
The costs and potential benefits of alternative scholarly publishing models

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Introduction. This paper reports on a study undertaken for the UK Joint Information Systems Committee (JISC), which explored the economic implications of alternative scholarly publishing models. Rather than simply summarising the study's findings, this paper focuses on the approach and presents a step-by-step account of the research process, highlighting the combination of process mapping, activity costing and macro modelling.

Method. The analysis relies primarily on existing sources, collating activity cost information from the wide-ranging literature on scholarly communication. Where necessary, these sources were supplemented by targeted informal consultation with experts.

Analysis. We examine the costs and potential benefits of the major alternative models for scholarly publishing, including subscription publishing, open access publishing and self-archiving. Adopting a formal approach to modelling the scholarly communication process and identifying activity costs, this paper presents activity and system-wide costs for each of the alternative publishing models. It then explores the potential impacts of enhanced access on returns to R&D.

Results. We find that different scholarly publishing models could make a material difference to the costs faced by various parties and to the returns on investment in R&D that might be realised.

Conclusion. It seems likely that more open access could have substantial benefits in the longer term. While the benefits may be lower during a transitional period they would be likely to be positive for both open access publishing and self-archiving alternatives.

A knowledge economy has been described 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 ([Department of Trade and Industry 1998](#)). 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. Recent advances in information and communication technologies are disrupting traditional publishing models, radically changing our capacity to reproduce, distribute, control and publish information. One key question is whether there are new opportunities and new models for scholarly publishing that might better serve researchers and more effectively communicate and disseminate research findings ([OECD 2005](#): 14).

Drawing on the study *Economic Implications of Alternative Scholarly Publishing Models* undertaken for the Joint Information Systems Committee (hereafter, 'the JISC study') in the United Kingdom ([Houghton et al. 2009](#)), this paper focuses on the approach to estimating the costs and potential benefits of alternative models for scientific and scholarly publishing. It presents a step-by-step account of the research process, highlighting the combination of process mapping, activity costing and macro modelling.

Publishing models

The JISC study focused on three alternative models for scholarly publishing, namely: subscription publishing, open access publishing and self-archiving.

- *Subscription publishing* refers primarily to academic journal publishing and includes individual subscriptions and the so-called Big Deal (i.e., where institutional subscribers pay for access to online aggregations of journal titles through consortial or site licensing arrangements). In a wider sense, however, subscription publishing includes any publishing business model that imposes access tolls and restrictions on use designed to maintain publisher control over readers' access in order to enable the collection of those tolls.
- *Open access publishing* refers primarily to journal publishing where access is free of charge to readers, while authors or their employing or funding organisations pay for publication, or alternatively the publication is supported by other sponsors making it free for both readers and authors. Use restrictions can be minimal as no access toll is imposed.
- *Open access self-archiving* refers to the situation where authors or their publishers deposit their work in online open access institutional or subject-based repositories, making it freely available to anyone with Internet access. Again, use restrictions can be minimal.

Of itself, self-archiving does not constitute formal publication so the JISC study's analysis focused on two publishing models in which self-archiving is supplemented by the peer review and production activities necessary for formal publishing, namely: (i) *green open access* 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) ([Smith 1999](#); [Van de Sompel et al. 2004](#); [Smith 2005](#); [Simboli 2005](#); [Houghton 2005](#)). Hence, each of the publishing models explored includes all of the key functions of scholarly publishing: crucially, they all include peer review and quality control.

Identifying costs and benefits

The first phase of the research sought to *identify* all the dimensions of cost and benefit associated with each of the publishing models.

Identifying costs: the scholarly communication process

To provide a solid foundation for analysis, we developed and extended the scholarly communication life-cycle model first outlined by Björk (2007). Björk developed a formal model of the scholarly communication life-cycle based on the IDEF0 process modelling method, often used in business process re-engineering. His 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.

Extending the model outlined by Björk (2007), the scholarly communication process model developed for the JISC study included five core scholarly communication process activities:

- fund research and research communication;
- perform research and communicate the results;
- publish scientific and scholarly works;
- facilitate dissemination, retrieval and preservation;
- study publications and apply the knowledge (Figure 1).

