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Economic Analysis of Alternative Options for the UK Science and Research System

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For all general enquiries and comments

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Contents

Summary

- This note sets out the economic rationale for an open access policy and a framework of analysis for comparing alternative policy options for improving access levels to scholarly research in the UK. This analysis of options was undertaken internally within BIS to inform the Government response to the recommendations of the Finch Group.

- The analysis at the core of this paper was undertaken prior to the recommendations of the Finch Group published in June 2012, and prior to the subsequent RCUK policy announcement. It therefore could not and was not intended to evaluate the policy that was subsequently announced by RCUK.

- The difficulties associated with precisely quantifying the monetary value of the expected benefits of open access at the time the analysis was carried out meant that a full cost-benefit analysis was not undertaken. The analysis is therefore a partial economic assessment based on cost-effectiveness, where the "effectiveness" is the quality and/or breadth of open access achieved by each policy option.

- Expanding public access to scholarly research has the potential of accelerating growth through enhanced innovation in an open and collaborative environment. Open access encourages diversity and horizontal exploration of applications, implicitly fostering multi-disciplinarity and collaboration. Both of these impacts are positive externalities which provide a basis for public sector intervention to bring access to socially optimal levels.

- Albeit starting from a low base of around 10% of publications in 2010, open access worldwide is growing fast. Policies to expand access have to be evaluated in light of this current state and have to be capable of delivering wider and better access. To inform development of UK policy, alternatives were evaluated on the basis of cost-effectiveness, where effectiveness is the level of access they grant.

- Without policy intervention and assuming constant growth rates of publications and open access from 2011 onwards, organically growing open access would cover 24% of all UK publications by 2015 and 51% of all UK publications by 2020. Based on our assumptions this organic constant growth would require funds amounting to a total of £1.8bn over 10 years to sustain open access payments and subscriptions payments to articles that are not offered in open access.

- Two options are considered in this paper. The first is to focus on improving the quality of access, to all organically growing open access publications, by making them fully mineable and re-usable. This would maintain the coverage of open

access as in the case of no policy, but would maximise usability. The cost is £2.3bn over the decade 2011 to 2020. That amounts to an additional £500m over 10 years to provide fully re-usable content (Gold access) covering 51% of all UK publications by 2020 (and subscriptions to articles that are not open access).

- The second policy option considered is to increase the coverage of open access by expanding access through Research Councils. This option rests on a mandate to offer all publications attributable to publicly funded Research Councils in Gold open access, fully mineable and re-usable. This policy would require £2.2bn over the decade 2011-2020, that is an additional £400m over 10 years, but it would deliver 64% of UK publications in either Gold or Green open access by 2020.

- Of the two options, the second is estimated to deliver better cost-effectiveness in the long-term. It would deliver a step change in the level of open access, and thus be more expensive in the early years. However over time Research Councils publications grow more slowly than organically growing open access. The option of paying (even for a step change initially) for the slower growing publication stream bears lower deadweight because the faster growing publication stream would happen anyhow and would be financed from outside the policy.

- The public budget for science currently stands at £4.6bn per annum. The simulated cost estimates, which average £40m to £50m per year, account for approximately 1% of this total.

1. Introduction

This analytical note describes the economic rationale for an open access policy and sets out a framework for comparing the outcomes of alternative policies aimed at expanding access to scholarly research. The framework is then used to compare the costs of alternative policies for open access in the UK. The analysis was carried out to inform policy advice for BIS' response to the recommendations of Janet Finch's consultation[1].

The definition of "open access" adopted follows from that of the Finch working group. Open access is the ability to download, read and print electronically published refereed journal articles, leaving aside research content that is publicly accessible in other formats[2].

The capability of mining text from the published content is an additional service that may or may not be offered together with downloading, viewing and printing as above. This additional service is also known as 're-use of content' and it is known to help researchers focus their topic-search for relevant published findings in global research (JISC, 2012). This right to re-use content also opens opportunities in a separate private market for harvesting data through electronic search engines and customised summaries of results. Whereas it is often assumed that full re-use is embedded in open access, this is only the case for a subset of open access options, which are set out in Section 4. For these reasons[3] and in order to add transparency to what is being paid for, in this note, text-mining or re-use of content is modelled as an add-on that increases the cost of open access in the options where this is relevant.

Economic reasons for public sector intervention in the market for open access are considered in the next section. The subsequent economic analysis focuses exclusively on the matter of costs incurred in the market for scholarly publishing and how to cover these costs. Whether a price should be paid for accessing published articles, who sets this price, what alternative options for this price exist and what would be the cost implications of these pricing options for a possible UK policy. Throughout it is worth bearing in mind that a price of zero is not only a possibility but a reality in certain sections of the market for scholarly publishing.

The analysis undertaken in this note is static and seeks to exploit available channels for increasing accessibility and transparency, given the state of play in the sector. Therefore, the prevalent business models in publishing industries, whether private, public or not-for-profit, will not be considered in this assessment. While responses from all parts of the system (including publishers) were factored into the recommendations of the Finch Group, it is beyond the scope of this note to consider regulatory frameworks or assess competitive practices.

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[1] http://www.bis.gov.uk/assets/biscore/science/docs/l/12-975-letter-government-response-to-finch-report-research-publications.pdf

[2] The report of the Janet Finch Working Group on Expanding Access to Published Research Findings (2012) considers the feasibility of applying the analysis to other published outputs.

[3] Since there is a variable supply and demand for re-use services these could be modelled in a separate market.

The difficulties associated with precisely quantifying the monetary value of the expected benefits of open access at the time the analysis was carried out meant that a full cost-benefit analysis was not undertaken. The analysis is therefore a partial economic assessment based on cost-effectiveness, where the "effectiveness" is the quality and/or breadth of open access achieved by each policy option.

The time horizon used for projections is the decade running from 2011 to 2020. This time horizon starts in the past because all projections are based on information on publications levels (open or otherwise) prevailing in 2010, which is the last year for which data was available. The upside is that the reader can directly see the year on year evolution of each projection. The downside of this time horizon is that it starts in the past. As explained in Section 6 below, the time horizon matters for implementation but less so for cost-effectiveness evaluation. Provided the time horizon is long and has more years in the future than in the past, the impact on the initial conditions on the cost-effectiveness evaluation is negligible.

The analysis at the core of this paper was undertaken prior to the recommendations of the Finch Group published in June 2012, and prior to the subsequent RCUK policy announcement. It therefore could not and was not intended to evaluate the policy that was subsequently announced by RCUK.

