EXPLORING THE COSTS AND BENEFITS OF ALTERNATIVE PUBLISHING MODELS

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Abstract

This paper reports findings from a project undertaken for the Joint Information Services Committee (JISC) in the UK which explored the Economic Implications of Alternative Scholarly Publishing Models [1]. The aim of the project was to examine the costs *and* potential benefits of the major emerging models for scholarly publishing, including subscription publishing, open access publishing and self-archiving. To ensure that cost-benefit comparisons can be made, analysis focuses on self-archiving models that include the certification and quality control functions necessary for formal scholarly publishing, namely (*i*) 'Green OA' self-archiving in parallel with subscription publishing and (*ii*) the deconstructed or overlay journals model in which self-archiving provides the foundation for overlay journal services. Adopting a formal approach to modelling the process and identifying activity costs, this paper examines scholarly communication life-cycle costs per article. It concludes that different scholarly publishing models can make a material difference to returns to R&D expenditure as well as the costs faced by various stakeholders. It seems likely that more open access would have substantial net benefits in the longer term and, while net benefits may be lower during a transitional period, they are likely to be positive for both open access publishing and self-archiving alternatives.

Keywords: scholarly publishing; open access; economics; cost-benefit analysis; alternative business models.

1. Introduction

A knowledge economy has been defined as one in which the generation and exploitation of knowledge has come to play the predominant part in the creation of

wealth. It is not simply about pushing back the frontiers of knowledge; it is also about the more effective use and exploitation of all types of knowledge in all manner of economic activities [2]. In a knowledge economy, innovation and the capacity of the system to create and disseminate the latest scientific and technical information are important determinants of prosperity [3]. Scholarly publishing plays a key role as it is central to the efficiency of research and to the dissemination of research findings and diffusion of scientific and technical knowledge. However, advances in information and communication technologies are disrupting traditional publishing models, radically changing our capacity to reproduce, distribute, control and publish information. In such an environment, one key question is whether there are new opportunities and new models for scholarly publishing that might better serve researchers and more cost-effectively communicate and disseminate research findings [4].

To date, debate on the economics of scholarly publishing and alternative publishing models has focused almost entirely on costs. From an economic perspective, however, the aim should be to have the most cost-effective system, not (necessarily) the cheapest, and however much one studies costs one cannot know which is the most cost-effective system until one examines both the costs and the benefits. The aim of the JISC EI-ASPM Project was to examine both costs *and* benefits, and in so doing to inform policy discussion and help stakeholders better understand the economic implications of alternative models for scholarly publishing [5].

The JISC EI-ASPM Project relied primarily on existing sources, collating activity cost information from a wide-ranging literature on scholarly publishing [6]. Where necessary, these sources were supplemented by informal consultation with experts in the field (*e.g.* in relation to scholarly book publishing, book distribution and discounts, library purchasing practices, repository operations and statistics, etc.). The project report presented a summary of the estimated costs and benefits, together with a full disclosure of sources and modelling assumptions. An simplified version of the JISC EI-ASPM Model has been made available online so that interested parties can explore the impacts of alternative assumptions, variables and costings [7].

2. Publishing models

The JISC EI-ASPM study focused on three emerging models for scholarly publishing, namely: subscription publishing, open access publishing and self-archiving. As self-archiving, of itself, does not constitute formal publication analysis focused

on two publishing models in which self-archiving is complemented by the peer review and production activities necessary for formal publishing, namely: (*i*) Green OA self-archiving operating in parallel with subscription publishing; and (*ii*) the deconstructed or overlay journals model in which self-archiving provides the foundation for overlay journals and services (*e.g.* peer review, branding and quality control services) which depend on repositories to provide registration, awareness, access and archiving. Thus all of the publishing models explored include the key functions of scholarly publishing (*i.e.* registration, certification, dissemination/awareness and preservation).

These publishing models are not necessarily alternatives. For example, self-archiving may depend on subscription publishing for peer review (*e.g.* 'Green OA'), and open access publishing does not prevent self-archiving (*e.g.* the self-archiving of pre-prints). There are also a number of variations, hybrids and alternatives (*e.g.* delayed open access, open choice/author choice, etc.). Moreover, in practice, models co-exist in various mixes in different fields of research. Nevertheless, these models do have some key defining characteristics, and these characteristics have cost implications for producers, intermediaries and the users and consumers of content, as well as for the flow of funds between them and the benefits each receives. They also have implications for the efficiency of research, the accessibility of research findings and their impacts, and thereby, for returns on investment in R&D.

2.1. Subscription or toll access publishing

Subscription or toll access publishing refers to journal (and database) publishing and includes individual subscriptions and the so called Big Deal – where institutional subscribers pay for access to online aggregations (*e.g.* of journal titles) through consortial or site licensing arrangements. In a wider sense, subscription or toll access publishing includes any publishing business model that imposes reader access tolls and restrictions on content use designed to maintain publisher control over that access in order to enable the collection of those tolls.

The key characteristics of subscription or toll access scholarly publishing include:

- A primary focus on scholarly journals and journal articles, although publishing research monographs is also characteristically toll access;
- Quality control, with much of the content being peer reviewed prior to publication;
- Reader access requires a toll payment by the reader or an intermediary (*e.g.* research libraries);
- Authors do not typically pay for publication, although in some fields it is quite common for publishers to levy page or plate charges;

- Publisher intellectual property requirements and/or licensing conditions set limitations on access to and use of the content;
- Online access to a particular publisher's titles is typically provided through proprietary access systems and/or access restricted websites.

2.2. Open access

Definitions of Open Access vary with major statements, such as The Budapest Open Access Initiative, The Bethesda Statement and The Berlin Declaration, developing the core concepts over time. Referring to these collectively as the 'BBB' definition, Peter Suber (2007) suggested that open access removes price barriers (*e.g.* subscription fees) and permission barriers (*e.g.* copyright and licensing restrictions) to royalty-free literature (*i.e.* scholarly works created for free by authors), making them available with minimal use restrictions (*e.g.* author attribution) [8]. The key characteristics being free online access with minimal use restrictions.

Bailey (2006) noted several key points. First, open access works are freely available. Second, they are online, which would typically mean that they are digital documents available on the Internet. Third, they are scholarly works – romance novels, popular magazines, self-help books, and the like are excluded. Fourth, the authors of these works are not paid for their efforts [perhaps, more accurately, not paid for the content]. Fifth, since most (but not all) authors of peer-reviewed journal articles are not paid and such works are scholarly, these articles are identified as the primary type of open access material. Sixth, there are an extraordinary number of permitted uses for open access materials. Aside from the requirements of proper attribution of the author and the assurance of the integrity of the work, users can copy and distribute open access works without constraint. Seventh, there are two key open access strategies: open access journals and self-archiving [9].

2.2.1. Open Access publishing

Open Access publishing (OA publishing) refers to journal publishing and includes situations where authors, their employing or funding organizations or other supporters contribute to the costs of publication in open access journals in the form of submission and/or publication payments (*i.e.* 'author-pays'), and/or sponsor and support the operation of journals that are free to both readers and authors (*i.e.* do not charge 'author fees').

The key characteristics of OA publishing include:

- A primary focus on scholarly journals and journal articles, although OA scholarly book publishing is now emerging;
- Quality control, with much of the content being peer reviewed prior to publication;

- Toll-free reader access to the online version of journal articles or books for anyone with Internet access;
- Authors, their funders or supporting institutions may be required to pay publication fees (*e.g.* in the 'author-pays' model), although often they are not;
- Less restrictive conditions are placed on use, although practices vary depending on publisher choice – with some publishers demanding copyright while others adopt more flexible licensing alternatives (*e.g.* creative commons or similar licensing).