Each of these activities is further subdivided into a detailed description of the activities, inputs, outputs, controls and supporting mechanisms involved, creating an activity model with some fifty-three diagrams and 190 activities. This formal process model was used to identify all of the activities involved throughout the scholarly communication life-cycle and to provide the foundation for detailed activity costing (details of the entire model in 'browseable' form can be found at <http://www.cfses.com/EI-ASPM/SCLCM-V7/>). That costing covered more than two thousand elements.

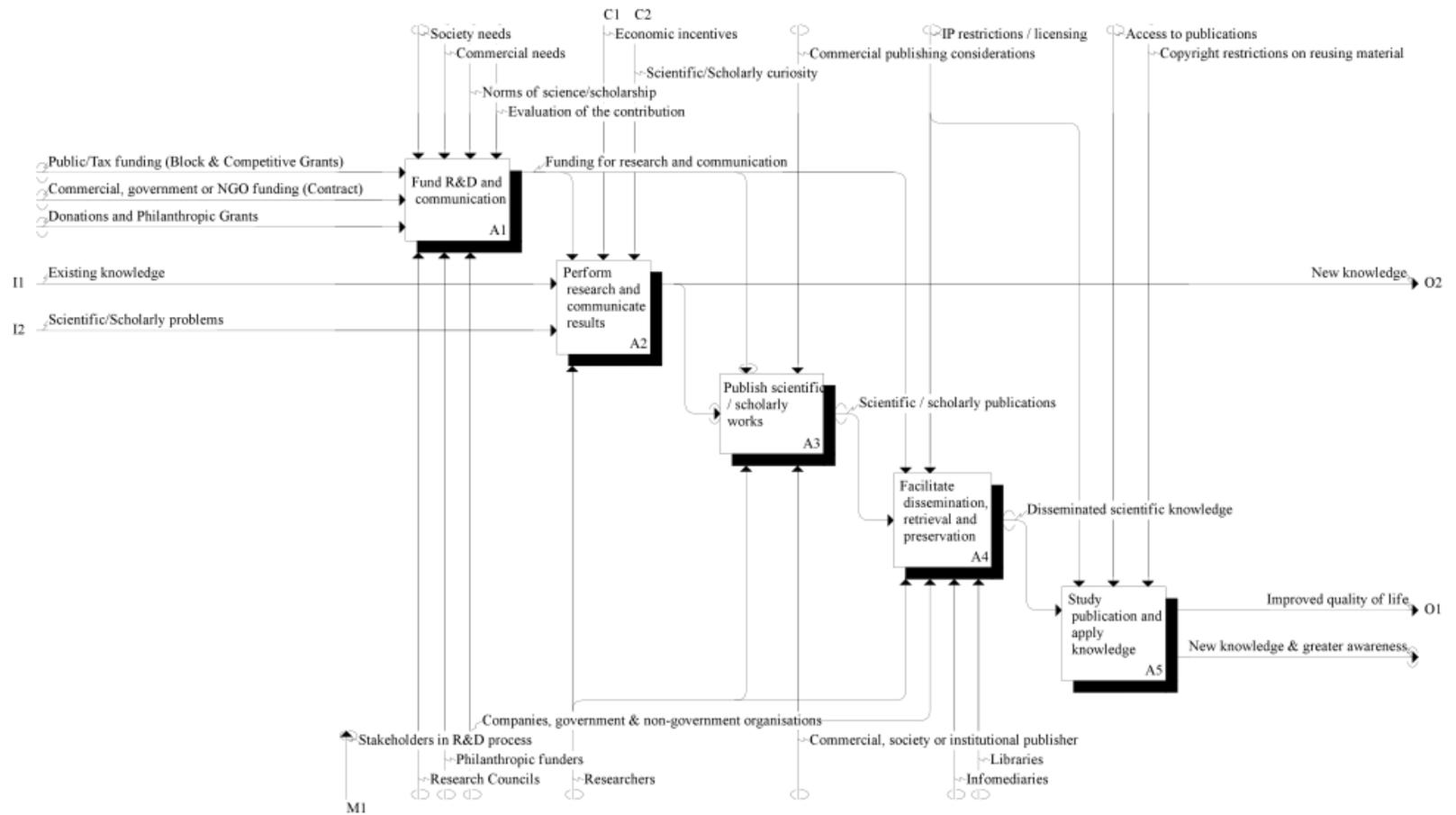


Figure 1: The scholarly communication life-cycle process

Identifying benefits: dimensions of impact

There are many ways to explore the impacts of alternative scholarly publishing models. Focusing on access and use, Houghton *et al.* (2006) noted impacts relating to research use of the content, use by industry and government, and use by the wider community. While providing a useful starting point, their analysis focused on use impacts (i.e., those relating to studying the publications and applying the knowledge) and did not fully explore the production-side impacts (i.e., those relating to funding and performing research and research communication) (Figure 1).

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 suggested analysis along the 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 for free, immediate and unrestricted access by exploring the time and cost involved in

accessing and using scientific and scholarly works (Figure 2).

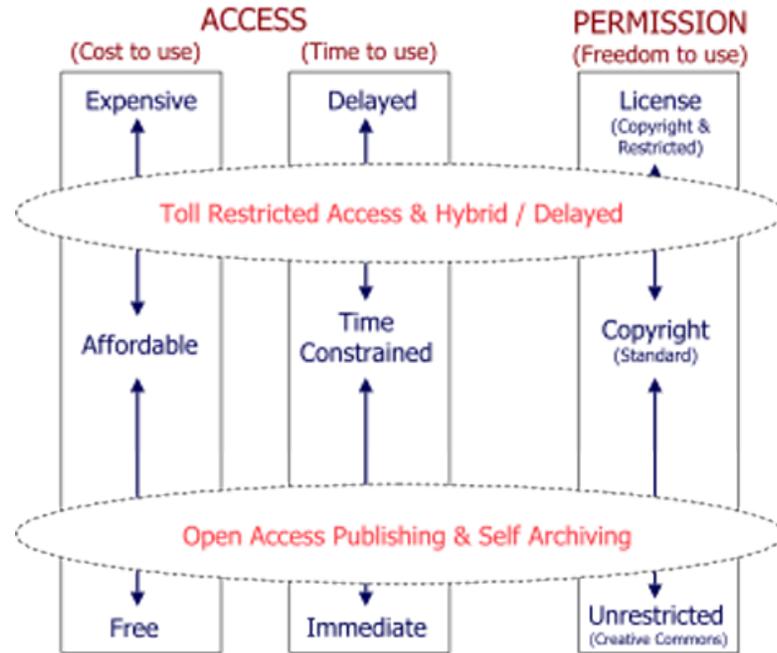


Figure 2: Dimensions of impact: access and permission

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 and society more generally, namely: an increase in the stock of useful knowledge, an increase in the supply of skilled graduates and researchers, the creation of new scientific instrumentation and methodologies, the development of networks and stimulation of social interaction, the enhancement of problem solving capacity, the creation of new firms, and the provision of social knowledge. Enhanced access and reduced permissions barriers could be important in all of these (arguably, with the exception of the third). 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 happened with the Weather Derivatives industry based on meteorological data (Pluijmers and Weiss 2001; Stell 2005)).

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 production-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. Hence, access and permission are crucial to the overall efficiency of the scholarly communication system.

Quantifying costs and benefits

There are three elements to our approach to quantifying costs and benefits. First, we explored the cost of activities throughout the scholarly communication process and then summed them to estimate system costs, and from that identified cost differences between the alternative publishing models. Second, we presented cases and scenarios to explore potential cost differences between alternative publishing models (looking, for example, at impacts on search and discovery, library handling costs, etc.), and from that explored the indirect cost differences. Third, we approached the issue from the top down and modelled the impact of possible changes in accessibility and efficiency on returns to R&D through further development and application of the modified Solow-Swan model outlined by Houghton *et al.* (2006) and Houghton and Sheehan (2006; 2009).

