Economic Implications and Benefits Assessment of an Updated UKRI Open Access Policy for Peer-Reviewed Research Articles

Produced as part of the UKRI Open Access Review 2018-2021



December 2020









This work is licensed under a Creative Commons Attribution 4.0 International License.

This work was commissioned by UK Research & Innovation (UKRI) in June 2020, with the final version submitted to UKRI in December 2020. The report was researched and produced by Alma Economics in association with fullstopp. The research team would like to gratefully acknowledge helpful comments received on earlier versions of the report by colleagues at UKRI and the Department for Business, Energy & Industrial Strategy (BEIS).

Table of Contents

Summary	1
Background and definitions	5
Pathways to open access	6
Gold OA	6
Green OA	6
Other forms of OA publishing	7
Copyright	7
Business models of academic journals	7
Transformative agreements	7
OA policies in the UK and recent international developments	9
OA policies in the UK	9
Open access in the international context	11
The new UKRI policy to achieve full and immediate OA	13
Approach and data	14
Desk-based research	14
Interviews	14
Survey with HEIs	15
Data	15
Approach to Modelling	17
OA publications in the UK	19
Prevalence of open access articles in the UK	19
UK Open Access articles by subject area	21
Overview of the scholarly publishing market	24
Financial analysis of the publishing market	24
Large commercial publishers	24
Open access publishers	26
Learned societies	29
Journal-level costs	32
Gold and Green OA from the publishers' perspective	36
The financial implications of OA for HEIs	38
Overall expenditures on OA	38
Expenditures on APCs	39
APCs 'in the wild'	42
Additional costs of processing OA articles	43
The costs of processing OA articles for HEIs and recent improvements: insights from our	
interviews with HEIs	44
Subscription fees	45

The impact of transformative agreements on the cost of publishing	46
Research articles affected by the new UKRI OA policy	48
The impact of the UKRI policy under different policy options	49
Scenario 1: UKRI OA funds will support OA publications in hybrid journals as well as full OA journals	. 50
Scenario 2: UKRI OA funds will support OA publications in full OA journals and hybrid journals that are part of transformative agreements	51
Scenario 3: UKRI OA funds will not support OA publications in hybrid journals, only full OA	50
journais	52
The use of block grants by HEIs	52
Alternative block grant allegation	53
	00
Fatimated ADCs in the full and immediate OA second	50
Estimated APCs in the full and inmediate OA scenario	00 57
Additional expenditures on APCs under the new OKRI policy	57
Additional impacts on HEIs of publishing open access	59
Main challenges of full OA for HEIs and research Institutes	62
The impact of the new UKRI OA policy on publishers	64
Estimating the financial impact of full and immediate OA on publishers	64
The broader impact of full OA on the publishing industry	67
Impact of transformative agreements	67
Impact of OA publishing on the UK publishing industry	68
The benefits of open access	/1
The benefits of OA	71
Societal benefits of OA	72
Estimating the benefits of OA publishing to society	74
Journals 'flipping' to OA	78
Main reasons to flip to OA	78
Distribution of UKRI-funded articles across journals	80
Estimating the number of journals flipping to OA following the new UKRI policy on OA	82
Conclusions	86
Key findings	86
Monitoring the transition to open access	87
Bibliography	90
Annex	94
Technical Appendix	94
Interview participants	98
Survey questionnaire	99

List of Tables

Table 1.	Articles published in 2018 by the top 10 countries for the total number of publications	
	available open access in August 20202	21
Table 2.	UK-authored and UKRI-funded research articles published in 2018 by journal publishing	
	model2	2
Table 3.	Number of journals publishing UK-authored articles by subject area and business model in	ן רר
Table 1	ZUIO	<u>'</u> ∠
Table 4.	model	; 3
Table 5.	Proportion of UKRI-funded articles published in 2018 by subject area and journal business	3
	model	23
Table 6.	Revenue and profit margin of large commercial publishers2	25
Table 7.	Revenue and profit margin for a sample of OA publishers2	27
Table 8.	Revenue and operating profit margin for a sample of learned societies	29
Table 9.	Average publishing cost per article estimated in the literature	33
Table 10.	Estimated average publisher costs per article by format and journal (£)	35
Table 11.	Expenditures on OA for UK HEIs between 2016 and 2019 as a % of the library budget 3	39
Table 12.	Expenditure in APCs from previous studies	39
Table 13.	Jisc estimated expenditures of UK HEIs on subscription	15
Table 14.	Number of articles that acknowledge UKRI funding published in 20185	50
Table 15.	Proportion of articles that would not comply with the new UKRI OA policy by subject area	
	assuming 2018 publication patterns – Scenario 15	50
Table 16.	Hybrid journals that negotiated transformative agreements (TAs)	51
Table 17.	Proportion of articles published in journals that are not part of a transformative agreement	
	assuming 2018 publication patterns5	51
Table 18.	Proportion of articles that would not comply with the new UKRI OA policy by subject area	
	assuming 2018 publication patterns – Scenario 3 5	52
Table 19.	Number of UK-authored articles funded by UKRI block grant	52
Table 20.	Regression coefficients of estimated 2018 APCs by subject area for UK-authored	
	articles 5	56
Table 21.	Average estimated APCs by journal business model and subject areas for UK HEIs and	
	research institutes (£)5	56
Table 22.	Average APCs by journal business model and subject areas for UK HEIs and research	
	institutes (£)5	57
Table 23.	Estimated costs of APCs in the scenario in which all UK-authored articles in 2018 were	
	published OA by journal business model and subject area (£ million)5	58
Table 24.	Estimated costs of APCs in the scenario in which all UKRI-funded articles in 2018 were	
	published OA by journal business model and subject area (£ million)5	58
Table 25.	Estimated additional APCs in the scenario in which all UK-authored articles and UKRI-	
	funded articles in 2018 were published OA (£ million)5	59
Table 26.	Key parameters in estimating total impact of UKRI OA policy on HEIs6	30
Table 27.	Estimated total impact of OA publishing for HEIs under different UKRI policy scenarios,	
	compared to the baseline scenario (£ million)6	31
Table 28.	Sensitivity analysis for the impact on HEIs of converting all UKRI-funded articles to OA,	
	compared to the baseline scenario (£ million)6	31
Table 29.	Key parameters in estimating total impact of UKRI OA policy on publishers6	34

Table 30.	Estimated total impact of OA publishing for publishers under different UKRI policy
	scenarios, compared to the baseline scenario; UK segment of the business only
	(£million)66
Table 31.	Sensitivity analysis for the impact on publishers of converting all UKRI-funded articles to
	OA, compared to the baseline scenario; UK segment of the business (£ million)
Table 32.	Input parameters required to estimate the broader societal benefits from OA publishing via
	increased returns to R&D75
Table 33.	Estimated total 20-year NPV of OA publishing societal benefits, compared to the baseline
	scenario (£ million)76
Table 34.	Sensitivity analysis for the total 20-year NPV of societal benefits if all UKRI-funded articles
	are published OA, compared to the baseline scenario (£ million)77
Table 35.	Journals flipping to a full OA publishing model if all UKRI-funded articles are required to be
	published in full OA journals, by subject area
Table 36.	Impact on hybrid and full OA journals after flipping if all UKRI-funded articles are required to
	be published in full OA journals
Table 37.	Sensitivity analysis of impact on hybrid and full OA journals after flipping if all UKRI-funded
	articles are required to be published in full OA journals

Annex

Table A1.	Number of hybrid journals by publisher94
Table A2.	Regression coefficients of estimated APCs by subject area for UK-authored articles, 2018
Table A3.	Regression coefficients of estimated APCs by subject area for UK-authored articles, 2017
Table A4.	Regression coefficients of estimated APCs by subject area for UK-authored articles, 2016
Table A5.	Estimated costs of APCs in the scenario in which all UK-authored articles in 2018 were published OA by journal business model and subject area and 75% of APCs are attributable to UK HEIs (£ million)
Table A6.	Estimated costs of APCs in the scenario in which all UKRI-funded articles in 2018 were published OA by journal business model and subject area and 75% of APCs are attributable to UK HEIs (£ million)
Table A7.	Estimated costs of APCs in the scenario in which all UK-authored articles in 2018 were published OA by journal business model and subject area and 50% of APCs are attributable to UK HEIs (£ million)
Table A8.	Estimated costs of APCs in the scenario in which all UKRI-funded articles in 2018 were published OA by journal business model and subject area and 50% of APCs are attributable to UK HEIs (£ million)
Table A9.	Assumptions for key model parameters97

List of Figures

Figure 1.	Total UKRI block grants awarded to UK HEIs and research institutes (£ million) 10
Figure 2.	Total Wellcome/COAF spend on APCs (£ million) 10
Figure 3.	Data inputs
Figure 4.	Proportion of UK-authored articles available OA in August 2020, by year of publication 20
Figure 5.	Proportion of UK-authored articles available open access in August 2020 by year of
	publication and OA model
Figure 6.	Share of articles requesting APCs funding that institutions decided not to fund, 2018/2040
Figure 7.	Proportion of researchers funded by UKRI that made use of their personal research budget
	to cover the cost of APCs, 2018/2019 41
Figure 8.	Proportion of researchers that made use of their personal research budget to cover the
	cost of APCs, 2018/2019 41
Figure 9.	Expenditure on subscriptions fees paid to the largest 5 publishers
Figure 10.	. Total subscription and APCs expenditures for 18 UK HEIs, 2014-2018 (£ million, current
	prices)
Figure 11.	Cost of increased open access
Figure 12.	Main challenges of OA faced by UK HEIs and research institutes
Figure 13.	Distribution of UKRI-funded articles across all journals in 2018
Figure 14.	Distribution of UK-authored articles across journals
Figure 15.	Social benefits of increased OA: Increasing accessibility and efficiency of research75
Figure 16.	UK-authored articles published OA in hybrid journals in 2018
Figure 17.	Distribution of UKRI-funded articles across all journals with more than 5% of UKRI-funded
	articles in 2018
Figure 18	. Distribution of UKRI-funded articles in hybrid journals with more than 5% of UKRI-funded
	articles in 2018
Figure 19.	Distribution of UKRI-funded articles in closed journals with more than 5% of UKRI-funded
	articles in 2018
Figure 20.	Journal decision tree following the introduction of the UKRI policy



Summary

Introduction

Since 2012, the UK has made significant strides towards Open Access (OA) in publicly funded peerreviewed research. In 2013, Research Councils UK (RCUK) introduced the RCUK Policy on Open Access requiring articles produced and funded by the RCUK to be made open access immediately after publication. OA requirements were also introduced for output submitted to the Research Excellence Framework (REF).

In 2018 RCUK transitioned into UK Research and Innovation (UKRI). In the same year, UKRI initiated an OA Review and declared its ambition for a new OA policy to reach immediate OA. The results of the OA Review will determine a single open access policy that supports both 'Gold' and 'Green with no embargo period for research output acknowledging funding from UKRI and its constituent councils. The OA review concerns research articles and monographs. The OA policy for research articles builds on well established OA policies, whereas the requirement for OA to monographs is a new requirement. This work focuses on research articles, and monographs are not in the scope of this report.

UKRI commissioned this report to better understand the economic implications of open access, with a focus on how the costs of publishing have changed with the rise of OA, and what the main implications of the new proposed OA policy are for Higher Education Institutions (HEIs), publishers, and UKRI. The report also explores the potential benefits of achieving full OA.

To address the research objectives, we adopted a mixed-methods approach that comprised a deskbased review, engagement with key groups of stakeholders, as well as quantitative data analysis and modelling. We estimated the costs and the benefits of the new UKRI policy and compared them with the current scenario (see section Approach to Modelling). The report will be used alongside the results of the OA Review's consultation and other Review activities to inform UKRI's new OA policy.

Impact of Open Access on HEIs and implications of the new UKRI policy

For HEIs, the rise of OA has necessitated increased spending on Article Processing Charges (APCs). Estimating total expenditure on OA is difficult, as expenditures are often split across departments and budgets, and some payments are difficult to track (so-called APCs 'in the wild'). We estimate that expenditure on APCs for UK-authored papers¹ in 2018 could have totalled £45-£90 million (see section Estimated additional expenditures on APCs under the new UKRI policy). Part of the APC spend is covered using the OA block grant² awarded by UKRI and other funders, while a part is paid by HEIs, and in some cases, directly by authors.

The proportion of UKRI-funded articles³ published in 2018 that was available OA in June 2020 was about 70% (including both Gold and Green articles). We estimate that if UKRI required all articles acknowledging UKRI funding to be available immediately OA, the additional expenditures for HEIs associated with OA publishing would total £20-£40 million each year on top of current expenditures by any part of the system, depending on the level of offsetting and the percentage of APCs of UK-authored papers that are payable by UK HEIs.

¹ UK-authored papers refer to articles for which at least one of the co-authors was affiliated with a UK institution. Please note that this does not imply these APC expenditures are met exclusively by UK institutions or authors; in many cases these APCs are paid by the institutions of co-authors based overseas or other non-UK sources.

² More information on OA block grants are available on the UKRI website.

³ UKRI-funded articles refer to articles acknowledging UKRI funding, as recorded in the Dimensions database.

The proportion of UK-authored articles published in 2018 and available OA in June 2020 is about 46%. We estimate that the additional expenditures required to make all UK-authored articles in 2022 available OA immediately at publication would be around £140-£280 million.

While a fairly large number of UKRI-funded articles published in 2018 was available OA in 2020 under the Green route (27% of all articles), only a small fraction of articles published under Green OA are usually available immediately after publication (i.e., Green no embargo). From our interviews, it emerged that many publishers are reluctant to offer the Green with no embargo option as they see it as potentially undermining subscription revenues. This does not necessarily mean that the Green route cannot play a role as part of the transition to open access, as Green OA models with some rights retention do enjoy support among some publishers and stakeholders.

In addition to APCs, HEIs continue to pay subscription fees to access non-OA content. Subscription fees paid by UK HEIs are estimated to be well over £200 million per year (see section Subscription fees). Despite the implementation of transformative agreements, which are meant to reduce the costs of publishing OA by bringing the payment for reading and publishing in a single contract, the combined expenditures on APCs and subscriptions have continued to rise. Given the available evidence, it is unclear whether HEIs can achieve substantial offsetting through the negotiation of transformative agreements (see section The impact of transformative agreements on the cost of publishing). Moreover, transformative agreements have not been negotiated with all publishers, although the number of agreements is increasing. At the time of writing there are 23 agreements in place in the UK.

The new UKRI policy will increase the number of articles published OA, which will in turn require additional funds to meet the cost of APCs. This is against the backdrop of widely anticipated HEI budget cuts in the wake of the COVID-19 epidemic, expected to be in the tune of 5%-30% according to HEIs we interviewed.

The members of cOAlition S announced that support for publication fees in transformative agreements will cease on 31 December 2024. However, it is unclear how OA publishing will remain sustainable without further agreements or other funding when transformative agreements and other arrangements expire. While there are alternative OA models which are not based on APCs, the APC-based model is currently the most widespread. The end of transformative agreements will imply that HEIs will need to maintain their subscription spend in addition to funding APCs, unless alternative models are adopted. There are also limits to the extent subscription expenditures can be repurposed to pay for APCs given that a large proportion of global scholarly output is not published OA.

The scholarly publishing industry under Open Access

Journals contribute to the scientific publishing process through maintaining a platform, sourcing reviewers, managing a pipeline of content and ensuring that articles on the platform can be discovered. Furthermore, journal reputation acts as a signal for the quality of published research, which in turn impacts academics' career path and visibility within the research community.

There has long been a vigorous debate on the profitability of the academic publishing sector (see section Financial analysis of the publishing market). The market is highly concentrated, with approximately 80% of it being controlled by a small group of large commercial publishers enjoying high profit margins.

In any sector, profit margins tend to decrease over time as new entrants are attracted to the market, bringing prices down. In the publishing industry, large publishers manage to maintain market power partly because of their scale – which enables them to strike 'big deals' with institutions – but also due to the role played by journals' reputation in the scholarly system: in economics terms, prestige is a scarce resource that enables journal owners to generate excess profits.

Born-OA journals have only emerged in the past two decades, and thus tend to lag behind more established subscription or hybrid titles in terms of their reputation and prestige. Furthermore, new

paradigms seeking to alter the role journals have traditionally played (and continue to play) in signalling high research quality – in the process also reducing costs associated with publication, for example by reducing pre-publication peer review – have emerged predominantly in the context of born-OA journals.

As a result, it is critical that discussions of OA take into account the distinction between these two issues: a) whether the published content is available free of charge and without other non-financial restrictions, and b) whether journals should continue to act as the key arbiters of research quality, or there should be a transition to a system where journal reputation is no longer a key consideration, leading to lower publication costs and lower profits for publishers.

The impact of the new UKRI policy on the publishing industry

In the scenario in which all UKRI-funded papers are published OA, we estimate a small decline in the annual industry profit margins for the UK segment of publishers' business (see section Estimating the financial impact of full and immediate OA on publishers).

Despite the concerns about OA expressed by learned societies, which often use revenue from publishing to finance other activities, previous studies show that open access has not had a negative impact (in the short-term) on the financial stability of learned societies and that in recent years they have transformed their business model to support the transition to full OA.

Overall, our estimates show that the new UKRI policy on OA will have a limited impact on publishers' overall profits. As mentioned in the previous section, the fact that journal reputation continues to play an important role in academia enables publishers of prestigious titles to make substantial profits irrespective of their key revenue sources (subscriptions or APCs).

In addition, the publishing market operates at a global level, with journals publishing research outputs from institutions around the world. Therefore, while UKRI funds high-quality research, the research output is still quite dispersed across journals, with most journals publishing a very small proportion of UKRI-funded articles. Only 3% of journals that published at least one UK-authored article in 2018 published more than 10% of UKRI-funded articles in 2018. In this respect, coordination with international funders is critical if the aim is to significantly impact journal business models (e.g. journals flipping to OA. See section Journals 'flipping' to OA).

In terms of the impact on the domestic publishing industry, a key aspect to note is that UK publishers rely heavily on exports, with 85% of revenue originating overseas. Therefore, the introduction of the UKRI OA policy will only influence a fraction of the remaining 15%, and its impact on the domestic industry is unlikely to be substantial.

Wider benefits of open access

Supporters of open access have pointed to a number of benefits of open access such as citation advantage, increased exposure of research output in the research community, increased accessibility of research output to the wider society, reduced costs of publishing due to more efficient distribution, increased collaboration across research institutes and companies, and increased innovation and return on R&D investment. However, quantifying these benefits is challenging because (i) there are no comprehensive data on how much OA content is accessed, (ii) part of the benefits of open access will be fully realised once there is a complete transition to OA, and (iii) due to transition costs the net benefits in the short term are lower.

Following Houghton et al. (2009), we identify two key channels through which the benefits of OA are derived (see section Estimating the benefits of OA publishing to society). Firstly, OA publishing is more efficient due to lower sales, marketing and printing costs, in addition to other administrative expenses. This means that per-article publishing costs for OA articles are lower than the costs of publishing the

same article in an equivalent subscription-only journal. This represents annual efficiency gains of around £90 million if all UKRI-funded papers are published OA, a saving of around £9 million each year averaged across the six years following policy implementation compared to the baseline scenario.

Secondly, OA publishing generates excess returns to R&D spending due to gains in the accessibility of knowledge as well as the efficiency of the research process. If all UKRI-funded articles are published OA, we estimate that the net present value (NPV) of the excess return to R&D over 20 years compared to a baseline scenario is close to £500 million. The total 20-year NPV of the benefits due to the increased social return on R&D spending and efficiency savings from OA publishing is approximately £8.3 billion, which is about £800 million higher than in the case in which the UKRI policy was not introduced.

The potential gains from a full UK-wide conversion to OA publishing could be significant and exceed the costs: the 20-year NPV of efficiency gains from reduced publisher costs would be approximately £3.3 billion, with another £5.3 billion increase in the NPV of returns to R&D investment.

As noted in the Finch report (2012), while the UK has been one of the leading countries in the adoption of OA policies, the costs and the benefits of the transition to OA will crucially depend on whether other countries put in place similar OA policies and systems. More widespread adoption of open access policies across the world will enable UK institutions to access more of the global research output free of charge, lessening or eliminating the burden of subscription fees for UK institutions.

Transformative agreements and their impact on the publishing industry

Many publishers favour transformative agreements because they allow them to maintain a constant stream of revenue while being compliant with OA mandates. They are also seen favourably by universities and funders, as they appear to prevent the "double-dipping" imposed by hybrid journals, which refers to the fact that hybrid journals charge both APCs and subscriptions fees.

However, these deals have been criticised for their similarity to the long established 'Big Deals' in enabling large publishers to maintain their dominance in the market. The term Big Deals is used to describe licensing agreements that provide access to the content of major publishers. The negotiation of transformative agreements has the potential to affect levels of competition in the market, leading to less innovation and higher prices in the medium term. They could also undermine the profitability of (i) full OA journals, as HEIs are locked into contracts with large publishers and have potentially less resource to invest in extra APCs, and (ii) small publishers if they are unable to negotiate transformative agreements, as they will no longer be compliant with the new UKRI policy.

Some publishers, especially small ones as well as learned societies, expressed concerns about the sustainability of their business model after the introduction of these agreements. In particular, for Arts and Humanities as well as Social Sciences fields for which the market is highly fragmented, publishers claim that it is hard to gain visibility and negotiate transformative agreements.

In response to these concerns, in 2019, Jisc negotiated transformative agreements with five small learned societies. These are the first agreements that Jisc negotiated on behalf of small publishers, in an effort to make the transition to OA sustainable for smaller publishers, including many learned societies.

Background and definitions

Over the past two decades, academic publishing has been affected by a series of innovations in the way scientific knowledge is produced and disseminated. The spread of the Internet, which allowed for the creation of platforms such as SSRN, Google Scholar and Mendeley, has made research output more easily accessible to a broader audience by distributing research globally and cheaply (Fyfe et al., 2017). With the costs of operating a digital platform being much lower than the costs of paper, ink, binding, packing and shipping, marginal costs of publishing have fallen to close to zero, and social web technologies such as ResearchGate and Academia.edu allow authors to publish and distribute their research directly.

One important innovation in the recent transformation of academic publishing has been the growth of open access (OA). OA refers to making scholarly research freely accessible to others without cost or other barriers. Since the 2002 Budapest Open Access Initiative, which was the first movement to use and define the term "open access", OA publishing has rapidly gained momentum among researchers, funders, and governments (Tennant et al., 2016). International alliances of research organisations have also worked towards accelerating the transition to OA.

The European Union, which defines open access as 'providing online access to scientific information that is free of charge to the reader', has included OA obligations for all the beneficiaries of the Horizon 2020 program. This program is the biggest European Research and Innovation program, with €80 billion invested in research and innovation between 2014 and 2020. Grant holders must ensure open access to peer-reviewed scientific publications as well as their research data.⁴ Similarly, Plan S⁵ and OA2020,⁶ established by library consortia and research funders, have promoted the transition to full open access publications to take place within the next few years.

https://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/open-access-dissemination_en.htm. ⁵ More details on the Plan S initiative can be found at: https://www.coalition-s.org/

⁴ See requirements of Horizon 2020 at:

⁶ More details on the OA2020 initiative can be found at: https://oa2020.org/wp-content/uploads/pdfs/Open-Access-2020-Executive-Summary.pdf

Pathways to open access

There are two main pathways to making research OA:

- 1. **Gold route:** Research is freely accessible at the point of publication, often accompanied by Article Processing Charges (APCs) levied on article authors. Publications with no APCs are known as platinum or diamond OA.
- 2. **Green route:** Research is posted to a public institutional or subject repository, often accompanied by an embargo period before deposition.

Despite the widespread use of the terms Green and Gold to refer to open access publications, it is worth highlighting that the degree of openness of a publication depends on several dimensions: cost, authoritativeness, peer-review, user rights, immediacy, and stability (Martín-Martín et al. 2018). The combination of these dimensions defines the different OA options, beyond the simple distinction between Green and Gold. However, for simplicity, in this report, we will mainly refer to Gold and Green as defined above.

Gold OA

Gold open access usually requires payment of an APC by the author, and the article is freely accessible to everyone immediately after publication. Although the mechanism through which publishers determine the level of APCs is opaque, evidence suggests that APCs are currently scaled based on perceived journal quality, as measured by a journal impact factor or citations per paper (Tennant et al. 2019). To mitigate the cost of APCs, publishers have introduced a number of alternate payment systems, including institutional memberships (which allow institution authors to publish for free or at reduced rates), prepayments (block purchase of APCs at a discounted rate) and waivers for authors in low-income countries.

While APCs have received significant attention from stakeholders and policymakers, a significant number of fully-OA journals listed in the Directory of Open Access Journals (DOAJ) do not use publication charges. Instead, they are supported by institutions, including foundations, government agencies, learned societies and research funders. Similarly, in the consortia (or library publishing) funding model, a number of libraries and other organisations work together to fund OA publishing.⁷

Green OA

Under Green OA, authors publish their article in a journal and then self-archive a copy in an institutional/specialist repository or freely accessible website. Green open access does not require payment of an APC. Unlike Gold OA, the copyright of Green OA publications usually sits with the publisher. Self-archiving policies often vary between journals, especially with respect to the timing in which the article can be made open access, the version that can be used by the author, etc.

Generally, the article is made freely available after a period of time (the embargo period) which depends on the policy of the journal (usually 6-12 months in STEM academic disciplines, and more than 12 months for the humanities and social sciences). Repositories form a key component of several academic disciplines, including arXiv for physics, mathematics, and computer science as well as RePEc for economics, with BioRXiv becoming increasingly popular for natural sciences.

⁷ One example is the Open Library of the Humanities (OLH), which charges libraries between USD 600-2500 to fund more than 250 published articles each year. Similarly, the Sponsoring Consortium for Open Access Publishing in Particle Physics (SCOAP3) pays publishers a fixed maximum annual payment from a common fund covering all articles published.

Other forms of OA publishing

Articles can also be shared in a variety of locations online. These cannot be neatly classified into 'Gold' or 'Green' and in some cases may break article licensing terms or copyright law. Journals that are free to read on a publisher's website but do not have a clearly identifiable licence are known as Bronze OA (Piwowar et al. 2018). The absence of a licence means that articles are free to read but do not permit further re-use rights, and that publishers are able to remove access at any point.

Alternatively, articles can be posted on academic social networks, such as ResearchGate or Academia.edu. These networks do not check for copyright compliance, and as much as half of all articles may be illegally posted (Jamali 2017). However, there are important concerns around the sustainability and ethics of these networks, and access may not be guaranteed as publishers have previously issued large-scale takedown notices to remove infringing content. Indeed, not all funders accept papers on academic social networks as open access and illegally published papers (through Sci-Hub or LibGen) are currently not considered OA at all.

Copyright

Copyright protection exists to ensure copyright owners retain the ability to benefit from reproduction and dissemination of their work. Traditional models of publishing require the full transfer of copyright from authors to publishers, including control over dissemination and reproduction, a process that has been required by many publishers since the 1990s (Fyfe et al. 2017). To maximise opportunities for redistribution and re-use of the articles for the authors, many OA articles are licenced under the Creative Commons Attribution (CC-BY).

In this regard, cOAlition S has developed a Rights Retention Strategy⁸ to enable their funded researchers to publish in their preferred journals and at the same time be compliant with OA requirements. The strategy requires articles to acquire a CC-BY licence before they are submitted to a journal. This ensures that authors retain the intellectual property of the manuscript and can make the accepted manuscript available open access at the time of publication.

Business models of academic journals

Journals in the research publishing market can be classified as fully OA, hybrid or subscription-based. Fully OA journals do not require payment from readers to access the publication, while subscriptionbased journals charge readers a subscription fee to access the content. To meet publication costs, some OA journals require the author to pay an Article Processing Charge (APC) to make the article fully OA.