A key distinction is that between OA journals that impose publication charges (*i.e.* 'author-pays') and those that do not.

There are also a number of hybrids, such as: delayed open access (*i.e.* where journals allow open access after a period during which articles are accessible to subscribers only); open choice / author choice (*i.e.* where authors can choose to pay author fees and make their works open access, or not to pay and make their works subscription only); and online open access (*i.e.* where journals allow free access to the online edition, while charging subscription fees for the print edition). Willinsky (2007) also mentioned 'development open access' (*i.e.* where journals provide free access for organisations and/or individuals in developing countries), and referred to subscription journal publishers that allow self-archiving as 'archival open access' [10].

The key characteristics of such models relate to the speed of access and delay imposed, uncertainty as to access for readers due to the mix of open and closed material, the variety of practices regarding imposition of copyright and use limitations versus the adoption of creative commons or similar licensing, and placement of the material in proprietary publishers' access systems used for subscription publishing. As a result, many of these hybrid and transitional models cannot be considered to meet widely accepted definitions of open access (*i.e.* available free, immediately and with minimal restrictions on use).

2.2.2. Self-archiving

Self-archiving (OA self-archiving) refers to the situation where authors deposit their work in institutional and/or subject repositories (it may also refer to making material available on personal and/or institutional websites and other forms of free online communication). OA repositories are typically either subject or discipline based, offering open and free access to pre-print and/or post-print papers (and other content) in a particular discipline or subject area, or institutionally based, offering the same level of open and free access to the work and outputs of particular institutions (*e.g.* a university or research institute). Institutional repositories may also perform other related knowledge management functions within the institu-

tion (*e.g.* holding collections for research management and reporting, open courseware and course-packs, etc.). Subject repositories tend to focus more on pre- and post-prints and work that has been subjected to editorial and/or peer review, while institutional repositories tend to be somewhat more varied in their content and levels of review [11].

The key characteristics of OA self-archiving include:

- Accommodation of a wider range of outputs than journals and journal articles alone;
- Limited quality control, with a mix of peer reviewed and non-peer reviewed content (*e.g.* pre- and post-prints), although some editorial oversight of postings is common;
- Toll-free access for authors *and* readers;
- Authors may grant greater freedom of use (*e.g.* creative commons or similar licensing), although practices vary considerably;
- Enhanced discoverability, with subject and institutional repositories providing metadata and adopting standards that ensure the material is discoverable through general purpose web searchers as well as specialised searchers (*e.g.* OAI-PMH).

Material deposited in such repositories may include journal articles prepared for and/or submitted for publication (*i.e.* pre-prints), articles that have been accepted for publication and/or published (*i.e.* post-prints), and/or a range of other research outputs, such as working papers, pre- or post-print book chapters or entire books, project reports, field or laboratory reports, and a range of research-related non-text digital objects, such as sound or image files, data collections, models, software, etc. as well as theses and dissertations, course material and learning objects. However, of itself, self-archiving does not constitute formal publication, except when it is formal publications that are self-archived (*e.g.* post-print journal articles, book chapters and books, etc.). Self-archiving other materials is a mechanism for the communication and the dissemination of informally-published and unpublished works.

Self-archiving can take a number of forms, running in parallel with other forms of formal publishing or, possibly, in time, operating as an alternative. On the, so called, *green road* to open access, self-archiving involves the deposit (typically by the author) of the final author's copy or final publisher's copy of a work, depending on publisher permissions, following its acceptance for publication – with OA repositories and existing journals operating as complementary parts of an evolving system wherein repositories provide registration, awareness, access and archiving, while journals provide certification through peer review and often parallel the other functions. In its *deconstructed* or *overlay* form, self-archiving provides the foundation for overlay journals and services (*e.g.* peer review, branding and qual-

ity control services), which depend on OA repositories to provide registration, awareness, access and archiving, while adding value to their content through quality control – but *not* paralleling the other functions [12].

To ensure that cost-benefit comparisons can be made, this paper focuses on those self-archiving models that include the certification and quality control functions necessary for formal scholarly publishing, namely: (*i*) Green OA self-archiving operating in parallel with subscription publishing; and (*ii*) the deconstructed or overlay journals model in which self-archiving provides the foundation for overlay journal services.

3. Identifying costs and benefits

The first phase of the JISC EI-ASPM Project sought to describe the three models of scholarly publishing, identify all the dimensions of cost and benefit associated with each of the models, and examine which of the main players in the scholarly communication system would be affected and how they would be affected by the use of alternative publishing models. In order to provide a solid foundation for analysis we developed and extended the scholarly communication life-cycle model outlined by Björk (2007) [13].

3.1. Identifying costs: The scholarly communication process model

Björk (2007) developed a formal model of the scholarly communication life-cycle to act as a roadmap for policy discussion and research concerning the process. Based on the IDEF0 process modelling method, often used in business process re-engineering, it provided the first detailed 'map' of the scholarly publishing process. Björk's central focus was the single publication (primarily the journal article), how it is written, edited, printed, distributed, archived, retrieved and read, and how eventually its reading may affect practice. Björk's model included the activities of the: researchers who perform the research and write the publications; publishers who manage and carry out the actual publication process; academics who participate in the process as editors and reviewers; libraries who help in archiving and providing access to the publications; bibliographic services who facilitate the identification and retrieval of publications; readers who search for, retrieve and read publications; and practitioners who implement the research results directly or indirectly [14].

Extending the model outlined by Björk (2007), the scholarly communication process model developed for the JISC EI-ASPM Project includes five core scholarly

communication process activities, namely: (*i*) fund research and research communication; (*ii*) perform research and communicate the results; (*iii*) publish scientific and scholarly works; (*iv*) facilitate dissemination, retrieval and preservation; and (*v*) study publications and apply the knowledge (Figure 1). This formal process modelling was used to identify activities and activity costs, and in its current form the model includes 53 diagrams and 190 activities. Details of the entire model in 'browseable' form can be found on the Web at http://www.cfses.com/EI-ASPM/SCLCM-V7/.

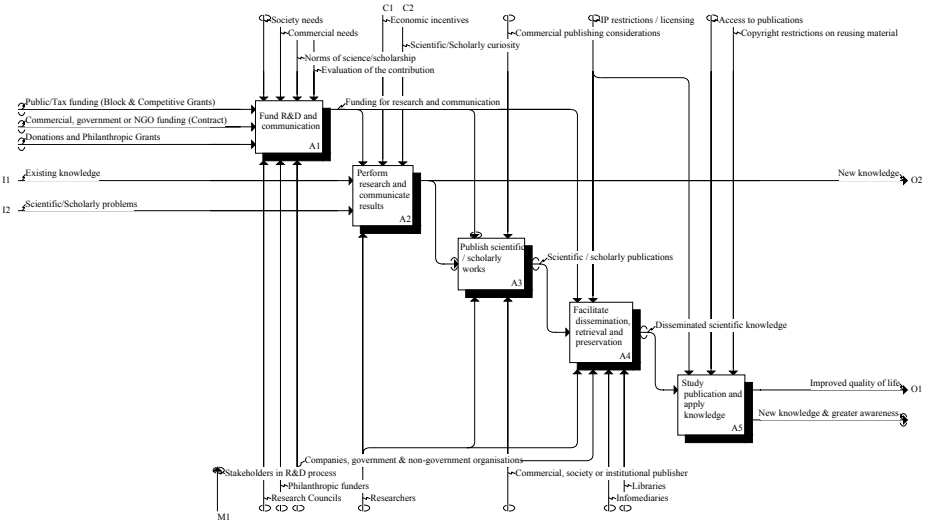

Figure 1: The scholarly communication process: Fund research, perform research, publish scientific and scholarly works, disseminate and preserve, study and apply.