The remainder of the note is organised as follows. The economic rationale for intervention in the market for scholarly publishing is set out in Section 2. Section 3 presents a framework for modelling the market for scholarly publishing, with a focus on the cost incurred and how to cover them. Section 4 reviews the options for exercising open access policy. Section 5 presents the modelling assumptions for a cost-effectiveness analysis of policy options and the benchmark projection of the current and future state of open access in the UK and in the World. Section 6 projects possible cost implications for the UK of alternative open access policies, under the same modelling assumptions as Section 5. Section 7 summarises sensitivity analyses of changes in the modelling assumptions. Section 8 summarises the cost-effectiveness analysis of options.

2. Economic Rationale for an Open Access Policy

Open access holds potential for enabling open innovation and speeding up the rate of technical progress that underpins sustainable long term growth. The value of widening access to the published findings of research has been expressed by funders of research[4] and transnational organisations[5]. However, our ability to attach specific values to the benefits attributable to open access is still incipient and often based on experiments or case studies of limited general application.

[4] http://publicaccess.nih.gov/policy.htm
[5] http://www.oecd.org/general/governmentsshouldimproveaccesstopubliclyfundedresearchfindsoecdreport.htm

An account of push and pull factors at work in the early expansion of open access is presented in Johnson, R (2003) "Open Access: Unlocking the Value of Scientific Research". Push factors for open access were to ensure the sustainability of libraries in light of the growth in academic journal counts (particularly e-journals) and a need to share results early in certain disciplines (arXiv.org). In response to these needs, open access started organically among the academic community, but because of the global nature of research and publishing it was also expanding rapidly in a fragmented manner. The fragmented manner in which open access was expanding meant that it was more prevalent in some areas of research than others and this had implications for coordinating funding to grant open access – costs of open access were being borne unevenly by research funders and any benefits of open access were only being exploited in certain areas. This inequality in the incidence and impact of open access became a pull factor for considering more coordinated action across funders. A more powerful pull factor for the expansion of open access is the potentially beneficial reach of findings to wider audiences, supporting exploitation and wider awareness of the benefits of public investments in science and research. These pull factors justify government action to facilitate and where relevant even out the uptake of open access in publicly funded research.

Open access is seen as an enabler of open innovation which, through seamless knowledge sharing across sectors, is itself the catalyst for competitiveness in the inter-dependent market for innovation (BIS, 2012). Open innovation is not associated to a single type of activity but to organisational policies, ways of working and corporate strategies all of which entail either exploration or exploitation of knowledge across proprietary boundaries inside and outside the firm (Huizhing, 2012). To support open innovation, the Government has a role in facilitating knowledge flows between the market and non-market sectors through creating the infrastructure that allows users to quickly exploit the findings of public research. An open access policy is instrumental in advancing this agenda (UK Innovation and Research Strategy for Growth, 2012[6]).

The economic value of open access therefore rests on wider usage of scholarly research enabling the virtuous cycle of speedier development of new technologies. Open access is associated with more downloads and reach a wider audience than non open access articles (Davis, 2011). Whether open access papers receive more citations or not remains a matter of debate (Gargouri, 2010) but if downloads and particularly early downloads were enough for the purpose of accelerating open innovation then the first stage of the virtuous circle is enabled by open access.

A benefit of open access that is often disregarded in the literature concerns the usage of freely available findings to widen the application of research, thereby increasing the diversity of experimentation that follows from an idea. As highlighted by Murray et al (2009) facilitating access for research inputs has at least as large an effect in enhancing scope and horizontal exploration as it has in vertical exploitation along defined research lines. In a world of increasing multi-disciplinarity and cross-discipline collaboration these diversification benefits are positive externalities that may not be taken into account when considering opening access. Positive externalities lead to suboptimal levels of openness according to this particular benefit and provide further legitimacy to a political drive to increase open access.

[6] http://www.bis.gov.uk/assets/BISCore/innovation/docs/I/11-1387-innovation-and-research-strategy-for-growth.pdf

3. A framework for analysing open access

This section describes and illustrates a simple framework of analysis for the market for scholarly publishing. The framework describes a refereed e-journal publication as a composite good made up of three elements: an initial manuscript, a referee process over the content of the manuscript and a publisher's certification that the published content has been peer reviewed.

The analytical framework considers the various stages of development of the initial manuscript into a refereed journal article; the parties (author, referee, publisher[7]) involved in each stage and the actions undertaken by each party and the costs of each stage. This framework is is used to compare options for implementing an open access policy. It is not designed to assess the benefits of scholarly research beyond publication. These issues were discussed in Section 2.

Figure 1 illustrates the process. An e-journal article is a bundled commodity composed three elements: a research paper, the peer review of the research paper and the formatting and uploading of the e-journal article. The costs of the manuscript are borne by researchers and their funders. The costs of refereeing are shared between researchers (and their funders) and publishers who organise the refereeing. The costs of certification, that is formatting the article to the journal specification, are largely borne by publishers[8]. Neither the author nor the publisher individually pay for and thus have ex-ante ownership of all three components which means that an agreement needs to be reached for either the author or the publisher to own the end product, so suitable compensations for costs can be established.

Standard practice in the market for scholarly publishing is for the publisher to have ownership of the e-journal article. Often authors transfer copyright of the e-journal version of the manuscript so it can be formatted to the journal specification and uploaded onto the relevant journal electronic site. As with any other well defined market, property rights enable the bearers of costs to establish transactions to recoup the costs incurred.

Figure 1 also depicts the transfer of property rights to the publisher and the means by which the publisher recoups its investment costs. Publishers have several methods for recouping their costs but where they are sole owners of the e-journal article, they are price-makers.This means they set the prices that determine alternative sources of income: subscriptions, article processing charges, advertisement.

[7] Throughout the framework "publishers" are those who organise a process of peer review for publication in an e-journal, regardless of whether the publisher is a private or public body or a learned society. For the purposes of this framework all e-journals, even OA journals, are provided by some "publisher" irrespective of business models and income streams (e.g. subscriptions, membership fees, author payments...)