In hybrid journals, research authors have the option of paying APCs to make individual articles open access, while the journal also receives subscription revenues from libraries and other institutions. This provides a relatively low-risk mechanism for journals to make some content open-access, while preserving existing business models. Previous studies have shown that the majority of fully OA journals do not charge APCs, but that the majority of OA articles are published in APC-charging journals (Crowford 2017).

Transformative agreements

The cost of APCs imposed by publishers alongside the rapid diffusion of hybrid systems has raised concerns regarding the sustainability of a full OA model. In an attempt to lower the costs of reading

⁸ More details on Plan S Retention Strategy can be found at: https://www.coalition-s.org/rights-retention-strategy/

and publishing imposed by hybrid journals (APCs and subscription fees), a new business model based on transformative agreements has been developed. These agreements lower subscription costs or APCs to partly compensate for OA publishing costs (whether through credits against future subscriptions when APCs are paid, or through bundling subscriptions and APCs). They combine services of reading, publishing and Open Access into one contract. Agreements may be with individual libraries (MIT and Royal Society of Chemistry), library systems (University of California and Cambridge University Press), or library consortia (VSNU-UKB and Springer Nature).

In the UK transformative agreements are negotiated by Jisc on behalf of HEIs and research institutes. Jisc is a non-profit organisation that provides digital services and solutions to higher education, further education and research institutes. Jisc sets out the requirements that apply to transformative agreements. In particular, the requirements for transitional (transformative)⁹ open access agreements are informed by analysis of previous agreements and agreed with publishers to determine the most suitable model for their agreement. The requirements that apply to transitional open access agreements negotiated in 2020 between institutions, consortia and publishers are:¹⁰

- Agreements must reduce and constrain costs.
- Agreements must be transitional.
- Agreements must aid compliance with funder mandates.
- Agreements must be transparent.
- Agreements allow OA content to be discoverable and support improvements in service and workflow for authors/administrators.

The two broad categories of transformative agreements are read-and-publish and publish-and-read. For read-and-publish agreements, the costs of reading and publishing are bundled into a single payment as opposed to letting individual researchers take responsibility for open access payments. Publish-and-read agreements only include the costs of publishing, with subscription access available at no extra cost. The difference between these agreements is that under read-and-publish all participating institutions bear the cost of reading access, while this burden only falls on publishingintensive institutions for publish-and-read agreements.

Another way to facilitate the transition to Open Access supported by Plan S is the introduction of Transformative Journals (TJ). TJs are subscription or hybrid journals that "*actively committed to transitioning to a fully Open Access journal*".¹¹ In particular, Transformative Journals commit to increasing by 5% (in absolute terms) or 15% (in relative terms) the proportion of open access articles published each year as well as eventually flipping to OA. Therefore, unlike hybrid journals, which are not supported as a model of publishing by Plan S funders, TJs are seen as a tool to facilitate the transition to an open access model.

⁹ In this report we use the terms transformative and transitional interchangeably (i.e. we use these two terms to refer to the same concept).

¹⁰ More details on the requirements for transitional open access agreements published by Jisc are available at: https://subscriptionsmanager.jisc.ac.uk/about/publisher-information

¹¹ Details on Transformative Journals are available on Plan S website: https://www.coalition-s.org/transformative-journals-fag/

OA policies in the UK and recent international developments

OA policies in the UK

The UK has been one of the first countries committing to an OA model in which research supported by public funds is made freely available to everyone. Two OA policies were introduced following the publication of the Finch Report (2012)¹², which set the policy direction with respect to OA: (i) in 2013, RCUK introduced the RCUK Policy on Open Access requiring all articles produced and funded by the RCUK to be made open access immediately after publication, (ii) OA requirements were also introduced for output submitted to the Research Excellence Framework (REF) and applied to journal articles and conference contributions accepted for publication between April 2016 and December 2020 and eligible for submission to REF 2021. In 2018 RCUK transitioned into UKRI. UKRI was established in 2018 by the Higher Education and Research Act 2017 and brought together the seven existing research councils with Innovate UK and Research England.13



To support HEIs and research institutes to comply with its Open Access policy, UKRI awards annual block grants to more than 100 research organisations receiving UKRI funds to cover the cost of making their research output freely accessible after publication.¹⁴ The size of block grants varies across institutions, and it is proportional to the size of the UKRI research grant awarded to the institutions. The main purpose of the grant is to pay for APCs, but institutions are given flexibility on how the funding can be spent. The amount of grant distributed to meet OA costs between 2013 and 2021 varied from around £15 million to £25 million (Figure 1).

¹² The 2012 Finch report is available at: https://web.archive.org/web/20170710110622/https://www.acu.ac.uk/research-information-network/finch-report-final

¹³ More details on UKRI can be found at: https://www.ukri.org/about-us/

¹⁴ The RCUK Block Grant in 2013/14 was paid for 16 months, the others for 12 months.



Figure 1. Total UKRI block grants awarded to UK HEIs and research institutes (£ million)

Other funders also support OA by providing additional funding to institutions to meet the cost of OA publications. For example, the Wellcome Trust has been providing institutions with funds to cover OA charges for Wellcome-funded researchers since 2013. The Wellcome Trust is part of the Charity Open Access Fund (COAF), a partnership between six health research charities funded in 2014 that supports open access publications. Apart from the Wellcome Trust, COAF includes Blood Cancer UK, the British Heart Foundation, Cancer Research UK, Parkinson's UK, and Versus Arthritis.

Between 2014 and 2019, COAF paid more than £30 million in APCs (Figure 2).¹⁵ COAF operated based on the six partners sharing a common open access policy. However, from January 2021 Wellcome Trust will implement Plan S open access policy, under which funding is not available for publications in hybrid journals, while the other partners will still provide funding for OA publications in hybrid journals.¹⁶ This resulted in COAF ending on 30 September 2020.



Figure 2. Total Wellcome/COAF spend on APCs (£ million)

¹⁵ Wellcome/COAF spend on APCs are available at: https://wellcome.org/grant-funding/guidance/organisations-in-receipt-openaccess-funding

¹⁶ More details on the charities' intended open access policies can be found at http://openaccess.ox.ac.uk/wp-content/uploads/sites/2/2020/07/charity-open-access-fund-support-for-open-access-costs.pdf

Open access in the international context

The UK has been one of the leading countries in the adoption of OA policies. In Europe, following the introduction of the RCUK Policy on Open Access, other countries started to encourage OA for the output produced by publicly funded institutions by providing funding for APCs and allowing Green open access as a route to compliance. Similarly to the UK, countries such as Austria, Sweden, Denmark, Norway, and Finland also have plans to move to full open access.

To meet the cost of open access, some European funders, such as the Austrian research funder FWF, decided to set a limit to the level of APCs they fund. Alternatively, others decided not to pay APCs for articles published in hybrid journals, such as the Netherlands Organisation for Scientific Research (NWO), highlighting that the hybrid model does not support the transition to full open access.

How to use the funding to support OA is actively debated among funders and other institutions. For example, the decision of cOAlition S not to support publications in hybrid journals was recently criticized by the European Research Council's (ERC) governing Scientific Council. The ERC withdrew its support for the open-access requirements set out by Plan S as ERC considers them as potentially damaging to young researchers and institutions that do not have the funding to publish their research output open access.¹⁷

In order to reduce the cost of open access, most research funders in Europe and large publishers have started to negotiate transformative agreements:

- Springer Nature was one of the first publishers to sign a transformative agreement, negotiating its first deal in 2014 with the VSNU consortium in the Netherlands (Monaghan et al., 2020).
- Since 2015, Dutch libraries started negotiating agreements with traditional academic publishers
 that allow Dutch authors to publish OA free of additional charges. Additional tools have been
 developed to provide authors with information on which journals offer open access options, such
 as the "open access journal browser".¹⁸ This tool also provides information about agreements
 between publishers and libraries and the number of articles published open access.
- In 2019, Elsevier signed a licence agreement with a coalition of Norwegian institutions under which the publisher agreed to cancel subscription fees and publish articles with corresponding authors from Norwegian institutions.
- In France, under the terms of a 2017 deal, authors from French institutions can publish papers under a CC-BY licence in a range of EDP Sciences journals without institutional subscription. In addition, in 2019 French institutions negotiated a four-year agreement with Elsevier that included a discount on subscription costs and a 25% discount on charges to publish OA articles.
- In 2017 Germany launched the Projekt DEAL to negotiate licensing agreements for all electronic journals from major publishers on behalf of a consortium of German universities.¹⁹ The aim of this project is to provide immediate open access to publications of authors from German institutions at a fair and reasonable price.

¹⁷ More details on the decision of the ERC Scientific Council to withdraw support for Plan S can be found at:

https://www.researchprofessionalnews.com/rr-news-europe-horizon-2020-2020-7-breaking-erc-scientific-council-withdraws-support-for-plan-s/

¹⁸ See the open access journals browser at: https://www.openaccess.nl/en

¹⁹ Details of the Projekt DEAL can be found at: https://www.projekt-deal.de/about-deal/

In addition, in 2016 the Swedish Government set out the goal on open access for the next ten years in the Swedish Research Bill 2016. The aim of the Bill is to set directives to ensure that publications are made immediately open access after publication.²⁰ Under this Bill, The Swedish Research Council is responsible for supporting the development of open access policies as well as promoting international cooperation to promote the diffusion of open access.

Also in the United States, over the past two years, the White House Office of Science and Technology Policy has consulted with members of the research community to collect stakeholders' views on how to improve access to research output. The first step towards open access was made in 2013 when the White House announced that research funded by public bodies would be available within one year from publication.²¹

Overall, the goal of major national research funders across Europe is to adopt sustainable approaches to support the transition from a model based on subscription fees to a fully OA market. As research often involves cross-border collaborations between researchers and articles are published in journals distributed worldwide, a certain degree of coordination between countries is crucial to support this transition. As noted in the Finch report, while the UK has been one of the leading countries in the adoption of OA policies, the costs and the benefits of the transition to OA will depend on whether other countries put in place similar OA policies and systems. Indeed, the more widespread the adoption of open access policies is across countries, the faster institutions would be able to access research output from across the world, avoiding the burden of paying subscription fees.

The NWO approach to supporting long-tail publishers via APC-free OA

The Netherlands has been advocating for OA for several years, resulting in a large percentage of publishers negotiating central agreements. Official OA reporting by the Dutch Association of Universities (VSNU) reports that in 2019 61% of all papers published by Dutch affiliated authors were available Open Access. A large proportion is covered by one of the more than 15 Transformative Agreements which have been negotiated over the years. A substantial long tail remains, including quite a few Dutch-language oriented titles, many of them in social sciences and humanities.

In order to achieve a seamless publishing route to 100% OA for Dutch researchers, the NWO (the Dutch Research Council) looked at solutions in Finland and Denmark where national platforms were launched to enable OA publishing routes for regionally focused journals: https://journal.fi and www.tidsskrift.dk.

To support the Dutch-oriented titles, the NWO envisions a similar approach. They have provided a three-year grant to the Humanities Cluster of the Royal Academy of Sciences to develop the national platform www.openjournals.nl. The platform will provide smaller, independent Dutch scholarly journals a means to make the transition to Open Access. The platform will be open source and run on a Diamond business model, meaning authors will not face any publication charges. As a result, the NWO comes closer to achieving their 100% OA objective while smaller publishers enjoy an APC-free Gold OA route and the dedicated infrastructure necessary to manage this.

²⁰ See more details on the Swedish Research Bill at: https://www.openaire.eu/os-sweden

²¹ See the Memorandum for the Heads of Executive Departments and Agencies at: https://www.eff.org/files/ostp-public-accessmemo.pdf

The new UKRI policy to achieve full and immediate OA

Following the introduction of OA policies in 2013, the number of peer-reviewed articles made available free of charge in the UK has significantly increased. However, the transition to OA has been slower than expected, and in 2018 UKRI announced a review of OA policy to establish how best to reach immediate OA in a sustainable way for all stakeholders involved in the process. The UKRI Open Access Review will determine a single OA policy for research articles that acknowledge funding from UKRI and its constituent councils (UKRI, 2020).

Following the first phase of the review, UKRI has set out policy proposals for research articles to be published open access. Both Green and Gold route are proposed. In particular, UKRI proposes that inscope research articles accepted for publication on or after 1 January 2022 must be:

- Published OA with journals or OA publishing platforms that make the final version of record immediately OA via their websites, and with a CC BY licence.
- Published with journals or platforms that allow the author's accepted manuscript or the version of record to be made immediately open access with a CC BY licence via a subject or institutional repository.

UKRI is also considering other options and issues that could form part of the policy:

- Allowing a CC BY-ND (no derivatives) licence as a case-by-case exception.
- Requiring journals, platforms and repositories to meet certain technical standards that support access, discovery and management of research outputs.
- Whether to require the author or their institution to retain the copyright of their publication or certain re-use rights.
- How to achieve public value, affordability, and the amount of funds required and in what mode, also whether there should be T&Cs on the use of UKRI OA funds, including not permitting these funds to be used for publication in hybrid journals or platforms unless these are part of a transformative agreement or similar arrangement.

Approach and data

This work aims to assess the economic implications of OA in the UK. To address the research objectives, we adopted a mixed-methods approach that comprises a desk-based review, engagement with key groups of stakeholders, as well as analysis of quantitative data and modelling.

Desk-based research

We carried out a comprehensive economic literature review of peer-reviewed academic papers, policy reports, and government documents providing quantitative evidence on the impact of the transition from a subscription-based to a fully OA publishing market. The primary goals of the review were (i) to understand the current state of the market, (ii) to analyse emerging trends in costs, and (iii) to identify key indicators for measuring the costs and benefits associated with different policy scenarios and OA routes.

To understand the financial sustainability of the publishing sector under open access, we drew data on revenues and profit margins from the financial statements and reports of a wide range of publishers and learned societies with different characteristics with respect to size, business model and discipline coverage.

Interviews

Alongside our research partners Fullstopp, we engaged with representatives from a broad range of stakeholders to explore the impact of OA on them as well as their views on the proposed policy changes. We conducted 46 interviews in total.²²

²² The list of interviewees is included in the Annex.

Interviewees included:

- Publishers of different sizes, business models and discipline coverage, including large publishers as well as learned societies, journals and university presses.
- Librarians from HEIs (large, small, research-intensive, specialist).
- Consumers of academic research, including businesses, public and private sector research organisations.
- Researchers/authors from various academic institutions.
- Representatives from funding organisations.

Survey with HEIs

We carried out an online survey of UK HEIs and research institutes.²³ The aim of the survey was to better understand recent trends and factors that drive decision-making in the sector and to capture detailed quantitative and qualitative information. The survey was distributed to approximately 180 HEIs and research institutes in the UK. Institutions were given three weeks to submit their answers. A total of 42 HEIs and 4 research institutes responded.

The survey covered the following key areas:

- Information on budget and expenditure (i.e. estimates of OA expenditures, APCs, and subscriptions in the financial years 2015/2016 to 2018/2019).
- Estimates of the additional costs incurred by the institution in supporting, promoting, or facilitating open access.
- Time spent to process open access articles.
- The allocation and use of the UKRI/COAF block grant.
- Attitudes on the transition to full and immediate OA.

Data

In order to assess the economic implications of OA, we combined several datasets (Figure 3):

• *Dimensions*: Data was sourced from Dimensions, an inter-linked research information system provided by Digital Science (https://www.dimensions.ai). Dimensions is a comprehensive citation database (comparable to Web of Science or Scopus) that links around 128 million academic publications such as journal articles, books and chapters to publication metadata and metrics as well as grants and other sources of funding. We extracted article-level data for articles that were published in 2018 with at least one author affiliated to a UK institution. The

²³ The survey was sent to all members of SCONUL (https://sconul.ac.uk/members-and-representatives), RLUK (https://www.rluk.ac.uk/) as well as the members of the Research Councils Libraries & Information Consortium (RESCOLINC) working group (https://www.ukri.org/contact/).

dataset provides information on the journal in which the article was published, the publisher of the journal, authors, research funders (and funder groups), citation counts, units of assessment (publication subject area) and whether the article was published through Gold OA route, Green OA etc., or whether the article is not openly accessible.²⁴ In addition, this dataset includes a number of other indicators such as corresponding authors and altmetrics, though we did not include these are part of our analysis as the majority of values for these indicators were missing.

- Directory of Open Access Journals (DOAJ): The DOAJ is a community-developed directory that provides a comprehensive listing of all open access peer-reviewed journals. To be listed in the directory, a journal must first apply with details about open access and editorial policies, then applications are reviewed and approved by the editorial team. The directory includes data on publishers, journal subject area, whether a journal charges APCs or submission fees and information about the editorial process. We use this dataset to identify full OA journals in our sample.
- Scopus: Scopus is a comprehensive abstract and citation database published by Elsevier and
 is similar to Dimensions in scope and data coverage. While we use Dimensions for article-level
 data, our analysis draws on the public version of the Scopus database to identify journal-level
 data, including CiteScore²⁵ and the total number of articles published in each journal (including
 those without any UK authors).
- Open APC Initiative: The Open APC Initiative publishes datasets of fees paid by HEIs (primarily in Europe) to publish open access journal articles under an open database license. Data is provided by universities and research institutions on a voluntary basis, and 65 UK HEIs currently share data with the Open APC Initiative. We use this dataset to retrieve the average APC charged by each journal, which we estimate by averaging article-level APC data by journal and year.
- UKRI block grant data: UKRI requires research organisations that receive UKRI funding to provide financial accounting of how funds provided through the UKRI OA block grant have been spent. The data is collected through a common reporting template developed in partnership with Jisc and the Wellcome Trust and includes article-level reporting data as well as any discounts, memberships and pre-payments. Due to issues with data quality and completeness, we use the Open APC Initiative as the primary source for APC data, with the UKRI block grant dataset used as a validation check. We also provide a brief discussion and analysis of this dataset in the section below titled "Block grants".

²⁴ In the Dimensions dataset UKRI-funded articles are only identified if the author acknowledges UKRI funding, which might lead to underestimate the number of UKRI-funded articles.

²⁵ CiteScore is the average citations that a journal receives over a three-year period. More details on CiteScore are available at: https://www.elsevier.com/editors-update/story/journal-metrics/citescore-a-new-metric-to-help-you-choose-the-right-journal

Figure 3. Data inputs



The final dataset contains articles published by UK authors, regardless of their source of funding. Throughout the document, we will refer to UK articles (or UK-authored articles) as those for which one of the co-authors was affiliated to a UK institution and UKRI-funded articles as those acknowledging UKRI funding.

The final sample contains around 170,000 UK-authored articles published in 2018 (which is the most recent year for which a complete set of the data needed is available). Since the dataset is at the article-level, it can be filtered and aggregated on a number of different variables. This means that a multitude of policies with a different scope can be analysed – for example, policies that just affect journals with APC > £3,000 or articles for which UKRI is the sole funder. In addition, it is possible to produce descriptive statistics or assess policy impact for any required subset of articles or journals.

Approach to Modelling

The costs and benefits of open access are compared between two scenarios. These scenarios include:

- *Baseline*: this is the scenario in which UKRI-funded articles can be published in any journal (subscription, hybrid or open).
- *Full UKRI OA*: this is the scenario in which all articles funded by UKRI are required to be published open access.

OA publishing occurs in both the baseline and full UKRI OA scenarios, which allows us to calculate costs and benefits from OA publishing under each scenario and compare the two results. We assume there are no changes in the values of our model parameters other than the share of UKRI-funded and UK-authored articles that are published OA. Since the costs and benefits of OA publishing are estimated at the article-level, summing these costs and benefits over the total number of articles published OA yields differing estimates of costs and benefits (and thus captures the impact of the new UKRI policy).

When estimating costs and benefits of the new UKRI policy over a ten-year timeframe, we assume that researchers will publish their future output in journals with a similar academic subject area and CiteScore as they did in 2018. This has two implications: first, the share of articles covered by each academic subject area remains constant over time, and second, the number of articles published in each journal is only driven by growth in total research output. We also assume that UK HEIs are responsible for paying APCs for all articles published by at least one UK co-author. In practice, around 60-70% of these articles are likely to attract an APC payable by UK HEIs (Universities UK 2017), and our reported estimates may slightly overestimate the true cost to HEIs of the new UKRI policy.

To predict the total cost of achieving full OA under the new UKRI policy, we first estimated the cost of publishing all UKRI-funded articles OA that were not published open access in 2018, both in hybrid and closed journals. Given that articles published non-OA are not subject to APCs, we estimated what the APC would be if they were to be published open access using a linear regression model on journal CiteScore and academic subject area.

For publishers, the new UKRI policy means an overall decline in subscription-based revenues (as UKRI-funded articles can no longer be published in subscription-only journals) and a corresponding increase in open access revenues, with impact on total profit determined by the difference in perarticle costs and revenues between subscription and OA publishing.

For HEIs, the impact of the new UKRI policy on publishing expenditures is driven by a number of factors, including annual growth in average APCs, administrative costs of processing OA articles, external funding such as the UKRI OA block grant and offsetting from transformative agreements. First, the total additional APCs required are added to the administrative costs of processing OA articles. The net cost to HEIs is then calculated by subtracting the value of the UKRI block grant, any other external funding and offsetting from transformative agreements.

Supporters of open access have pointed to a number of benefits from increased access to research though identifying specific benefits and attempting to measure them precisely is a challenging endeavour. Following Houghton et al. (2009), our model focuses specifically on quantifying two key benefits: the efficiency gains throughout the research process due to the lower costs of OA publishing models, and the additional social returns to investment in R&D as knowledge in OA-published research forms the basis of further research or real-world applications across the public and private sectors as well as HEIs. Gains from increased accessibility of research and efficiency of the research process can be quantified as an increase in social return to R&D spending that would not have occurred in the baseline scenario.

More details on our data analysis and modelling, including results, can be found in the relevant chapters of this report. We have listed the key assumptions used in our modelling approach when estimating the impact of the new UKRI policy on HEIs and publishers and the societal benefits of OA publishing. These can be found in tables located in the respective sections of the report that discuss these findings. The values for these key assumptions are drawn from the wider literature around open access publishing. If previous research has identified a range of estimates, we have chosen the more conservative value.

OA publications in the UK

Prevalence of open access articles in the UK

With OA policy mandates in place, significant progress has been made towards making UK research output available to everyone. Previous studies have provided estimates of the number of articles available OA:

- The number of UK-authored articles immediately accessible on publication (on either Green or Gold OA) rose from 20% in 2012 to 37% in 2016 (compared to a 25% global average) (Universities UK, 2017).
- In 2016, 54% of all UK-authored research articles were publicly accessible within 12 months, compared to a 32% global average (Universities UK, 2017).
- Research England (2018) found that in 2016 80% of outputs covered already met REF requirements.

Using data extracted from Dimensions, Figure 4 shows the proportion of articles published in each year between 2011 and 2018 which were available open access in August 2020.²⁶ The figure includes Green (both with embargo and with zero embargo period), Pure Gold, and Bronze articles, as defined in the Dimensions dataset. The proportion is higher the more recent the year of publication, with 41% of articles published in 2011 being available OA compared to 71% of 2018 articles. It is worth noticing that some of the papers published in 2018 under Green OA with 24 months embargo or longer would not have been OA as of August 2020, although they are likely to become OA in future. This might explain the fact that the trend appears to be levelling off in 2017-2018; it is likely more articles will become OA in the future.

²⁶ This summary data was extracted from Dimensions in August 2020.



Figure 4. Proportion of UK-authored articles available OA in August 2020, by year of publication

Source: Dimensions article data merged with Scopus data on journal publishing model and subject area (see methodology). The figure includes Green (with and without embargo), Gold, and Bronze articles

The proportion of UK-authored articles published in 2018 under the Green route available OA in August 2020 was around 27% (Figure 5). This is an increase from 2011 when around 15% of articles were published through Green OA. Gold publications, both in hybrid (Hybrid) and full OA journals (Pure Gold), have also increased since 2011 and represented 31% of 2018 articles available OA in August 2020. The proportion of Bronze articles has remained quite constant in the last eight years.



Figure 5. Proportion of UK-authored articles available open access in August 2020 by year of publication and OA model

Source: Dimensions article data merged with Scopus data on journal publishing model and subject area (see methodology)

As already mentioned, the UK has been one of the leading countries in the adoption of OA policies. As a result, the UK is also the country with the highest proportion of articles available OA among the top publishing countries by the number of articles published, including both OA and non-OA articles (Table 1). With the exception of the UK and Brazil, the most prolific publishing countries across the world had less than 55% of their 2018 research output available open access in August 2020.

Table 1. Articles published in 2018 by the top 10 countries for the total number of publications available open access in August 2020

	All OA	Bronze	Green	Hybrid	Pure Gold	Total OA
United States	53%	17%	14%	7%	15%	337,511
China	37%	9%	5%	4%	19%	164,267
United Kingdom	71%	13%	27%	14%	17%	138,780
Germany	50%	12%	12%	9%	17%	80,135
Japan	44%	18%	6%	7%	14%	65,799
India	39%	12%	7%	4%	16%	46,386
France	52%	11%	17%	8%	15%	55,504
Canada	49%	16%	11%	7%	16%	51,388
Italy	51%	12%	13%	7%	19%	50,819
Australia	49%	13%	14%	6%	17%	47,713
Brazil	68%	11%	7%	8%	42%	63,596
Average top 10 countries	51%	13%	12%	7%	19%	

Source: Dimensions. All OA includes Bronze, Green, Hybrid, and Pure Gold. Green refers to articles for which a free copy of the submitted version is publicly available, or if the version is unknown, a free copy is available through an OA repository.

UK Open Access articles by subject area

In order to retrieve the subject area of the UK articles published in 2018, we merged Dimensions data with Scopus. The final dataset contains articles published by UK authors, regardless of their source of funding.²⁷ The final sample used to conduct the analysis of the costs and benefits associated with OA contains about 170,000 UK articles and 32,000 UKRI-funded articles (Table 2).²⁸

Articles are categorised based on the business model of the journal they are published in:

- Closed refers to articles published in closed journals (also called subscription-based journals). Bronze publications, as well as green publications published in closed journals, are also included in this category.
- Full OA refers to articles published in full open access journals.
- Hybrid Gold OA indicates articles published open access in hybrid journals under the Gold route.
- Hybrid Green OA indicates articles published open access in hybrid journals under the Green route.
- Hybrid Subscription indicates articles published closed (not open access) in hybrid journals.

²⁷ Data on published papers were extracted from Dimensions in June 2020. The dataset contains OA publications that were available open access as of June 2020.

²⁸ Around 10% of all UK-authored articles could not be matched to a journal in the Scopus database due to differences in the way that journal names were recorded and the absence of any other unique identifiers for journals.

For the purpose of our analysis, we include articles published Bronze in the *Closed* category, as they will not comply with the new UKRI OA policy which allows only the Gold and Green (no embargo period) route.

The proportion of UKRI-funded articles published in 2018 and available open access, either Green or Gold, in our sample is around 71%. Notably, more than half of UKRI-funded articles (54%) were published OA in hybrid journals, while the proportion of UK articles published in hybrid journals was significantly lower, especially those published Gold.

	UK articles (n =170,678)	UKRI-funded articles (n=32,663)
Closed	46,756 (27%)	4,729 (14%)
Full OA	24,265 (14%)	6,032 (18%)
Hybrid - Gold OA	24,375 (14%)	10,049 (31%)
Hybrid - Green OA	30,499 (18%)	7,417 (23%)
Hybrid - Subscription	44,783 (26%)	4,436 (14%)

Table 2. UK-authored and UKRI-funded research articles published in 2018 by journal publishing model

Source: Dimensions article data merged with Scopus data on journal publishing model and subject area (see methodology)

The UK-authored articles in our sample were published in around 11,700 journals across five different subject areas (Table 3). Closed journals tend to be smaller compared to hybrid and full OA journals. Closed journals in our sample published, on average, 80 articles in 2018, compared to an average of 150 articles published in full OA journals and more than 200 articles in hybrid. Closed journals also published, on average, a smaller proportion of UK articles (8 articles) compared to full OA (15 articles) and hybrid (26 articles).