3.2. Identifying benefits: Dimensions of impact and benefit

There are various ways to explore the impacts and possible benefits of different scholarly publishing models. Focusing on access and use, Houghton *et al.* (2006) noted that potential benefits include impacts relating to research use, industry and government use, and use by the wider community [15]. They suggested that the most immediate impacts would be felt within research, wherein potential benefits include:

- Speed of access, speeding up the research and discovery process, reducing the time and cost involved in achieving a given outcome and, thereby, improving the efficiency of R&D;
- More complete access, leading to better informed research, reducing the pursuit of blind alleys and duplicative research, saving wasteful R&D expenditure and, thereby, improving the efficiency of R&D;

- Wider access, providing enhanced opportunities for multi-disciplinary research, inter-institutional and inter-sectoral collaborations, and enabling researchers to study their context more broadly, potentially leading to increased opportunities for application and commercialisation;
- Greater public access, potentially leading to improved research education outcomes and enabling a given education spend to produce a higher level of educational attainment, leading to an improvement in the quality of the 'stock' of researchers and research users.

Given relative levels of access under the subscription or toll access publishing system, Houghton *et al.* (2006) suggested that the impacts of enhanced access for industry and government users may also be significant, with potential benefits including:

- The potential for wider access to both accelerate and widen opportunities for adoption and commercialisation of research findings, thereby increasing returns on (public) investment in R&D and reducing the cost of (private) investment in its commercialisation;
- The potential for wider access for doctors and nurses, teachers and students, smaller firms in knowledge-intensive industries, such as consulting, engineering, architecture and design, electronics, software, biotechnology, nanotechnology, etc., with a positive impact on quality of service, innovation and productivity in those sectors of the economy; and
- The potential for the emergence of new industries based on readily accessible content (as happened with the Weather Derivatives industry based on meteorological data) [16], with potential for the emergence of value adding services overlaying the content (*e.g.* peer review services, bibliometrics and webometrics for research evaluation, etc.).

Impacts might be felt more in particular industries (*e.g.* knowledge intensive services, biotechnology, etc.). Impacts in such areas as management and economic consulting and engineering might be significant, raising the quality of advice to the benefit of clients across the economy. There may also be significant impacts on policy development, through more informed policy debate and enhanced access to the 'science' underpinning policy decisions. One particularly important dimension might be the potential for greater access for small firms, enabling them to do more research internally, thereby increasing their 'absorbtive capacity' and enabling them to be more innovative [17].

In relation to the wider community, Houghton *et al.* (2006) suggested that benefits might include the potential contribution of enhanced access to the 'informed citizen' and 'informed consumer', with implications for better use of health and education services, and better consumption choices leading to greater welfare benefits.

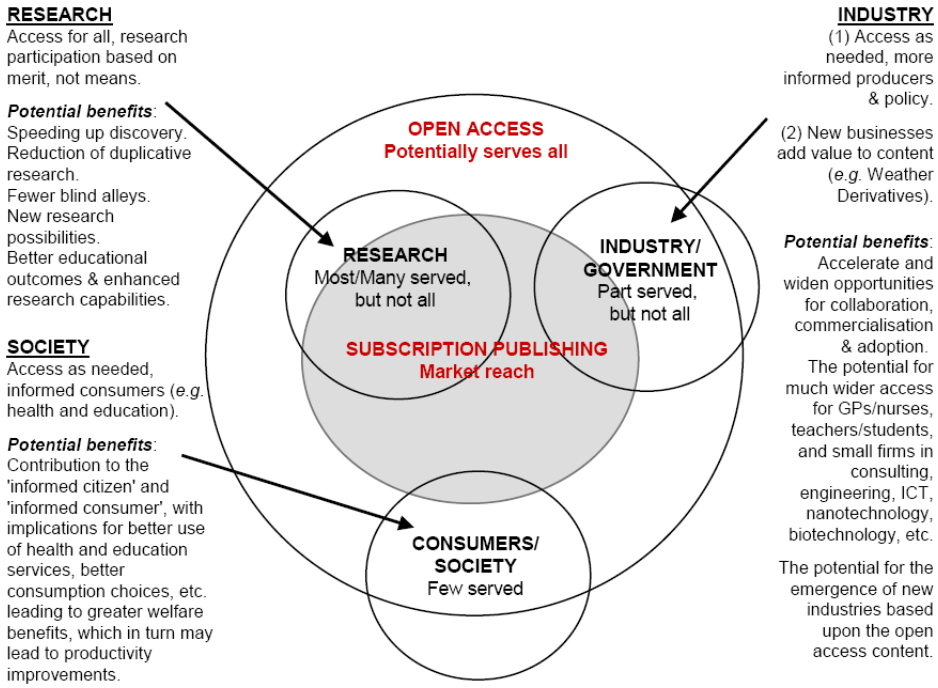

Figure 2: An impacts framework: subscription publishing versus open access.

While providing a useful starting point, their analysis focused on use impacts and did not explore the production-side impacts fully or explicitly. The key issues in open access are access and permission – where *access* includes accessibility in the sense of ease and affordability (time and cost), and *permission* refers to permission to use the material in terms of what is permitted and the time and cost involved in checking and obtaining permission. This suggests analysis along the overlapping dimensions of access and permission, mediated by cost in terms of both money and time. In essence, setting the publishing models against the 'ideal' of open access (*i.e.* for free, immediate and unrestricted access) by exploring the time and cost involved in accessing and using scientific and scholarly works and whenever required for whatever purpose (Figure 3).

Drawing on a number of previous reviews and following an established lead, Martin and Tang (2007) explored seven mechanism or channels through which the benefits of publicly funded research may flow through to the economy or to society more generally, namely:

1. An increase in the stock of useful knowledge;
2. The supply of skilled graduates and researchers;
3. The creation of new scientific instrumentation and methodologies;
4. The development of networks and stimulation of social interaction;

5. The enhancement of problem solving capacity;
6. The creation of new firms;
7. The provision of social knowledge [18].

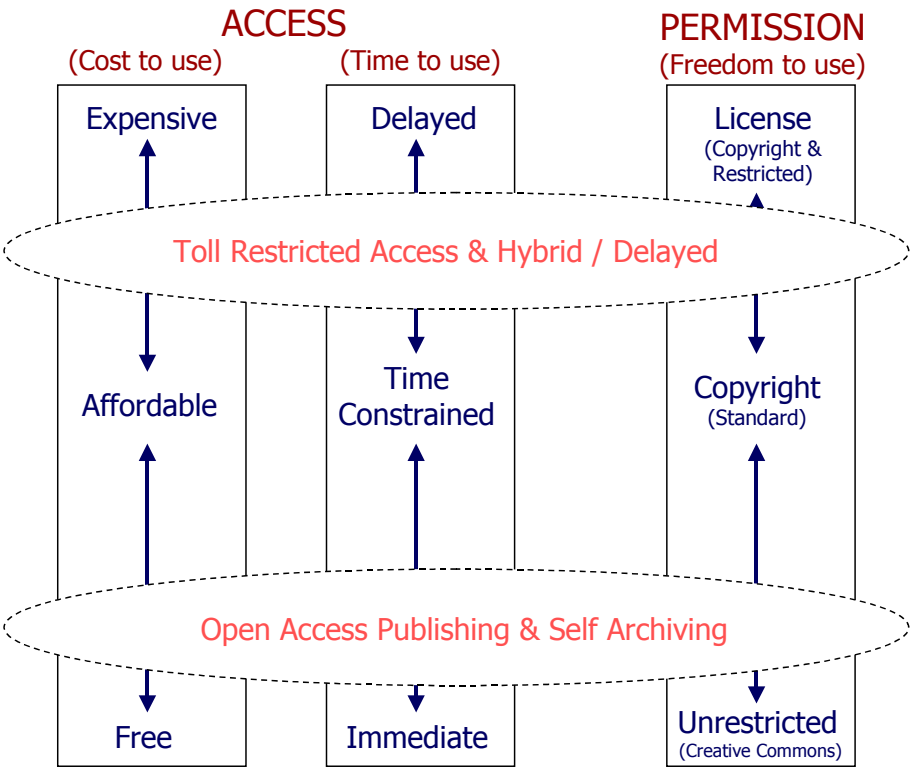

Figure 3: Dimensions of impact and benefit: access and permission.