[8] PEER Economics Report (2011); JISC (2009)

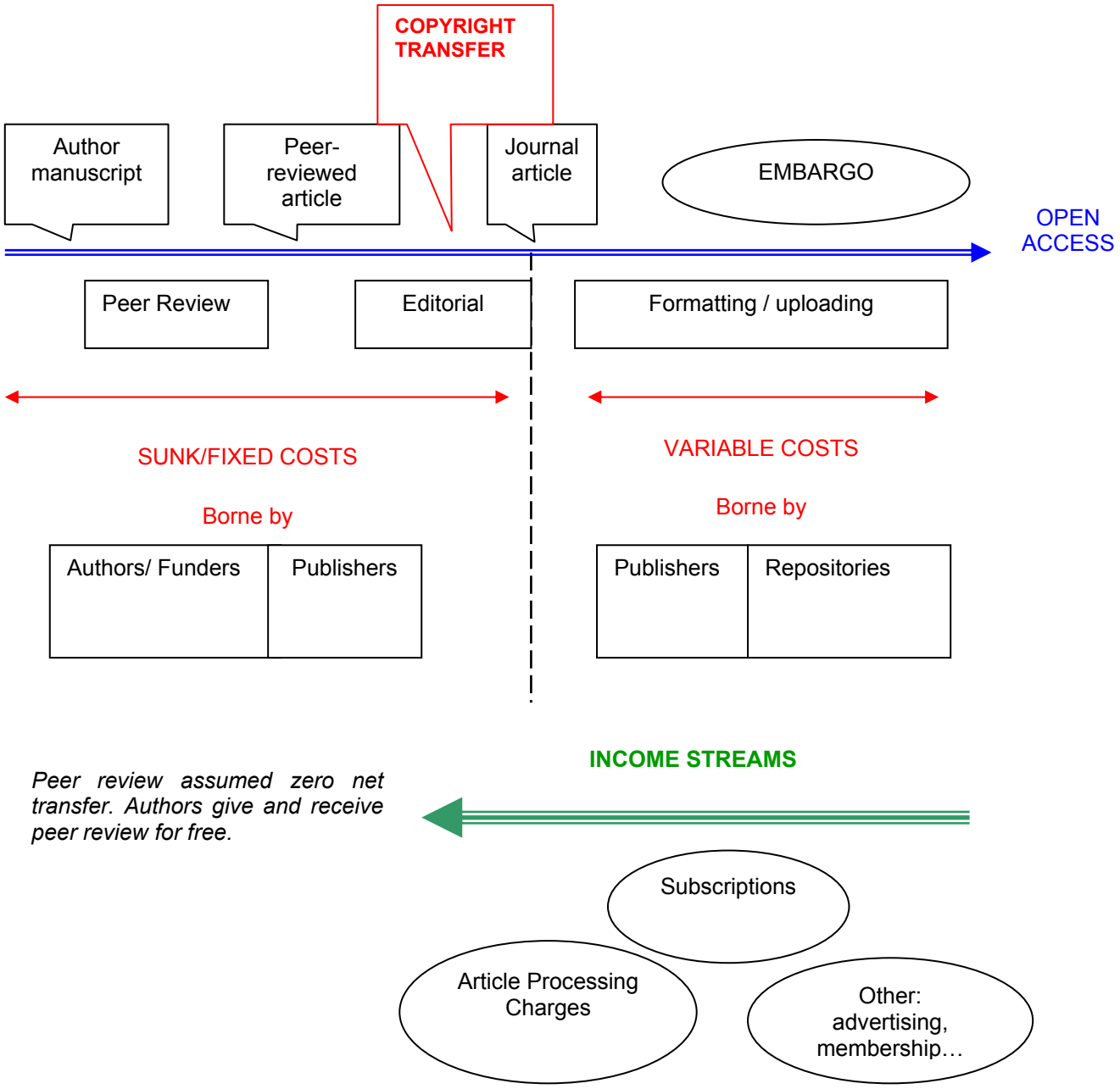

Figure 1: The timeline of transformation of a research manuscript into an e-journal article, including the transfer of copyright from the author to the publisher ahead of publication. The top arrow shows actions that transform the manuscript into a peer reviewed article and this one into a journal article. The costs of each action and who bears them are displayed in the middle. The lower arrow displays mechanisms for covering the costs.

The top half of Figure 1 illustrates stages of development of a manuscript and actions involved. The bottom half illustrates the monetary part, costs of the actions, who bears those costs and sources of income to meet those costs.

As illustrated in the top arrow, the critical point in this process is the transformation from peer-reviewed manuscript (copyright owned by authors) to refereed e-journal article

(copyright owned by publisher). At this point the minimum cost of peer review[9] and part of the editorial work except typesetting and formatting (journal branding) has been undertaken. These costs are fixed and sunk for society: they will not change and cannot be recouped.

Any further costs could be recouped if adequate property rights over the e-journal article are made clear. Such property right allocation often takes the form of a voluntary transfer of copyright from the author to the publisher. The value added by a publisher after this point is the certification that a due process of peer review has taken place and attribution of the discovery to the author. The value of certification and attribution are independent of the aforementioned sunk costs.

When the number of journals and articles are small, such a certification process can be carried out individually by a reputable editor and such is the case for some niche open access journals managed by academics that have a small numbers of submissions and limited readership. However, for more general journals that are aimed at broad disciplines and are of world-wide interest, certification and attribution have to reach global scale – this is the value added by publishers; they provide reassurance that the quality of content is commensurate to the reputation of the journal.

Certification and attribution services are provided through journal branding (typesetting and formatting) and uploading and maintaining the e-journal article in the relevant electronic platform. These are variable costs that increase with the volume of articles processed[10]. Variable costs depend on breath and level of readership and the presence of intermediaries such as libraries that enhance accessibility. RIN (2008) and JISC (2009) provide detail of these costs. The end result is an e-journal article, access to which is embargoed by the publisher which exercises its property rights with the aim of recouping incurred costs. After the embargo period is over, the journal article is released on open access[11].

The lower arrow in Figure 1 illustrates various ways of recouping costs incurred in the services of certification and attribution. Typically income for publishers comes from "selling" access to the e-journal article. Access to the e-journal can be sold to users who pay a subscription for accessing articles on publication. Alternatively access to the e-journal article can be sold to the author who compensates the publisher for their costs by paying an Article Processing Charge (APC henceforth) and guarantee the article will be freely available on publication.

So long as property rights over the e-journal article lie with the publisher, and considering the market of scholarly publishing is global and unregulated, it is down to the publisher to decide or negotiate the prices for subscriptions and APCs. While publishers are price-setters in the market for scholarly publishing, there is nothing in the framework that prevents publishers from setting a price of 0 for their certification and attribution services,

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[9] Cost of peer review is *assumed* to be a zero net cost in this framework overall; authors provide and receive peer review for free

[10] CEPA for RIN estimated in 2008 that around half of a "first copy" is editorial including the stages of formatting to journal branding and uploading for re-use, after copyright transfer.

[11] This staged process of access is not uncommon in markets where the final good is a composite: movies can be enjoyed by subscribers to private TV providers before being available in freeview.

and many do so[12]. Equally, some publishers provide and charge for advertising services with their journals and it is conceivable that they could use this income to reduce the need for subscriptions or APCs.