	Arts and Humanities	Health Sciences	Life Sciences	Physical Sciences	Social Sciences
Closed	951	1380	584	1378	1872
Full OA	67	797	314	403	228
Hybrid	233	1046	655	1113	770

Table 3. Number of journals publishing UK-authored articles by subject area and business model in 2018

Source: Dimensions article data merged with Scopus data on journal publishing model and subject area (see methodology)

Overall, both UK and UKRI research articles published in Health Sciences, Life Sciences, and Physical Sciences are more likely to be published open access (both in hybrid and full OA journals), compared to those published in Arts and Humanities and Social Sciences (Tables 4 and 5). Despite Arts and Humanities being the subject area with the lowest proportion of open access articles, UKRI-funded articles published in this subject area are significantly more likely to be published open access (53%), especially in hybrid journals, compared to UK-authored articles (21%). Similarly, the proportion of UKRI-funded articles in Social Sciences published open access (61%) is significantly larger than UK articles in the same subject area (38%).

	Arts and Humanities	Health Sciences	Life Sciences	Physical Sciences	Social Sciences
Closed	60%	21%	16%	23%	45%
Full OA	2%	17%	19%	15%	7%
Hybrid – Gold OA	7%	16%	22%	14%	9%
Hybrid – Green OA	11%	11%	15%	28%	22%
Hybrid – Subscription	20%	35%	28%	20%	17%

Table 4. Proportion of UK-authored articles published in 2018 by subject area and journal business model

Source: Dimensions article data merged with Scopus data on journal publishing model and subject area (see methodology)

Table 5. Proportion of UKRI-funded articles published in 2018 by subject area and journal business model

	Arts and Humanities	Health Sciences	Life Sciences	Physical Sciences	Social Sciences
Closed	35%	10%	8%	15%	29%
Full OA	3%	28%	21%	15%	8%
Hybrid – Gold OA	28%	31%	40%	27%	31%
Hybrid – Green OA	22%	14%	15%	30%	22%
Hybrid – Subscription	12%	17%	16%	12%	10%

Source: Dimensions article data merged with Scopus data on journal publishing model and subject area (see methodology)

Overview of the scholarly publishing market

Financial analysis of the publishing market

Journals contribute value-added to the publishing process through maintaining a platform, sourcing reviewers, managing a pipeline of content and ensuring that articles on the platform can be discovered. Furthermore, journal reputation acts as a signal for the quality of published research, which in turn can impact academics' career path and visibility within the research community.

It has been estimated that the market for scholarly journals is worth approximately £8 billion (\$10 billion) a year, with 40% of the revenue coming from the US, 27% from Europe and the Middle East, and 33% from the rest of the world (Johnson et al., 2018). The market is highly concentrated: approximately 80% of the market is controlled by a small group of large commercial publishers that tend to enjoy high profit margins – the subject of a vigorous debate in academia and beyond, with many arguing that they represent a drain on the resources available to fund research (Larivière et al., 2015).

It is important to note that a comprehensive analysis of the financial stability of market participants is not possible due to a lack of publicly available accounting information. A number of the largest players are part of larger group structures, which leads to only partial accounting information being published for the business segments of interest. This applies to Elsevier, Springer Nature and Taylor Francis. Some market participants are private companies outside of the UK and therefore do not have to provide any financial information publicly, e.g. SAGE. Lastly, some market participants are registered charities rather than corporations and are not subject to the same reporting requirements. For example, this applies to the Royal Society of Chemistry and the Royal Economic Society. In particular, the absence of the level of detailed financial information published by public corporations prevents any kind of systematic analysis of the levels of indebtedness of the sector, which would be key to fully assessing financial stability.

Large commercial publishers

As shown in a 2017 report commissioned by Universities UK that sampled 38 institutions in the UK, Elsevier, Springer Nature, and Wiley have the largest share of the subscription market (28.5%, 15.8% and 11.2%, respectively) (Universities UK 2017). The pattern of APC payments also reflects the structure of the market, with these three publishers accounting for over half of all APCs (Universities UK 2017).





	Revenue, £ million			Operat	t margin	
Publisher	2017	2018	2019	2017	2018	2019
Elsevier	2,473	2,538	2,637	37.0%	37.1%	37.3%
Springer Nature	1,438	1,456	1,508	22.9%	n/a	n/a
Wiley ²⁹	1,346	1,406	1,409	12.3%	13.2%	12.4%
Taylor & Francis ³⁰	530	533	560	39.2%	37.0%	39.0%
Oxford University Press ³¹	847	840	841	13.0%	11.9%	11.5%
Cambridge University Press ³²	306	316	327	5.3%	5.4%	7.5%

Table 6.	Revenue and	profit margin	of large commerc	ial publishers
----------	-------------	---------------	------------------	----------------

Note: year labels refer to financial year ends. All currency conversions use the average exchange rate for 2019. Springer Nature profit margin figures are not publicly available for 2018 and 2019.

With the growth in online publishing, scientific knowledge moved from being paper-based to webbased, and this has drastically reduced the marginal cost of distribution. In addition, in recent years, large publishers have made extensive investment in digital publishing infrastructure. For example, Elsevier acquired Mendeley and SSRN in 2013 and 2016, respectively, while Springer acquired MacMillan in 2015.

Elsevier is the biggest publisher in the market, with 2,500 journals and 496,000 articles published in 2019. In 2019, Elsevier launched six new subscription-based journals and 100 full OA journals. In 2019 its revenue was £2,637 million, up by 3.9% compared to the previous year, with profit rising by 4.4% to £982 million. Of the total revenue, 24% came from Europe, 45% from North America, and 31% from the rest of the world. The main source of revenue is subscriptions (75%), while less than 2% is from advertising.³³ The revenue by format is 84% electronic and 16% print. The second biggest publisher is Springer Nature with £1,508 million revenue in 2019 and 592 Open Access journals³⁴ which generate around 10% of total revenue.³⁵

In the UK, data from the Open APC Initiative collected across 69 HEIs show that in 2019 Springer Nature had the highest amount of expenditures on APCs in fully OA journals with £872 thousand paid by UK HEIs, corresponding to 37% of total expenditure.³⁶ The average expenditure on APCs was around £2,243 per article for a total of 389 articles published OA (approximately 32% of all articles published). Elsevier, instead, dominates the market for hybrid journals. In 2019, total expenditure on APCs for the sample of HEIs above to publish in hybrid journals owned by Elsevier was £1.5 million, corresponding to 38.5% of the total amount spent on APCs for hybrid journals, with 549 articles published and an average APC of £2,820. Although OA is perceived as a threat to their profits, large publishers have seen their market share unchanged, as they continue to use subscription models while significantly increasing the number of hybrid journals (Björk 2017). The fact that large publishers have

- ³² Cambridge University Press annual reviews are available at: https://www.cambridge.org/about-us/annual-report
- ³³ See Elsevier annual report and financial statement at: 2019-annual-report.pdf (relx.com)

³⁴ Springer Nature 2019 Responsible Business Report

²⁹ Wiley's financial statement is available at: https://www.annualreports.com/Company/john-wiley-sons-inc

³⁰ The financial figures for Taylor & Francis are available at: https://www.informa.com/globalassets/documents/investor-relations/2020/informa-annual-report-2019.pdf

³¹ Oxford University Press annual reviews are available at: https://global.oup.com/about/annualreport/?cc=us

is available at: https://responsiblebusiness.springernature.com/2019/assets/files/responsible-business-report-2019.pdf

³⁵ https://www.ft.com/content/8dc9c370-492d-11e8-8ae9-4b5ddcca99b3

³⁶ See the Open APC Initiative website at: https://treemaps.intact-project.org

been able to expand in the OA market and maintain subscription level unchanged is put forward by some commentators as one of the reasons slowing down the transition to OA (Matthias, Jahn, and Laakso 2019). Moreover, even though the vast majority of authors support OA publishing, the choice of where to publish is usually based on the journal's reputation, impact factor, quality and review speed, making it hard for new entrants to compete with well-established publishers (Severin et al., 2020).

Analysis of Wiley's 2019 financial statement

Wiley is one of the main publishers in the academic publishing industry. In 2019, total company revenue was about £1,409 million, with a double-digit operating profit margin of 12.4%. The three main market segments of the company are research, publishing, and digital solutions.

Of the total revenue, 52% was from the research segment, of which 71% from subscriptions, 19% licensing, reprint, backfiles and other activities, 6% open access, and 4% publishing technology services.

Approximately 50% of the total revenue from subscriptions was generated from publishing rights owned by Wiley, while the remaining 50% was derived from publication rights owned by professional societies. The contracts signed between Wiley and societies are usually long-term contracts (5-10 years). As stated in Wiley's 2019 annual report:

"Society alliances bring mutual benefit, with the societies gaining Wiley's publishing, marketing, sales, and distribution expertise, while Wiley benefits from being affiliated with prestigious societies and their members".

In 2019, the publishing segment generated about 32% of total company revenue (48% Scientific, Technical and Medical and professional publishing, 28% education publishing, 11% courseware, 8% licensing, distribution, advertising and other, and 7% test preparation and certification).

More than 50% of the total revenues generated in 2019 came from the US, while the UK was the second largest market and accounted for around 8% of Wiley's revenues.

Since the introduction of OA policies in the UK, Wiley has worked on developing open access products to sustain the increasing demand for OA in the UK. However, as for other large publishers, open access is listed as a risk for the financial stability of the company in the 'risk factors' session of the financial statement:

"Changes in laws, tariffs, and regulations, including regulations related to open access, could adversely impact our consolidated financial position and results of operations. [...] [Open access has] the potential to put pressure on subscription-based publications. If such regulations are widely implemented, our consolidated financial position and results of operations could be adversely affected."

Open access publishers

The OA market represents a small proportion of the whole scholarly publishing market, although it is growing at a faster rate than the wider market. In 2016 it was estimated to be around £370 million

compared to £100 million in 2013 (Johnson, Watkinson, and Mabe 2018). Between 2017 and 2018, it has been estimated that the OA market grew by 15% with the global market estimated to be worth more than half a billion GBP in 2019 (Delta Think, 2019).³⁷

	Revenue, £ million		Operating profit margin			
Publisher	2017	2018	2019	2017	2018	2019
PLOS	27.0	24.4	23.1	-8.5%	-12.0%	-0.3%
of which: UK market ³⁸	1.5	1.4	1.4	4.0%	1.6%	11.0%
Hindawi	14.2	20.9	n/a	13.6%	24.0%	n/a
eLife	5.0	6.4	6.0	-6.0%	7.2%	5.1%

Table 7. Revenue and profit margin for a sample of OA publishers

Note: year labels refer to financial year ends. All currency conversions use the average exchange rate for 2019. Revenues and profit margins of PLOS in 2019 and figures for the UK market were provided by PLOS representatives that participated in the interview.

Some of the main open access publishers worldwide are PLOS, Hindawi, Frontiers, eLife and MDPI. In the OA market, publishers typically adopt two expansion strategies: they either increase the number of journals in their portfolio, which is the approach of Hindawi and MDPI, or they increase the number of articles published in their journals, such as PLOS.

PLOS is a non-profit open access publisher. The first journal was launched in 2003. The 2018 financial statement published by PLOS shows a breakdown of the costs³⁹: 76% publishing costs (40% editorial, 18% production, 18% technology), 19% general and administrative costs, and 5% publication fee support. Most of the revenue comes from APCs paid by authors, with an average APC of around £1,925. PLOS became a pioneer of mega journals – large open access journals exercising low selectivity among accepted articles – when it launched PLOS One. According to a recent analysis, PLOS One alone has more articles than all small OA publishers put together (Rodrigues, Abadal, and de Araújo 2020).

Notably, PLOS was loss-making in the previous three years. These losses are not driven by exceptional accounting items but direct expenses relating to publishing and management that exceeded revenues in recent years. However, PLOS shows a healthy profit margin in the UK market in 2019 (11%), with revenue of £1.4 million in the same year.

Hindawi contrasts with PLOS by showing healthy profit margins that are more in-line with large commercial publishers.⁴⁰ Revenues increased 46.3% in 2018 (the most recently available financial year) relative to 2017 revenues while operating costs increased only 28.6%, resulting in an uplift in operating profit margin to 24.0%. eLife has generated positive operating profits in 2018 and 2019 after generating negative operating profits in 2017.⁴¹

eLife's profit margin has moved with revenue growth, which is common for smaller operators where relatively small changes in revenues can have a significant impact on an operator's ability to spread fixed costs (such as management expenses) across activities. 28.9% revenue growth in 2017 appears

³⁷ More details on the analysis conducted by Delta Think are available at: https://deltathink.com/open-access-market-sizing-update-2019/

³⁸ Figures on the UK market has been estimated based on the number of submission and publications.

³⁹ The 2018 PLOS financial statement is available at: https://plos.org/financial-overview/

⁴⁰ Hindawi financial statements are available at:

https://find-and-update.company-information.service.gov.uk/company/08671628/filing-history

⁴¹ eLife annual reports are available at: https://elifesciences.org/annual-reports

to have been key in enabling eLife to transition from making an operating loss to generating an operating profit margin of 7.2%.

Overall, these figures point to full OA being a sustainable business model for publishers.

Main costs faced by OA publishers - A review of PLOS financial statements

During the last three years the PLOS profit margin has significantly increase in the UK market, reaching 11% in 2019 with a total revenue of £1.4 million generated the academic publishing sector through the payment of APCs. Table A shows a detailed disaggregation of the costs incurred by PLOS in 2019 in the UK market.

Table A: Costs and revenue of PLOS in the UK market, 2019

Revenue	£1,400,000
Costs:	
Journal and Community Development	£172,000
Sales and Marketing	£161,000
Customer Support and Services after Publication	£238,000
Submission to Publication costs	£668,000

Note: Financial figures for the UK market have been estimated based on the number of submissions and publications.

- Journals and community development costs: they represent 14% of the costs and include aims and scope development, editorial board costs, commissioning content, competitor analysis, benchmarking, policy development, portfolio development.
- Sales and Marketing costs: they represent 13% of costs and include sales teams, sales administration, legal costs for contracts, integration with and promotion on social media networks, sponsorship.
- *Customer Support and Services after Publication costs:* they represent 20% of costs and include reader services, helpdesk, usage/impact/other reports, training, author queries about copyright or CC licences.
- Submission to Publication costs, including Peer Review Management: they represent more than half of the total costs (54%). They include triaging, recruiting and training peer reviewers and editors, peer review management and tracking systems, platform, copyediting, formatting, typesetting, proofreading.
Learned societies

When considering the financial position of learned societies, it is important to consider that learned societies are typically non-profit organisations and therefore do not have the same incentives to maximize operating profit margins or to avoid loss-making activities. However, despite the lack of incentives to generate profit at the organisation-wide level, learned societies have incentives to generate profits on publishing activities to use these funds to cross-subsidise other activities.

Most societies only publish one peer-reviewed journal, with some of the journals published by societies being leading journals in their field, often outsourced to commercial publishers and university presses as shown in the Wiley case study presented above and also discussed by Universities UK (Universities UK 2017). Indeed, publishers and university presses provide learned societies with existing infrastructure, expertise, great scale, and expertise in transitioning journals to OA.

Learned societies use subscription income to subsidise activities such as conferences, research awards, and supporting postgraduate and young researchers. An implication of learned societies using publishing to cross-subsidise other activities is that changes in the profitability of their publishing activities will have knock-on impacts on these activities.

In this respect, concerns were expressed by learned societies after the publication of the Finch report in 2012 and following the RCUK OA policy proposal in 2013. The British Sociological Association declared:

"Whilst we are still attempting to model the likely impact of current proposals and (OA) policies, it is already clear that many of these important activities are under threat. In particular, the learned society support for peer review, editorial functions, author services and general support/advice on publishing will be some of the first services to be lost."⁴²

	Revenue, £ million			Operating profit margin		
Society	2017	2018	2019	2017	2018	2019
British Medical Association	-	138.80	139.00	-	0.2%	-1.6%
Of which: publishing activities:	-	83.12	81.69	-	13.6%	12.9%
Royal Society of Chemistry	63.52	63.59	67.25	8.7%	6.2%	2.3%
Of which: publishing activities:	53.58	54.28	57.41	32.5%	33.8%	32.7%
Royal Economic Society	1.39	1.40	1.36	-1.9%	-13.7%	-20.9%
Of which: Economic Journal:	0.85	0.88	0.76	29.2%	15.0%	3.6%
Of which: journals and publishing:	0.94	0.95	0.85	18.0%	1.9%	-11.3%

Table 8. Revenue and operating profit margin for a sample of learned societies

⁴² Full text of the 'The implementation of open access Oral and Written evidence' is available at: https://publications.parliament.uk/pa/ld201213/ldselect/ldsctech/122/12202.htm

However, societies are very heterogeneous in size and profits. As noted by Johnson and Fosci (2015):

"Margins generated from publishing are, however, more variable for smaller societies, meaning that while some make losses from publishing, others do generate large surpluses relative to their total income."

Table 8 presents the income and profit margin for three learned societies in different fields:

- The British Medical Association, which is both a professional association and a trade union, made 59% of its 2019 income from publishing, with most of the remainder (35%) coming from membership subscriptions. The operating profit margin of the British Medical Association is close to zero and was slightly negative in 2018 and 2019, but the profit margin on publishing activities is in-line with the median estimate for large commercial publishers.
- The Royal Society of Chemistry generated £67.3 million of income across the group in their financial year ending 2019, with 85.4% of income coming from publishing revenues.⁴³ Revenues have been relatively stable in recent years with a growth of 1.3% in 2018 and 5.8% in 2019.⁴⁴ Similar to the British Medical Association's breakdown of activities, the operating profit margin on publishing activities is considerably higher than the overall profit margin, again showing cross-subsidization of non-publishing activities.
- The Royal Economic Society is the only case in the table above of a learned society generating negative operating profits on their publishing activities, which was true for the Royal Economic Society in the financial year ending 2019. This is partly the temporary result of introducing new systems. From their 2019 annual review:

"In recent years, the Society has purposely operated deficit budgets in order to invest in new systems (such as the website and membership system) and in activities to execute the Society's strategy. The Executive Committee are committed to reducing the deficit and to moving to a balanced budget in the coming years".⁴⁵

However, despite costs associated with introducing new systems, the Economic Journal generated positive operating profit (3.6%) during the overall loss-making financial year ending 2019 in (-11.3% in the journal and publishing segment overall) and in 2018 generated an operating profit margin of 15%, above the median operating profit margin for large commercial publishers.

Despite the concerns expressed by learned societies, Universities UK (2017), which analysed revenues and profit margin of 30 learned societies, shows that OA did not have (short-term) negative consequences on the financial stability of learned societies. Moreover, a recent study by Wise and Estelle (2020) commissioned by Wellcome, UKRI, and the Association of Learned and Professional Society Publishers (ALPSP), shows that in recent years, learned societies had transformed their business model to support the transition to full OA, with most of their journals offering open access options, and others flipping to OA.

The report also shows that the financial concerns of learned societies could be mitigated by transformative agreements, on which learned societies seem very positive as they ensure a stable

 ⁴³ The financial statements of the Royal Society of Chemistry are available at: https://www.rsc.org/about-us/corporate-information/
 ⁴⁴ The financial statements of the British Medical Association are available at: https://www.bma.org.uk/media/2736/bma-2019-accounts.pdf

⁴⁵ The 2019 Royal Economic Society annual review is available at: https://www.res.org.uk/uploads/assets/uploaded/e97b755b-0435-4330-82361490ecb95640.pdf

stream of revenue. The main concern, however, remains whether societies, especially smaller ones, will be able to negotiate deals with libraries. In this respect, in 2019 the Wellcome Trust committed to supporting small societies to negotiate transformative agreements complying with the new UKRI policy. The society publishers interviewed welcomed this approach as it provides a perspective towards a sustainable transition and a level playing field with larger publishers.

In addition, in 2019 Jisc negotiated transformative agreements with five small societies: the Microbiology Society, Portland Press, IWA Publishing, the Company of Biologists and the European Respiratory Society.⁴⁶ These are the first agreements that Jisc negotiated on behalf of small publishers, in an effort to make the transition to OA sustainable for smaller publishers, including many learned societies.

Learned societies' views on OA

The interviews with representatives of learned societies highlighted some of the unique challenges that societies face in relation to Open Access.

Interviewees from representative bodies and societies (both self-publishing societies and societies which outsource their publishing operations) highlighted the fact that their broader activities are heavily subsidised by and therefore dependent on their publishing revenues. As highlighted by one society, it is not uncommon for society publishing surpluses to exceed 50%. At the same time, much of this surplus flows into subsidising conferences, fellowships and other contributions, and societies are often dependent on their publishing surplus to support their activities. The interviewee mentioned that in an OA environment based on Gold OA with APCs, the price of APCs per article set by the society to continue financing these activities would be too high, and funders would likely not be willing to meet it.

In coming up with a sustainable OA publishing model, societies are facing difficult discussions with their publishing partners. In some cases, larger publishers publish journals for learned societies, and these are typically sold as part of larger subscription packages. One body representing a large number of societies mentioned that publishing partners are urging societies to publish more articles and charge lower APCs. This is often in stark contrast with the wishes of journal editorial boards, which prefer applying stringent selection criteria and publishing a low number of articles.

This friction has implications for publishers and their societies regarding the speed at which they can transform their entire portfolio into OA via the Gold route. One learned society indicated that anticipating changes to their publishing operations required to rebalance the budget considerably and under the assumption that OA could lead to a dip in revenues as compared to the subscription model. Indeed, the interviewee reported that the society had planned a significant reduction in the available funding from publishing to cross-subsidise other activities.

In an attempt to highlight better ways forward to support the wider activities of learned societies, one society highlighted that its publishing revenue constitutes 15% of their total income, while the majority of its revenue comes from earmarked government funding for certain activities, such as awarding fellowships and organising conferences. This puts the society in the position of offering OA options without worrying about cross-subsidising activities using the publishing revenue. As a result, there is no need to drastically rework the society's internal cost structures to support a sustainable Gold OA path for their publishing programme.

⁴⁶ More details on access agreements with learned societies are available at: https://www.jisc.ac.uk/news/jisc-consortium-secures-fiveopen-access-agreements-with-learned-societies-09-dec-2019

The Biochemical Society and Portland Press transitioning towards Gold OA without APCs

Portland Press and The Biochemical Society operate seven journals, and they face similar challenges as other smaller and medium-sized publishers in terms of Gold OA transformation. At the same time, they have embraced the transition and adopted a Read and Publish model, combined with so-called "transformative renewals" that follow the traditional subscription process.

With a few hundred existing subscribers and relatively few journals, the society decided to work with their vendors to set up "transformative renewals" as an alternative for subscribers in the renewal cycle. In addition, Portland Press identified the larger accounts with which tailor-made Read and Publish agreements could be made. Currently, this includes Jisc in the UK and CAUL in Australia. The price to participate was set up, based on historical subscription spend and APC spend based on the annual output (of researchers at participating institutions) in the Biochemical Society's seven journals. It is hoped that even as a small self-publishing society with a couple of hundred subscribers, the transition could be executed through harnessing the existing renewals process and partnerships both with vendors as well as consortia.

Participants obtain access to an all-inclusive arrangement, meaning that an unlimited number of OA articles can be published across all seven Portland Press journals under the agreed terms. Given their all-inclusive nature, these offers will be subject to a series of reviews. In the end, they hope and expect to evolve the model based on these initial pilots, which will last until the end of 2022. Similarly, the Microbiology Society is also carrying out this model to transform towards Gold OA without APCs.

Journal-level costs

Publishers incur a broad range of expenses across salaries and benefits, technical, editorial, operations, sales and marketing as well as administration. These expenses vary significantly across journals even across relatively small factors, including the degree of editorial oversight, office location and editorial management platforms. Thus, developing a cost function for publishers could produce results from several hundred to several million pounds across start-up, early-stage and mature stage costs.

Journals are highly heterogeneous in terms of both output and inputs that go into their production. Before we embark on any analysis of journal-level costs it is critical to highlight that there are substantial differences in costs across journals, and that these can reflect both differences in efficiency of production as well as the overall approach and outputs. For example, as discussed in the following section, several born-OA journals operate a rapid publication process, which involves far less effort being invested in reviewing an article pre-publication. Leaving aside the broader question of whether such an approach may be preferable to the approach taken by more established journals, it remains important to keep in mind that the associated costs will differ from those of more traditional publishers even in the absence of any inefficiencies. Non-profit publishers in the United States are required to make their annual filings with the Internal Revenue Society publicly available. Using the Guidestar database and 2018 filings for Form 990 (Program Service Revenue), the median publishing cost per article was estimated at \$2,266, excluding publishers that overlapped journal publishing activities with other programmes and services. 42 out of the 57 journals in the sample were published by learned societies, and journals on average received \$4,392 in revenue per article (median \$3,296).

Evidence suggests that APC pricing is set in part based on a cost-recovery model, including indirect costs and surplus. Research Information Network (2008) estimated publisher surplus to be around 13% of revenues, consistent with a 2019 survey of Association of Learned and Professional Society Publishers members (University of California Libraries, 2016). In addition, a review of reputable studies identified a median publishing cost-per-article of \$2,580, adjusting for the 13% surplus. While some of these studies also reported a range of costs, the above figure only uses average costs where possible.

Estimated average publishing cost per article	Specific cost breakdowns (if available)
GBP 2,863 (Research Information Network 2008)	 40% direct fixed cost 21% variable cost 21% indirect cost
	• 18% surplus
USD 1,959 (Edgar and Willinsky 2010)	• 11% Editorship
	• 15% Management
	• 7% Copy editing
	• 5% Article layout
	3% Proofreading
	• 1% Website
	3% Customisation
	• 4% Technical
	• 3% Promotion
	21% Subscription costs
	• 16% Journal printing
	• 4% Postage
	• 9% Other
GBP 2,337 (Houghton et al. 2009)	• Estimated surplus of 20%

Table 9. Average publishing cost per article estimated in the literature

USD 2,215 (Clarke 2007)	
GBP 2,632 (M. Jubb 2011)	
USD 1,425 (Wellcome Trust 2003)	Refereeing 22%
	 Editorial and typesetting (i.e. from acceptance to first copy) 33%
	Subscription management 7%
	 Physical production and distribution (including postage) 23%
	• Sales and marketing 13%
	• Promotion to authors 2%
USD 760 (Eve 2014)	Article production costs 53%
	• Staffing costs 32%
	• Overhead 15%

USD 3,750 (Van Noorden 2013)

One leading open access publisher, Frontiers, published expenditure data in 2015, which included \$6.8 million on publishing operations, \$1.9 million in discounts and waivers, \$1.0 million on honoraria and awards as well as \$1.7 million on general and administrative expenditures. Adjusting for the number of articles published yields a publishing cost estimate of \$1,826 per article.

In general, the estimates for publishing costs per article are meant to reflect actual average costs for producing peer-reviewed publications. A journal with a low acceptance rate that spends a good deal of its resources evaluating manuscripts it ultimately rejects will generally have higher costs. The intention of identifying an average publishing cost per article is to identify a range of numbers that would be considered as broadly sustainable (able to support core publishing operations, with some surplus to fuel innovations) in an APC-dominant environment and with broadly the same mix of approaches (e.g. in terms of resources invested in pre-publication review) as is the case today. Any 'average' cost estimate should be treated with caution, and it should not be taken to represent the optimal level of cost, or even a 'reasonable cost' yardstick, for any given journal.

There are relatively few estimates of the impact of transitioning to open access on publishers, with a 2012 analysis by Bernstein Research using Elsevier data finding net savings of 10%-12% but a potential decrease in revenue by 14%-27% and operating profit margin between 6%-22% (Aspesi et al., 2012). Cost savings were obtained through discontinuation of print, reduction in customer service loads, and other workflow efficiencies, balanced against higher IT costs (due to more downloads), higher administrative burdens (for collecting APC micropayments), and the loss of advance revenues and the interest these generate.