Enhanced access and reduced permissions barriers are important in all of these (arguably, with the exception of number 3). More open and less restricted access would effectively increase the stock of useful knowledge that is accessible to would-be users; contribute through impacts on education to enhancing the supply and skills of researchers; enable the development of networks on the basis of a shared, common and complete set of information; enhance problem solving capacity by providing the necessary supporting information; enable the provision of a range of social knowledge (*e.g.* in health care); and provide opportunities for the emergence of new firms and new industries (as noted above).

Of course, the principal input to the process of performing research and communicating the results is existing knowledge, as the production of knowledge depends, in large part, on its consumption. Hence, costs and benefits on the pro-

duction-side also relate, in large part, to access and permission – the costs associated with limiting and managing access, copyright, licensing and permissions; and the cost savings (benefits) of not doing so. Indirect benefits also relate, in large part, to access and permission – the greater use, higher profile and higher impact/return for funders, researchers and research institutions, publishers and those facilitating dissemination, retrieval and preservation. Access and permission, therefore, are crucial to the overall efficiency of the scholarly communication system.

Hence, our approach to exploring and quantifying costs, impacts and benefits is twofold. First, a detailed 'bottom up' costing which provides a foundation for the estimation of cost savings and the development of scenarios exploring impacts and benefits. Second, a 'top down' modelling of impacts on returns to R&D through further development and application of the modified Solow-Swan model outlined in Houghton *et al.* (2006) and Houghton and Sheehan (2006; 2009), which introduced *accessibility* and *efficiency* into the standard model as negative variables, in order to explore the impact of increasing accessibility and efficiency on returns to R&D expenditure [19].

4. Quantifying costs and benefits

There are three elements to our approach to quantifying costs and benefits. First, we explore the costs of the process activities and system costs, and from that we can see cost differences and direct savings. Second, we present cases and scenarios to explore the potential cost savings resulting from alternative publishing models (looking, for example, at impacts on search and discovery, library handling costs, etc.), and from that we can explore the indirect cost differences. Third, we approach the issue from the top down and model the impact of changes in accessibility and efficiency on returns to R&D. This paper presents an example from each of these steps.

4.1. Estimating process activity and system costs

In the first of these steps, we produce detailed costings of activities with a focus on cost differences between the three publishing models. One key challenge is to separate the cost impacts of publishing models from those of publishing format, so that we can explore the cost differences between toll and open access publishing business models independent of differences between print and electronic production. Our approach is to estimate costs for print, dual-mode (*i.e.* parallel print and

electronic production) and electronic-only formats for toll and open access business models, and then to compare toll and open access models as if they were all electronic or 'e-only'. All of the costings included commercial publisher management, investment and operating margins. A summary of the journal publisher activities costed can be found in Annex I.

For subscription or toll access publishing, we estimate an average publisher cost of around £3,247 per article for dual-mode production, £2,728 per article for print only production and £2,337 per article for e-only production. All of these exclude the costs associated with external peer review and value-added tax (Figure 4). For open access publishing, we estimate average per article costs at £1,524 for e-only production. We explored the implied publisher costs of overlay services to open access self-archiving (*i.e.* the deconstructed or overlay journals model) using the same commercial management, investment and profit margins, and found that operating peer review management, editing, production and proofing as an overlay service would cost around £1,125 per article excluding hosting, or £1,260 including hosting.

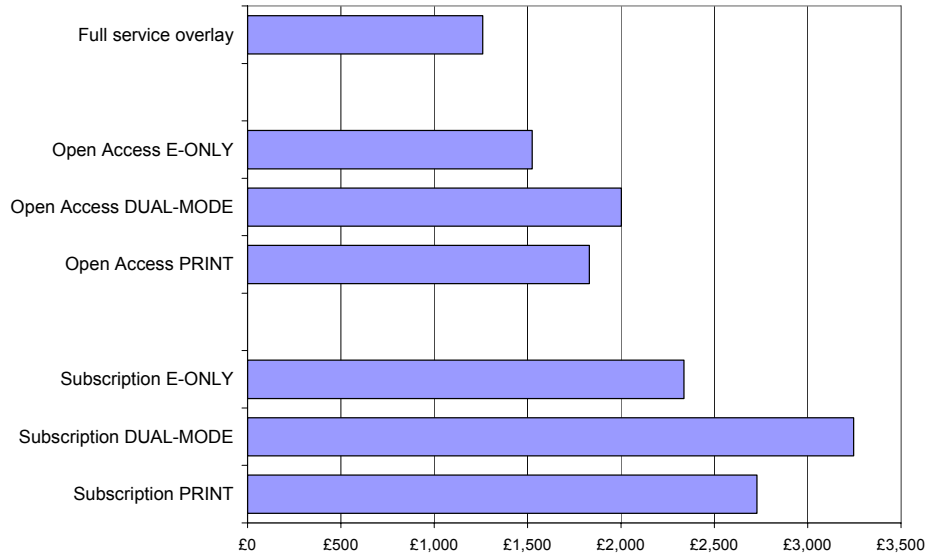

Figure 4: Estimated average publisher costs per article by format and model (GBP, circa 2007) [20].

Not surprisingly, the cost difference between print and electronic formats is often greater than the difference between toll and open access publishing models. One example is that of estimated UK higher education library handling costs (Figure 5), for which the difference between toll access print and e-only is much greater than

the difference between toll and open access models in e-only form. Based on activity times reported in library activity surveys [21], we estimate SCONUL library journal handling costs at £112 per title per year for subscription journals in print format, £28 per title for subscription journals in e-only format and £20 per title for open access e-only journals. Of course, this assumes that research libraries continue to play a role in facilitating access to open access journals, in cataloguing and linking, user instruction and so on.