Therefore, although open means free at the point of access, it does not mean costless[13]. Some publishers require compensation for the costs incurred.

4. Options for exercising open access

This section sets out the potential alternative courses of action for exercising open access options in the UK scholarly publishing sector. In the framework depicted by Figure 1 there are two non-exclusive routes to make the findings of scholarly research on publication accessible.

1. The author exercises her property rights over the manuscript (not the refereed article) and deposits this version in an open electronic repository or digital library for free – known in this analysis as GREEN access. Some publishers allow for the unbranded but peer-reviewed manuscript to be offered in Green open access.

2. The publisher exercises its property rights and charges a price (that could be zero) for making the e- journal article immediately accessible on publication. Two common options for the publishers to collect this price for access are:

    2.1. Users pay a **subscription fee** for accessing articles that are otherwise embargoed for some period of time.

    2.2. Authors pay an **article processing charge** (APC – that could be 0) for the publisher to make the article available to any user immediately on publication. This is known as GOLD access. The APC could be zero.

Only options 1. and 2.2. make the findings available to everyone. Option 2.1. provides availability limited only to those covered by the subscription. A national licence is the only subscription option with a potential to reach everyone within the UK borders but may require pooling subscription resources from libraries and other publicly funded providers of access.

It is also worth noting that Green and Gold open access originate in a single country but grant accessibility world-wide, whereas subscriptions and a national license grant access domestic access to non-domestic articles. Yet it is important to bear in mind that required access to publications is not determined solely, or even predominantly, by national boundaries.

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[12] Many listed in the Directory of Open Access Journals report no publication fees.
[13] Armbruster (2010) analyses various examples of OA implementation – all examples acknowledge costs but only a few report on actual values, these range between 0.3% and 1% of the relevant research budget.

Many alternative options to expand open access have been trialled by research funders across the globe. Armbruster (2010) provides a good overview of implementation challenges and opportunities and so does the PEER Economics Report (2011). Since the implementation of open access is organic and evolving it is unlikely that a single implementation mechanism will prevail. Any policy recommendation will have to be open and flexible to be successful.

Any policy option will have to be a mixed model allowing for both APCs and subscriptions; and possibly further complemented by voluntary Green access through repositories. This is because provision has to be allowed for researchers to reach the remaining world-wide articles that are not in open access. Such provision most often takes the form of subscriptions, hence justifying a so-called mixed-model of access options.

To illustrate the above point, current levels of open access (Green and Gold) are close to 10% of world-wide publication (Laakso et al 2011, 2012; EU Project SOAP, 2011), the UK share of world publications is 6% (BIS, 2011). Estimates of UK only open access are not available but even in the extreme case where all UK publications were offered in open access, this will only cover 6% of world publications.

5. Methodology and baseline

This section establishes the modelling assumptions and approach used for the cost-effectiveness evaluation of different policy options. A baseline scenario for the current and future state of open access in the UK and the world is simulated under stated modelling assumptions. This provides a benchmark against which to evaluate the cost and effectiveness of alternative policies.

5.1 Methodology

The costs of each alternative are determined by the prices paid for different modes of access to scholarly research described in Section 4. The prices considered for the projections in this section are national averages. A number of recent reports on open access consider in detail pricing structures for all types of publishers and publications and assess the distribution of these costs across publishers and users (PEER Project, 2011; Finch Report, 2012). The prices in the market for electronic scholarly publishing depend on the relative negotiation power of, and costs incurred by, publishers and users/libraries and as a result the costs of expanding access to scholarly publishing will not be evenly distributed across all parties. Since not enough is known about the distribution of take up and availability of open access options across disciplines or regions, only the national dimension is considered in this note. Further research would be required to assess distributional effects accurately.

The benchmark against which to assess the merits of each policy option is the current situation, sometimes known as the “do nothing” option. All simulations for current state of open access in the UK and the alternative policy options project the levels of publications prevailing in 2010, which was the last year for which data was available, forward over the following 10 years. Thus the time horizon for simulations is 2011 to 2020.

World-wide open access to journal articles has been growing at an annual rate of 20% over the past five years (Laakso, 2011). This means that the incentive power of additional funds will be, to some extent, limited by the fact that this activity is already developing without aid.

Given that there is already growing open access and that quantifiable benefits are not available, alternative policies have to be evaluated on the basis of the incremental accessibility they grant and the cost-effectiveness of this accessibility[14]. For each policy, the additional level of open access is established first and then the additional cost of achieving this incremental level is assessed against the benchmark of the current state of open access.

Indirect and unintended effects of the policy are out of the scope of this analysis. Policies instigated by Government may encourage others to follow suit bringing about further incremental open access beyond what is attributable directly to the policy. Equally, open access is a global movement and a UK initiative to widen access may encourage similar initiatives elsewhere: the EU also has an open access policy. The likelihood and impact of these nudging effects is unknown and thus too tentative to include in the cost-effectiveness analysis but if these nudging effects were significant, the projections below would represent an over-estimate of costs and an under-estimate of open access in the UK and world-wide. More research is needed to understand the indirect impact of an open access policy on other funders of research in the UK and elsewhere.

After establishing the benchmark position in the current state of open access in the UK and the world, two alternative options for expanding access are considered:

1) Maintain the coverage (e.g. the proportion of UK articles that are being offered under open access) but **improve the quality of open access** by making current open access fully re-usable (full text mining) – gold access

2) **Expand the coverage of open access** (e.g. increase the proportion of UK articles that are offered in open access): in this case not all of the articles in open access are fully text mineable; there is a mix of Green and Gold access

In all simulations in this paper prices are assumed constant so that all differences in total estimated costs can be attributed to the changes in either quality or coverage of the policy. Inflation is therefore neglected so as to aid straightforward attribution of effectiveness. HMT Green Book methodology is to discount future net benefits, at a rate of 3.5% per annum to calculate a Net Present Value. Such discounting is not applied to the main cost-effectiveness analysis in this paper both for reasons of presentational clarity and because the analysis does attempt quantification of benefits. Sensitivity tests, reported in Section 7, were carried out to ensure that the ranking of options in NPV terms would not have affected the rankings in gross nominal value.

[14] Where quantification of benefits is known to be unfeasible a cost-effectiveness methodology can be used assess the merits of alternative policies in terms of the costs per unit of effectiveness (Rieg Cellini, 2010), where the unit of effectiveness is tailored to the programme.

5.2 The current state of open access in the UK

The UK currently has a mixed model in place whereby a proportion of UK scholarly research is offered under some kind of OA framework, but subscriptions are still paid for journals and articles that are not available for free on publication.