Previous studies find that the revenue per article under subscription models is twice that of full OA journals (Research Consulting, 2017). Springer Nature's chief executive Daniel Ropers recently stated that open access journals, which generate roughly 10% of Springer Nature's research, enjoy similar

profit margins to subscription-based models,⁴⁷ thus suggesting that subscription-based journals have higher costs than OA journals. Houghton et al. (2009), perhaps the most comprehensive study to date of the costs and benefits of OA, estimate the average publisher cost per article by format and model. Irrespective of the format and the model of the journal, the authors estimate that costs are higher for subscription-based compared to open access journals (Table 10).

	Model				
Format	Subscription-based	Open access			
Print	2,728	1,831			
Dual-mode	3,247	2,003			
E-only	2,337	1,524			

able 10. Estimated average publishe	r costs per article by	format and journal (£)
-------------------------------------	------------------------	------------------------

Source: Houghton et al. (2009)

Cost of publishing OA under different business models

One area of concern relates to the (extra) overheads caused by the transition from a subscriptionbased to an OA model. During the interviews, we asked publishers for their views on the costs associated with the different business models and how OA has impacted on these costs.

One publisher mentioned that moving to open access required additional one-off investments as well as an increase in on-going costs. An example of one-off investment was the investment in a crossorganisational project aimed at reviewing and amending workflows, including revisiting those workflows geared towards improving metadata quality, enabling data-driven OA sales and internal restructuring. The additional on-going costs stem from new licenses to system providers to support these OA workflows moving forward. The importance of good quality metadata in an OA environment was also mentioned by another publisher. The same publisher highlighted that data is important to inform business decisions, such as whether to negotiate transformative agreements with institutions and consortia. In this respect, data on authors, affiliation, funders and any other relevant information needs to be collected at the start of the submission lifecycle. This information is then used to identify target customers and to negotiate new agreements. However, it was mentioned by publishers that this requires significant additional investments for publishers that simultaneously sustain both a subscription and OA model.

We also asked publishers to provide details on their costs of publishing. Two publishers interviewed mentioned that 60%–70% of the total cost of publishing is pre-publication, i.e. the stage between submission and acceptance of the author's manuscript (AAM) and that these costs are not affected by whether the article is published OA or closed.

That said, some born-OA publishers implement a different publication process aimed at keeping the cost of publishing low. This is called rapid publication process as the pre-publication checks are

⁴⁷ More details available at: https://www.ft.com/content/8dc9c370-492d-11e8-8ae9-4b5ddcca99b3

carried out by the editorial team, after which content is published online. In this so-called open peer review system, the process of vetting editorial quality occurs after publication by the wider academic community – whereas traditional peer review is carried out prior to publication by dedicated peer reviewers. This results in a faster publication process, often linked to a relatively low APC. In the view of one publisher applying this model, this publication process allows them to run a cost-efficient business and reduces the financial burden of the publication process.

Gold and Green OA from the publishers' perspective

During the interviews we carried out with publishers, we asked what their view was on the two OA routes, Gold and Green with no embargo period, and how the new policy will affect their business model.

Among the publishers interviewed, those active in STEM disciplines welcomed the Gold OA route with APCs and mentioned it as the preferred route. The main reason is that APCs allow covering the costs incurred by publishers, such as peer review and other costs incurred during the submission process. Many publishers also mentioned that Gold OA has allowed subscription-based journals to offer an OA option without affecting the sustainability of publishers' business.

More specifically, most of the publishers interviewed prefer Gold OA in the context of transformative agreements. They mention that the agreements negotiated during the last few years with institutions and consortia, in the UK as well as abroad, has led to a much broader OA uptake among researchers as they offer access to OA publishing free of charge at the point of publication, making OA affordable for everyone, including early career researchers. Publishers also mentioned that transformative agreements alleviate the involvement of researchers in administrative procedures during the publication process. Indeed, under transformative agreements, APCs are processed by the institution centrally rather than the researchers themselves.

Almost all the publishers interviewed exhibited substantial pushback on Green OA models that involved CC BY licensing and no embargo period. The reason is that this OA route has the potential to undermine the revenue from subscriptions. Indeed, a publisher claimed that when a significant amount of the content of subscription-based journals is published OA, universities are more likely to cancel the subscriptions. In addition, some publishers also mentioned that institutional repositories are suboptimal from a discovery perspective because articles are often hard to find compared to articles published in journals.

When asked to make a suggestion in support of the Green OA model, publishers generally suggested implementing CC BY-Non Commercial (CC BY-NC) or CC BY-No Derivatives (CC BY-ND) licences.⁴⁸ One publisher mentioned the latter as the most relevant licence in AHSS fields because textual context is particularly important in those disciplines. Three of the publishers interviewed currently have Green OA zero-embargo licences for their journals. However, their embargo policies specifically state that the licence should be CC BY-NC, as they do not want competitive platforms hosting their manuscripts for commercial reasons with no embargo. In contrast, another publisher said that repository policies had not harmed their business model in the past, and hence they did not expect Green OA to have a fundamental impact on their business.

The publishers interviewed also expressed dissent with the introduction of the Plan S Rights Retention Strategy. The Rights Retention Strategy gives funders the power to transfer the copyright of articles published under the auspices of their grants directly into the public domain, bypassing the control

⁴⁸ The CC BY-NC license excludes the commercial use from the license grant, while the CC BY-ND license allows for redistribution, both commercial and non-commercial, both prohibits users from modifying to the work.

publishers or authors usually exercise in deciding upon licence types. The Rights Retention Strategy makes Green OA routes compliant with funders' requirements, and publishers see it as a threat as it has the potential to increase Green OA and undermine their subscription revenues.

In summary the majority of publishers view Green with zero embargo as a risk to the sustainability of their business. As a result, four publishers interviewed, for whom UKRI-funded articles represent a small proportion of the publications, said they were unlikely to implement major transformations to comply with the UK OA policies, and thus consider not to offer OA route compliant with the new UKRI policy (e.g., Green OA with no embargo).

New university presses and smaller presses collaborating to support immediate and full OA

New university presses are one potential means of committing to support faculty with access to publication services, as well as speeding up the transition to OA. University College London (UCL) decided to adopt a distinct means of achieving OA: in 2015, the university launched UCL Press as the UK's first fully OA university press. Focusing primarily on books, especially from the humanities and the social sciences, UCL Press funds the publication process. It also publishes books by researchers outside the host institution, usually charging a Book Processing Charge (BPC) to non-UCL authors. While the majority of books have a UCL author, co-author or general editor, external researchers are also contributors to books published by the Press.

Compared to the industry leaders, the Press remains relatively small. As a supporting infrastructure, however, it has grown to be the biggest OA-only university press in the UK, and acts as a lab for publishing and marketing ideas around academic content. The same supporting infrastructure was suggested for peer-review journal articles.

While UCL Press is an example of a collection of publishing services centred around one institution, it is frequently mentioned as an example of a solution that could also be shared among smaller presses. Society and scholar-led publishers often find it difficult to generate the scale necessary to negotiate with vendors. Some interviewees also suggested expanding this model into a joint business case framework. The Society Publishers' Coalition is already exploring such models.

While a number of interviewees welcome the idea of shared sourcing and even negotiating in order to speed up the transition to OA, all the press representatives underline the importance of individual commissioning of content, branding and the ability to tailor content presentation to their specific target audiences – a model to which new university presses can certainly contribute.



The financial implications of OA for HEIs

In this section, we analyse the main OA expenditures for HEIs. These include APCs, employing staff, and additional expenditures incurred in supporting, promoting, or facilitating open access. In addition, we analyse expenditures on subscription fees and how these have evolved over the last decade. There is great uncertainty about the overall expenditures of HEIs on APCs and subscriptions. Expenditures on subscriptions in 2018 are estimated to be above £200 million while the total APCs paid by HEIs in 2017 is estimated to be approximately £32 million. The section also includes findings from the survey with HEIs and research institutes.

Overall expenditures on OA

In our survey of HEIs and research institutes, we asked them to provide an estimate of their total spend on open access, including expenditure on APCs, transformative agreements, staff employed, and any other expenditures related to open access. However, collecting information on the total expenditures in OA is non-trivial. Most HEIs mentioned that the figures were likely to underestimate the total cost of OA, with the main reasons being:

- Figures do not include APCs 'in the wild' (see section APCs 'in the wild').
- OA expenditures are split across different departments and are therefore difficult to collect.
- Administration costs relating to open access are difficult to estimate.
- Some institutions do not have a specific portion of their budget allocated to open access.

Overall, the figures provided by a sample of 23 HEIs show that expenditure on OA represents around 9% of the total library budget in 2019 (Table 11). However, the sample includes several small HEIs; therefore, it cannot be considered a representative sample. For this reason and the ones mentioned above, these figures should be interpreted with caution as they are likely to underestimate the actual amount of expenditures on open access.

Research institutes tend to report higher OA expenditure as percentage of the library budget (25%) compared to HEIs. However, only four research institutes responded to the survey, and the sample is too small to draw robust conclusions on differences and similarities between HEIs and research institutes. For this reason, throughout the report, the results of the survey will be presented using aggregated data.

Table 11. Expenditures on OA for UK HEIs between 2016 and 2019 as a % of the library budget

	2015/2016	2016/2017	2017/2018	2018/2019
OA expenditure as % of library budget	7%	9%	9%	9%

Source: Alma Economics survey with HEIs and research institutes. The sample includes 23 HEIs and research institutes. Library budget does not include block grants or other OA funding.

Expenditures on APCs

With the rise of OA, overall expenditure on APCs by UK institutions has significantly increased. Previous studies have attempted to estimate the total cost of APCs paid by UK HEIs (Table 12). These studies are based on small samples of HEIs. They include only APCs paid directly by institutional funds, without accounting for APCs paid by authors using external sources of funding, and therefore provides only a partial estimate of the total amount spent on APCs.

Source	Year	APC expenditure	Sample	Data
Jisc (2016)	2014	£21.6 million (12% of total expenditure on subscriptions (approximately £180 million)	The estimate (£21.6 million) refers to all UK HEIs. It was arrived at based on a sample of 23 institutions	The dataset includes APCs paid from the block grant and other funders/institutional funds.
Universities UK (2017)	2016	£11 million (20% of subscription fees paid by the institution in the sample)	The estimate (£11 million) refers to a sample of 37 HEIs. The total expenditures on APCs by all UK HEIs was estimated to be £33 million	Data do not include APCs paid to publishers who publish only OA journals
Lawson (2018)	2017	£25 million (Total expenditure in APCs for all UK institutions estimated around £32 million)	The estimate (£25 million) refers to a sample of 53 HEIs. Based on the sample of 53 HEIs, the authors estimate total expenditure on APCs by all UK HEIs to be £32 million	The dataset includes expenditures on APCs provided by the institutions in the sample

Table 12. Expenditure in APCs from previous studies

The average price of APCs paid by universities has increased since the introduction of OA policies in the UK in 2013. Open APC Initiative's data show that the average APCs paid by UK HEIs increased from £2,089 in 2014 to £2,423 in 2019, which corresponds to an increase of 16% in five years (i.e. around 8% when adjusting for general price inflation).

In order to pay for APCs, authors usually apply for OA funding. However, not all articles requiring APCs are paid by the institution either through the block grant or funding made available by the central fund. In the survey, we asked HEIs and research institutes about the proportion of articles that requested APCs funding in the academic year 2018/2019 for which the request was rejected.

About 50% of institutions stated that they refused to pay APCs for 1% to 10% of the articles that requested the funding, while 33% of the remaining institutions rejected 11%-40% of all requests they received (Figure 6). The main reasons were:

- Lack of funding.
- The article did not meet the OA requirements set by the funder.
- Articles were submitted to hybrid journals while the institution did not support publications in hybrid journals.



Figure 6. Share of articles requesting APCs funding that institutions decided not to fund, 2018/2019

Source: Alma Economics survey with HEIs and research institutes. The sample includes 42 HEIs and research institutes

We also asked HEIs and research institutes about the main criteria they applied when deciding the allocation of OA funding. Most of the respondents answered that funding is allocated on a first-come, first-served basis. This means that authors apply for OA funding, and the funding is allocated based on the order of the applications. However, this is not the only criteria mentioned:

- A few HEIs mentioned that they take into account the quality of the paper in the funding allocation process.
- Some HEIs give priority to research articles submitted to full OA journals.
- A couple of HEIs mentioned that they set a cap to the price of APCs that they are willing to pay. If publishers charge a higher price, they will refuse to pay the APCs. For one HEI the cap is £500 (excluding VAT, and once any publisher discounts/vouchers have been applied). Another HEI set the cap of £3,500 for APCs in hybrid journals and mentioned that if the price is higher, they try to negotiate with the publisher to lower the price.

Estimating the APCs paid by HEIs is challenging because sometimes authors make use of their personal research funds to pay for APCs, and these payments are often hard to track. Survey

participants were asked to estimate the proportion of researchers funded by UKRI that made use of their personal research budget to cover the cost of APCs. About 27 HEIs were able to provide an estimate. Of these, 30% declared that none of the APCs paid for UKRI-funded articles was paid using authors' personal budget funding other than block grant or OA funding made available by the institution (Figure 7). However, as shown in Figure 7, 70% of the respondents in our sample declared that between 1% and 10% of authors had used their personal funds to cover the cost of APCs. One HEI declared that this was due to authors deciding to pay for APCs despite the fact that a Green route was available, while another mentioned that this was due to authors not being aware of the existence of OA funding.



Figure 7. Proportion of researchers funded by UKRI that made use of their personal research budget to cover the cost of APCs, 2018/2019

When we asked the same question for all researchers, not only those funded by UKRI, the percentage of authors using their personal budget to cover APCs was higher (Figure 8). Almost 20% of the HEIs in our sample estimated that between 11% and 20% of researchers used their personal budget, while 15% estimated that the proportion was more than 20%. Fewer than 10% of the surveyed HEIs believed that researchers' personal budgets were never used to pay APCs. Most institutions, however, highlighted that it is extremely difficult to track these payments. Some based the estimates on anecdotal evidence based on the fact that UKRI block grant and the OA funding of the institutions were not enough to pay for all APCs.

Source: Alma Economics survey with HEIs and research institutes. The sample includes 27 HEIs and research institutes.





Source: Alma Economics survey with HEIs and research institutes. The sample includes 23 HEIs and research institutes.

Researchers' attitudes towards OA

Different views on OA emerged among researchers during the interviews.

One researcher emphasised that while they see OA as the way forward, this is not the case for many of their peers. In this respect, some researchers mentioned that the only way to achieve full compliance to OA policies is making it mandatory to publish in OA journals, even when these were not the preferred journals. Indeed, from the researchers' perspective, the most important consideration was to publish in reputable journals, irrespective of the OA options available and the level of the APC.

Overall, HEIs argued that researchers showed a positive attitude towards open access. Several librarians mentioned that the view on OA among researchers has changed fundamentally thanks to the policies of the past few years. This was partly due to the institutional resources devoted to promoting OA, and partly due to the importance that OA gained in the public debate since 2013. However, HEIs also mentioned that there are significant differences between young and older researchers, with the former generally being much more supportive of OA.

Researchers interviewed pointed out that improved guidance from their universities would support them and their peers in making decisions about the OA publishing process. Many researchers identified a very concrete solution, with one interviewee saying that "it would make a big difference to have a comprehensive list of journals compliant with funders' requirements, as it is not clear whether certain journals are compliant and what the different OA options available are – both APC-based or APC-free". An interesting development in this area is the Plan S Journal Checker, currently under development (https://www.coalition-s.org/development-of-plan-s-journal-checker-tool-tender-results/).

With respect to OA routes, interviews with researchers demonstrated that the Green OA route is appreciated, as it allows them to upload their Authored Accepted Manuscript (AAM) to their website. However, when asked about the role of Green OA in the discovery process, they mentioned that whenever they find an AAM in a repository or on a platform, they always search for the Version of Record (VoR) on the publisher's website. They argued that they want to be sure they are looking at the right version, which includes any changes made over time. Similarly, another researcher in an AHSS field said that Green OA was not the ideal solution for several reasons: it contributes to increased version fragmentation and splintered citations, and it does not take into account the work of editors and reviewers. This researcher, who sits on the editorial boards of several journals, believes that this undermines the scientific community's effort in making the submitted article a VoR.

APCs 'in the wild'

Providing a clear picture of the expenditure on APCs is difficult because data are not systematically collected across HEIs and research institutes. Moreover, the studies mentioned in Table 12 calculate APCs across different samples of institutions, which makes it hard to compare expenditures over time.

Estimating the total expenditure on APCs is also difficult because sometimes APCs are not paid through centrally-managed funds (through block grants or the institutional fund). These payments are called APCs 'in the wild' and funders and institutions cannot track them because (i) authors use their

own money to pay the APCs or (ii) authors use external funds that their institution is not aware of. Often institutions are not aware of these payments because authors do not inform their institutions about the payments, information on payments are not collected and shared across departments, or because a comprehensive list of APC funding source is not available.

Andrew (2016) recently carried out an estimation of the total costs of publication for the University of Edinburgh. The study shows that the proportion of APCs 'in the wild' could account for up to 20% of total publication costs.

In order to shed light on the proportion of authors that make use of funds 'in the wild', Springer Nature conducted a survey among authors and found that among the respondents:

- 27% of the authors surveyed only use 'wild' funding sources to pay for APCs.
- 50% of surveyed authors combined easily monitored sources with funding sources 'in the wild'.
- Compared to the overall sample, UK authors are less likely to use so-called funds 'in the wild'. However, there is still a consistent proportion of authors who use funds 'in the wild' alone (12%) or combined with other funds (37%).

The report also highlights that identifying and tracing the source of APCs funding, including those 'in the wild', is crucial to understand the real cost of OA and to accelerate the transition to open access (Springer Nature, 2020). In addition, tracking APCs 'in the wild' is important for institutions to negotiate fair offsetting agreements for open access publishing (Andrew, 2016).

In our survey of HEIs and research institutes, we asked institutions to provide an estimate of the APCs 'in the wild'. Among the institutions included in our sample, 65% were not able to provide an estimate of the APCs 'in the wild'. Some institutions provided figures of APCs 'in the wild' as a proportion of the total expenditures on APCs. This proportion ranged from 5% to 40%. Overall, most institutions agreed that tracking APCs in the wild is challenging.

Additional costs of processing OA articles

Complying with open access mandates generates administrative and management costs for research institutions. Early estimates of the cost of OA show that in 2013/2014 UK research institutions spent £9.2 million on management, advocacy, and infrastructure costs not fully covered by block grants (Research Consulting, 2014). The report also showed that the cost per article of processing APCs did not significantly decrease as the number of articles processed by the institutions increased, suggesting that in the first phase of implementation there was little room for economies of scale. The costs of processing OA articles in the report were calculated using the figures provided by Johnson and Fosci (2015). The authors conducted a survey of UK HEIs and based on the responses they received they estimated that the average cost to the HEI of processing articles Gold and Green OA was £88 and £33, respectively.

In 2018, Research England surveyed 18 institutions to assess their progress towards the delivery of OA. Institutions stressed that the implementation of OA policies was mostly carried out by dedicated staff employed by the institution. In addition, several costs associated with OA policies beyond additional staff and APCs were mentioned, including academic resources, infrastructure, institutional policy and advocacy, legal and financial services and monitoring (Research England 2018).

As part of our survey of HEIs and research institutes, we asked respondents to estimate the additional costs of OA incurred in supporting, promoting, or facilitating open access during the financial year

2018/2019, besides APCs and the cost of employing staff. These include marketing, consultancy, staffing, software, travel, repositories, and any other cost. A sample of 36 HEIs and research institutes provided a breakdown of these additional costs of OA by category. On average, institutions spent approximately £33,500 in 2019 on these additional costs, about 7% of total OA expenditure. Software licensing and developing and repositories were the two most expensive activities, making up approximately 50% of the additional costs of OA.

In addition, we asked HEIs to estimate the time spent by authors and admin staff to process an OA article. Johnson and Fosci (2015) estimated that the total time to process Gold and Green OA articles was 119 and 52 minutes, respectively. Since then, the time to process Green articles has remained similar (43 minutes), while for Gold, we found that the average is now around 92 minutes. While we cannot rule out that the decrease in the time employed to process Gold articles that we find is specific to our sample, it may also reflect the impact of transformative agreements that seem to have sped up the process. In this respect, according to Swedish authors and institutions surveyed on the Springer Compact deal:

"To approve an article where the author is clearly affiliated with the institution takes less than two minutes. This workload is to be compared with the effort it would otherwise take each researcher to pay their separate billing, should they choose to publish OA."⁴⁹

Similarly, in the context of a survey conducted among publishers to evaluate the impact of transformative agreements in the last five years, a representative of Springer commenting on the Springer Compact deal signed with the UK highlighted that:

'The workflow [required by the agreement] has been simple and efficient and saved time, effort and money for institutions, administrators and individual researchers. Institutional needs have driven the build and iterative improvement of systems and reporting and these improvements have made further time and cost savings for institutions and authors'.⁵⁰

The costs of processing OA articles for HEIs and recent improvements: insights from our interviews with HEIs

In interviews with HEIs, the dominant topic with regards to Gold OA concerned the availability of funding and the associated administrative overheads, which research-intensive HEIs deem particularly problematic.

In addition to publication fees under the Gold OA model, all the interviewees mentioned that the socalled 'hidden costs of managing open access' should also be taken into account when assessing the impact of the transition to a new model. These costs refer to the administrative overhead costs – including handling metadata, managing repositories and other reporting work – which requires the support of many FTEs. This increase in FTEs is directly related to the increasing administrative efforts associated with enabling OA through institutional repositories to ensure compliance – both for the REF and to increase the number of OA publications. As an example, at one large HEI, the number of staff members required to undertake this work increased from five in 2013 to fifteen in 2020.

However, the representative of one of the HEIs interviewed highlighted that there have been significant efficiency improvements in the processing of OA articles. The Jisc Router is an important initiative in this respect. The Jisc Router enables institutions to integrate directly with publishers and automatically

⁴⁹ Full-text on the evaluation of the Springer Compact is available at:

https://www.kb.se/download/18.2705879d169b8ba882a5560/1556566760356/Evaluation_of_offset_agreements_SC_Report_3.pdf ⁵⁰ Survey responses are available at: https://collections.lib.utah.edu/ark:/87278/s6fr4zxb

ingests content and metadata into dedicated institutional repositories. Depositing metadata directly reduces the administrative burden significantly.

Research-intensive institutions also argued that the rise in transformative agreements – in which the researcher is not involved in the payment process – leads them to expect a more seamless publication process and a higher uptake of OA publishing. As one institution mentioned, an important condition for this is that publishers also improve their systems for identifying affiliated researchers, which would improve the payment workflows between publishers and institutions. Otherwise, researchers will remain heavily involved in verifying the payment process.

In addition, many HEIs stated that Green OA policy alignment across funders would be helpful – examples of this would include alignment on embargo periods and licence types. As mentioned by one institution, such alignment would help save significant staff time.

All the institutions interviewed highlighted that reporting on OA expenditure is very challenging. The main issue is that OA payments involve different organisational units at the respective institutions, including department-level payments or specific research group budgets. These units do not have shared reporting workflows that would enable one to easily collect information on the total OA expenditure. Secondly, in many cases, the institutions can see that affiliated authors have indeed published OA, but no payment can be traced back to the accounting systems (e.g. APCs 'in the wild').

Subscription fees

Research institutions pay for subscription or licensing fees to access the content of closed journals. Subscription pricing deals between publishers and research organisations are generally protected by non-disclosure agreements and are often based on historical arrangements. As highlighted in the Finch Report, subscription fees vary across institutions and are not necessarily related to size and research intensity, with many publishers charging fees based on universities' subscription levels in the print era.

In 2016, Jisc estimated that the total expenditure of UK HEIs on journal subscriptions was about £180 million (Jisc, 2016) (Table 13). Expenditures on subscriptions have significantly increased in the last decade. In 2020, Jisc published updated figures on subscription fees paid by UK institutions to the ten largest publishers and showed that between 2013 and 2019 they almost doubled, going from £70 million in 2013 to £130 million in 2019 (Table 13).⁵¹

Source	Year	Subscriptions	Sample
Jisc (2016)	2013	£70 million	Journal subscriptions fees paid by UK HEIs to the top ten largest publishers
Jisc (2020)	2016	£180 million	Journal subscription fees estimated using FOI data and SCONUL data
Jisc (2020)	2019	£130 million	Journal subscriptions fees paid by UK HEIs to the top ten largest publishers

Table 13.	Jisc estimated	expenditures	of UK HEIs or	n subscription
	0100 00000000	onpontation oo		1 0000011011011

⁵¹ Data were showed during the online event "UK Jisc and Wiley read and publish agreement" that took place on 10 March 2020. The online presentation is available at: https://www.jisc.ac.uk/events/jisc-and-wiley-read-and-publish-agreement-10-mar-2020

We analyse data on expenditure on subscriptions using publicly available datasets derived from freedom of information (FOI) enquiries. ⁵² The dataset contains payments made by around 150 UK HEIs for access to academic journals from ten large publishers between 2010-2019. Figure 9 shows the total amount of subscription fees paid to five largest commercials publishers, for which data are available every year. These include Elsevier, Wiley, Springer, Taylor & Francis, and Sage.

Between 2010 and 2019 subscription fees increased by more than half, from £68 million to £104 million. These five publishers account for half of the total subscription fees paid by institutions (Lawson, 2018); therefore, total expenditure in 2019 is likely to be above £200 million.



Figure 9. Expenditure on subscriptions fees paid to the largest 5 publishers

In addition, projections of expenditures on subscription fees based on data gathered from Freedom of Information requests suggest that they will continue to increase by 3% to 5% every year until 2021, with APCs increasing at a similar rate (Universities UK, 2017).

The impact of transformative agreements on the cost of publishing

Since the introduction of OA policies, Jisc has negotiated a number of transformative agreements with publishers on behalf of UK HEIs.

Lawson (2018) analysed the impact of offsetting agreements on the total publication costs faced by HEIs. Offsetting agreements are a type of transformative agreements in which fees for subscription and APCs offset one another. In 2015 Jisc had negotiated offsetting agreements with Wiley, Taylor and Francis, SAGE, Institute of Physics Publishing, and Royal Society of Chemistry. The amount offset in 2015 was estimated at around £1.2 million for the 34 HEIs in the sample and around £1.8 million across all UK institutions (Lawson, 2016). In 2016, Jisc negotiated the Springer Compact that allows UK researchers to publish OA in 1,600 Springer journals and simultaneously access the content of Springer journals. This deal increased the estimated amount offset to £9 million in 2017 (Lawson, 2018).

However, it is worth highlighting that the figures above: (i) do not include the administration costs that universities face to process open access articles, (ii) are estimated based on the amount that

Source: Publicly available datasets derived from freedom of information (FOI) requests.

⁵² Data and details on the FOI requests are available at: https://zenodo.org/record/3657776#.X4c0_eaSIPa

institutions would have paid in the absence of offsetting agreements, therefore assuming that offsetting agreements did not have an impact on authors' publication choices.

In 2017, the report produced by Universities UK (Universities UK, 2017) showed that total expenditures on APCs and subscriptions combined increased 40% between 2013 and 2016 for a sample of eleven universities, with subscription spend increasing by 20% and APCs more than fourfold in three years.



Figure 10. Total subscription and APCs expenditures for 18 UK HEIs, 2014-2018 (£ million, current prices)

Figure 10 shows expenditure on APCs and subscriptions between 2014 and 2018 for a sample of 18 institutions and 7 large publishers. ⁵³ With the exception of Elsevier, all the publishers in the sample negotiated offsetting deals with UK institutions between 2014 and 2017.⁵⁴ The figure shows that total expenditure increased by 40% between 2014 and 2018. Though the number of publications has also increased over this time period, data from the Open APC initiative suggests that at least part of the growth in total expenditures is driven by an increase in average APCs.