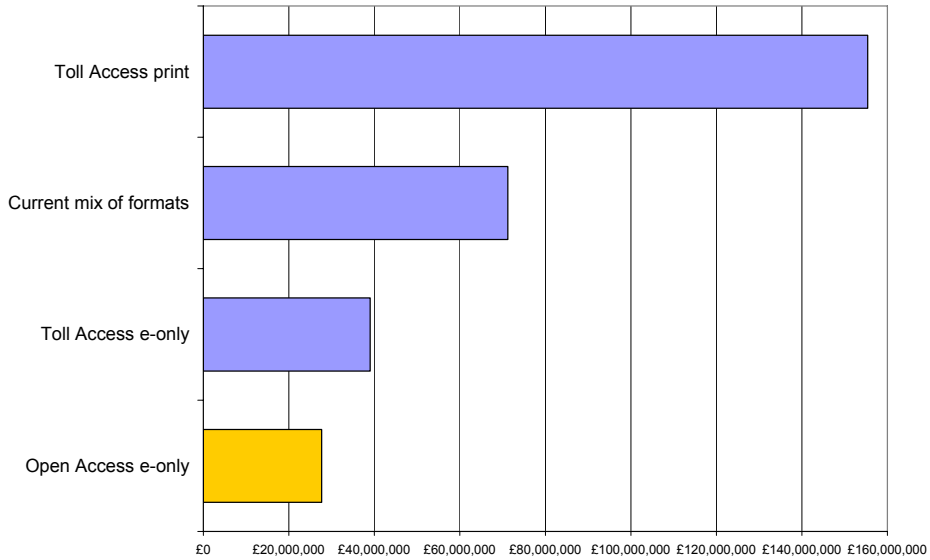

Figure 5: Estimated SCONUL library handling costs by mode and model (UK Higher Education, 2006-07).

At 2006-07 subscription levels, we estimate that journal handling activities alone would have cost SCONUL libraries £155 million if they had all been print subscriptions, £39 million if they had all been e-only subscriptions, and £28 million if they had been open access e-only. The mix of formats acquired by SCONUL libraries in 2006-07 is estimated to have involved journal handling costs of around £70 million. Hence, in an open access world, a shift to open access journal publishing could save SCONUL libraries around £44 million a year in handling costs, in addition to subscriptions expenditures of around £113 million.

4.2. Estimating system costs, cost differences and savings

In the second of the three steps, we sum the costs of the three publishing models through the main phases of the scholarly communication life-cycle, including re-

search production, publisher, and library and dissemination activities, to highlight system cost differences. From this we can estimate potential cost savings from the alternative publishing models.

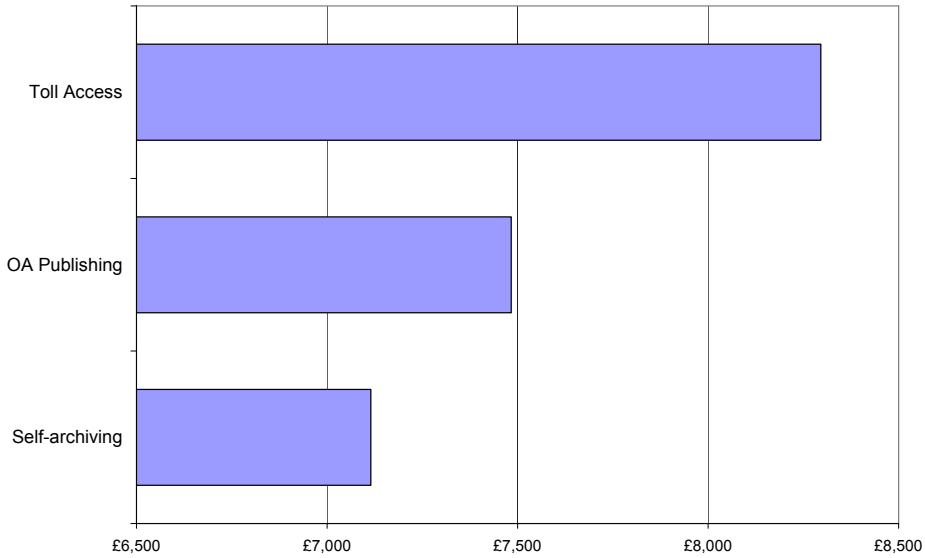

Figure 6: Estimated scholarly communication system costs per article (GBP, circa 2007) [22].

Summing the costs of production, publishing and dissemination *per article* in electronic-only format suggests that average subscription or toll access publishing system costs would amount to around £8,296 per article (excluding VAT), average open access publishing costs would amount to £7,483 per article and average open access self-archiving costs would amount to £7,115 per article (including overlay review and production services with commercial margins). At these costs, open access publishing would be around £813 per article cheaper than subscription or toll access publishing, and open access self-archiving with overlay services around £1,180 per article cheaper (Figure 6). For the journal article output of UK higher education in 2007, these journal article cost differences would have amounted to savings of around £80 million per annum from a shift from subscription access to open access publishing, and £116 million per annum from a shift from subscription access to open access self-archiving with overlay services.

In addition to direct cost differences, there are potential system cost savings in the discovery, access, dissemination and use of the content. Based on the cases and scenarios explored in the JISC EI-ASPM study we estimate that open access publishing for journal articles might have brought system savings of around £215 million per annum nationally in the UK (at 2007 prices and levels of publishing

activity), of which around £165 million would have accrued in higher education. The open access self-archiving with overlay services model explored in the study is necessarily speculative, but a repositories and overlay services model may well produce greater cost savings than open access publishing – with our estimates suggesting system savings of perhaps £250 million nationally, of which around £200 might have accrued in higher education.

These savings can be set against the cost of open access publishing, which if all journal articles produced in the UK had encountered author fees of £1,500 per article published would have been around £170 million nationally in 2007, of which around £150 million would have been faced by higher education institutions. While repository costs vary widely, we estimate that a system of publications-oriented repositories in which all articles were self-archived once would have cost around £22 million nationally, of which £18 million would have been for higher education.

4.3. Comparing estimated costs and savings

In simplified form, the following figures summarise the estimated impacts for the UK nationally and for UK higher education of unilateral national and worldwide adoption of alternative open access publishing models, including (*i*) 'Green OA' self-archiving, (*ii*) 'Gold OA' or author-pays journal publishing, and (*iii*) self-archiving with overlay services (*i.e.* the deconstructed or overlay journals model). Increased returns are from public sector and higher education R&D spending expressed as annual increases in current values [23]. As many of the potential cost savings could not be fully realised unless there was worldwide open access and all scholarly articles were open access, research and library handling cost savings are scaled to UK article outputs in the unilateral national open access scenarios.

Separating modelled increases in returns to R&D resulting from enhanced access from the cost impacts, these figures also present the net cost impacts of the alternative publishing models. Where net cost is negative it represents a saving, and where positive it represents a cost (*i.e.* effectively the investment required to obtain the increased returns). For example, at 2007 prices and levels of publishing activity, it is estimated that unilateral 'Green OA' in the UK would have brought net benefits of £114 million per annum from higher education but would have required an additional cash spend of £10 million, whereas with worldwide 'Green OA' the net benefits would have been £182 million as a part of which there would have been a cost saving in higher education of £57 million (Figure 7).

These comparisons of costs and cost savings suggest that in an open access world cost savings alone are likely to be sufficient to pay for open access journal publishing or self-archiving alternatives, independent of any possible increase in

returns to R&D that might arise from enhanced access. Thus, it seems possible that in an open access world open access publishing alternatives could be supported from within existing budgetary allocations [24].