BIS (2011) reports that in 2010 UK researchers published 123,600 articles, accounting for 6.4% share of world publications (1,936,000). Departing from these initial figures and using the gross annualised growth rates over the last 5 years of 3% for the UK and 4% for the world it is possible to project publication levels over the 10 years until 2020. Such a simulation reduces the UK share of world publications to 5.8% in 2020. These levels of publications under a constant growth assumption are the baseline for the rest of the cost-effectiveness analysis.

The proportion of open access papers world-wide was estimated in Laakso (2011)[15] to be 10% (192,000 articles) in 2010 and growing at an annual rate of 20% on average in the previous 5 years. Under the assumption that this rate of growth would be constant over the next 10 years, world open access would reach 42% by 2020.

There are currently no published estimates of open access coverage or growth rates that would be applicable to UK publications only. The standard practice in other literature has been to assume that the UK share of world open access would be the same as the UK share of world publications. This would allocate to the UK 6% of the open access publications simulated above.

However, BIS notes that with incentives in place such as the Wellcome Trust scheme for open access, the take up in the UK is arguably higher than in other countries where these schemes are less prevalent. If the take up of open access in the UK is higher than in other countries then the UK share of world open access ought to be higher than the all publication share.

Therefore BIS used the proportion of open access journals registered in the Directory of Open Access Journals (DOAJ) attributed to the UK. This is 533 UK journals registered among 7,600 in total, giving an assumed 7% share of world open access attributable to the UK.

Finding 1: The current state of open access in the UK is such that, provided constant growth was maintained, by 2015, 24% of UK articles would be open access and by 2020 over 50% of UK articles would be open access.

[15] http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0020961#pone-0020961-g004

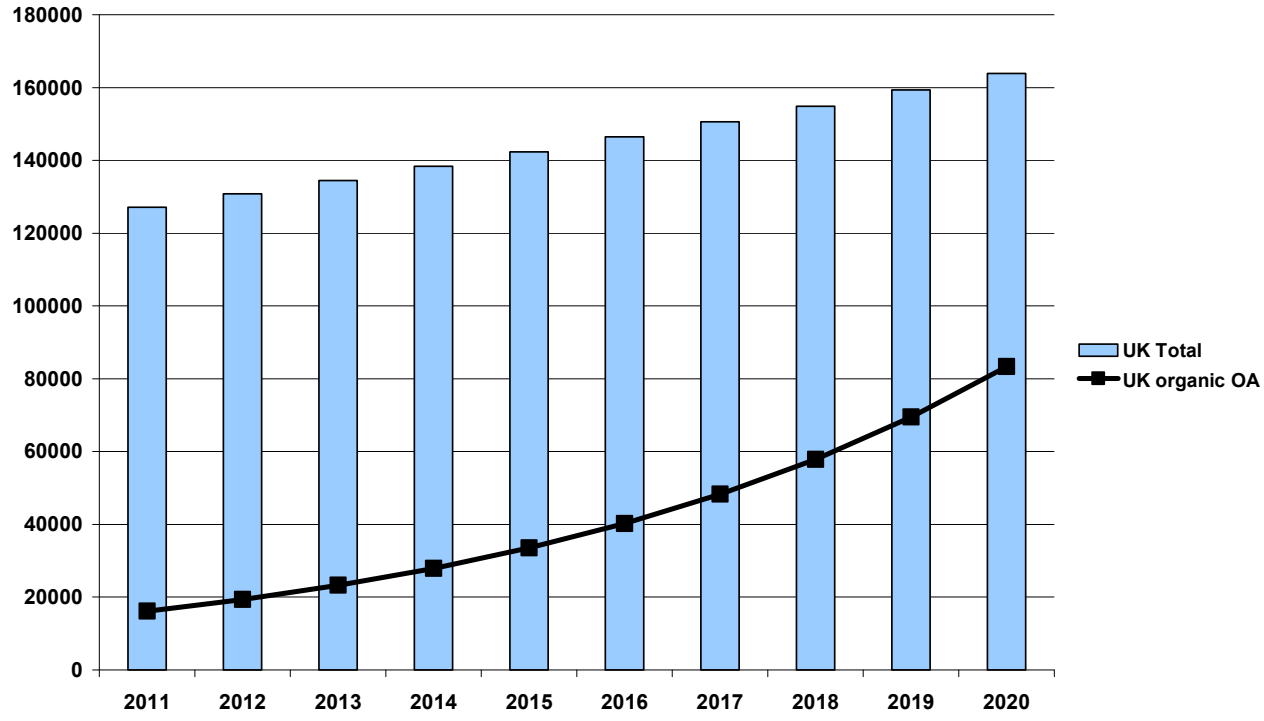

Figure 2: Organically growing open access in the UK, under the assumption of constant growth from 2011 to 2020. Bars display article counts attributable to the UK. The line shows (green and gold) open access article counts attributable to the UK.

On the basis of the above projections, by 2020, the percentage of publications in open access in the UK will significantly overtake the percentage for the world.

Table 1: Projected Expansion of OA (%) under constant growth assumption

	2010	2015	2020
Percentage of World OA in Total World Publications	10	20	42
Percentage of UK OA in Total UK Publications	11	24	51

Adopting the same estimates as the Finch (2012) report[16], UK universities spent an estimated £12m in article processing charges for open access journals in 2011. Dividing this amount by the number of estimated open access papers in the UK in that year (16,000) obtains a hypothetical APC of £750 for each article in (Green or Gold) open access in the UK in 2010. Applying this unit cost to the simulated number of articles in

[16] http://www.researchinfonet.org/wp-content/uploads/2012/06/Finch-Group-report-FINAL-VERSION.pdf

open access over the decade, indicates that the cost of maintaining constant growth in open access at the current average APC in the UK would rise from £12m in 2011 to £25m in 2015 and £63m in 2020 (all years in Table 2 below)

With open access coverage growing at a 20% rate world-wide it is conceivable that investment in subscriptions to non open access articles would fall, since the number of these will be reduced. Savings can thus be achieved at the national level that would compensate for the above costs to some extent.

According to Finch (2012) to gain access to the rest of the world publications, estimated subscription costs of £150m were incurred throughout the UK in 2011, of which £112m by universities alone. Subscriptions are paid per (bundles of) journals, not per article. The simulations in this note are based on article counts and thus the following subscription cost per article was developed: there are 18,000 journals in the SCOPUS database; if all were covered by the £150m it would work at a subscription cost per journal of just over £8,000; assuming an average of 100 articles per journal in that year it gives a subscription cost per article of £80 on average[17].

