>92.9%</b>	£66,003	<b>6.8%</b>	£3,432	<b>0.4%</b>	£973,317
LSHTM	£431,170	<b>80.8%</b>	£98,051	<b>18.4%</b>	£4,576	<b>0.9%</b>	£533,798
Newcastle	£1,806,955	<b>86.7%</b>	£264,885	<b>12.7%</b>	£11,616	<b>0.6%</b>	£2,083,456
Plymouth	£797,744	<b>98.8%</b>	£9,076	<b>1.1%</b>	£352	<b>0.0%</b>	£807,172
Portsmouth	£547,687	<b>98.4%</b>	£8,763	<b>1.6%</b>	£352	<b>0.1%</b>	£556,802
QMUL	£1,117,813	<b>95.8%</b>	£47,055	<b>4.0%</b>	£2,200	<b>0.2%</b>	£1,167,068
RHUL	£683,004	<b>99.0%</b>	£6,425	<b>0.9%</b>	£352	<b>0.1%</b>	£689,782
Salford	£798,763	<b>96.5%</b>	£27,583	<b>3.3%</b>	£1,144	<b>0.1%</b>	£827,490
Sheffield	£1,498,839	<b>87.1%</b>	£211,113	<b>12.3%</b>	£10,208	<b>0.6%</b>	£1,720,160
Sussex	£958,613	<b>94.7%</b>	£51,844	<b>5.1%</b>	£2,288	<b>0.2%</b>	£1,012,745
Swansea	£879,687	<b>95.3%</b>	£41,167	<b>4.5%</b>	£2,200	<b>0.2%</b>	£923,055
UCL	£2,940,492	<b>64.0%</b>	£1,565,022	<b>34.0%</b>	£91,080	<b>2.0%</b>	£4,596,594
Warwick	£1,849,466	<b>94.6%</b>	£100,762	<b>5.2%</b>	£4,312	<b>0.2%</b>	£1,954,540
<b>Total</b>	<b>£30,505,902</b>	<b>87.5%</b>	<b>£4,127,329</b>	<b>11.8%</b>	<b>£214,544</b>	<b>0.6%</b>	<b>£34,847,775</b>

might be considered transitional or whether they will remain in place in the long term. For them to be considered transition costs, there needs to be a clear “line of sight” between the current subscription/hybrid OA system and a situation where OA becomes the predominant model of scholarly communication. In practical terms, this would mean evidence of publishers transitioning their business models to incorporate some kind of “offsetting” and, ultimately, “flipping” arrangements (i.e., replacing subscription-based with OA-based models). In the current market, publishers are developing new business models which, in some cases, involve offsetting arrangements, including ones which appear to allow for flipping within the foreseeable future (Springer, 2015). Where this is the case, however, the complexity of the different publishing models and a variety between them can create challenges for institutions. A more fundamental challenge for HEIs is that not all publishers have accepted the transition assumption of HEIs or have meaningful offsetting arrangements or plans for flipping in place.

Our study provides empirical evidence that some offsetting is occurring, particularly as discounted APCs for subscribers. However, the additionality of APC costs indicated would suggest that, at present, any offsetting taking place does not fully compensate for the additional costs of Gold (including hybrid) OA. The need from an institutional point of view for HEIs (or consortia) negotiating with publishers to build an understanding of the TCP into the negotiations, resulting in meaningful offsetting, is becoming more apparent. Significantly, this is reflected in the UK by the recent statement of principles articulated by Jisc on offsetting (Jisc, 2015), which builds on policy positions of UK funders to engage with hybrid as a transition approach (Finch et al., 2012; Jubb, 2014). Important features of this include the aim that offsetting models lead to benefits for specific institutions with greater APC expenditure (rather than just based on global averages) (Björk & Solomon, 2014a), and should involve ongoing offset business processes that can be reasonably administered by the different stakeholders. On the last point, it is clear from our study that administrative costs are currently only a relatively small proportion of the TCP but their place in the TCP to be monitored along with other costs associated with OA management.