Estimating activity and system costs

In the first of these three steps, we produced a detailed costing of all of the activities identified in the scholarly communication process model, focusing on activity and cost differences between the three publishing models. These costings relied primarily on existing sources, collating activity cost information from a wide-ranging literature on scholarly communication and publishing (e.g., Tenopir and King (2000) and subsequent tracking studies; Halliday and Oppenheim (1999); Friedlander and Bessette (2003); OECD (2005); European Commission (2006); Houghton *et al.* (2006); Electronic Publishing Services and Oppenheim (2006); King (2007); Björk (2007); Clarke (2007); Research Information Network (2008)). Where necessary, these sources were supplemented by informal consultation with experts in the field.

One key challenge was to separate the cost impacts of publishing models from those of publishing format, so that we could explore the cost differences between subscription and open access publishing models independent of differences between print and electronic production. Our approach was to estimate costs for print-only, dual-mode (i.e., parallel print and electronic production) and electronic-only formats for the subscription and open access business models, and then to compare subscription and open access models as if they were all electronic.

For this paper we focus on publisher activities relating to journals, but it should be noted that the JISC study (Houghton *et al.* 2006) included detailed activity costing for activities throughout the scholarly communication life-cycle, including funding research and research communication, performing research and communicate the results, publishing scientific and scholarly works, and facilitating dissemination, retrieval and preservation (Figure 1). The JISC study also explored open access and electronic book publishing. All of these costings included commercial publisher management, investment and operating margins. They are expressed in 2007 British pounds and, where necessary, they were converted to pounds using OECD published annual average exchange rates and adjusted to 2007 using the UK consumer price index published by the Office of National Statistics. A summary of the journal publisher activities identified can be found in [Appendix I](#), and the modelling parameters can be found in [Appendix II](#). There is also an online model: [Economic Implications of Alternative Scholarly Publishing Models \(EI-ASPM\)](#), which allows users to experiment with different values for the main parameters.

For *subscription journal publishing*, we estimated 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 electronic-only production. All of these exclude the costs associated with external peer review and value-added tax (Figure 3). For *open access journal publishing*, we estimated average per article costs at £1,524 for electronic-only production. We estimated 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 might cost around £1,127 per article excluding hosting, or £1,260 including hosting.