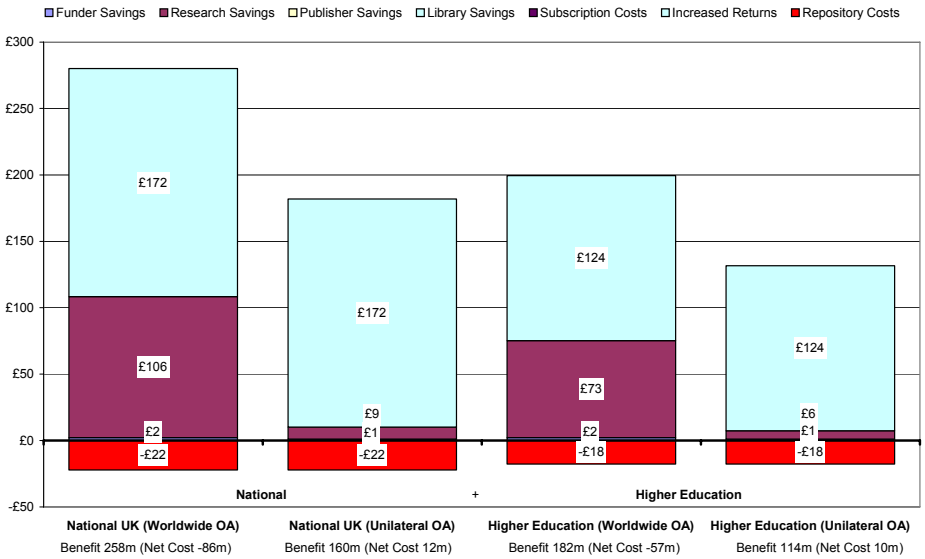

Figure 7: Estimated cost impact of "Green" OA self-archiving (GBP millions per annum).

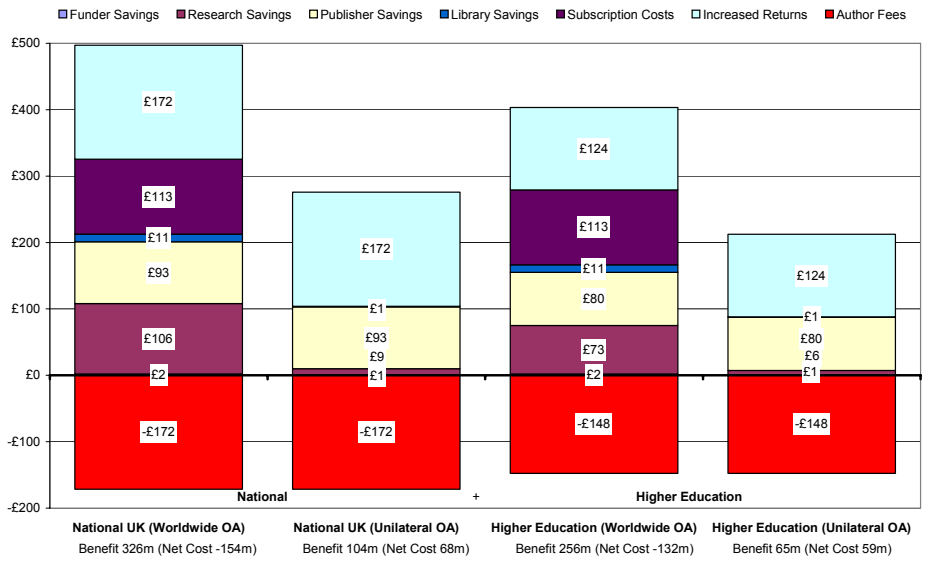

Figure 8: Estimated cost impact of "Gold" OA publishing (GBP millions per annum).

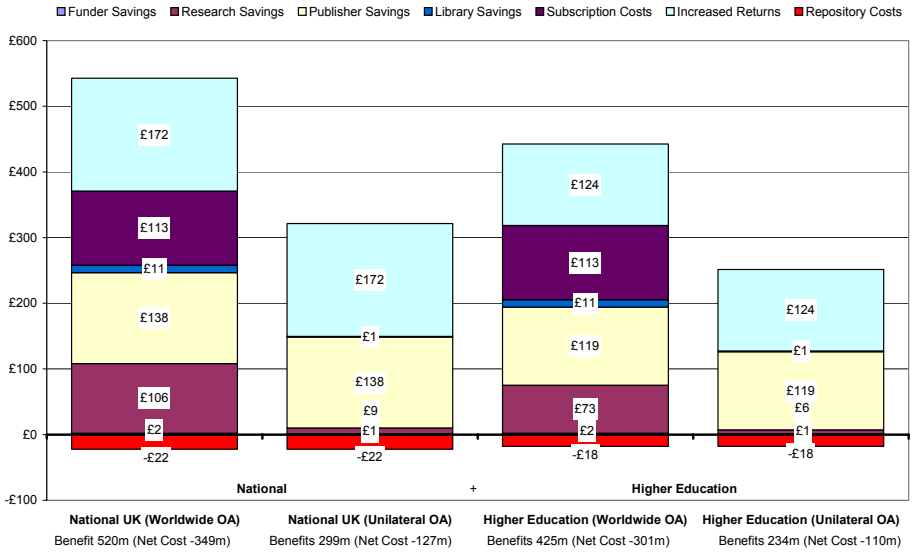

Figure 9: Estimated cost impact of OA self-archiving with overlay services (GBP millions per annum)

4.4. Estimating the impact of more open access on returns to R&D

In the third of the three major steps we modify a basic Solow-Swan model to estimate the impacts of changes in accessibility and efficiency on returns to R&D [25]. The standard Solow-Swan approach makes some key simplifying assumptions, including that:

- All R&D generates knowledge that is useful in economic or social terms (*efficiency of R&D*);
- All knowledge is equally accessible to all entities that could make productive use of it (*accessibility of knowledge*); and
- All types of knowledge are equally substitutable across firms and uses (*substitutability*).

A good deal of work has been done to address the fact that the substitutability assumption is not realistic, as particular types of knowledge are often specialised to particular industries and applications. Much less has been done about the other two, equally unrealistic, assumptions. Addressing these, we introduce *accessibility* and *efficiency* as negative or friction variables, to reflect the fact that in the real world there are limits and barriers to access and to the efficiency of production and usefulness of knowledge. Then we explore the impact on returns to R&D of reducing the friction by increasing accessibility and efficiency [26].

We produced range estimates, looking at rates of return from 20% to 60% and increases in access and efficiency of 1% to 10%, and produce a table for each major

category of R&D expenditure (Table 1). The ranges are quite large, but for the purposes of discussion based on an extensive review of the literature, we take the lower bound average 20% social return on public sector R&D and suggest that a 5% increase in accessibility and efficiency might be plausible. Despite limitations in models of this type these model parameters are well grounded, and if anything, err on the conservative side [27]. For example, the percentage change in *accessibility* and *efficiency* is based on metrics relating to: the share of publications in general and journals in particular in the research stock of knowledge; the share of the research stock of knowledge potentially available to open access; a number of proxy measures of accessibility, including UK research library subscriptions and conservative estimates of the open access citation advantage; and a number of estimates of the potential efficiency implications of access limitations, such as poorly informed and duplicative research, and of relaxing those limitations, such as speeding up the research and discovery process and facilitating greater collaboration.

Higher Education R&D spending in 2006		*Rate of return to R&D*				
£6,062 million		20%	30%	40%	50%	60%
Per cent change in accessibility and efficiency		Recurring annual gain from increased accessibility & efficiency (millions)				
	1%	24	37	49	61	73
	2%	49	73	98	122	147
	5%	*124*	186	249	311	373
	10%	255	382	509	637	764

Table 1: Impact estimation ranges: UK Higher Education Expenditure on R&D (GBP millions, 2006).

Rates of return to R&D spending vary considerably, so the further one moves from the aggregate the larger the range of uncertainty. Nevertheless, given a 20% rate of return to public sector R&D, for the major categories of research expenditure in the UK in 2006 a 5% increase in accessibility and efficiency would have been worth:

- £172 million a year in increased returns to public sector R&D;
- £124 million a year in increased returns to Higher Education R&D (Table 1); and
- Around £33 million a year in increased returns to UK Research Councils competitive grants funded research.

Importantly, these are recurring annual gains from one year's R&D expenditure, so if the change that brings the increases in accessibility and efficiency is a permanent one, they can be converted to growth rate effects.