Estimating whether the cost of publishing open access under transformative agreements is lower is difficult because it is not clear how universities account for offsetting, whether reducing APCs or reducing the amount paid in subscriptions. Even if

all the necessary data was consistently collected and was available to us, it would still be impossible to know with certainty what the counterfactual would have been – i.e. how high expenditures would have been in the absence of transformative agreements.

The evidence provided in Figure 10 suggests that total expenditures, including both APCs and subscription fees, have steadily increased over the last five years despite the negotiation of offsetting deals with publishers. As noted by Earney (2017) in his evaluation of offsetting agreements:

'If an OA model is meant to replace the subscription model, why does expenditure on both APCs and subscriptions continues to rise so inexorably? [...] The fact that the expenditure lines are not flat or falling, in either case, makes offsetting agreements resemble nothing more than an 'advantageous lock-in' for status quo publishers.'

Following on from the above, it is unclear whether HEIs can achieve substantial offsetting through the negotiations of transformative agreements.

In light of that, since 2018 Jisc introduced more stringent requirements on transformative agreements

⁵³ The sample of institutions includes: Cranfield University, King's College London, LSE, Lancaster University, Swansea University, UCL, University of Bath, University of Birmingham, University of Cambridge, University of Edinburgh, University of Glasgow, University of Liverpool, University of Manchester, University of Oxford, University of Reading, University of Sheffield, University of St Andrews, University of Sussex. We restrict the sample to seven publishers for which data are available each year: Elsevier, Wiley, Springer, Taylor & Francis, Sage, Royal Society of Chemistry, Institute of Physics.

⁵⁴ Agreements between publishers and UK institutions do not cover the whole sample period (2014-2018).

with respect to the role that these should play in reducing the cost of publishing OA while allowing institutions to access paywalled content. Jisc requirement is that agreements should:

"Enable institutions to publish 100% of their research OA and access paywalled articles for an affordable and sustainable fee. For clarification, the total fee charged for both access to paywalled content and OA publishing must result in a reduction on existing subscription expenditure." ⁵⁵

Given this new and more stringent requirement, further analysis will be required to evaluate the extent to which transformative agreements can mitigate the cost of open access.

It is also worth highlighting that funders see transformative agreements as a temporary tool to facilitate the transition to OA. Members of cOAlition S announced that support to publication fees in transitional agreements will cease on 31 December 2024. It will then be important to ensure that OA publishing will remain sustainable without further agreements and additional funding when transformative agreements expire. While there may have been some transitional costs in setting up an OA infrastructure that won't need to be incurred again in future, most of the cost of publishing OA will still need to be covered even if a full transition to OA is achieved.

The 2020 Wiley-Jisc "read and publish" transitional agreement

In March 2020 Wiley and Jisc signed a "read and publish" transitional agreement involving 150 institutions and more than 200 library administrators. Authors affiliated to institutions participating in the agreement can publish articles in any of Wiley's journals with no further open access costs.

In August 2020, Wiley announced that after six months since the introduction of the agreement, 3600 articles were published open access, the majority of which were hybrid articles (93%), while 7% of the articles were published Gold OA. The figures provided by Wiley also show that the proportion of articles published OA between March and August 2020 was significantly higher (78%) than the proportion of articles published in the same period in 2019 (30%).

Under the Wiley-Jisc agreement, authors from a participating institution would publish OA articles in hybrid and full OA journals at no cost. In addition, if funding is not available through the author's institution, Wiley offers a 25% discount on APCs. In 2020, the total discount offered was equivalent to £3.68 million of savings in APCs.

Overall authors expressed very positive views on the OA publication process under Wiley-Jisc agreement. In particular, 75% of authors submitting an OA article to one of Wiley's journals declared to be either satisfied or very satisfied with the OA publication process, compared to 66% in 2019. In addition, Wiley set out the Wiley Open Access Account Dashboard, which is an online tool for account management and administration that helps institutions to make administration account easier and more efficient. To support institutions using the Dashboard, Wiley provided Q&A sessions, webinars, and training sessions attended by institutions and librarians.

⁵⁵ Details on Jisc requirements are available at: https://subscriptionsmanager.jisc.ac.uk/about/publisher-information

Research articles affected by the new UKRI OA policy



In this section, we estimate the impact of the new UKRI policy under three different policy scenarios:

- 1. UKRI OA funds will support OA publications in hybrid journals as well as full OA journals.
- 2. UKRI OA funds will support OA publications in full OA journals and hybrid journals that are part of transformative agreements.
- 3. UKRI OA funds will not support OA publications in hybrid journals, only full OA journals.



The three policy scenarios were included in the consultation conducted by UKRI with a wide range of stakeholders to determine how to move forward with open access.

The following sections describe the proportion of articles in each subject area that, assuming 2018 publication patterns persisted, would no longer be compliant under the three different policy scenarios listed above. The number of articles that would not comply with the new UKRI policy increases when moving from Scenario 1 to Scenario 3. In Scenario 1, 28% of all UKRI-funded articles would not be compliant as they are currently published in subscription-only journals or in hybrid journals following a subscription model. In comparison, under Scenario 2, 44% of all UKRI-funded articles would not be compliant; these include articles that are published in closed journals or hybrid journals not covered by a transformative agreement, regardless of whether they are published through an OA or subscription model. Finally, in Scenario 3, 59% of all UKRI-funded articles would not be compliant as these are currently published in subscription-only journals.

Following the implementation of the new policy, authors of research articles that acknowledge UKRI funding and would have otherwise been published in non-compliant journals will have two choices: (i) find sources of funding, other than block grants, to publish the article OA in non-compliant journals, (ii) choose a different (compliant) journal to publish the article.⁵⁶ The number of articles affected will depend on the policy UKRI will decide to implement.

⁵⁶ This is based on the assumption that no journals will flip or offer a new OA compliant option in response to the new UKRI policy.

	Arts and Humanities	Health Sciences	Life Sciences	Physical Sciences	Social Sciences
Closed	298	765	530	2290	846
Full OA	29	2104	1340	2335	224
Hybrid – Gold OA	241	2300	2509	4079	920
Hybrid – Green OA	185	1027	961	4608	636
Hybrid – Subscription	102	1226	1003	1801	304
Total	855	7422	6343	15113	2930

Table 14. Number of articles that acknowledge UKRI funding published in 2018

Source: Dimensions article data merged with Scopus data on journal publishing model and subject area (see methodology)

Scenario 1: UKRI OA funds will support OA publications in hybrid journals as well as full OA journals

Under this policy option, UKRI-funded researchers will be allowed to publish their research open access in full OA and hybrid journals. cOAlition S funders have already announced that they will no longer support Open Access publication fees in subscription venues. Similarly, following a consultation with key stakeholders, the Wellcome Trust announced that it would withdraw support for research output published in hybrid journals. UKRI, however, is still considering allowing open access publications in hybrid journals even when these are not part of a transformative agreement as a policy option.

	Arts and Humanities	Health Sciences	Life Sciences	Physical Sciences	Social Sciences
Closed	35%	10%	8%	15%	29%
Hybrid – Subscription	12%	17%	16%	12%	10%
Total	47%	27%	24%	27%	39%

Table 15. Proportion of articles that would not comply with the new UKRI OA policy by subject area assuming 2018 publication patterns – Scenario 1

Source: Dimensions article data merged with Scopus data on journal publishing model and subject area (see methodology)

Under this scenario, 28% of all UKRI-funded articles would not be compliant as they are currently published in subscription-only journals or in hybrid journals following a subscription model. Arts and Humanities and Social Sciences are the subject areas with the highest proportion of articles that would no longer comply with the new UKRI policy if 2018 publication patterns persisted; 47% of Art and Humanities (including both Closed and Hybrid – Subscriptions articles) and 39% of Social Sciences articles will need to be published in different journals compared to where they would have been published prior the introduction of the new policy (Table 15).

Scenario 2: UKRI OA funds will support OA publications in full OA journals and hybrid journals that are part of transformative agreements

Under this scenario, UKRI-funded researchers would no longer be able to publish articles in hybrid journals not covered by existing transformative agreements, even if the journal provides an openaccess publishing model. Instead, they would only be allowed to publish in journals that are fully openaccess or hybrid journals that are covered by transformative agreements (as of 2020, these include journals published by SAGE, Springer Nature and Wiley-Blackwell in addition to several other smaller publishers). This policy scenario is aligned with Plan S and Wellcome Trust requirements. Both organisations have announced that they will support publications in hybrid journals only where these are part of a transformative agreement.

Under Scenario 2, 44% of all UKRI-funded articles would not be compliant; these include articles that are published in closed journals or hybrid journals not covered by a transformative agreement, regardless of whether they are published through an OA or subscription model.

Table 16 shows the number and proportion of hybrid journals that already negotiated transformative agreements, and that would therefore comply with the new UKRI policy. Social Sciences and Art and Humanities are the subject area with the lowest proportion of hybrid journals that would comply with UKRI policy under this policy scenario. Overall, across the five different subject areas, around 50% of the journals have negotiated transformative agreements, while the remaining 50% would no longer be compliant with the UKRI policy under this policy scenario. A breakdown of hybrid journals by publisher is included in the Annex (Table A1).

	Arts and Humanities	Health Sciences	Life Sciences	Physical Sciences	Social Sciences
Hybrid journals with TAs	128	499	295	528	455
(% of all hybrid journals)	55%	48%	45%	47%	59%

Table 16. Hybrid journals that negotiated transformative agreements (TAs)

Source: ESAC data on Transformative Agreements as of August 2020, merged with Dimensions article data and Scopus data on journal publishing model and subject area (see methodology)

Table 17 shows the proportion of articles published in hybrid journals, both closed and open access, currently not covered by transformative agreements and that would no longer comply with the new UKRI policy. Physical Sciences has the highest proportion of articles published in hybrid journals not currently covered by transformative agreements, both Gold and subscription (67% and 77% respectively). In all five subject areas, more than half the articles published in hybrid journals would no longer be compliant under the new UKRI policy and will need to be published in a different journal.

Table 17. Proportion of articles published in journals that are not part of a transformative agreement assuming 2018 publication patterns

	Arts and Humanities	Health Sciences	Life Sciences	Physical Sciences	Social Sciences
Hybrid – Gold OA	57%	64%	62%	67%	53%
Hybrid – Subscription	69%	66%	56%	77%	58%

Source: ESAC data on Transformative Agreements as of August 2020, merged with Dimensions article data and Scopus data on journal publishing model and subject area (see methodology)

Scenario 3: UKRI OA funds will not support OA publications in hybrid journals, only full OA journals

Under this scenario, no hybrid journals will comply with UKRI OA policy, irrespective of whether they are covered by transformative agreements or not. Out of the three policy scenarios, this is the most stringent, as UKRI-funded articles will only be allowed to be published in full OA journals. Therefore, the total proportion of articles affected is higher under this scenario compared to the ones presented above.

Under this scenario, 59% of all UKRI-funded articles would not be compliant as these are currently published in subscription-only journals or hybrid journals. The proportion of non-compliant articles (by subject area) under this policy scenario varies between 54% (Physical Sciences) to 75% (Arts and Humanities) depending on the subject area, with Arts and Humanities being the most affected subject, with three out of four articles no longer compliant with the new policy (Table 18).

Table 18. Proportion of articles that would not comply with the new UKRI OA policy by subject area assuming 2018 publication patterns – Scenario 3

	Arts and Humanities	Health Sciences	Life Sciences	Physical Sciences	Social Sciences
Closed	35%	10%	8%	15%	29%
Hybrid – Gold OA	28%	31%	40%	27%	31%
Hybrid – Subscription	12%	17%	16%	12%	10%
Total	75%	58%	64%	54%	71%

Source: Dimensions article data merged with Scopus data on journal publishing model and subject area (see methodology)

Block grants

Data provided by UKRI containing per-article block grant spending across HEIs as part of their annual submission to Jisc can be used to estimate the total number of articles for which OA publication costs were funded by the UKRI block grant. In general, articles that receive block grant support have their publication costs funded in full, while not every article published OA receives funding from the UKRI block grant.

The table below provides a breakdown of UK-authored articles funded by the UKRI block grant that were published in 2017, as this was the last full year for which data is available. Note that due to data quality issues with how article DOIs were recorded, not all articles listed in the RCUK reporting template could be matched to an article in the Dimensions dataset, and the numbers below only represent 68% of the UK-authored articles funded by the UKRI block grant and published in 2017.

Table 19. Number of UK-authored articles funded by UKRI block grant

	Arts and Humanities	Health Sciences	Life Sciences	Physical Sciences	Social Sciences
Full OA	9	500	414	562	76
Hybrid – Gold OA	120	698	991	2062	412
Other (including OA Green)	44	73	92	121	106
Total	173	1271	1497	2745	594

Source: UKRI, Dimensions article data merged with Scopus data on journal publishing model and subject area (see methodology)

30,823 OA articles published in 2017 acknowledged UKRI as a funder (across OA Gold, OA Green, OA Bronze and Hybrid OA) and 6,280 articles with available data received UKRI block grant funding in 2017. Out of these 6,280 articles, 328 did not acknowledge UKRI as a funder, but these papers were largely funded by other UK-based research organisations or charities. Compared to the distribution of all UK articles across different subject areas, a greater share of articles that received UKRI block grant funding was classified as physical sciences (44% versus 28%) or life sciences (24% versus 12%), while fewer articles were classified as health sciences (20% versus 37%).

While the UKRI block grant covers a relatively small number of articles, it remains an important source of funding for many HEIs to cover expenses associated with OA publishing. As another key funding source, the COAF grant, has been phased out, financial support (whether from UKRI, HEIs themselves, research organisations or the UK government) is critical to enable a sustainable transition to OA. The importance of OA funding for HEIs is addressed more in details in the next section.

The use of block grants by HEIs

Block grants were widely discussed in the interviews we carried out, particularly how the grants have been used to meet OA costs. Several institutions mentioned they would not be able to support the OA transition without this instrument. One librarian of a highly research-intensive HEI, in particular, argued that their institution had not planned any funding transition from subscriptions to APCs, and therefore block grant is the only source of funds used to pay APCs. In this respect, all HEIs interviewed recommended that block grants remain in place to support OA publications while there is an ongoing need to pay for subscriptions.

Regarding the use of the block grant, most HEIs mentioned that they use it to either pay for APCs or to cover overhead expenses. One librarian argued that while some HEIs have used their block grants primarily to cover APCs, others have used them to cover the costs of hiring new FTEs to support the OA transition. Consequently, for the latter institutions, any reduction in block grants has implications for staffing levels as well.

One librarian also mentioned that the block grant was not enough to cover all APCs, and therefore, they had to suggest alternative OA routes to researchers, such as Green OA or other APC-free routes. However, it was highlighted that this might put libraries and researchers in a difficult position, as it implies that the researcher cannot publish in their preferred journal because no funding is available.

The main concern among research-intensive institutions is that a significant increase in the number of authors who choose a Gold OA route to compliance would exceed the current levels of UKRI block grant funds. Therefore, funding APCs can become problematic as HEIs cannot cover these costs beyond their current subscription expenditures. In addition, larger institutions argued that they are currently hesitant to enter into multi-year transformative agreements because the associated publication fees cannot be covered by the existing subscription budget. In this respect, one HEI emphasised that the UKRI block grant funds for transformative agreements should be unrestricted.

Alternative block grant allocation

The UKRI block grant is allocated to HEIs and research institutes to contribute towards the cost of open access publishing of UKRI-funded research, and it is centrally managed by libraries. Research grant and fellowship applications to UKRI are not usually permitted to include provision for OA article publication charges, which are met exclusively by the block grant. In principle, the provision of separate OA funding (such as the block grant) could incentivise authors to take into account APC prices in their publishing decision (i.e. to become more price-sensitive) and favour journals with lower APCs.

However, our interviews with researchers and the survey with HEIs suggested that despite the block grants covering the majority of APCs, some authors may still need to search for external funding to pay for APCs, especially in subjects where funding is limited, and the cost of APCs is high.

Under the new UKRI policy, all articles published in subscription journals will be required to be published OA, while currently authors have the option to publish articles in closed journals. Although it is difficult to reach robust conclusions as the policy has not been implemented yet, the new UKRI policy might pose an issue of affordability as the block grant may no longer be enough to cover the publication costs of UKRI-funded research.

One possible alternative mechanism of OA funding allocation would be to include open access funding in the research grant. Given that the new UKRI policy will require UKRI-funded research output to be published open access, UKRI should consider leaving authors free to use their research budget to cover the cost of open access. This could have two advantages: (i) it would provide incentives for authors to choose journals with lower APCs (as the budget saved on OA could be invested in other research-related activities), (ii) it would remove the administrative burden for researchers to obtain funds from external sources and make it easier to track APC payments.

Funders' views on OA policy and funding

Open Access policies in the UK have led to an increase in OA uptake by researchers seen by many HEIs as a core achievement from the past six years of policies in this area. However, this increase in acceptance also poses challenges to funders' ability to forecast and budget for OA.

Of the funders interviewed, most of those with an earmarked budget for publication charges were engaged in block grant programmes. Most funders mentioned that budgeting block-grant funding based on historical data is challenging. Researchers have demonstrated a shift in appetite for OA, depleting funding more rapidly than anticipated.

In addition, some funders mentioned that the actual monitoring of funded researchers has been problematic as often payment cannot be traced, which in turn hinders future budgeting. Consequently, better direct monitoring and reporting is required to enable funders to budget grant needs more accurately.

However, one of the funders interviewed noted that not all funders have a dedicated budgetary structure to support OA. An example of this was offered by another funder, who stated they had to pay a significant amount of APCs on behalf of researchers in 2019 out of discretionary or travel budgets.

In addition to challenges in allocating funds, the funders interviewed also clearly articulated the importance of prestige for researchers and the research output produced. Publishing in the most reputable journals is currently seen as vital for one's career and their ability to attract further funding, albeit funders and institutions are increasingly implementing measures to assess research differently and not via journal title or publications. The funders mentioned that many leading journals do not offer a compliant route to OA at the moment, which might prevent researchers from publishing in the journals of their choice.

The impact of the new UKRI policy on HEIs

In order to predict the total cost to HEIs of achieving full OA under the new UKRI policy, we first need to estimate the cost of publishing OA all UKRI-funded articles that were not published open access in 2018, both in hybrid and closed journals. Given that articles published non-OA are not subject to APCs, we estimate what the APC would be if they were to be published open access.

In particular, we develop a model to predict the APCs that would be paid by each article based on the subject area (Arts and Humanities, Health Sciences, Life Sciences, Physical Sciences, and Social Sciences) and CiteScore of each journal. We assume that articles are published in the same journals or an equivalent OA journal. We estimate the parameters of the model based on data on the APCs paid by UK institutions to publish in hybrid and full OA journals in 2018.

More specifically, we use the following specification for an article in journal *i*:

 $\textit{EstimatedAPC}_{i} = \beta_{0} + \beta_{1}\textit{CiteScore}_{i} + \varepsilon_{i}$

CiteScore refers to a journal's 2017-2019 CiteScore, which captures the average number of citations per document that the journal receives over a three-year period. ε_i is the error term.

We estimate this specification separately for each of the broad subject areas in our dataset (Arts and Humanities, Health Sciences, Life Sciences, Physical Sciences and Social Sciences) (Table 20). This is equivalent to including interaction terms between actual APC paid and subject area in a specification estimated for the whole dataset: average APCs, as well as the relationship between actual APC paid and CiteScore, varies across subject areas. We use the model to predict APCs for hybrid and full OA journals for which APCs paid were not available in the data. While Table 20 reports results for 2018 APCs, we have included as a robustness check coefficient estimates for 2016 and 2017 APCs in the

Annex (Tables A3 and A4). These results are largely similar in magnitude to the coefficient estimates for 2018 APCs.

Subject Area	Intercept (β₀)	Slope (β1)	R ²
Arts & Humanities	639.12	174.89	0.14
Health Sciences	1055.71	106.40	0.30
Life Sciences	1505.58	80.88	0.22
Physical Sciences	1193.98	83.29	0.04
Social Sciences	689.25	124.97	0.17

 Table 20. Regression coefficients of estimated 2018 APCs by subject area for UK-authored articles

Source: Estimates produced by Alma Economics. N = 122 (Arts & Humanities), 620 (Health Sciences) 347 (Life Sciences), 544 (Physical Sciences), 340 (Social Sciences)

Estimated APCs in the full and immediate OA scenario

Table 21 shows the average estimated APCs for non-open access journals. Estimated APCs were calculated by averaging article-level predicted APCs based on the regression coefficients from Table 20 across all articles in each subject area and journal business model. For articles published in full OA and hybrid journals, we instead use the actual APCs paid by UK institutions in 2018 to publish the articles full OA.⁵⁷ Our estimated average APCs based on journal CiteScore show that APCs of hybrid and closed journals are higher across all subject areas.

	Arts and Humanities	Health Sciences	Life Sciences	Physical Sciences	Social Sciences
Closed	813	1,646	2,019	1,744	1,100
Full OA	489	1,523	1,707	1,545	1,112
Hybrid – Gold	1,290	2,297	2,533	2,004	1,577
Hybrid – Green	1,399	2,182	2,542	2,109	1,522
Hybrid – Subscription	1,131	2,142	2,467	2,098	1,507

Table 21.	. Average estimated APCs by journal busines	s model and subject areas for UK HEIs
	and research institutes (£)	

Source: Estimates produced by Alma Economics

⁵⁷ The estimates for full OA journals in Table 21 and Table 22 do not align because we estimated APCs for full OA journals (as well as hybrid journals offering an OA Green publishing option) for which no data was available from the Open APC Initiative.

The estimate in Table 21 also includes estimated APCs for Hybrid-Green. Although Green articles are not subject to APCs, only Green with no embargo will comply with the new UKRI OA policy, while any Green OA subject to any embargo period will not be allowed. The Dimensions dataset at our disposal does not distinguish Green articles by embargo period. This prevents us from estimating the level of APCs only for Green articles subject to embargo, and instead we estimate the average APCs for all Green articles.

As a robustness check, Table 22 below reports average APCs by journal business model and subject area using Open APC Initiative data on actual APCs for articles published in full OA and hybrid journals. The values for estimated APCs align in magnitude with data for actual APCs when compared across subject areas.

	Arts and Humanities	Health Sciences	Life Sciences	Physical Sciences	Social Sciences
Full OA	347	1,550	1,646	1,536	1,112
Hybrid – Gold	1,828	2,592	2,743	2,228	2,089

Table 22. Average APCs by journal business model and subject areas for UK HEIs and research institutes (£)

Source: Estimates produced by Alma Economics

Estimated additional expenditures on APCs under the new UKRI policy

Tables 23 and 24 show the estimated cost of publishing OA all 2018 UK-authored and UKRI research articles, respectively, broken down by different subject areas using the APCs estimated in the previous section. For UK articles the upper estimate for overall publishing costs would be approximately £310 million, while for UKRI-funded articles the upper estimate cost would amount to about £68 million.

Notably, the sample includes all UK-authored articles and all the articles that acknowledge UKRI funding, irrespective of who the corresponding author is. This implies that for UKRI-funded articles, we estimate the overall expenditure in APCs as if all the APCs were to be covered by UKRI. However, the cost of publishing open access might be covered by other funders. Similarly, for UK-authored articles, open access expenditures may be covered by funders of the non-UK based co-authors such as non-UK HEIs (for example, if we assume that 25% of APCs are covered by funders that are not UK HEIs, then the total APC expenditures incurred by UK HEIs falls by 25%).

The results reported in Tables 23 and 24 capture the total additional APCs under the new UKRI policy and should be treated as an upper estimate of the total APC expenditures incurred by UK HEIs. Estimated costs of APCs under scenarios in which not all APCs are attributable to UK HEIs are included in the Annex (Tables A5-A8). Under differing assumptions about the proportion of APCs attributable to UK HEIs, we estimate that total expenditures by UK HEIs on APCs could total £45-£90 million in 2018 across open access articles published in full OA and hybrid journals.

Table 23. Estimated costs of APCs in the scenario in which all UK-authored articles in 2018 were published OA by journal business model and subject area (£ million)

	Arts and Humanities	Health Sciences	Life Sciences	Physical Sciences	Social Sciences
Closed	5.83	21.96	6.95	19.14	13.00
Full OA	0.14	16.48	7.10	11.27	1.91
Hybrid - Gold OA	1.07	22.62	12.11	12.99	3.84
Hybrid - Green OA	1.76	15.53	8.53	27.72	8.57
Hybrid - Subscription	2.72	47.62	14.95	20.06	6.82
Total	11.5	124.2	49.6	91.2	34.1

Source: Estimates produced by Alma Economics based on Dimensions data

 Table 24. Estimated costs of APCs in the scenario in which all UKRI-funded articles in 2018

 were published OA by journal business model and subject area (£ million)

	Arts and Humanities	Health Sciences	Life Sciences	Physical Sciences	Social Sciences
Closed	0.25	1.64	1.33	4.30	1.07
Full OA	0.02	3.62	2.57	4.31	0.30
Hybrid - Gold OA	0.36	5.60	6.54	8.60	1.66
Hybrid - Green OA	0.31	2.50	2.60	9.55	1.06
Hybrid - Subscription	0.14	3.11	2.44	3.90	0.51
Total	1.1	16.5	15.5	30.7	4.6

Source: Estimates produced by Alma Economics based on Dimensions data

Based on the actual and estimated APCs in our model, we calculate the additional cost of publishing all UK and UKRI-funded articles that in 2018 were not published open access (Table 25). In column 1 we estimate that the additional APC spend required to publish all UKRI-funded articles OA in 2018 would be around £14 million. This additional expenditure includes publishing open access articles that at the time were published in closed journals and articles that were published closed in hybrid journals.

Our upper estimate of the additional cost to publish OA all UK-authored articles that in 2018 were published closed would be around £160 million. Our estimate of the level of APCs that would be required to publish all UK-authored papers published non-OA in 2018 (in both hybrid and subscription-only journals) is similar to the amount spent by universities on subscriptions as estimated by Jisc.⁵⁸

⁵⁸ See: https://www.jisc.ac.uk/events/jisc-and-wiley-read-and-publish-agreement-10-mar-2020. Please note that this comparison is

Columns 2 to 4 provide our estimates of the additional expenditures that would be required under the assumption that articles published Green OA in 2018, will no likely longer comply with the UKRI policy and therefore will pay APCs to be published OA. As explained in the previous section, Green articles subject to embargo period will not be allowed under the new UKRI policy. Therefore, to be published open access in the same journal, they will have to be published with no embargo – if the journal offers this option – or they will be subject to an APC.

Column 2 provides estimates of the additional cost in the scenario in which 50% of Green articles published in 2018 will no longer comply with the UKRI policy. Column 3 provides estimates of costs under the assumption that only 20% of the Green articles were published with no embargo, while column 4 includes the APCs estimated for all Green articles.

As shown in a study conducted in 2017, more than 80% of articles published Green in 2017 were subject to an embargo period for institutional repositories of 6 months or more (Universities UK, 2017). This suggests that it is reasonable to assume that the vast majority of Green articles will no longer comply with the UKRI policy.

	Closed + Hybrid Subscription	Closed + Hybrid Subscription + 50% Green	Closed + Hybrid Subscription + 80% Green	Closed + Hybrid Subscription + all Green
50% of APCs attribut	able to UK HEIs			
UK-authored articles	79.6	95.1	104.4	110.6
UKRI-funded articles	9.4	13.4	15.8	17.4
75% of APCs attribut	able to UK HEIs			
UK-authored articles	119.3	142.6	156.5	165.9
UKRI-funded articles	14.0	20.0	23.6	26.0
100% of APCs attribu	Itable to UK HEIs	5		
UK-authored articles	159.1	190.1	208.7	221.2
UKRI-funded articles	18.7	26.7	31.5	34.7

Table 25. Estimated additional APCs in the scenario in which all UK-authored articles and UKRI-funded articles in 2018 were published OA (£ million)

Source: Estimates produced by Alma Economics

Additional impacts on HEIs of publishing open access

While the figures in the previous section show the APCs that would have been required had the new UKRI policy been implemented in 2018, to arrive at an estimate of the overall increase in spending in future years we also need to take into account several additional factors:

provided only to provide an indication of the magnitude of the estimated cost, and we do not imply that subscription spend could or should be redirected to pay for APCs.