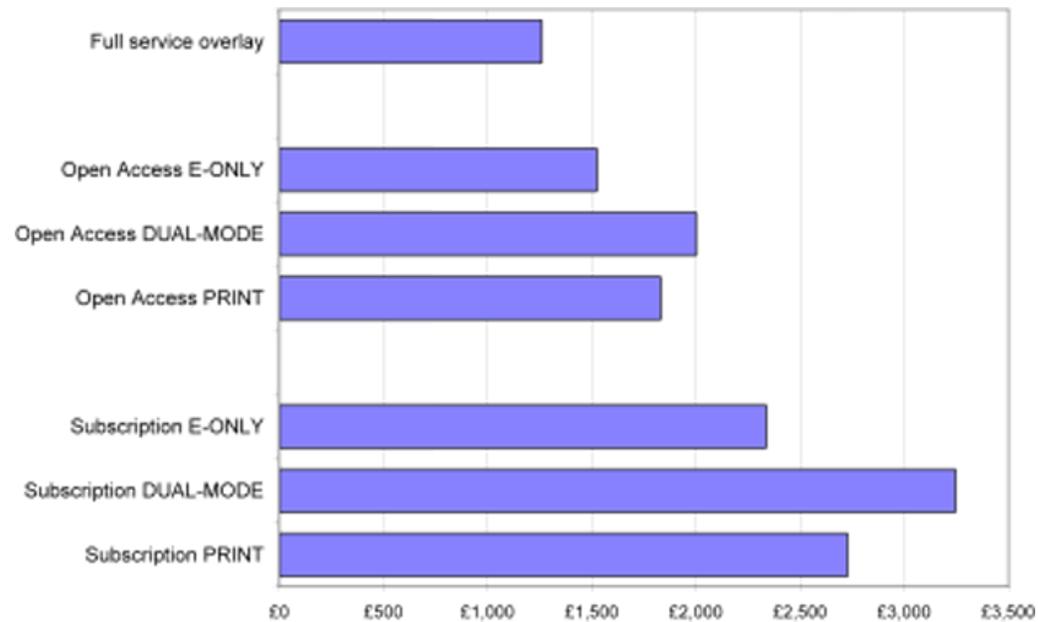


Figure 3: Estimated average publisher costs for an article by format and model (Pounds sterling circa 2007)
(Note: Overlay services include operating peer review management, editing, proofing and hosting, with commercial margins.
Estimates for print and dual-mode open access publishing exclude copy print and delivery related costs, assuming that the content is produced print ready and print is an add-on.)

Estimating system costs and identifying cost differences

In the second of the three main research steps, we summed the costs of the three publishing models through the main phases of the scholarly communication life-cycle, in order to explore potential system-wide cost differences between alternative publishing models. Summing the costs of writing, peer review, publishing and dissemination *for each article* in electronic-only format suggested that average subscription journal publishing system costs might amount to around £8,296 an article (excluding value-added tax), average open access journal publishing costs might amount to £7,483 an article and average overlay review and production services costs might amount to £7,113 an article (including commercial margins). At these costs, open access publishing would cost around £813 an article less than subscription publishing, and open access self-archiving with overlay services around £1,183 an article less (Figure 4).



Figure 4: Estimated scholarly communication system costs for an article (Pounds sterling circa 2007)
 (Note: Includes the direct costs of writing, peer review, publishing and disseminating in electronic-only format, and excludes value-added tax.
 Archiving with overlay services includes publisher production and review costs, including commercial margins).

In addition to these direct production cost differences, there are potential system cost differences in the discovery, access, dissemination and use of the content (e.g., in search, discovery and retrieval, research reporting and evaluation, publisher production and distribution, library acquisition and handling). Based on the cases and scenarios explored in the JISC study we estimated that open access author-pays publishing for journal articles might have brought system-wide savings of around £215 million a year nationally in the UK (at 2007 prices and levels of publishing activity), of which around £165 million would have related to higher education. The open access self-archiving with overlay services model is necessarily more speculative, but a repositories and overlay services model may well produce greater cost savings, with our estimates suggesting system savings of perhaps £250 million nationally of which around £200 million might have related to 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 an 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, we estimated 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.

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

In the third of the three major research steps, we modified a basic Solow-Swan model to estimate the impacts of changes in accessibility and efficiency on returns to R&D. 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 specific to particular industries and applications. Much less has been done about the other two, equally unrealistic, assumptions. Addressing these, we introduced *accessibility* and *efficiency* as negative or friction variables, to reflect the fact that there are limits and barriers to access and to the efficiency of production and usefulness of knowledge. Then we explored the impact on returns to R&D of reducing the friction by increasing accessibility and efficiency ([Houghton and Sheehan 2006](#), 2009; [Houghton et al. 2009](#)).

We produce range estimates, looking at typical rates of return from 20% to 60% ([Arundel and Geuna 2003](#)) and plausible increases in accessibility and efficiency of 1% to 10%, and produce a table for each 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 took the lower bound average 20% social return on public sector R&D and suggested that a 5% increase in accessibility and efficiency might be plausible. Despite limitations in models of this type, these model parameters, if anything, may err on the conservative side ([Houghton et al. 2009](#)). For example, the percentage change in *accessibility* and *efficiency* is based on metrics relating to several factors: 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 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 ([Appendix II](#)).

Higher education R&D spending in 2006 (£6,062 million)	Rate of return to R&D				
	20%	30%	40%	50%	60%
Percentage change in accessibility and efficiency	Recurring annual gain from increased accessibility and efficiency (£ million)				
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

Rates of return to R&D spending vary, 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 £33 million a year in increased returns to UK Research Councils competitive-grants-funded research. 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.

Comparing costs and benefits

One 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 should be discounted accordingly. This reflects the fact that a shift to open access publishing 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. This has the effect that over a transitional period of twenty years one is comparing twenty years of costs with ten 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 was complete and was no longer affecting returns to R&D. In such a model one would be comparing twenty years of costs with twenty 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.