5. Comparing costs and benefits

It's not possible to compare subscription with open access publishing directly at the national level, because they perform very different roles: subscription publishing seeks to provide UK subscribers with access to worldwide research (to the limits of affordability); whereas open access seeks to provide worldwide access to UK research. These are very different things. Therefore, we explore the lower and upper bounds. First, we explore the cost-benefit implications of simply adding open access publishing and self-archiving to current activities, all other things remaining the same (*i.e.* ceteris paribus scenarios); and then we explore the implications of open access publishing and self-archiving as alternatives to current activities, by adding the estimated savings to estimated increases in returns to R&D (*i.e.* net cost scenarios) (Figure 10).

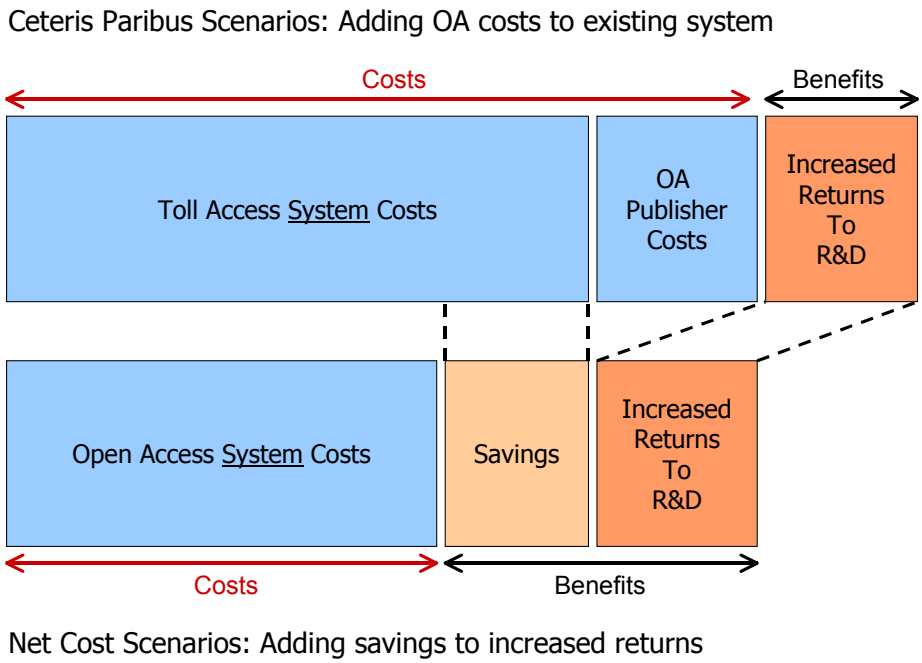

Figure 10: Conceptual map of benefit/cost scenarios.

One major issue in comparing costs and benefits over a period is whether to model the transitional period or a 'steady-state' alternative system. Because of the lag between research expenditure and the realisation of economic and social returns to that research, the impact on returns to R&D is lagged and the value of those returns discounted accordingly. This reflects the fact that a shift to open access pub-

lishing or self-archiving would be prospective and not retrospective, and that the economic value of impacts of enhanced accessibility and efficiency would not be reflected in returns to R&D until those returns were realised. Put simply, this has the effect that over a transitional period of 20 years one is comparing 20 years of costs with 10 years of benefits. An alternative approach would be to model a hypothetical 'steady-state' system for alternative publishing models in which the benefits of historical increases in accessibility and efficiency enter the model in year one. This would reflect the situation in an alternative system, after the transition had worked through and was no longer affecting returns to R&D. Put simply, in such a model one would be comparing 20 years of costs with 20 years of benefits.

We took the view that it was more realistic and of more immediate concern to model the transition. Nevertheless, it must be emphasised that a transitional model returns significantly lower benefit/cost ratios than would a hypothetical alternative 'steady-state' model. To explore the extent of the difference we 'force fed' our transitional model by simply putting the increase in returns to R&D into year one – effectively ignoring the lag between R&D expenditure and the realisation of impacts and thus simulating the situation in which the benefits of historical increases in accessibility and efficiency enter the model in year one. To an approximation, the increased returns in a steady-state model might be 3 to 10 times greater than in the transitional model.

The cost-benefit comparisons performed suggest that the additional returns to R&D resulting from enhanced accessibility and efficiency alone would be sufficient to cover the costs of parallel open access self-archiving without subscription cancellations (*i.e.* Green OA). When estimated savings are added to generate net costs there is a substantial increase in the benefit/cost ratios, and for both open access publishing and self-archiving (*i.e.* Gold OA as well as Green OA) the benefits exceed the costs, even in transition. Indicative modelling of post-transition 'steady-state' alternative systems suggests that, once established, alternative open access publishing and/or self-archiving models would produce substantially greater net benefits.

For example, during a transitional period we estimate that in an open access world: the benefits from increased returns to R&D resulting from open access publishing all journal articles produced in UK higher education would be around double the costs; the benefits of 'Green OA' self-archiving would be around seven times the costs; and the benefits from open access self-archiving with overlay editorial and peer review services would be more than 20 times the costs (Annex II). Indicative modelling of post-transition 'steady-state' alternative systems returns benefits of almost 6 times costs for open access publishing and more than 40 times the costs for the open access self-archiving alternatives (Table 2) [28].

Net Cost Scenarios	Costs	Benefits: Savings	Benefits: Increased returns	Benefit/ Cost Ratio
Ceteris Paribus Scenarios				
Transitional Model:				
OA Publishing in HE (unrealistic)	1,787	..	615	0.3
OA Publishing Nationally (unrealistic)	2,079	..	2,353	1.1
OA Repositories in HE	189	..	615	3.2
OA Repositories Nationally	237	..	2,353	9.9
Simulated Steady State Model:				
OA Publishing in HE (unrealistic)	1,787	..	6,876	3.8
OA Publishing Nationally (unrealistic)	2,079	..	26,318	12.7
OA Repositories in HE	189	..	6,876	36.3
OA Repositories Nationally	237	..	26,318	110.8
Net Cost Scenarios				
Scenario (Unilateral UK Open Access)				
Transitional Model:				
OA Publishing in HE	1,787	1,068	615	0.9
OA Repositories in HE (Green OA)	189	76	615	3.7
OA Repositories in HE (Overlay Services)	189	1,330	615	10.3
OA Publishing Nationally	2,079	1,261	2,353	1.7
OA Repositories Nationally (Green OA)	237	106	2,353	10.4
OA Repositories Nationally (Overlay Services)	237	1,563	2,353	16.5
Simulated Steady State Model:				
OA Publishing in HE	1,787	1,068	6,876	4.4
OA Repositories in HE (Green OA)	189	76	6,876	36.7
OA Repositories in HE (Overlay Services)	189	1,330	6,876	43.3
OA Publishing Nationally	2,079	1,261	26,318	13.3
OA Repositories Nationally (Green OA)	237	106	26,318	111.3
OA Repositories Nationally (Overlay Services)	237	1,563	26,318	117.4
Scenario (Worldwide Open Access)				
Transitional Model:				
OA Publishing in HE	1,787	3,382	615	2.2
OA Repositories in HE (Green OA)	189	786	615	7.4
OA Repositories in HE (Overlay Services)	189	3,326	615	20.8
OA Publishing Nationally	2,079	3,941	2,353	3.0

cont'd

cont'd

Net Cost Scenarios	Costs	Benefits		Benefit/ Cost Ratio
		Savings	Increased returns	
OA Repositories Nationally (Green OA)	237	1,132	2,353	14.7
OA Repositories Nationally (Overlay Services)	237	3,875	2,353	26.2
Simulated Steady State Model:				
OA Publishing in HE	1,787	3,382	6,876	5.7
OA Repositories in HE (Green OA)	189	786	6,876	40.5
OA Repositories in HE (Overlay Services)	189	3,326	6,876	53.9
OA Publishing Nationally	2,079	3,941	26,318	14.6
OA Repositories Nationally (Green OA)	237	1,132	26,318	115.6
OA Repositories Nationally (Overlay Services)	237	3,875	26,318	127.2

Table 2: Summary of benefit/cost comparisons (GBP millions and benefit/cost ratio) [29].