Parameter	Value	Notes
Growth rate of articles published OA	4%	Johnson, Watkinson, and Mabe (2018). We assume this value is equivalent to the growth rate of all research output, so the share of OA publications remains constant over time in the absence of changes in UKRI policy
Annual growth in average APCs	2%	Universities UK (2017)
Administrative costs of OA publishing per article	£68	Alma Economics survey of HEIs, value has been averaged across OA Green and OA Gold
UKRI block grant	£23 million	Funding made available through the UKRI block grant or any other OA funding mechanisms; our base assumption is that this OA grant funding will be at the same level as in 2020/21
% of APCs attributable to UK HEIs	75%	Universities UK (2017), conservative estimate

Table 26. Key parameters in estimating total impact of UKRI OA policy on HEIs

For publishers that have transformative agreements in place, we would expect to see an amount of 'offsetting' – i.e. discounts in the amount of APCs based on the institution's subscription spend. Based on the limited available evidence, we assume this offsetting to be 50% of the total spend in APCs (which we test as part of our sensitivity analysis below). Finally, we assume that all non-compliant articles will be published Gold OA after the introduction of the UKRI OA policy.

Figure 11. Cost of increased open access



Estimates of the total impact of OA publishing for HEIs compared to the baseline scenario are listed in the table below for the following policy scenarios:

- Full UKRI OA: all UKRI-funded articles are published full and immediate OA.
- Full UK OA: all UK-authored articles are published full and immediate OA.

In Table 27 'Annual APC expenditures' refers to total spending on APCs, while 'Net average publishing costs' takes into account other administrative expenses associated with OA publishing, offsetting savings from transformative agreements, the UKRI block grant as well as funding from external sources.

	Full UKRI OA	Full UK OA			
50% of APCs attributable to UK HEIs					
Annual APC expenditures	25	160			
Net average publishing costs	22	144			
75% of APCs attributable to UK HEIs (central scenario)					
Annual APC expenditures	37	239			
Net average publishing costs	33	212			
100% of APCs attributable to UK HEIs					
Annual APC expenditures	49	319			
Net average publishing costs	43	280			

 Table 27. Estimated total impact of OA publishing for HEIs under different UKRI policy scenarios, compared to the baseline scenario (£ million)

Source: Estimates produced by Alma Economics.

All figures are yearly averages over the first six years of UKRI policy implementation.

Under the central scenario assumptions, transitioning all UKRI-funded publication to OA is expected to cost an additional £37 million each year in APCs compared to the baseline scenario (in 2020 prices, averaged over the six years after policy implementation) (Table 28). After adjusting for offsetting from transformative agreements and assuming that funding from the UKRI block grant and external sources remain constant at 2020/21 levels over time, we estimate that additional OA publishing expenses for HEIs will total approximately £33 million per year (averaged over the first six years of policy implementation).

To capture potential variation in the impact of the UKRI policy, the table below outlines estimates for alternative outcomes for UK HEIs if all UKRI-funded articles are published OA. These outcomes are based on changes in the share of APC expenditures offset by current agreements and changes in the percentage of APCs attributable to UK HEIs (Scenario A and B).

Table 28. Sensitivity analysis for the impact on HEIs of converting all UKRI-funded articles to OA, compared to the baseline scenario (£ million)

	Scenario A	Average	Scenario B
Parameters			
Offsetting (% of APC spend)	10%	50%	90%
% of APCs attributable to UK HEIs	100%	75%	50%
Outputs			
Annual APC expenditures	49	37	25
Net average publishing costs	49	33	19

Source: Estimates produced by Alma Economics.

All figures are yearly averages over the first six years of UKRI policy implementation.

Main challenges of full OA for HEIs and research institutes

As a consequence of the implementation of the new UKRI policy, in the survey carried out with HEIs and research institutes we asked institutions about the biggest challenges they expect to face in complying with the new policy (Figure 12).

Meeting the costs of OA is the biggest challenge faced by institutions, with 70% of the respondents declaring that meeting the cost of APCs will be very challenging. Another challenge will be to support researchers in complying with the new open access policy, which was mentioned as very challenging for more than 40% of institutions. In particular, some institutions mentioned that researchers usually care about journals' prestige, and it is difficult to influence their publication behaviour as they are very resistant to any restriction on where to publish.

Meeting administration costs of open access, instead, is seen by most institutions as moderately challenging (65%). This might be due to the fact that most institutions have open access infrastructure in place already, and the additional workload might be absorbed by the existing staff.





Source: Alma Economics survey with HEIs and research institutes. The sample includes 46 HEIs and research institutes

Additional challenges mentioned by institutions are:

- Meeting different requirements imposed by different funders will require additional effort by authors and administrative staff.
- Institutions are sceptical that large publishers will accommodate UKRI OA policy requirements, resulting in fewer available routes to OA.
- Small institutions receiving small OA funds mostly rely on the Green route. If journals do not offer a Green route compliant with the UKRI OA policy, the institution won't be able to comply with the policy.
- The Rights Retention Strategy, which would make the Green route possible, is seen with favour by institutions, but they are not very confident that publishers will be willing to accept it.
- The costs for the technical development of the institutions' repository in order to meet Green OA policy requirements will be very challenging, especially given the expected timescale.

In addition, universities expressed concerns regarding the library budget cut due to COVID-19. Despite 50% of the institutions not being able to provide estimated figures, the vast majority of them estimated that the library budget would be significantly lower for next year. The other 50% of respondents estimated a budget cut between 5% and 30%. In this respect, Universities UK and Jisc asked large publishers to reduce the cost of agreements by 25% due to the financial impact of the pandemic on library budgets.⁵⁹

The impact of COVID-19 on library budgets

During the interviews with HEIs we asked them to highlight the implications of COVID-19 for their budgets and OA.

HEIs reported expected library budget cuts in the range of 5%–30%. Most institutions do not yet have clear guidance on their budgets. One institution mentioned that the budget cut has made them hesitant to engage in multi-year transformative agreements with publishers because they are uncertain on whether the budget will be sufficient to cover the publication fees. In this respect, several HEIs also indicated that some publishers have already agreed not to increase their prices in transformative deals.

The budget cuts due to COVID-19 make the process of converting institutional material budgets from a read-focused (subscription) to a publication-focused approach more challenging. In one interview, a librarian highlighted that they are currently working on the OA funding budget and experiencing a significant gap in funding due to a combination of expected budget cuts and a simultaneous increase in OA output. Consequently, the institution has an immediate need to close this funding gap by reducing staff or material expenditures elsewhere.

In the interviews, HEIs consistently emphasised the fact that COVID-19 has severely impacted not only their budgets, but also their materials acquisition strategies. The institutions interviewed said their main priority at the moment is ensuring that students have digital access to their reading list materials. As one institution mentioned, this priority implies that funding is directed towards online textbooks, e-books and other online resources, at the cost of material expenditures on journals.

The same interviewee said this situation has reinforced their awareness of the limited resources available to finance the Gold OA route and will also contribute to a large number of journal subscription cancellations.

Furthermore, an HEI librarian argued that the UK's zero-rate VAT policy on e-publications allowed them to redirect part of the resulting savings towards enabling the digitisation of the reading list. The interviewee therefore warmly welcomed the VAT exemption, saving 20% on e-publications agreements. However, they also mentioned that it does not significantly help with the OA transition because (thus far) this exemption does not apply to APCs, but only to subscription-based publication packages, such as e-books.

⁵⁹ More details are available at: https://www.jisc.ac.uk/news/universities-will-cancel-deals-with-publishers-if-they-dont-respond-tocurrent-financial-pressures-13-aug-2020

The impact of the new UKRI OA policy on publishers

Estimating the financial impact of full and immediate OA on publishers

We estimate the impact of the proposed UKRI policy on publisher revenue, costs and profits by drawing on inputs from our analysis of the Dimensions dataset as well as parameter values from the existing literature on academic research publishing. The key parameter is the share of UKRI-funded articles published full and immediate OA: for the baseline scenario, we assume that this share remains constant at 2018 levels over time, while this share increases beginning in 2022 following the implementation of the new policy.



For publishers, we draw on the following data sources to estimate per-article costs and revenues:

Parameter	Value	Source
Revenue per article (subscription)	£4,100	Johnson et al. (2017)
Revenue per article (OA)	£2,156	Open APC Initiative (average APC)
Cost per article (subscription)	£3,185	Houghton et al. (2009) (adjusted for inflation)
Cost per article (OA)	£1,802	Average of Houghton et al. (2009) (adjusted for inflation) and cost estimates by Frontier Publishing (2015) and eLife (2015)
Growth rate of articles published OA	4%	Johnson, Watkinson, and Mabe (2018). We assume this value is equivalent to the growth rate of all research output, so the share of OA publications remains constant over time in the absence of changes in UKRI policy
Annual growth in average APCs	2%	Alma Economics assumption

Table 29. Key parameters in estimating total impact of UKRI OA policy on publishers
Per-article revenues and costs are multiplied by the total number of subscription and OA articles to obtain estimates for total subscription and OA revenues. For subscription-based articles, publishers derive subscription revenue from two sources, UK HEIs' subscriptions to all global research output as well as revenue from global HEIs' subscriptions to access UK-authored non-OA articles. This means that total subscription revenue for the UK segment as we define it here is the sum of total revenue from global subscriptions to UK-authored articles and total subscription revenue from UK HEIs, as estimated by Lawson (2016). To apportion the costs associated with research output accessible through UK HEI subscriptions, we multiply total subscription revenue from UK HEIs by the per-article profit margin for articles accessible through subscriptions.

We report results from our analysis at the industry level, separated into the OA and subscription-based publishing subsectors. In general, results cannot be disaggregated from the industry level to the publisher level. Many publishers have both subscription and OA journals in their portfolio, and if an UKRI-funded author switches from publishing in a subscription journal to publishing in an OA journal by the same publisher (in response to the new UKRI policy), then the loss in subscription revenue is balanced by an increase in OA revenue.

Estimates of the total impact of OA publishing for publishers compared against the baseline scenario are listed in the table below for the following policy scenarios:

- Full UKRI OA: all UKRI-funded articles are published full and immediate OA.
- Full UK OA: all UK-authored articles are published full and immediate OA.

In the baseline scenario, our model estimates that total revenues reach an annual average of £1.1 billion, £157 million of which come from OA publishing (in real terms, averaged over the six years after policy implementation). Average per article profit margins for subscription publishing (29%) are slightly higher than margins for OA publishing (20%), with an annual industry-wide profit margin of 27% for the UK market.

Under our model assumptions, if all UKRI-funded papers are published OA, total industry profit declines by around one percentage point (Table 30), which represents a £45 million decrease in revenue each year (the loss of subscription publishing revenue subtracted from the gain in OA publishing revenue) averaged over the first six years of policy implementation offset by a £32 million decrease in costs (the decrease in subscription publishing costs subtracted from the increase in OA publishing costs), as per-article costs of OA publishing are lower. These results are based on the assumption that per-article costs and revenues are only impacted by the annual growth rate in APCs, and existing subscription-based journals may not have the same revenues and costs if they choose to flip to an OA model.

Difference in per-article revenues and costs between OA and subscription-based publishing models imply that per-article profit margins are smaller for articles published open access compared to articles published under a closed model. Therefore, publishers are expected to earn smaller profits on articles that shifted from subscription-based to OA publishing under the new UKRI policy. We do not expect any negative impact on the revenue of full OA publishers.

Table 30. Estimated total impact of OA publishing for publishers under different UKRI policy
scenarios, compared to the baseline scenario; UK segment of the business only (£
million)

	Full UKRI OA	Full UK OA
Total revenues (subscription)	-94	-607
Total costs (subscription)	-73	-471
Total revenues (OA)	49	319
Total costs (OA)	41	267
Profit margin	-1.2%	-9.6%

Source: Estimates produced by Alma Economics.

All figures are yearly averages over the first six years of UKRI policy implementation.

In line with our analysis of impacts on HEIs, to capture potential variation in the impact of the proposed UKRI policy, the table below outlines estimates for alternative outcomes for UK publishers if all UKRIfunded papers are published OA. The parameters we vary for our sensitivity analysis are the amount of offsetting (90% in the worst-case scenario; 50% in the central scenario; 10% in the base-case scenario) and the per-article OA publishing margin (10% in the worst-case scenario, 20% in the central and best-case scenarios). Table 31 shows that open access has a small impact on profit margins also under different level of offsetting and per-article OA publishing margin (between -2.3% and -0.6%).

Table 31. Sensitivity analysis for the impact on publishers of converting all UKRI-funded articles to OA, compared to the baseline scenario; UK segment of the business (£ million)

	Scenario A	Central	Scenario B
Parameters			
Offsetting (% of APC spend)	90%	50%	10%
Per-article OA publishing margin	10%	20%	20%
Outputs			
Total costs (OA)	45	41	41
Profit margin	-2.3%	-1.2%	-0.6%

Source: Estimates produced by Alma Economics.

All figures are yearly averages over the first six years of UKRI policy implementation.

The broader impact of full OA on the publishing industry

Impact of transformative agreements

Transformative agreements are seen with favour by publishers because they allow them to maintain a constant stream of revenue while being compliant with OA policies, and by funders as they are seen as a solution to so-called "double-dipping" by hybrid journals. The term double-dipping refers to the fact that hybrid journals charge both APCs to authors and subscriptions fees to libraries. However, these deals have been criticised for their similarity to the 'Big Deals', enabling large publishers to maintain their dominance in the market⁶⁰. The term Big Deals is often used to describe licensing agreements that provide access to the content of major publishers.

In a report on the impact of offsetting deals, Earney (2017) highlights:

"A review of the publishers receiving the bulk of the expenditure on APCs suggests that far from posing a threat to those status quo publishers, it is a very profitable additional revenue stream and the same publishers who dominate the subscription journals market dominate the OA market as well".

In addition, competition in the publishing industry is partly prevented by lack of transparency due to the use of non-disclosure clauses in subscription deals between HEIs and publishers. As highlighted by Johnson et al. (2017), offsetting deals can be even less transparent than subscriptions because they are often based on the estimated future number of OA publications and the impact that these would have on publishers' profit, which are hard to verify objectively. Increasing transparency would allow consortia to acquire information before entering agreements, and it would provide more details on the pricing strategy of publishers under transformative agreements.

In general, transformative agreements might impact on:

- *Competition*. Transformative agreements might (i) discourage new entrants, and (ii) lock universities into publishing deals with large publishers, thus potentially squeezing the profits of smaller publishers as a result.
- *Profits of full OA journals*. The profits of OA journals might be negatively impacted for two main reasons: (i) transformative agreements allow large publishers to offer significant discounts on APCs that makes full OA journals less competitive, (ii) transformative agreements are expensive and leave universities with a lower budget to spend on OA publications in full OA journals.
- *Small (hybrid) publishers*. Small hybrid publishers that do not have the bargaining power to negotiate deals with libraries might be forced to flip to OA or exit the market.
- *Innovation*. The lack of competition, the high concentration of the market, and the high barriers to entry pose challenges to the ability of the industry to invest in innovation.

Transformative agreements from the point of view of publishers, HEIs, and funders

During the interviews carried out with publishers we asked about their view on transformative agreements. Some publishers, mostly smaller ones, expressed concerns about the sustainability of their business model following the introduction of these agreements.

Publishers in AHSS fields highlighted that the market is highly fragmented and characterised by many

⁶⁰ See position paper "For Full, Immediate and Transparent Open Access" available at:

https://frontiersinblog.files.wordpress.com/2020/03/position-statement-transformative-agreements.pdf

small publishers. This makes it hard for them to gain visibility and negotiate complex transformative agreements. One such publisher highlighted the fact that many smaller publishers, often publishing only a handful of journals, operate in very specific fields. Funders, consortia and institutions do not have the resources to negotiate with all of these publishers, since there are too many. This was acknowledged in the interviews by all publishers, irrespective of their size and market power. As a result, small publishers expressed concerns about becoming non-compliant with the new UKRI policy in the event they fail to negotiate transformative agreements.

In addition, one publisher highlighted the impact of transformative agreements on the competitiveness of the market. This publisher, who did not negotiate a transformative agreement, experienced a shift in submissions away from his journals towards those of their competitors who have such agreements in place. Although he mentioned that the causal relationship is not clear, he also pointed out that publishers that negotiated transformative agreements have a clear comparative advantage on those who do not have the opportunity to negotiate deals with libraries.

Similarly, HEIs and funders interviewed are also concerned about supporting smaller, particularly academic-led and society journals, in terms of both business models and infrastructure. They mentioned that smaller publishers typically lack the resources and infrastructure necessary to negotiate a transformative agreement – including trained sales representatives, OA approval portals and more advanced submission systems, amongst other factors. Moreover, lower output levels naturally place these publishers lower on the priority list when it comes to transformative agreements. In order to accommodate this situation, one major funder stressed that it would apply OA criteria in transformative agreements with a degree of flexibility, depending on the respective publisher's size.

Impact of OA publishing on the UK publishing industry

The publishing industry represents an important industry in the UK, with a contribution of more than £10 billion to the economy in 2018 (Department for Digital, Culture, Media and Sport, 2018). The publishing industry is one of the UK's creative industries, and it includes books and academic journals, as well as newspapers, magazines and software.

The Publishing Yearbook published by the Publishers Association shows that in 2018 total income from academic journals was around £2.1bn, an increase of 4% compared to 2017. In the same year, the total income from open access publishing increased by 16% from £217 million to £255 million.

The income from subscriptions for academic publishers has increased by 30% over the past five years. However, while in 2014 it represented 83% of total income, in 2018 it had dropped to 74%.

Most of the UK publishers' revenue in 2018 came from exports (85%). Revenue from exports increased by 3% between 2017 and 2018, with North America accounting for 40% of total export revenue, followed by Europe (25%) and East/South Asia (23%).

Frontier Economics (2017) estimated that in 2015 the UK publishing industry employed 29,000 employees, of whom 2,900 worked in academic journal publishing and 26,000 in book (both academic and non-academic) publishing. These numbers do not include freelancers and other jobs indirectly supported by the publishing industry. If these are also taken into account, the whole publishing industry is estimated to support around 70,000 jobs.

While the UK publishing industry makes an important contribution to the UK economy, estimating the potential impact that the UKRI OA policy will have on the industry will depend on how heavily journals rely on UKRI-funded publications. Figure 13 shows the distribution for articles acknowledging UKRI funding across journals (all types) in 2018. Approximately 65% of the journals in our sample did not publish any articles acknowledging funding by UKRI. Only 350 (3%) of journals had more than 10% of the articles they published acknowledging funding from UKRI.



Figure 13. Distribution of UKRI-funded articles across all journals in 2018

Source: Dimensions article data merged with Scopus data on journal publishing model and subject area (see methodology)

Typically, publishers are active globally. Similarly, UK publishers rely heavily on exports, with 85% of UK publishers' revenue coming mostly from outside the UK. Therefore, the introduction of the UKRI OA policy will only influence a fraction of the remaining 15%, and its impact on the domestic industry is unlikely to be substantial. In addition, as shown above, the new UKRI policy will have a small impact on publishers' profits. Therefore we do not expect a significant impact on public finances and taxes paid by the publishing industry.

Finally, even if all the UK-authored articles were to be published open access, the impact on the UK publishing industry is likely to be small, as only a small proportion of journals hosts a significant proportion of UK articles (Figure 14).



Figure 14. Distribution of UK-authored articles across journals

Source: Dimensions article data merged with Scopus data on journal publishing model and subject area (see methodology)

Publishers' view on the new UKRI policy in the context of the international publishing market

All the publishers interviewed highlighted that the impact of the new UKRI policy on the publishing market will depend on the extent to which publishers rely on UKRI-funded research output. The majority of the publishers interviewed have a highly diversified international author base. Some publishers pointed out that the percentage of UKRI-funded research published in their journals is limited, and therefore, the policy will have a small impact on the business model of their journals.

However, one publisher mentioned that UKRI would set a precedent for other policies to follow. The publisher argued that it would be naïve to consider the new UKRI OA policy in isolation and not to anticipate a broader change in UK OA policy. In addition, the publishers highlighted that UKRI's leadership position as a funder goes beyond the UK and that the alignment between UKRI and other funders might have in the future a significant impact on the publishing industry as a whole.

In this respect, one publisher specifically suggested speeding up the transition via the cOAlition S mechanism, particularly in markets such as China, where publications constitute a high, fast-growing share of annual article output. Indeed, many of the international publishers interviewed perceived Asian markets as major stumbling blocks to facilitate the transition to OA. Therefore, aligning these markets would be an important step towards OA.

The benefits of open access

The benefits of OA

Measuring the benefits of open access is difficult for several reasons. First, there is no comprehensive data on how much OA content is accessed, and most of the evidence of the benefits of open access are based on interviews and surveys (Fell, 2019). Survey and interviews provide an important source of information to estimate the costs and benefits of open access. Still, a more systematic and comprehensive data collection is required (see section Monitoring the transition to open access for details on the available sources of data). Second, part of the benefits of open access in the UK will be fully realised once there is a complete transition to OA and when other countries will also transition to open access. More widespread adoption of open access policies would enable UK institutions to access more of the global research output free of charge, lessening or eliminating the burden of subscription fees. Finally, due to transition costs involved in the transition to open access (e.g., negotiating agreements with publishers, setting up the infrastructure to support open access processes, updating publication policies within institutions, training authors and administrative staff etc.) the net benefits in the short term are likely to be lower.

Previous studies that have attempted to measure broader social impacts have been criticised for using observational (as opposed to experimental data) and including non-financial benefits, which require many hard-to-test assumptions to be quantified (Anderson, 2014). In general, however, these studies have been beneficial in highlighting the mechanisms through which open access publishing impacts the broader scholarly communication process, and recent research has provided support for OA supporters' claims using up-to-date methodologies and datasets that are much larger and broader in scope than previously used.

OA increases the impact of research through greater availability and re-use, both in terms of academic

citations as well as broader societal impact. Though the broad literature examining the open access citation advantage (OACA) has received pushback, in part due to methodological issues, recent robust studies have continued to show a meaningful effect (though a wide range of estimates of the magnitude). Piwowar et al. (2018) find that after adjusting for age and discipline, OA articles receive 18% more citations on average, an effect largely driven by Green and Hybrid OA. Similarly, Ottaviani (2016) finds a 19% citation advantage using a natural experiment as papers published Green OA emerge from embargoes, and Archambault et al. (2014) identify a 40% advantage in citations using field-normalised citation rates over a sample of one million papers. Using panel data for sciences journals and controlling for the quality of the articles, McCabe and Snyder (McCabe and Snyder 2014) find that moving to open access increases the number of citations by 8%.

The available evidence also suggests that OACA does not come from a selection effect in which researchers choose to publish OA only papers which are expected to have a bigger impact. Examining citation counts for papers published OA both under mandates or voluntarily, Gargouri et al. (2010) find that both papers published OA under mandates or voluntarily receive a larger number of citations than non-OA papers. Findings from Science-Metix (2018) suggest that OACA is especially strong for the Arts and Humanities as well as the social sciences.

Open access brings benefits to publishers and libraries as well. Many subscription-based publishers continue to produce print versions of their journals, which are accompanied by logistical costs of printing and shipping. Switching to an open access business model often means that it is possible to implement more efficient procedures and eliminate costs associated with copy-editing and typesetting. Innovations such as pre-print servers or post-publication peer review (in journals such as PeerJ or eLife) increase the speed of research publication and dissemination. With lower publishing costs, libraries can generate significant savings that free up resources for other activities, though less research-intensive institutions are likely to benefit more (Research Information Network, 2008).

Societal benefits of OA

A recent review conducted by (Fell, 2019) identifies the main economic and societal benefits associated with open access found by previous studies. Through the collection of several case studies, the review identifies several benefits of OA, such as improving collaboration across research institutions and companies, increasing innovation and return on R&D investment, facilitating the development of new products and services, or avoiding duplicate research and therefore improving its efficiency.

To measure broader societal impact, providers such as Plum Analytics or Altmetric.com have developed alternative metrics, or altmetrics, such as social media usage or media attention. If open access articles have fewer restrictions on access by journalists, businesses, policymakers and individuals, then it is likely that these articles will be shared across different communication channels, promoting engagement. The available evidence suggests that open access articles receive more attention on social media, although this relationship is not especially strong and may be overshadowed by the journal's prestige or dedicated media/communications apparatus (Wang et al., 2015; Adie, 2014; Brembs et al., 2013). In addition, articles widely reshared on Twitter are more likely to have a higher number of citations than less-shared articles, but it is possible that a selection effect dominates (papers with more impact are more frequently shared on social media) (Eysenbach, 2012; McKiernan et al., 2016). In general, the full size of this effect is difficult to measure, as many academics share interesting findings or links through e-mail, and more data is required to conclude that open access has a significant effect on the societal impact of research.

Increased OA makes it possible to use automated tools to collect and analyse the available literature, a practice known as text- and data-mining (TDM).⁶¹ TDM is an important element of research because it allows for aggregating a large number of individual findings, screening for statistical errors or conducting automated literature searches to identify convergence of evidence or testable hypotheses for further research. By decreasing the time required to search for relevant literature by categorising information and highlighting noteworthy findings, TDM prevents researchers from spending time "re-inventing the wheel". The traditional model of transferring copyright from authors to publishers has hindered the use of TDM, which publishers often view as copyright infringement. Systematic downloads are generally not allowed due to publishers' fears that their content might be stolen (with corresponding lost revenue). The growth of rights-retention by authors through a CC-BY licence or Green OA model has been an important step in making more research available for TDM.

Open access greatly impacts consumers of research, including the public sector, commercial firms, SMEs and the general public. By making research available to anyone with access to the Internet, open access creates the potential for knowledge to be used in innovative ways. Increased access to research has been positively associated with return on financial investment (Beagrie and Houghton, 2014) and facilitates partnerships between publishers, government and firms. In one of the interviews it was mentioned that companies indeed benefit from more open access because it supports the market-research and partner discovery process. The content has no barrier to be accessed, which allows firms to learn about results from research groups and increase efficiencies in the product development process. The interviewee highlighted the return on investment is probably higher for R&D intensive companies with highly technical staff, which in many cases are corporate researchers themselves working in specialised fields.

Houghton et al. (2009) conducted a cost benefit analysis of open access in the UK under different journal business models and estimated the impact of open access on the return on investment on R&D. The authors include in their model two novel parameters: accessibility and efficiency (see next section for details).

Finally, open access also has the potential to impact on the education system. Over the past few years, there has been a dramatic increase in the use of open educational resources (OER) which refer to teaching and research material that has been made available to the public free of charge. A stated in the Budapest Open Access Initiative, one of the aims of open access is be to provide unrestricted access to peer-reviewed articles to *"all scientists, scholars, teachers, students, and other curious minds. Removing access barriers to this literature will accelerate research, enrich education, share the learning of the rich with the poor and the poor with the rich, make this literature as useful as it can be, and lay the foundation for uniting humanity in a common intellectual conversation and quest for knowledge."⁶²*

In the recent years, several studies have tried to investigate the impact of the adoption of OER, and the majority of them show that the adoption of OER material has positive consequences on the learning experience of students (see Hilton (2020) for a review of the literature).

⁶¹ For more details on the value of TDM see the Jisc report available at: https://www.jisc.ac.uk/sites/default/files/value-text-mining.pdf ⁶² The full text of the Budapest Open Access Initiative is available at: https://www.budapestopenaccessinitiative.org/read

Estimating the benefits of OA publishing to society

As discussed in the previous section, supporters of open access have pointed to a number of benefits from increased access to research, though identifying specific benefits and attempting to measure them precisely is a challenging endeavour. To provide a quantitative estimate of the total benefits, we focus on two specific mechanisms following the framework set out by Houghton et al. (2009):

- 1. OA publishing and self-archiving models are lower cost alternatives, such that there are savings throughout the scholarly communication process. The implication of these savings is that the same output of knowledge can be produced with less expenditure or more knowledge could be produced with the same level of expenditure. These savings from direct publisher cost differences and indirect research and library handling cost differences are the first form of benefits.
- 2. OA publishing and self-archiving models do not depend on imposing limitations on access and permission to use, making the knowledge being conveyed more accessible and more useful.