Under the simulated cost per article of £80, subscription costs in the UK for world articles that are not open access would start falling only in 2015 from an estimated £150m to £133m in 2020. The simulation of subscription costs is approximate but it is needed for illustration of the compensation mechanism whereby the more articles that are available in open access, the lower is the need to pay for articles that are not open access. Since open access is growing faster than publication rates, if growth rates were constant as assumed, the total number of non open access papers follows a hump shape with a peak in 2015. After this point, open access papers grow faster than the alternative category and subscription costs start to fall compared to previous years.

Table 2: Current state of open access with constant growth rates (APC at £750; Subscription at £80), £m

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Cumulative
APC	12	15	17	21	25	30	37	44	52	63	315
Subscription	143	145	148	149	150	150	148	145	141	133	1,452
Total	155	160	165	170	175	180	185	189	193	196	1,767
OA Coverage	11%				24%					51%	

[17] In sensitivity analyses a lower bound for this cost was also considered using universities' estimated £112m in subscriptions for the same numbers of journals to obtain an average cost of subscription per article £60. The ranking of options in terms of cost-effectiveness was not affected.

Finding 2: In the absence of any policy and under constant growth assumptions, the cumulative cost of funding organically growing open access estimated to reach 51% of UK publications by 2020 is £1.8bn. This nominal cost includes disbursements for APCs and subscription costs to access non open access articles world-wide over a decade.

6. Comparing alternative policies for widening open access

This section compares what proportions of open access can be achieved nationally under various policy alternatives and compare the costs of each alternative against the current baseline, allowing for subscriptions costs to access non open access papers world-wide.

6.1 Expanding quality of access: Gold option

Organically growing open access in the current state does not guarantee that all open access is text mineable and fully accessible on publication, as dictated by Gold open access. One way of expanding access to scholarly research in the UK is to improve the accessibility of the organically growing open access publications so that articles projected to be open access under the current state are Gold accessible.

Gold access requires the author to pay higher APC in exchange for the publisher to waive its property rights and make the article available as a public good on electronic publication. There is no embargo and full re-use of content for text-mining is available. According to Ambruster (2010), the cost of this option for the Wellcome Trust comes at around £2,000 per article and this is the APC used here for this option. Other sources cited in this note have offered different estimates of the APC. Section 7 offers a summary of sensitivity analyses.

Granting Gold access to organically growing open access in the UK would have entailed APC costs of £32m (rather than the current £12m) in 2011[18], rising to £67m in 2015 and £167m in 2020, at which point 51% of all UK publications would be available in Gold open access. Because this option does not entail changes in the article counts of open access in the UK or world-wide, the costs of subscriptions would be the same as in the current state.

[18] Projections start in 2011 for transparency so that projections can be traced back to the origin year, 2010, but they have the effect of hypothesizing the first few years rather than reflecting reality. The time horizon matters for implementation but less for cost-effectiveness evaluation. Provided the time horizon is long and has more years in the future than in the past, the impact on the initial conditions on the cost-effectiveness evaluation is negligible.

Table 3: Gold access to organically growing open access in UK (APC at £2,000; Subscription at £80), £m											
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**Cumulative**
APC	32	39	47	56	67	80	96	116	139	167	839
Subscription	143	145	148	149	150	150	148	145	141	133	1,452
Total	175	184	194	205	217	230	245	261	280	300	2,291
OA Coverage	11%				24%					51%	

Finding 3: A policy aimed at granting Gold access to all organically growing publications in the UK would entail a cumulative nominal cost of £2.3bn. This is a cumulative total over a decade of £500m, over and above current state costs to grant Gold access to 51% of all UK publications by 2020.

6.2 Expanding coverage of open access: Gold for Research Councils

The natural alternative to granting Gold fully mineable access to organically growing open access is to add to the organically growing level by expanding the coverage in the UK. This can be achieved through the mandate of having all articles attributable to Research Councils' funding offered in Gold access, while allowing for other UK publications, not attributable to Research Councils, to continue to be offered in Green or Gold open access. Such a mandate delivers a larger proportion of UK publications in Green or Gold than in the current state. The modelling framework was developed as follows.

According to data provided in their Impact Reports to BIS, Research Councils refereed publications stood at 32,000 in 2010 and this had been growing at 3% a year since 2007. This amounts to a proportion of around 25% of all UK publications overall. Bearing in mind that current levels of open access in the UK have been assumed to be around 11% or 16,000 articles in 2011, it is evident that not all publications attributable to Research Councils are currently offered in open access, Gold or otherwise, so there is potential in this policy. The potential rests on the mandate of Gold for articles funded publicly through Research Councils delivering an initial step change in the coverage of open access whilst allowing for organic growth of open access after that. Figure 3 illustrates this potential under the assumption of constant growth. Following the initial boost of the mandate for Gold access for Research Councils funded publications – which admittedly should happen over time rather than in a single year – open access continues to grow organically elsewhere reaching an estimated 64% of UK publications in 2020.