The success of HEIs in the UK and elsewhere in negotiating offsetting arrangements could impact more widely the perceived future viability of hybrid OA. The recent Max Planck Society initiative calls for international action around offsetting and flipping, identifying offsetting agreements as “the most promising” options for achieving a transition from subscriptions to fully OA publishing (Schimmer, Geschuhn, & Vogler, 2015). However, apart from libraries demanding offsetting deals “more energetically” and with greater international coordination, it does not suggest mechanisms for achieving such a transition. Apart from engaging in negotiations, as costs rise there are, of course, various other options open to HEIs. Funding agencies may withdraw from or limit funding for hybrid journal APC payments (either by capping

the level of APC supported or limiting the total budget available for hybrids). However, the evidence for the UK suggests this would immediately reduce the proportion of outputs available in OA. The negotiation of a cost-neutral transition to OA may, on the other hand, be difficult to achieve, at least in the short term. The question in that case will be how long is it acceptable for additional transitional costs to be borne by funders and institutions? One possible compromise for funders and institutions keen to encourage hybrid as a transitional mechanism might be to pay APCs for hybrid journals only if the publisher has in place an offset model which has been in some way “approved” by the research funder. This would, of course, necessitate the production of clear criteria for such approval, but documents such as the Jisc offset principles could be a good basis for such criteria (Jisc, 2015). Such an approach might itself encourage offsetting agreements. A related approach might be to establish criteria for the value of various OA-related services publishers’ provide (licenses available, deposit in repositories, etc.) and fund them according to these criteria. This would, of course, require detailed work to establish relevant cost and value criteria. In all cases, it will be important to continue to develop an evidence base to inform such work both in the UK and internationally. The data examined in this study was of a better quality and more easily available than that reported in Pinfield et al. (2015); however, there is still a pressing need in the UK and internationally to ensure that more institutional data, collected and shared in more standardized ways, are available to inform ongoing developments.

## Conclusion

This study demonstrates that the APC market is currently complex, with variable pricing, discounts, and other additional charges contributing to institutional costs. Nevertheless, it is clear that, in the UK, centrally managed APC expenditure has continued to rise steeply. This can largely be attributed to the policy and funding position among UK funding agencies. APC payments in 2014 varied from £0 to £4,536 (\$6,904; mean = £1,586; \$2,415). There was considerable variation in the levels of payments across different institutions, reflecting research activity and policy differences. The largest number of institutional APC payments was made for articles in the Health and Life Sciences. Commercial subscription publishers were responsible for the largest proportion of the centrally managed APC market in HEIs, many offering hybrid options. Hybrid options were, nevertheless, considerably more expensive than those for fully open access titles. However, there was a correlation between APC price and journal quality (shown in journal citation rates).

APCs in the 24 UK institutions (using a sample of seven publishers) now constitute 12% of the “total cost of publication” with APC administration, 1%, and subscriptions, 87%. This is at a time when subscription costs for institutions have risen, indicating that APCs and administrative

costs currently constitute additional costs for HEIs (i.e., subscriptions have not declined commensurately as APC costs have increased). There is likely to be an impetus to review current Gold-centric policy positions and funding arrangements in the UK. While the approach appears to have resulted in an increase in take-up of OA, it has created major cost pressures—pressures illustrated in the TCP modeling. Time will tell how these pressures will be addressed in terms of policy development, both in terms of continued pursuit of Gold OA and the incorporation of Green OA in policy approaches.

The developing evidence base can inform policy development in the UK and internationally about the shape a Gold-centric approach can take, including the extent to which support for hybrid journals is a transition mechanism. The pattern of market activity of HEIs in the context of the UK's largely Gold-centric position to date and the challenges it has created, along with discussion of the ways in which those challenges may be addressed in the future, will have a significant impact on ongoing development both within and beyond the UK.

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