The first mechanism implies that OA publishing is more efficient compared to subscription-based publishing due to decreased need for sales, marketing and printing costs, in addition to other administrative expenses. Estimates from Houghton et al. (2009) and self-reported costs by Frontier and eLife suggest that per-article publishing costs for OA articles are lower (by around 43%) than costs for publishing the same article in a subscription-only journal. ⁶³ These costs hold commercial management, investment and profit margins constant and factor in overlay services provided by publishers such as operating peer review management, editing, proofing and hosting, but do not include the costs of external peer review or VAT.

Assuming that 50% of the difference in per-article publishing costs between subscription and OA publishing are efficiency savings,⁶⁴ this yields projected annual efficiency savings due to OA publishing of £83 million in the baseline scenario and £92 million if all UKRI-funded papers are published OA (averaged across the first six years of policy implementation). This translates to an annual average efficiency saving of £9 million.

For the second mechanism, OA publishing increases the return to R&D spending due to two main factors (Houghton et al. 2009):

- **Accessibility:** by making research output widely accessible, OA increases the speed and the quality of innovation, thus increasing the social returns on investment in R&D.
- **Efficiency:** open access lowers the risk of duplicate research, creates new collaborative opportunities, a faster research and discovery process, and decreases the risk of pursuing blind alleys.

Therefore, increased OA publishing may reduce time spent on duplicative research and speed up the scientific process (Figure 15). We assume that the increase in accessibility and efficiency due to increased OA publishing is linearly related to the share of UK papers published OA: as this share increases, the excess return on R&D from OA publishing also increases.

 ⁶³ 2015 self-reported per-article cost estimates from Frontiers and eLife were reported in Johnson, Watkinson, and Mabe (2018).
 ⁶⁴ Part of the difference between OA and subscription publishing costs may reflect differences in quality – resources dedicated to editing – rather than represent inefficient/socially wasteful spending.



Figure 15. Social benefits of increased OA: Increasing accessibility and efficiency of research

Table 32. Input parameters required to estimate the broader societal benefits from OA publishing via increased returns to R&D

Parameter	Value	Methodology
% overall increase in accessibility of knowledge	20%	% of all knowledge from journals, from Houghton et al. 2009) adjusted by share of UK research output relative to global output
% overall gain in efficiency	5%	Houghton et al. (2009) adjusted by share of UK papers published OA
Social rate of return to R&D	20%	Hall, Mairesse and Mohnen (2010)
Annual growth in R&D spending	4%	Office for National Statistics (2018)
Lag between R&D spending and impacts	10 years	Houghton et al. (2009)
Depreciation in stock of knowledge	10%	Houghton et al. (2009)
Discount rate	3.5%	HMT Green Book

Once we adjust for depreciation in the stock of knowledge and lag between R&D spending and impacts, we create a 20 x 20 matrix to capture the impact of increased returns to R&D spending over

a 20-year timeframe. Specifically, we estimate the total excess R&D social return due to gains in accessibility and efficiency from OA publishing (around 2.7% in the baseline scenario and 3.0% if all UKRI-funded articles are published OA, compared to a 20% overall social return to R&D spending).

We then apply this estimate to total UK R&D spending across the public and private sectors as well as HEIs, which yields a recurring annual gain from the effect of increasing one year of R&D spending due to OA publishing. Because the increase in accessibility and efficiency is permanent, this is equivalent to increasing the growth rate of R&D spending. For any given year in our 20x20 matrix, we only count the recurring annual gain incurred ten years after R&D spending occurred (representing the lag between R&D spending and impacts), adjusting for a 10% discount rate (representing depreciation in the stock of knowledge). Since each year represents one row and column, we have created a 20x20 matrix that can be summed across.

Estimates of the total 20-year NPV of OA publishing benefits to society compared against the baseline scenario are listed in the table below for the following policy scenarios:

- Full UKRI OA: all UKRI-funded articles are published OA.
- Full UK OA: all UK-authored articles are published OA.

We assume that the base level of social return on R&D spending is 20%. If all UKRI-funded articles are published OA, then the annual excess return to R&D spending due to OA publishing totals 3.0% (0.7% gain in accessibility and 2.3% gain in efficiency). Compared to the baseline scenario, this represents an increase in the excess return due to OA publishing of 0.31 percentage points (0.07 percentage points gain in accessibility and 0.24 percentage points gain in efficiency).

Combined with the efficiency gains from the reduced costs of OA publishing, under our assumptions, these estimates translate to a total 20-year NPV of the benefits from OA publishing of £8.3 billion, which is £0.8 billion higher than in the baseline (no policy change) scenario. More specifically, some articles are published OA in both the baseline and "Full UKRI OA" scenarios, which lead to efficiency gains from reduced publishing costs and excess social return to R&D spend. Assuming all other parameters remain constant (the parameters listed in Table 32), the greater share of articles published OA in the "Full UKRI OA" scenario leads to additional benefits compared to the baseline scenario. Table 33 reports the 20-year NPV of these additional benefits.

The potential gains from a UK-wide conversion to OA publishing are significant: we estimate that the total 20-year NPV of the efficiency gains from reduced publisher costs would total £3.3 billion, with another £5.3 billion increase in the social return to R&D investment. For this scenario, we assume there are no changes in parameter values compare to the "Full UKRI OA" scenario (all UKRI-funded articles are published OA) except for the share of UK-authored articles published OA, which now is set at 100%.

Table 33. Estimated total 20-year NPV of OA publishing societal benefits, compared to the baseline scenario (£ million)

	Full UKRI OA	Full UK OA
Efficiency gain from reduced publishing costs	304	3,300
Excess social return to R&D spend	483	5,254

Source: Estimates produced by Alma Economics

To capture potential variation in the impact of the UKRI policy, Table 34 outlines estimates outcomes under different assumptions for the broader societal benefits of OA publishing if all UKRI-funded papers are published OA. These outcomes are based on changes to the social rate of return to R&D expenditures and the share of savings from per-article OA publishing costs due to efficiency gains.

Table 34. Sensitivity analysis for the total 20-year NPV of societal benefits if all UKRI-funded articles are published OA, compared to the baseline scenario (£ million)

	Scenario A	Central	Scenario B
Parameters			
Social rate of return to R&D spend	10%	20%	30%
% of savings from OA publishing per paper from reduced costs	25%	50%	75%
Outputs			
Efficiency gain from reduced publishing costs	152	304	455
Excess social return to R&D spend	242	483	725

Source: Estimates produced by Alma Economics

Journals 'flipping' to OA

Main reasons to flip to OA

Some journals have transitioned from a subscription-based or hybrid model to full Open Access. This event is known as the "flip". In general, journals seek to flip for a wide range of reasons. Solomon et al. (2016) review previous literature on flipping combined with extensive qualitative research. Publishers take into account a number of considerations when deciding whether to flip: (i) financial viability of the OA model (compared to subscription based model), (ii) whether authors are being supported by their institutions or other funders in meeting the costs of APCs (iii) how many articles are already published OA in the journal (in case of hybrid journals), and (iv) how many OA journals there are already in the same market segment (Jones 2014).

The growth in the take-up rate of the OA option offered by hybrid journals in the last decade has potentially had the effect of disincentivising journals from flipping, as hybrid business models allow publishers to generate revenues from both subscriptions and APCs. In addition, several publishers have created mirror journals as an alternative to flipping a title to full OA. Mirror journals are fully OA journal versions of subscription-based journals. The journals have the same name, editorial board, and submission system, and the only difference is that the first contains OA articles while the latter contains content that it is only accessible to subscribers. This model is similar to the hybrid model, as publishers still get both subscription fees and APCs, but it prevents them from being affected by bans on hybrid journals implemented by several funders in Europe.

 0
 0
 0
 0
 0

 0
 0
 0
 0
 0
 0

 0
 0
 0
 0
 0
 0

Flipping is not very common among commercial publishers, with most usually choosing to create new OA journals or acquire existing OA journals – two examples being BioMed Central, acquired by Springer in 2008, and Co-Action, acquired by Taylor & Francis in 2017 (Matthias et al., 2019).

A review of Elsevier open access journals shows that between 2013 and 2017 only 42 journals, out of the 2,300 OA journals owned by the publisher, flipped from subscription to open access.⁶⁵

That said, there are several examples of hybrid journals that decided to flip to OA. For example, in 2012, Wiley decided to flip several of its journals from hybrid to open access. One of these was Aging Cell, a hybrid journal co-owned with the Anatomical Society. The main reasons that convinced the editorial board to flip the journal were: (i) the fact that the community in which the journal operated was strongly supportive of OA, (ii) the journal had reached a high impact⁶⁶ factor and high rejection rate (high rejection rates, which is the number of articles rejected divided by the number of articles submitted to the journal, ensure the transition to open access does not impact on academic standing or profits of journals), (iii) the fact that take-up rate of the OA option offered by the hybrid version was already significant (around 15%) before flipping.⁶⁷

Recently, Momeni et al. (2019) investigated the impact of flipping on the number of citations, the number of articles published, and the impact factor of the journal. The study analysed a sample of 171 journals that flipped to OA and found that flipping had a positive effect on the impact factor of the journal, potentially due to the fact that previous articles were also made available OA leading to an increase in the number of citations received. However, they do not find a clear citation advantage for articles published after the flipping. Bautista-Puig et al. (2020) instead found that switching to OA has a positive impact on the number of citations for 220 journals that decided to flip.

Conversely, a number of journals have also "reverse-flipped" from open access to closed. Matthias et al. (2019) suggested a number of reasons for this event, including difficulties in remaining financially viable. They found that 152 journals decided to move from OA to subscription access across different disciplines. Among these, more than 60% of the journals were born as subscription-based journals that flipped to OA before reverse-flipping back to subscription.

As mentioned in the section above, one of the factors influencing the decision to flip for hybrid journals is the proportion of articles that are already published OA in the journal. Figure 16 shows the proportion of UK-authored articles published open access in hybrid journals. The figure shows that for around 350 hybrid journals (around 8%), all the UK-authored articles were published OA. For around 75% of the journals, the proportion of UK-authored articles published open access is less than 50% of all the UK-authored articles published in those journals.

If we take the distribution of UK-authored articles in hybrid journals as a rough proxy for the distribution of total articles published open access in hybrid journals by the rest of the world, there appear to be several journals that, despite the high share of open access articles, haven't flipped yet. This suggests that many journals may decide against flipping even if a large proportion of their articles are published OA.

However, the graph clearly shows that the distribution of open access articles across journals is not uniform. In particular, there are fewer hybrid journals with a high share of OA articles compared to journals with a low proportion, which suggests that journals with a high share of open access articles are more likely to flip to OA.

⁶⁵ The dataset is available at: https://figshare.com/articles/Elsevier_embargo_periods_2013_2015/1554748/11

⁶⁶ The impact factor is used to rank journals based on the number of citations received by the articles published in a journal. The calculation is based on a two-year period.

⁶⁷ The article is available at: https://www.wiley.com/network/archive/two-open-access-case-studies-a-journal-flip-and-a-new-launch



Figure 16. UK-authored articles published OA in hybrid journals in 2018

Source: Dimensions article data merged with Scopus data on journal publishing model and subject area (see methodology)

Distribution of UKRI-funded articles across journals

Whether the introduction of the UKRI policy on open access will have any impact on publishers' business models will depend on the extent to which journals rely on UKRI-funded publications. Closed journals and hybrid journals with a lower proportion of UKRI-funded publications will not be significantly affected by UKRI policy and are therefore less likely to introduce changes to comply with the policy. Conversely, closed and hybrid journals (in the scenario in which UKRI ceases to support publications in hybrid journals) whose primary market is the UK are more likely to be significantly impacted as they will no longer be able to publish UKRI-funded articles.

As showed in Figure 13, approximately 65% of the journals in our sample did not publish any UKauthored articles funded by UKRI. Only 350 (3%) of journals had more than 10% of the articles they published acknowledging funding from UKRI.

Figure 17 shows the distribution of UKRI-funded articles across journals restricting the sample to journals in which at least 5% of the articles were funded by UKRI in 2018. There are around 730 journals that in 2018 contained at least 5% of articles acknowledging URKI funding. The majority of these journals were in Physical Sciences (34%), Life Sciences (27%), and Health Sciences (26%). There are approximately 100 journals with more than 30% of their articles being UKRI-funded.



Figure 17. Distribution of UKRI-funded articles across all journals with more than 5% of

Number of journals

Source: Dimensions article data merged with Scopus data on journal publishing model and subject area (see methodology)

Figures 18 and 19 show the distribution of UKRI-funded articles across hybrid and closed journals, respectively. Both figures include only journals for which UKRI-funded articles make up more than 5% of all articles they published in 2018. There are approximately 500 hybrid journals for which UKRI-funded articles constituted more than 5% of the total (Figure 18), while that's true for fewer than 200 closed journals (Figure 19).





Number of hybrid journals Source: Dimensions article data merged with Scopus data on journal publishing model and subject area (see methodology)





Number of journals

Source: Dimensions article data merged with Scopus data on journal publishing model and subject area (see methodology)

Overall, the above figures show that UKRI-funded articles represent a small proportion of publications for the majority of journals, thus suggesting that the UKRI OA policy might have limited impact in terms of incentivising publishers to change their business models.

However, an important aspect to consider is the number of citations associated with each article. Articles with a high number of citations increase the average CiteScore of the journal, thus increasing its prestige and revenue. The extent to which publishers will be affected by the UKRI OA policy will depend not only on the number of UKRI publications they may 'lose', but also on how much this will impact their CiteScore and ultimately their revenue.

Estimating the number of journals flipping to OA following the new UKRI policy on OA

Identifying the number of journals that will flip to full OA if UKRI ceases to support publication in hybrid journals is challenging, as it depends on a number of difficult-to-quantify factors. To attempt to provide an indicative answer, we approximate a journal's decision to flip based on three key parameters:

- The share of UKRI-funded papers published in the journal, adjusted to capture non-linearities (journals with a higher share of UKRI-funded articles will be disproportionately impacted by UKRI policy)
- The difference in per-article revenue between subscription and OA publishing
- The share of articles in the journal currently published OA

In our stylised model, each journal receives a large number of submissions and chooses to publish the ones that are likely to generate the highest number of citations, given that journals with the highest CiteScore are expected to generate the highest revenues. Journals decide whether to flip or not based on the estimated impact on their revenue. The key mechanism driving different outcomes under flipping and not flipping is that if a journal chooses not to flip to full OA, the number of total citations (measured as the product of CiteScore and total articles published) declines. This is the impact of UKRI-funded papers moving from non-compliant journals to full OA journals. Thus, journals that are not fully OA can choose from one of the following options:

- 1. Retain existing publishing model (i.e. not flip): In this scenario, journals 'lose' UKRI-funded articles they would have otherwise published to OA journals. If the number of UKRI-funded articles is relatively small, then the journal is able to replace these articles with non-UKRI-funded articles that would attract a similar number of citations. As the number of UKRI-funded articles that can no longer publish in the journal increases, however, these articles will be replaced by articles that attract significantly fewer citations.
- 2. **Flip to full OA:** In this scenario, journals still publish the same mix of articles in terms of CiteScore, but each article (including non-UKRI-funded articles) now pays an APC, and journals lose their subscription revenue.

If a journal does not flip, the total number of citations received across all articles in the journal falls in proportion to the share of UKRI-funded articles in the journal. More specifically:

 $CiteScore(NoFlip) = CiteScore \times \left(\frac{Number \ of \ UKRI - funded \ articles}{Total \ number \ of \ articles}\right)^{a}$

where *a* represents an adjustment factor that captures non-linearities in the relationship between the number of UKRI-funded articles and impact on the journal if these articles were to be published elsewhere.

Intuitively, if the share of UKRI-funded papers relative to a journal's total output is small, then the total number of citations should not be significantly impacted because there are a number of non-UKRI-funded papers that would have generated a similar number of citations and impact on the broader field. If the journal has to replace a larger number of UKRI-funded papers, then the total number of citations will fall more as the journal has to replace these papers with non-UKRI-funded papers that generate fewer citations and impact on the broader field (as these are submissions the journal would have otherwise rejected).

Because we have estimated a journal's APC (or equivalent per-article subscription revenue) based on its CiteScore and subject area, a decrease in the total number of citations leads to a decline in total estimated revenue. If this decline in revenue due to fewer citations (in other words, lower journal impact) outweighs the decrease in per-article revenue from moving to OA publishing, then a journal will choose to flip. Figure 20 summarises this decision-making process, assuming that journals are fully rational and behave according to their best interest financially.





Full OA journals benefit from the proposed UKRI policy because they will be able to publish UKRIfunded articles previously published in journals that remain closed. To quantify this benefit, we calculate the total number of citations lost by non-flipping journals and allocate them to full OA journals proportional to their CiteScore: journals with the highest CiteScore receive the most impactful UKRIfunded papers (as these papers' authors would want to publish in journals with similar levels of readership and impact). This, in turn, leads to increased revenue for full OA journals as their CiteScore rises.

If all UKRI-funded papers are required to be published in full OA journals, under our asssumptions we estimate that 186 journals will flip in response (Table 35). As shown in Table 36, we expect average CiteScore and revenue from APCs to both fall slightly for hybrid journals, and as UKRI-funded articles move from hybrid journals that choose not to flip to full OA journals, average CiteScore and revenue increases for full OA journals (the magnitude is larger since there are fewer full OA journals compared to hybrid journals). Table 37 shows the number of journals flipping to OA and the associated change in average CiteScore and revenue from APCs if we assume that actual APCs are 20% above or below the level of estimated APCs.

Table 35. Journals flipping to a full OA publishing model if all UKRI-funded articles are required to be published in full OA journals, by subject area

	Arts and	Health	Life	Physical	Social
	Humanities	Sciences	Sciences	Sciences	Sciences
Number of flipped journals	5	68	49	44	20

Source: Estimates produced by Alma Economics

Table 36. Impact on hybrid and full OA journals after flipping if all UKRI-funded articles are required to be published in full OA journals

	Hybrid Journals	Full OA Journals
Number of flipped journals	186	N/A
% change in average CiteScore	-3%	12%
% change in average revenue from APCs	-1%	3%

Source: Estimates produced by Alma Economics

Table 37. Sensitivity analysis of impact on hybrid and full OA journals after flipping if all UKRI-funded articles are required to be published in full OA journals

	Hybrid Journals	Full OA Journals
Actual APCs are 20% lower than estimated		
Number of flipped journals	212	N/A
% change in average CiteScore	-3%	12%
% change in average revenue from APCs	-1%	4%
Actual APCs are 20% higher than estimated		
Number of flipped journals	173	N/A
% change in average CiteScore	-3%	13%
% change in average revenue from APCs	-1%	3%

The above results suggest that for most journals, the loss in per-article revenue in moving from subscription to OA publishing outweighs the potential impact in loss of journal impact and citations by losing the ability to publish UKRI-funded articles. Hybrid journals that are 'close to the edge' (the majority of their articles are published OA as opposed to subscription) are the most likely to flip: flipped journals have an average OA share of 91% (across OA Gold and Green) compared to an OA share of 49% for non-flipping journals. Because the majority of their publications are already OA, they lose little subscription revenue by flipping to full OA.

However, journals with less than half of their existing output published OA face potentially significant declines in subscription revenue. For these journals, it makes more sense to retain a subscription-based model with higher per-article revenues, and the relatively small share of UKRI-funded papers in these journals means that publishers are able to maintain existing subscription pricing models without worrying that HEIs will choose to end their subscriptions. These results are also robust to sensitivity analysis around effective differences in per-article revenue between subscription and OA publishing: for a 10% difference in per-article revenue, only 265 journals flip, and a significant number of journals begin to flip only if the difference falls below 5%.⁶⁸

Our modelling thus implies that encouraging publishers to increase either their share of OA output in their hybrid journals or the financial impact of losing many impactful, well-cited papers is key to tilting the scales in favour of flipping to full OA. One way of taking this step suggested in several interviews with publishers is launching coordinated action with other organisations (such as cOAlition S) – while UKRI does not impact a significant share of research output on its own, combining its leverage with those of other funders/national research organisations can sufficiently raise the stakes of publishers retaining their existing subscription business models and encouraging a broader transition to full OA publishing.

Publishers' view on flipping

During the interviews with publishers we asked for their views on flipping to OA and the main factors they consider when deciding to flip to OA.

Most publishers, irrespective of their size and field, did not provide a clear answer on the importance of different factors influencing the decision to flip to OA. Many of them cited "economic viability" as a precondition for flipping, without providing further details on what is considered economically viable.

One society publisher explained that they would require OA revenue to represent more than 50% of total revenue over 2-3 years to make the decision to flip the journal completely. That said, the publisher also highlighted that flipping to full OA should not prevent researchers who do not have access to funding – for example, those outside the UK – from publishing in the journal. Indeed, this publisher is concerned that researchers without access to OA funding would find it more difficult to publish in journals that require payment upon publication.

In addition, another international publisher offered a very clear roadmap: by 2025, 50% of all the research articles they publish should be immediately OA. Although this publisher aspires to have 100% full and immediate OA by that time, a large number of their authors come from Asian countries, where they do not yet see a strong interest in or substantial support for OA. As a result, the international dimension of the journal's publication weighs strongly on the business model and timeline.

⁶⁸ This parameter is intended to capture frictions in transitioning from a subscription to an OA model. Because these frictions are likely to have financial implications, we model them as an effective difference in per-article revenue between subscription and OA publishing. For example, if we assume a value of 10% for this parameter, this means transition costs at the article-level total around 10% of the difference in per-article revenue between subscription and OA publishing.

Conclusions

This section highlights the main findings based on our quantitative analysis and the qualitative information collected throughout our engagement with key stakeholder groups.

Key findings

Assuming similar publication patterns as in 2018, we estimate that the implementation of the new UKRI policy under which all articles acknowledging UKRI funding will be required to be published open access may necessitate additional APC payments of £20-£40 million per year.

Many of the publishers interviewed seem reluctant to offer the Green with no embargo OA option, as they see Green OA as a threat to their subscription revenues. This suggests that Gold OA seems the most viable route to achieve full and immediate OA. However, this does not necessarily mean that the Green route cannot play a role in facilitating the transition to open access, as Green OA models with some rights retention do enjoy support among some publishers and stakeholders.

Transformative agreements aim to reduce the overall costs of subscriptions and APCs as the number of papers being published OA increases, but it is unclear how much cost offsetting they can help achieve. In addition, transformative agreements could increase the market power of large publishers and negatively impact the financial sustainability of small publishers and new entrants, leading to reduced innovation and higher prices in the medium term.

While members of cOAlition S announced that support for publication fees in transitional agreements will cease on 31 December 2024, it is unclear how OA publishing will remain sustainable without further agreements or other funding when transformative agreements and other 'transitional' arrangements expire. There are also limits to the extent subscription expenditures can be repurposed to pay for APCs given that a large proportion of global scholarly output is not published OA and this is likely to remain true for the foreseeable future.

Established journals are likely to remain profitable even as OA policies are adopted, as there are strong incentives within academia to publish in reputable journals. The impact of the new UKRI policy on publishers' profits and business model is likely to be limited as UKRI-funded papers represent a small proportion of the output of most journals.

Despite the costs, the wider benefits of OA are large and justify the additional investments required. Open access (i) enables efficiency savings on publishing and research dissemination costs and (ii) generates excess returns to R&D spending due to gains in the accessibility of knowledge as well as the efficiency of the research process.

Monitoring the transition to open access

To fully capture the costs and benefits of open access, detailed analytical work will be needed in the coming years. This would include comprehensive impact evaluations of the new UKRI reform to measure the academic and non-academic impact of open access, the economic impact, and the wider societal impact.

In this section, we suggest a list of indicators that can be used to monitor the transition to open access once the new UKRI OA policy is introduced:

• The proportion of UKRI-funded articles published open access

These figures will allow tracking progress towards achieving full OA and identify what the preferred routes to OA (Gold and Green) among authors are. This analysis could be carried out annually using Dimensions data, to which UKRI already have access. The dataset provides information on the journal in which the article was published, the publisher of the journal, authors, research funders (and funder groups), citation counts, units of assessment (publication subject area) and whether the article was published through Gold OA route, Green OA etc., or whether the article is not openly accessible.

Using Dimensions data, UKRI could identify the proportion or UKRI-funded articles that are published open access every year by OA route. Similarly, Dimensions data provide information on articles funded by cOalition S members. This would allow UKRI to track progress towards open access at international level.

<u>The proportion of journals compliant with the UKRI policy</u>

This information will allow estimating whether there is any evidence that the implementation of OA policies by UKRI and other funders has had an impact on the business model of journals, thus facilitating the transition to full OA (e.g., full OA journals, journals offering Green no embargo OA etc.).

This analysis can be conducted combining DOAJ (which is the most comprehensive dataset of full OA journals), Scopus (a comprehensive database published by Elsevier, similar to Dimensions in scope and data coverage), and the Sherpa Romeo dataset (made available by Jisc). These datasets provide information on journals business models and will allow identifying whether journals have changed their model following the implementation of the UKRI policy (or whether they offer additional routes to OA). The analysis should be carried out focusing on journals publishing UK-authored articles only (i.e. the UK segment of the market), as done in this report.

Offsetting

One of the requirements set out by Jisc is that agreements must reduce and constrain costs of publications. Under the policy scenarios that allow publications in hybrid journals covered by

transformative agreements, it will be important to estimate the value offset by HEIs and the evolution of expenditures on APCs and subscriptions. This will allow evaluating whether the implementation of transformative agreements has helped mitigate the costs of OA.

UKRI could collaborate with Jisc, which holds information on the costs of transitional agreements and the necessary data to evaluate the level of offsetting provided by transformative agreements. A similar approach to the one implemented by The National Library of Sweden could be followed.⁶⁹ The National Library of Sweden evaluates annually the Springer Compact from an economic perspective and provides recommendations on future actions. UKRI could conduct a similar analysis. The evaluation could be carried out every year or bi-annually, depending on the level of resources that UKRI will decide to invest, and it should focus on transformative agreements signed with large publishers.

In order to conduct the analysis, data on subscriptions and APCs paid by UK HEIs and research institutes could be collected through surveys (see the section below for more details on conducting surveys). Alternatively, data on APCs for a sample of UK HEIs are collected and made publicly available by the Open APCs Initiative.⁷⁰

<u>Administration costs of processing OA articles</u>

This information will allow evaluating whether the costs of processing OA publications have been affected by the increased volume of OA articles. A comparison of the expenditures on processing OA articles over time will also highlight how they evolved and explore whether there was an increase in efficiency in processing OA articles.

UKRI could periodically survey institutions about the timing and the administration costs of processing OA articles. The frequency of the survey will depend on the resources made available by UKRI. As part of this project, we conducted a survey with UK HEIs and research institutes to collect data on administration costs of OA, the time required to process Gold and Green articles, APCs, and subscriptions. The same questionnaire could be distributed to HEIs and research institutes to collect data not publicly available (the questionnaire is included in the Annex).

APCs 'in the wild'

Collecting information on APCs 'in the wild' will enable a better understanding of the actual cost of OA and whether the current size of block grant reflects the costs faced by authors and HEIs.

As mentioned in the report, it is hard to estimate APCs 'in the wild' because often payments made by authors are not tracked by the institutions. Significant work needs to be done to improve the collection of data on APCs. First, a comprehensive view of APC funding sources is needed. Second, the involvement of publishers, HEIs, and authors is required: (i) publishers could facilitate monitoring APCs by providing better metadata on financial transactions and publications, (ii) researchers should inform their institutions on their publications and payments to journals, and (iii) HEIs should invest in increasing the level of coordination and communication across departments.