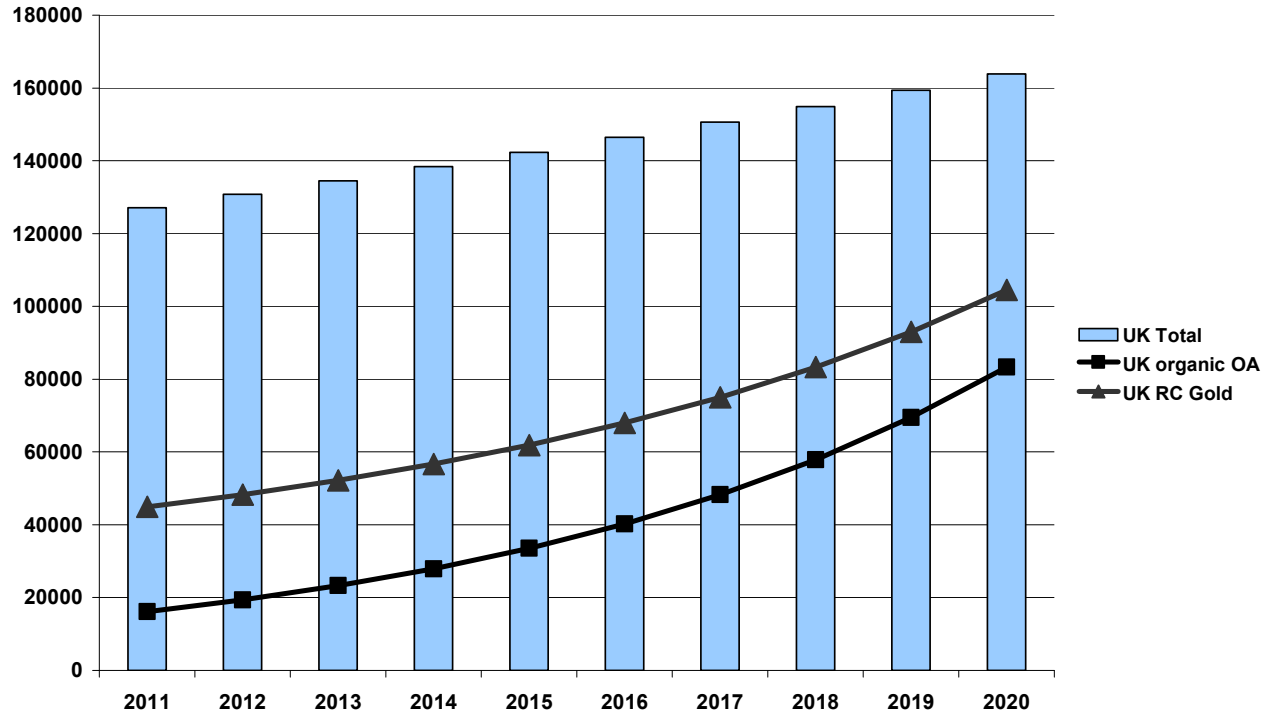

Figure 3: Organically growing open access in the UK and level of open access to be delivered under a Gold mandate for all publications attributable to Research Councils funding. All under constant growth assumption. The bars display article counts attributable to the UK. The square line displays organically growing open access article counts. The triangle line displays potential level of open of open access that could be delivered through a mandate for gold access for Research Councils funded articles plus organically growing open access for the rest.

According to Ambruster (2010) full compliance is a strong assumption: even for the Wellcome Trust where mandated Gold access is fully funded by the Trust, full compliance has proven difficult to achieve. Sensitivity tests run by BIS demonstrate that a minimum of 55% compliance with a possible Gold mandate for all publications attributable to Research Councils would be needed to deliver higher coverage of open access than the current organically growing level.

Table 4: Percentage of UK OA in Total UK Publications (%)

	2010	2015	2020
Baseline (current growth assumptions)	11	24	51
100% compliance with Gold mandate for RC funded articles	35	43	64
55% compliance with Gold mandate for RC funded articles	24	32	52

The simulation of costs is identical to the previous case: the average APC is maintained at £2,000 per article so that differences in the total costs are due to coverage, not to price differences. In the simple model of constant growth adopted for these simulations, a policy

of Gold mandate for Research Council publications starts with an instantaneous increase in open access. Such a step change should realistically happen over some years but for the purpose of evaluating cost-effectiveness over a decade, the initial conditions have a negligible effect on the total. How to achieve a step change in compliance is definitely a matter for implementation with a higher weight on public costs in the first few years where the step change is delivered. However the distribution of costs over the decade does not affect the total cumulative costs and is thus less relevant for choosing the most cost-effective policy.

Table 5: Research Councils Gold mandate (APC at £2000; Subscription at £80), £m.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Cumulative
APC	66	68	70	72	74	76	79	81	84	86	756
Subscription	140	143	145	147	148	148	146	143	139	132	1,431
Total	206	211	215	219	222	224	225	225	222	218	2,187
OA Coverage	35%				43%					64%	

Table 5 illustrates the costs incurred from this policy and the effectiveness in terms of coverage of open access of UK publications. An initial sunk cost amounting to the difference in total cost in the current situation (£155m in Table 2) and Research Councils Gold (£206m in Table 5) in 2011of £51m could hypothetically achieve a 35% open access coverage if 100% compliance with the Gold mandate for Research Councils funded publications was achievable.

After 2011 organic growth warrants a continued increase in Gold and Green open access above growth in Research Councils publications to deliver 64% of UK publications in open access by 2020. The cumulative total nominal cost of this policy amounts to £2.2bn over the decade.

Finding 4: A policy mandate of Gold access for publicly funded publications attributable to Research Councils has the potential to deliver a step change in open access. Such a mandate would involve a cumulative cost over a decade of £2.2bn, including an initial sunk cost of £51m to accommodate increased compliance. This is £400m over the baseline but it will deliver 64% of UK publications in Green and Gold access by 2020; that is 13% more publications in open access than in the baseline scenario.

The mechanism through which this policy achieves higher effectiveness can be readily observed in Figure 4. Public funds required for this mandate account for the Gold access for Research Council publications (circles), thereby requiring higher public investment in the first few years. After 2016, organically growing open access (Green and Gold but paid from other funders) would overtake as the main driver of open access, reducing the relative weight of public funding in the total cost but still delivering higher levels of open access by 2020.