6. Conclusions

The costs, benefits and impacts of alternative scholarly publishing models revealed in the JISC EI-ASPM study demonstrate that research and research communication are major activities and the costs involved are substantial. Preliminary analysis of the potential benefits of more open access to research findings suggests that returns to research can also be substantial, and that different scholarly publishing models can make a material difference to the returns realised as well as the costs faced. It seems likely that more open access would have substantial net benefits in the longer term and while net benefits may be lower during a transitional period, they are likely to be positive for both open access publishing and self-archiving alternatives. This suggests that there are likely to be gains realised from moving towards more open access scholarly publishing models.

Acknowledgements

The authors would like to acknowledge the support of the UK Joint Information Systems Committee (JISC), particularly Neil Jacobs, and thank the expert JISC EI-ASPM Project review group, including Matthew Cockerill (Biomed Central), Fred Friend (JISC), Malcolm Gillies (City University), Paul Hubbard (HEFCE), Donald King (University of North Carolina), Danny Quah (London School of Economics) and Astrid Wissenburg (RCUK) for their comments and suggestions. The research

also benefited from the very generous contributions of Bo-Christer Björk of the Hanken School of Economics in Helsinki, and Donald King of the University of North Carolina. The JISC EI-ASPM Project research team included Australian and UK-based groups. The Australian team was led by John Houghton and included Bruce Rasmussen and Peter Sheehan of The Centre for Strategic Economic Studies at Victoria University in Melbourne, together with Colin Steele, Emeritus Fellow at The Australian National University in Canberra; and the UK team was led by Charles Oppenheim and included Anne Morris of the Department of Information Science, Claire Creaser, Helen Greenwood and Mark Summers of LISU, and Adrian Gourlay of the Department of Economics, at Loughborough University.

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[22] Includes the direct costs of writing, peer review, publishing and disseminating in e-only format, and excludes VAT. Self-archiving includes publisher production and review costs, including commercial margins (*i.e.* overlay services).

[23] Increased returns are recurring gains from one year's R&D expenditure. Such returns can be expressed in Net Present Value (NPV), lagged and recurring over the useful life of the knowledge. For the sake of simplicity and transparency in these charts we have simply taken the original value of annual returns as indicative. In the cost-benefit comparisons present below returns are presented in Net Present Value and lagged.

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ANNEX I

JOURNAL PUBLISHER ACTIVITY COST ITEMS INCLUDED

Activity/Item	*Description*
Establishment:	**Costs relating to establishing a new journal title**
Title development and launch	Costs of investigating demand from authors and readers
Establish 'editorial office', recruit editor and editorial board	Costs of establishing the title's management and oversight
Operate and manage editorial board meetings	Overall management of journal business strategy
Include new title in existing system for author recruitment and marketing	Embedding title into publisher's operations
Operation:	**On-going operational costs**
Article processing (first-copy costs)	***Costs associated with production of an article***
Handling submissions (internal)	Management of submissions (incl. author 'copyright' agreement, payment agreement for author-pays, etc.)
Peer review management (internal)	Management of the peer review process
Article/manuscript production (internal)	Editing, formatting, proofing, 'typesetting', etc. including illustrations, data conversion, hyperlinks, etc.
Peer review conduct (external)	Work of external peer reviewers
Revision and re-submission (external)	Work of author(s) in revision and re-submission
Non-article processing	***Costs associated with non-article journal content***
Covers	Preparation and proofing
Index	Preparation and proofing
Editorial	Handling, preparation and proofing
Letters	Handling, preparation and proofing
Book reviews	Handling, preparation and proofing
News and commentary	Handling, preparation and proofing
Advertising content	Handling, preparation and proofing

cont'd

cont'd

Activity/Item	*Description*
Production and distribution	***Costs of (re)production and distribution***
Quality assurance	Costs of quality assurance (incl. e-content, multimedia, metadata, etc.)
Print: Printing and binding, etc.	Costs of paper, printing and binding
Print: Packaging and postage	Costs of packaging and postage
Online: Operation of systems and servers	Operation of servers and systems (incl. hosting, upload, upgrades, etc.)
Online: Attaching DOIs	Costs of generating and attaching DOIs
Online: Authentication and access control	Costs of access control (toll access only)
Online: Technical and customer support	Customer support costs (technical, claims, etc.)
Online: Usage statistics	Costs of generation of usage statistics
Distribution: Indexing and abstracting	Costs of indexing and abstracting
Distribution: Subscription maintenance	Subscription maintenance (subscription model only)
Overheads:	**Business and operational overheads**
Development of systems	Costs of IT/manual systems/platforms development
Marketing: to authors	Costs of author recruitment
Marketing: to buyers / readers	Costs of marketing title
Sales: Price negotiations	Cost of sales negotiation (price in subscription model)
Sales: Licensing negotiations	Cost of sales negotiation (price in subscription model)
Rights: Copyright permissions	Costs of handling copyright permissions
Payments	Costs of handling payments (incl. subscriptions, author-pays, sponsors, advertising, payment to editors and reviewers, etc.)
General administration	Administration overheads
Building, facilities and equipment	Costs of facilities
Finance and business reporting	Costs of accounting and reporting

See http://www.cfses.com/EI-ASPM/ for details.

ANNEX II

MODELLING PARAMETERS AND ASSUMPTIONS

Parameter	*Basis*	*Value*
Percentage change in accessibility (access)	(i) 50% of the 20% of the stock of knowledge that is journals (ii) 50% of the 40% of the stock of knowledge that is publications	10% to 20%
CHANGE IN ACCESSIBILITY		
Percentage change in accessibility (OA citation)	(i) 25% of the 20% of the stock of knowledge that is journals (ii) 25% of the 40% of the stock of knowledge that is publications	5% to 10%
Combined estimate of the percentage change in accessibility to be modelled	*Conservative consensus of the above*	*5% to 10%, estimate 5%*
CHANGE IN EFFICIENCY		
Percentage change in efficiency (wasteful expenditure: duplicative research and blind alleys)	Authors' estimate, for illustrative purposes	1% to 5%, estimate 2%
Percentage change in efficiency (new opportunities: collaborative opportunities)	Authors' estimate, for illustrative purposes	1% to 5%, estimate 2%
Percentage change in efficiency (speeding up the process)	Authors' estimate, for illustrative purposes	1% to 5%, estimate 2%
Combined estimate of the percentage change in efficiency to be modelled		*5%*
R&D ASSUMPTIONS		
Social returns to R&D	Conservative consensus from literature (Arundel & Geuna 2004) [30]	20% to 60%, estimate 20%
Rate of growth in R&D spending	UK National Statistical Office	5% per annum (current prices)
Lag between R&D spending and impacts	Mansfield (1991, 1998) [31]	3 years to publication plus 7 years to impact, 10 years
Discount rate (risk premium)	Conservative consensus from literature	10% per annum
Rate of cost increases	Conservative estimate from CPI	3% per annum

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June 2009
Printed on demand
by *"Nuova Cultura"*
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