⁶⁹ The 2018 evaluation of the Springer Compact is available at:

https://www.kb.se/download/18.2705879d169b8ba882a5561/1556566760424/Evaluation_of_offset_agreements_SC_Report_4-20181008.pdf

⁷⁰ Data are available at: https://treemaps.intact-project.org/

Usage of open access articles

The key aim of OA is to make research output accessible to everyone. Therefore, UKRI should monitor the usage of open access research. One way to evaluate whether OA research output is more utilised following the implementation of the UKRI policy is to analyse the number of times OA articles are cited. This analysis could be carried out using the Dimensions dataset, which includes the number of citations for each article. UKRI could build an indicator using the number of citations of each article divided by the total number of citations (to account for the overall trend in citations). The indicator would provide an indication of whether open access increases the exposure of OA research articles in the research community and other consumers of academic research.

Another proxy for article usage is the number of downloads. Journal Usage Statistics Portal (JUSP), aggregates data on downloads of articles from 180 university libraries in the UK and includes a separate category for articles marked as OA for a sample of journals.⁷¹ Another source of data is IRUS-UK, which aggregates data from 110 UK institutional repositories. The dataset includes the number of items downloaded from the repositories and the date. These two datasets could be used to evaluate whether the new UKRI policy has increased the number of downloads of OA articles.

⁷¹ More details on the Journal Usage Statistical Portal are available at: https://jusp.jisc.ac.uk/

Bibliography

Adie, Euan. 2014. 'Attention! A Study of Open Access vs Non-Open Access Articles'. Figshare.

https://doi.org/10.6084/M9.FIGSHARE.121369 0

Anderson, Rick. 2014. 'Is Rational Discussion of Open Access Possible?' Insights: The UKSG Journal 27 (2): 171–80. https://doi.org/10.1629/2048-7754.162

Andrew, Theo. 2016. Improving estimates of the total cost of publication by recognising 'APCs paid in the wild'. The Winnower. https://thewinnower.com/papers/4241improving-estimates-of-the-total-cost-ofpublication-by-recognising-apcs-paid-in-thewild

Archambault, Éric, Didier Amyot, Aurore Nicol, and Françoise Provencher. 2014. 'Proportion of Open Access Papers Published in Peer-Reviewed Journals at the European and World Levels—1996–2013'.

https://digitalcommons.unl.edu/cgi/viewcontent .cgi?article=1007&context=scholcom

Aspesi, Claudio, Andrea Rosso, and Richard Wielechowski, 2012. Reed Elsevier: Transitioning to open access-are the cost savings sufficient to protect margins. Bernstein Research

https://richardpoynder.co.uk/OAcosts.pdf

Bautista-Puig, Nuria, Carmen Lopez-Illescas, Felix de Moya-Anegon, Vicente Guerrero-Bote, and Henk F. Moed. 2020. 'Do Journals Flipping to Gold Open Access Show an OA Citation or Publication Advantage?' Scientometrics 124 (3): 2551–75. https://doi.org/10.1007/s11192-020-03546-x

Beagrie, Neil, and J. W. Houghton. 2014. 'The Value and Impact of Data Sharing and Curation: A Synthesis of Three Recent Studies of UK Research Data Centres."'.

http://repository.jisc.ac.uk/5568/.

Björk, Bo-Christer. 2017. 'Scholarly Journal Publishing in Transition: From Restricted to Open Access'. Electronic Markets 27 (2): 101– 9.

https://doi.org/10.1007/s12525-017-0249-2

Brembs, Björn, Katherine Button, and Marcus Munafò. 2013. 'Deep Impact: Unintended Consequences of Journal Rank'. Frontiers in Human Neuroscience 7. https://doi.org/10.3389/fnhum.2013.00291

Clarke, Roger. 2007. 'Journal Publishing Cost Profiles'. 2007. http://rogerclarke.com/EC/JP-CP-050428.html

Crowford, Walt. 2017. 'GOAJ2: Golden Open Access Journals 2011–2016.' https://waltcrawford.name/goaj2.pdf

Davis, Philip M. 2009. 'Author-Choice Open Access Publishing in the Biological and Medical Literature: A Citation Analysis'. Journal of the American Society for Information Science and Technology 60 (1): 3–8. https://doi.org/10.1002/asi.20965

Earney, Liam. 2017. 'Offsetting and Its Discontents: Challenges and Opportunities of Open Access Offsetting Agreements'. Insights the UKSG Journal 30 (1): 11–24. https://doi.org/10.1629/uksg.345

Edgar, Brian D., and John Willinsky. 2010. 'A Survey of Scholarly Journals Using Open Journal Systems'. Scholarly and Research Communication 1 (2).

https://doi.org/10.22230/src.2010v1n2a24

Eve, Martin Paul. 2014. *Open Access and the Humanities: Contexts, Controversies and the Future*. Cambridge: Cambridge University Press.

https://doi.org/10.1017/CBO9781316161012

Eysenbach, Gunther. 2012. 'Correction: Can

Tweets Predict Citations? Metrics of Social Impact Based on Twitter and Correlation with Traditional Metrics of Scientific Impact'. Journal of Medical Internet Research 14 (1): e7.

https://doi.org/10.2196/jmir.2041

Fell, Michael J., 2019. 'The Economic Impacts of Open Science: A Rapid Evidence Assessment.' Publications, 7(3), p.46. https://www.mdpi.com/2304-6775/7/3/46/htm

Frontier Economics. 2017. 'The Contribution of the Publishing Industry to the UK Economy: A Report for the Publishers Association'. https://www.publishers.org.uk/policyresearch/t he-value-of-uk-publishing/

Fyfe, Aileen, Kelly Coate, Stephen Curry, Stuart Lawson, Noah Moxham and Camila M. Røstvik, 2017. 'Untangling academic publishing: A history of the relationship between commercial interests, academic prestige and the circulation of research'. https://eprints.bbk.ac.uk/id/eprint/19148/1/Unt anglingAcPub.pdf

Gargouri, Yassine, Chawki Hajjem, Vincent Larivière, Yves Gingras, Les Carr, Tim Brody, and Stevan Harnad. 2010. 'Self-Selected or Mandated, Open Access Increases Citation Impact for Higher Quality Research'. Edited by Robert P. Futrelle. PLoS ONE 5 (10): e13636. https://doi.org/10.1371/journal.pone.0013636

Hall, Bronwyn H., Jacques Mairesse, and Pierre Mohnen. 2010. 'Measuring the Returns to R&D.' Handbook of the Economics of Innovation 2:1033-82.

https://doi.org/10.1016/S0169-7218(10)02008-3

Hilton, John. 2020. 'Open Educational Resources, Student Efficacy, and User Perceptions: A Synthesis of Research Published between 2015 and 2018'. Educational Technology Research and Development 68 (3): 853–76. https://doi.org/10.1007/s11423-019-09700-4

Hook, Daniel W., Mark Hahnel, and Christian Herzog. 2019. 'The Price of Gold: Curiosity?' ArXiv:1905.00880 [Cs], May.

http://arxiv.org/abs/1905.00880

Houghton, John, Bruce Rasmussen, Peter Sheehan, Charles Oppenheim, Anne Morris, Claire Creaser, Helen Greenwood, Mark Summers, and Adrian Gourlay, 2009. Economic implications of alternative scholarly publishing models: Exploring the costs and benefits. http://vuir.vu.edu.au/15222/1/El-ASPM_Report.pdf

Jamali, Hamid R. 2017. 'Copyright Compliance and Infringement in ResearchGate Full-Text Journal Articles'. Scientometrics 112 (1): 241– 54.

https://doi.org/10.1007/s11192-017-2291-4

Jisc. 2016. 'Article Processing Charges (APCs) and Subscriptions'. https://www.jisc.ac.uk/sites/default/files/apcand-subscriptions-report.pdf

Johnson, Rob and Mattia Fosci. 2015. 'On Shifting Sands: Assessing the Financial Sustainability of UK Learned Societies'. Learned Publishing 28 (4): 274–82. https://doi.org/10.1087/20150406

Johnson, Rob, Mattia Fosci, Andrea Chiarelli, Stephen Pinfield, and Michael Jubb. 2017. 'Towards a Competitive and Sustainable Open Access Publishing Market'.

https://libereurope.eu/wpcontent/uploads/2017/03/OA-market-report-28Final-13-March-201729-1.pdf

Johnson, Rob, Anthony Watkinson and Michael Mabe. 2018. 'An Overview of Scientific and Scholarly Publishing'. https://www.stmassoc.org/2018_10_04_STM_Report_2018.pd f

Jones, Jackie. 2014. 'To Flip or Not to Flip'. https://blog.alpsp.org/2014/09/open-accessdaily-challenge-new.html

Jubb, Michael. 2011. 'Heading for the Open Road: Costs and Benefits of Transitions in Scholarly Communications'. LIBER Quarterly 21 (1): 102. https://doi.org/10.18352/lq.8010

Jubb, Michael. 2019. 'Evidence to inform a response to the UKRI review of open access

policies'

https://www.publishers.org.uk/publications/res ponse-to-the-ukri-review-of-open-accesspolicies/

Larivière, Vincent, Stefanie Haustein, and Philippe Mongeon. 2015. 'The Oligopoly of Academic Publishers in the Digital Era'. Edited by Wolfgang Glanzel. PLOS ONE 10 (6): e0127502.

https://doi.org/10.1371/journal.pone.0127502

Lawson, Stuart. 2016. 'Report on Offset Agreements%3A Evaluating Current Jisc Collections Deals. Year 1 – Evaluating 2015 Deals', 260546 Bytes.

https://doi.org/10.6084/M9.FIGSHARE.404777 7.V1

Lawson, Stuart. 2017. 'Report on Offset Agreements: Evaluating Current Jisc Collections Deals. Year 2 – Evaluating 2016 Deals', 254893 Bytes.

https://doi.org/10.6084/M9.FIGSHARE.538386 1.V1

Lawson, Stuart. 2018. 'Report On Offset Agreements: Evaluating Current Jisc Collections Deals. Year 3 – Evaluating 2017 Deals'. Zenodo.

https://doi.org/10.5281/ZENODO.1473588

Martín-Martín, Alberto, Rodrigo Costas, Thed van Leeuwen, and Emilio Delgado López-Cózar. 2018. 'Unbundling Open Access Dimensions: A Conceptual Discussion to Reduce Terminology Inconsistencies'. Preprint. SocArXiv. https://doi.org/10.31235/osf.io/7b4aj

Matthias, Lisa, Najko Jahn, and Mikael Laakso. 2019. 'The Two-Way Street of Open Access Journal Publishing: Flip It and Reverse It'. Publications 7 (2): 23. https://doi.org/10.3390/publications7020023

McCabe, Mark J., and Christopher M. Snyder. 2014. 'Identifying the effect of open access on citations using a panel of science journals'. Economic Inquiry 52 (4): 1284–1300. https://doi.org/10.1111/ecin.12064

McKiernan, Erin C, Philip E Bourne, C Titus Brown, Stuart Buck, Amye Kenall, Jennifer Lin, Damon McDougall, et al. 2016. 'How Open Science Helps Researchers Succeed'. ELife 5 (July): e16800.

https://doi.org/10.7554/eLife.16800

Momeni, Fakhri, Nicholas Fraser, Isabella Peters, and Philipp Mayr. 2019. 'From Closed to Open Access: A Case Study of Flipped Journals'. ArXiv:1903.11682 [Cs], October. http://arxiv.org/abs/1903.11682

Monaghan, Jessica, Mithu Lucraft, and Katie Allin. 2020. "APCs in the Wild": Could Increased Monitoring and Consolidation of Funding Accelerate the Transition to Open Access?

https://doi.org/10.6084/m9.figshare.11988123 .v4

Piwowar, Heather, Jason Priem, Vincent Larivière, Juan Pablo Alperin, Lisa Matthias, Bree Norlander, Ashley Farley, Jevin West, and Stefanie Haustein. 2018. 'The State of OA: A Large-Scale Analysis of the Prevalence and Impact of Open Access Articles'. PeerJ 6 (February): e4375.

https://doi.org/10.7717/peerj.4375

Pollock, Dan and Ann Michael. 2019. 'Open Access Mythbusting: Testing Two Prevailing Assumptions about the Effects of Open Access Adoption'. Learned Publishing 32 (1): 7–12. https://doi.org/10.1002/leap.1209

Research Consulting. 2014. 'Counting the Costs of Open Access'. 2014. http://www.researchconsulting.co.uk/wpcontent/uploads/2014/11/Research-Consulting-Counting-the-Costs-of-OA-Final.pdf

Research England. 2018. 'Monitoring Sector Progress towards Compliance with Funder Open Access Policies'. https://re.ukri.org/documents/2018/researchengland-open-access-report-pdf/

Research Information Network. 2008. 'Activities, Costs and Funding Flows in the Scholarly Communications System in the UK'. http://www.rin.ac.uk/system/files/attachments/ Activites-costs-flows-report.pdf Rodrigues, Rosângela Schwarz, Ernest Abadal, and Breno Kricheldorf Hermes de Araújo. 2020. 'Open Access Publishers: The New Players'. Edited by Sergio A. Useche. PLOS ONE 15 (6): e0233432.

https://doi.org/10.1371/journal.pone.0233432

Severin, Anna, Matthias Egger, Martin Paul Eve, and Daniel Hürlimann. 2020. 'Discipline-Specific OA Publishing Practices'. https://f1000researchdata.s3.amazonaws.com /manuscripts/25075/68d5c631-9401-4db2a90d-1b3187ba382a_17328_-_anna_severin_v2.pdf?doi=10.12688/f1000res

earch.17328.2&numberOfBrowsableCollection s=23&numberOfBrowsableInstitutionalCollecti ons=5&numberOfBrowsableG

Solomon, David J., Mikael Laakso, and Bo-Christer Björk. 2013. 'A Longitudinal Comparison of Citation Rates and Growth among Open Access Journals'. Journal of Informetrics 7 (3): 642–50. https://doi.org/10.1016/j.joi.2013.03.008

Solomon, David J., Mikael Laakso, and Bo-Christer Björk. 2016. Converting scholarly journals to open access: A review of approaches and experiences. https://digitalcommons.unl.edu/cgi/viewcontent .cgi?article=1026&context=scholcom

Springer Nature. 2020. "APCs in the Wild: Exploring Funding Streams for an Accelerated Transition to Open Access'.

https://figshare.com/articles/_APCs_in_the_Wil d_Could_Increased_Monitoring_and_Consolid ation_of_Funding_Accelerate_the_Transition_t o_Open_Access_/11988123/4

Tennant, Jonathan P., Harry Crane, Tom Crick, Jacinto Davila, Asura Enkhbayar, Johanna Havemann, Bianca Kramer, et al. 2019. 'Ten Myths around Open Scholarly Publishing'. Preprint. PeerJ Preprints. https://doi.org/10.7287/peerj.preprints.27580v 1

Tennant, Jonathan P., François Waldner, Damien C. Jacques, Paola Masuzzo, Lauren B. Collister, and Chris. H. J. Hartgerink. 2016. 'The Academic, Economic and Societal Impacts of Open Access: An Evidence-Based Review'. F1000Research 5 (September). https://doi.org/10.12688/f1000research.8460. 3

'UKRI Open Access Review: Consultation'. 2020.

https://www.ukri.org/files/funding/oa/openaccess-review-consultation/

University of California Libraries. 2016. 'Pay It Forward: Investigating a Sustainable Model of Open Access Article Processing Charges for Large North American Research Institutions.' https://www.library.ucdavis.edu/wpcontent/uploads/2018/11/ICIS-UC-Pay-It-Forward-Final-Report.rev_.7.18.16.pdf

Universities UK. 2017. 'Monitoring the Transition to Open Access: December 2017'. https://www.universitiesuk.ac.uk/policy-andanalysis/reports/Pages/monitoring-transitionopen-access-2017.aspx

Van Noorden, Richard. 2013. 'Open Access: The True Cost of Science Publishing'. Nature News 495 (7442): 426. https://doi.org/10.1038/495426a

Wang, Xianwen, Chen Liu, Wenli Mao, and Zhichao Fang. 2015. 'Erratum to: The Open Access Advantage Considering Citation, Article Usage and Social Media Attention'. Scientometrics 103 (3): 1149–1149. https://doi.org/10.1007/s11192-015-1589-3

Wellcome Trust. 2003. 'Economic Analysis of Scientific Research Publishing'. https://wellcome.ac.uk/sites/default/files/wtd00 3182_0.pdf

Wise, Alicia and Lorraine Estelle. 2020. 'How Society Publishers Can Accelerate Their Transition to Open Access and Align with Plan S'. Learned Publishing 33 (1): 14–27. https://doi.org/10.1002/leap.1272



Technical Appendix

Table A1. Number of hybrid journals by publisher

Publisher	Hybrid journals
Elsevier	1037
Springer Nature	1021
Wiley-Blackwell	622
SAGE	194
Oxford University Press	143
Cambridge University Press	85
Taylor & Francis	52
American Chemical Society	50
Institute of Physics Publishing	40
Emerald	38
BMJ Publishing Group	36
Royal Society of Chemistry	36
Brill	22
Wolters Kluwer Health	22
Mary Ann Liebert	20

Source: Dimensions article data merged with Scopus data on journal publishing model and subject area (see methodology). For conciseness, publishers are only listed if they include at least 20 hybrid journals in their portfolio. A journal is classified as hybrid if at least one article associated with the publisher in the Dimensions database records a value of "OA - Hybrid" for the "Open Access" variable.

Table A2. Regression coefficients of estimated APCs by subject area for UK-authored articles, 2018

Subject Area	Intercept	Slope	R ²	RMSE
Arts & Humanities	639.12	174.89	0.14	811
Health Sciences	1055.71	106.40	0.30	1,003
Life Sciences	1505.58	80.88	0.22	958
Physical Sciences	1193.98	83.29	0.04	996
Social Sciences	689.25	124.97	0.17	946

Source: Estimates produced by Alma Economics

Table A3. Regression coefficients of estimated APCs by subject area for UK-authored articles, 2017

Subject Area	Intercept	Slope	R ²	RMSE
Arts & Humanities	686.90	153.13	0.15	862
Health Sciences	1115.85	105.91	0.29	1018
Life Sciences	1333.51	90.68	0.26	889
Physical Sciences	1418.91	38.50	0.08	947
Social Sciences	421.18	170.50	0.26	858

Source: Estimates produced by Alma Economics

Table A4. Regression coefficients of estimated APCs by subject area for UK-authored articles, 2016

Subject Area	Intercept	Slope	R ²	RMSE
Arts & Humanities	611.35	148.85	0.07	933
Health Sciences	1061.35	102.70	0.30	988
Life Sciences	1496.21	69.24	0.21	903
Physical Sciences	1503.45	34.90	0.06	938
Social Sciences	635.06	145.67	0.22	890

Source: Estimates produced by Alma Economics

Table A5. Estimated costs of APCs in the scenario in which all UK-authored articles in 2018 were published OA by journal business model and subject area and 75% of APCs are attributable to UK HEIs (£ million)

	Arts and Humanities	Health Sciences	Life Sciences	Physical Sciences	Social Sciences
Closed	4.37	16.47	5.21	14.36	9.75
Full OA	0.10	12.36	5.32	8.45	1.43
Hybrid - Gold OA	0.80	16.97	9.08	9.74	2.88
Hybrid - Green OA	1.32	11.65	6.40	20.79	6.43
Hybrid - Subscription	2.04	35.72	11.21	15.05	5.12
Total	8.6	93.2	37.2	91.2	25.6

Source: Estimates produced by Alma Economics based on Dimensions data

Table A6. Estimated costs of APCs in the scenario in which all UKRI-funded articles in 2018 were published OA by journal business model and subject area and 75% of APCs are attributable to UK HEIs (£ million)

	Arts and Humanities	Health Sciences	Life Sciences	Physical Sciences	Social Sciences
Closed	0.19	1.23	1.00	3.23	0.80
Full OA	0.02	2.72	1.93	3.23	0.23
Hybrid - Gold OA	0.27	4.20	4.91	6.45	1.25
Hybrid - Green OA	0.23	1.88	1.95	7.16	0.80
Hybrid - Subscription	0.11	2.33	1.83	2.93	0.38
Total	0.8	12.4	11.6	23.0	4.6

Source: Estimates produced by Alma Economics based on Dimensions data

Table A7. Estimated costs of APCs in the scenario in which all UK-authored articles in 2018 were published OA by journal business model and subject area and 50% of APCs are attributable to UK HEIs (£ million)

	Arts and Humanities	Health Sciences	Life Sciences	Physical Sciences	Social Sciences
Closed	2.92	10.98	3.48	9.57	6.50
Full OA	0.07	8.24	3.55	5.64	0.96
Hybrid - Gold OA	0.54	11.31	6.06	6.50	1.92
Hybrid - Green OA	0.88	7.77	4.27	13.86	4.29
Hybrid - Subscription	1.36	23.81	7.48	10.03	3.41
Total	5.8	62.1	24.8	45.6	17.1

Source: Estimates produced by Alma Economics based on Dimensions data

Table A8. Estimated costs of APCs in the scenario in which all UKRI-funded articles in 2018 were published OA by journal business model and subject area and 50% of APCs are attributable to UK HEIs (£ million)

	Arts and Humanities	Health Sciences	Life Sciences	Physical Sciences	Social Sciences
Closed	0.13	0.82	0.67	2.15	0.54
Full OA	0.01	1.81	1.29	2.16	0.15
Hybrid - Gold OA	0.18	2.80	3.27	4.30	0.83
Hybrid - Green OA	0.16	1.25	1.30	4.78	0.53
Hybrid - Subscription	0.07	1.56	1.22	1.95	0.26
Total	0.6	8.3	7.8	15.4	2.3

Source: Estimates produced by Alma Economics based on Dimensions data

Parameter	Value	Notes
Growth rate of articles published OA	4%	Johnson, Watkinson, and Mabe (2018). We assume this value is equivalent to the growth rate of all research output, so the share of OA publications remains constant over time in the absence of changes in UKRI policy
Annual growth in average APCs	2%	Alma Economics assumption
Administrative costs of OA publishing per article	£68	Alma Economics survey of HEIs, value has been averaged across OA Green and OA Gold
UKRI block grant	£23 million	Funding made available through the UKRI block grant or any other OA funding mechanisms; our base assumption is that this OA grant funding will be at the same level as in 2020/21
Revenue per article (subscription)	£4,100	Johnson et al. (2017)
Revenue per article (OA)	£2,156	Open APC Initiative (average APC)
Cost per article (subscription)	£3,185	Houghton et al. (2009) (adjusted for inflation)
Cost per article (OA)	£1,802	Average of Houghton et al. (2009) (adjusted for inflation) and cost estimates by Frontier Publishing (2015) and eLife (2015)
% overall increase in accessibility of knowledge	20%	% of all knowledge from journals, from Houghton et al. 2009) adjusted by share of UK research output relative to global output
% overall gain in efficiency	5%	Houghton et al. (2009) adjusted by share of UK papers published OA
Social rate of return to R&D	20%	Hall, Mairesse and Mohnen (2010)
Annual growth in R&D spending	4%	Office for National Statistics (2018)
Lag between R&D spending and impacts	10 years	Houghton et al. (2009)
Depreciation in stock of knowledge	10%	Houghton et al. (2009)
Discount rate	3.5%	HMT Green Book

Table A9. Assumptions for key model parameters

Interview participants

Publishing companies:

Cambridge University Press Edinburgh University Press Elsevier F1000 IOPP Microbiology Society MIT Press PLOS Portland Press Royal Society of Chemistry Sage Publications Springer Nature The Royal Society Wiley

HEIs:

Imperial College London Queen's University Belfast University of Cambridge DHSC NWO Wellcome Trust

Representative bodies:

Association of Learned and Professional

In addition, we conducted interviews with six researchers.

University College London University of Exeter University of Glasgow University of Oxford University of Salford University of Winchester

Consumers of academic research:

British Library GlaxoSmithKline Jisc KNT OpenPharma

Funders:

APHA Cancer Research UK DEFRA

Society Publishers Open Access Scholarly Publishers Association Publishers' Association Research Libraries UK SCONUL Society Publishers Accelerting OA

Survey questionnaire

Please specify in which institution you are employed Please specify your role Please specify in which month your financial year begins.

Information on budget and expenditure - please use your best estimate. We are aware that the exact figure may be difficult to find.

1. Please estimate your library's total allocated budget in the financial years 2015/2016 to 2018/2019 (excluding block grant and any other funding related to open access)

2. Please estimate the total spending on open access in the financial years 2015/2016 to 2018/2019 (this includes expenditure to publish open access articles and any other expenditures in activities related to open access. This also includes transformative agreements.)

3. Please estimate the total spending by your institution on transformative agreements with publishers in the financial years 2015/2016 to 2018/2019 (these include transitional agreements, read-and-publish, and publish-and-read)

4. Please estimate the total spending by your institution on journal subscriptions in the financial years 2015/2016 to 2018/2019

5. Please provide details of costs, other than Article Processing Charges (APCs) and employed staff, incurred by your institution in supporting, promoting or facilitating open access in the financial year 2018/2019 in the following categories:

Marketing and events Consultancy Temporary/agency staffing costs Software licensing and development Travel and subsistence Repositories Other

Time spent to process open access articles

6. Please estimate the time spent (in minutes) by administrative staff in making an article open access through the Gold route for the financial year 2018/2019

7. Please estimate the time spent (in minutes) by authors in making an article open access through the Gold route for the financial year 2018/2019 (This includes the time spent in identifying the requirements/options available to make article Gold OA, directing the request to appropriate administrative staff, and providing relevant information to the administrative staff.)

8. Please estimate the time spent (in minutes) by administrative staff in making an article open access through the Green route for the financial year 2018/2019

9. Please estimate the time spent (in minutes) by authors in making an article open access through the Green route for the financial year 2018/2019 (This includes identifying and providing the version of the article to administrative staff or depositing the article in case this is the author's responsibility)

10. Please estimate training and development costs for staff for the financial year 2018/2019

Allocation and use of RCUK/COAF block grants

11. Please estimate the total spending on APCs by the central fund that was not covered by RCUK/COAF funds for the financial year 2018/2019

12. Please indicate the proportion of articles for which APCs paid by the central fund that were not covered by RCUK/COAF funds for the financial year 2018/2019

13. Please indicate the proportion of articles for which APCs paid by the central fund that were partly covered by RCUK/COAF funds for the financial year 2018/2019

14. Please estimate the proportion of researchers that made use of their personal research budget to cover the cost of APCs in the financial year 2018/2019?

15. Please estimate the proportion of researchers that are funded by UKRI and that made use of their personal research budget to cover the cost of APCs in the financial year 2018/2019?

16. Please estimate the proportion of the total research budget allocated to researchers that was used to pay APCs in the financial year 2018/2019

17. Please estimate the proportion of articles requesting APCs funding that your institution decided not to fund in the financial year 2018/2019

18. What are the criteria that your institution applies to decide whether to pay for APCs?

19. How is open access funding allocated among researchers to cover the cost of APCs?

20. Please estimate the expenditure on APCs that are paid 'in the wild' (see https://openaccess.jiscinvolve.org/wp/2016/05/03/apcs-in-the-wild-report-from-the-loch-pathfinder-project/ for the definition of 'in the wild')

Impact of open access policies

21. Please describe any major changes to your library's subscription to journals or conference proceedings between 2015 and 2019.

22. Under the new UKRI policy on open access, how challenging will it be to:

Meet the cost of APCs Meet administration costs to process open access articles Support researchers in complying with the new open access policy Other (please specify)

23. What are the key benefits, financial and other, for your organization that you expect from the implementation of the new OA policy?

24. As a consequence of the Covid-19 pandemic, some libraries are expecting budget cuts. Do you estimate that your library's budget will be cut and if so, by how many percent?


Economic Implications and Benefits Assessment of an Updated UKRI Open Access Policy for Peer-Reviewed Research Articles

UK Research and Innovation

Produced as part of the UKRI Open Access Review 2018-2021