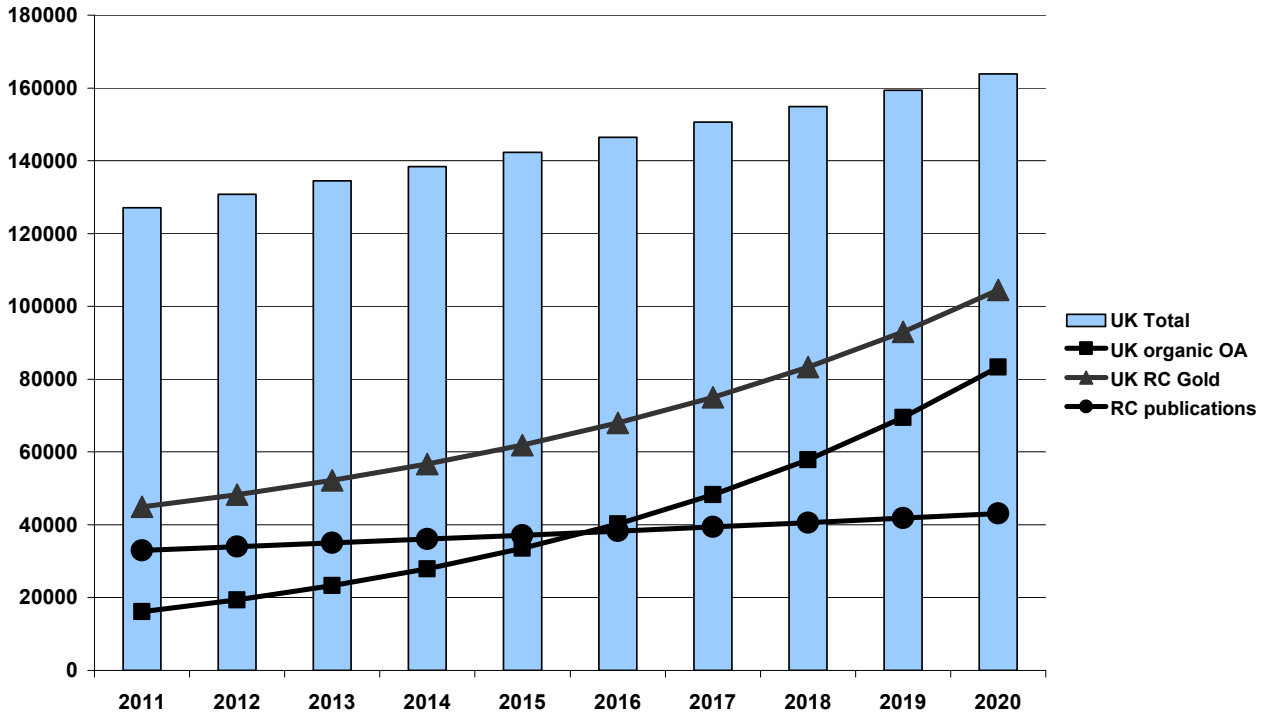

Figure 4: The potential for lower deadweight in a Gold mandate for research attributable to Research Councils. All under constant growth assumption. Bars display UK article counts. Squares display UK organically growing open access minus Research Councils publication counts. Circles display Research Councils publication counts. Triangles display total UK open access counting Research Councils and organically growing open access.

The option of paying (even for a £51m initial step change) for the slower growing publication stream bears lower deadweight for public funding because the faster growing publication stream would happen anyhow and would be financed from outside this policy. It therefore has the potential to deliver better value for money than the alternative policy or even doing nothing.

7. Sensitivity Analyses

This section lists multiple sensitivity analyses run by BIS to complement the main findings of the two alternative policies considered. None of the tests changed the findings that will be compared in the cost-effectiveness section below.

Preset Value: This valuation technique discounts future costs at a 3.5% annual rate. This discount gives a lower weight to further ahead costs and it could make a difference to nominal valuations because the distribution of costs over time is different under the two options. In particular Research Councils Gold mandate option bears higher weight of costs in the early years, and thus would matter proportionally more in a present value estimate. The Present Values of total costs amount to £1.51bn for the benchmark (current state of open access in the UK) and to £1,94bn and £1,89bn respectively for the expanding quality (Gold Access) and expanding quantity (Research Councils Gold mandate) Gold mandate.

The difference between the two alternatives is smaller than in nominal terms, but it remains the case that Research Councils Gold mandate has a lower cost overall and achieves wider open access coverage.

Compliance: All policies have been evaluated assuming 100% compliance with either Gold Access for all UK open access publications or with Gold mandate for all Research Councils publications. Such an assumption is hypothetical and partial compliance would be a more realistic assumption. A minimum of 55% compliance would be needed for Research Councils Gold mandate to achieve higher coverage of open access. This would have a lower cost option than 100% coverage, which is already less expensive than the Gold Access option. Therefore, assuming partial compliance does not affect the ranking of options, unless compliance is expected to be lower than 55%.

Article Processing Charges: These have been kept constant at £2,000 per article so as to isolate the impact of policies strictly on the chosen effectiveness measure: coverage of open access. The same APC applies to both alternative options and thus a higher or lower APC would affect the total cost of both alternative policies but not the ranking in terms of cost-effectiveness. The distribution of costs across disciplines facing different APCs is an important matter for implementation.

Other costs: Only the main direct costs of accessing articles have been considered here. The Finch Report (2012) suggests that additional costs of managing access borne by libraries to make journals more accessible to users (procurement, receiving and indexing, archiving, management and administration, IT systems and library storage) could account for an additional £52m a year. The higher take up of open access induced by the Research Councils Gold mandate policy has the additional potential of reducing these costs, which are borne for non open access papers, and thus potentially offset some of the costs of the Gold mandate, in addition to lower subscription costs as discussed above.

Higher rate of world expansion of OA: The implementation of open access policies in the UK and elsewhere is increasing the take up rates. In an update of previous estimates, Laakso et al (2012) obtain higher rates of expansion of open access (Green and Gold) world wide than in a previously (2011). In this modelling framework, higher rates of expansion of open access elsewhere would have an impact on subscription levels, which grant access to articles that are not open access world-wide (including the UK). The impact would be the same in both policies and thus this would not affect their ranking in terms of cost-effectiveness.

Distribution of costs internally: This is the most interesting element of sensitivity looking forward. At the time of this evaluation there was not enough information to carry out any analysis of the distribution of incidence of and costs borne by different disciplines or different funders of research. It is unclear whether the impact would be different across the two alternatives considered and whether this would change the ranking of policy options.

8. Cost-Effectiveness Analysis

Expanding public access to scholarly research has the potential of speeding up growth through enhanced innovation in an open and collaborative environment (BIS Economics

Paper No 15, 2012). Open access encourages diversity and horizontal exploration of applications (Murray, 2009), implicitly fostering multi-disciplinarity and collaboration. Although the benefits of open access have proven difficult to quantify in monetary terms, because of the positive externalities it carries, it is arguably at a suboptimal level and this warrants policy intervention to expand open access to publicly funded scholarly research.

Open access is expanding rapidly and it is already incurring costs for the UK economy, not all of which are borne by the public sector. Expanding access beyond the current state would incur additional costs:

Under assumptions of constant growth in publications and open access, and in the absence of any policy, the UK would spend a cumulative total of £1,8bn in the decade from 2011 to 2020 in already organically growing open access to UK research, to deliver 51% of UK publications in open access (Gold and Green) by 2020.

Improving access to the organically growing open access so that it is all fully mineable and accessible would cost £2.3bn over the decade 2011 to 2020. This is an additional £500m over a decade to grant fully accessible and text mineable on publication for 51% of UK publications by 2020.

The alternative to improving the quality of access to maximise use is to increase the coverage of open access, leaving the quality of accessibility to the market. Coverage would be increased if a policy mandate was provided for all publications funded by Research Councils to be accessible in Gold access. A minimum of 55% compliance is needed for this policy to expand Gold and Green access over the alternative option. A 100% compliance policy would incur cumulative costs of £2.2bn over the decade 2011-2020, to deliver an increased level of open access (Gold and Green) coverage of 64% by 2020, granting full access to at least Research Councils funded publications. This is an additional £400m in total over the decade, with a slightly higher weight of costs in the initial years, but altogether cheaper than the alternative.

These estimates indicate that the Research Councils Gold mandate has the potential of delivering better cost-effectiveness than the alternative if paid for with public funds. The reason for this superiority is that a Research Councils policy would involve publications growing more slowly than organically growing open access, after an initial step change. The cost (even including the initial step change) for the slower growing publication stream bears lower deadweight because the faster growing publication stream would happen anyhow and would be financed from outside the policy.

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