The cost-benefit comparisons we 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 open access*). 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 open access* as well as *green open access*) the benefits exceed the costs, even in transition. Indicative modelling of a post-transition steady-state alternative system suggests that, once established, alternative open access publishing and/or self-archiving models would be likely to produce substantially greater net benefits.

For example, during a transitional period we estimated that in an open access world the benefits from cost savings and increased returns to R&D resulting from open access publishing all journal articles produced in UK higher education would be around twice the costs. Additionally, the benefits of *green open access* 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 around twenty times the costs. Indicative modelling of post-transition steady-state alternative systems returns benefits of almost six times costs for open access publishing and more than forty times the costs for the open access self-archiving alternatives ([Appendix III](#)).

In a 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 openaccess journal and article publishing models for national and higher education publication outputs (i.e., comparing the cost of producing, publishing and handling national and higher education outputs under different publishing models, not the cost of alternative publishing models for the UK or UK higher education). Based on the results reported in Appendix III, Figure 5 shows the impacts of *green open access* self-archiving in parallel with subscription publishing, Figure 6 the impacts of *gold open access* or author-pays journal publishing, and Figure 7 shows the impacts of the *deconstructed* or *overlay journals* model of self-archiving with overlay services. Costs, savings and increased returns are over twenty years and expressed in Net Present Value in millions of Pounds sterling, and reported increases in returns to R&D expenditure relate to public sector and higher education R&D.

As many of the potential cost savings cannot be fully realised unless there is worldwide adoption of open access alternatives, in the unilateral national open access scenarios funder, research, library handling and subscription cost savings are scaled to the UK's article output (i.e., are in proportion to the share of worldwide journal literature that would be open access as a result of the unilateral adoption of alternative open access models by the UK). In the *green*

open access model (Figure 5), self-archiving operates in parallel with subscription publishing, so there are no publisher, library handling or subscription cost savings.

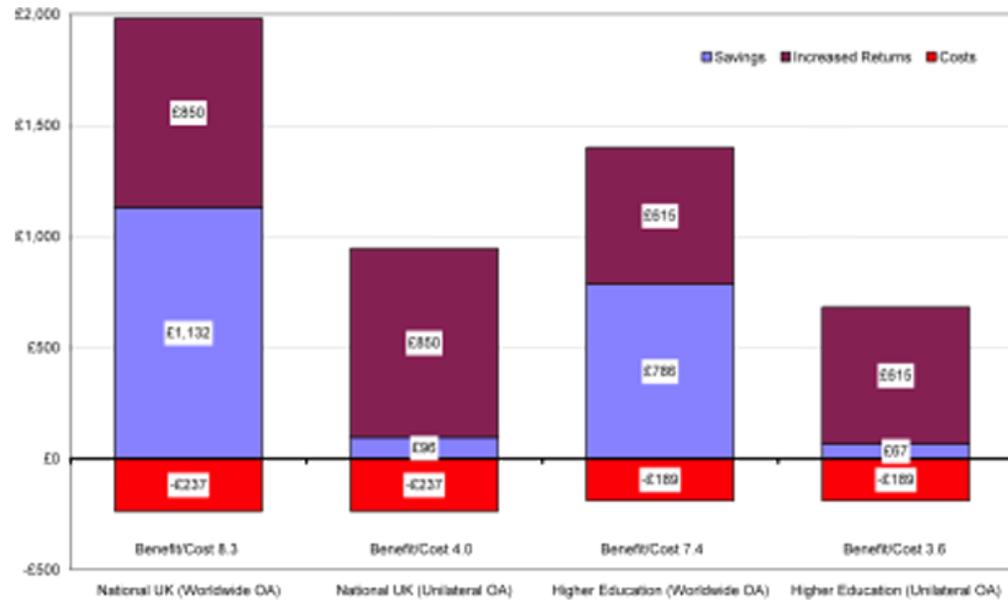


Figure 5: Estimated impact of *green open access* self-archiving (Pounds sterling in millions over twenty years)

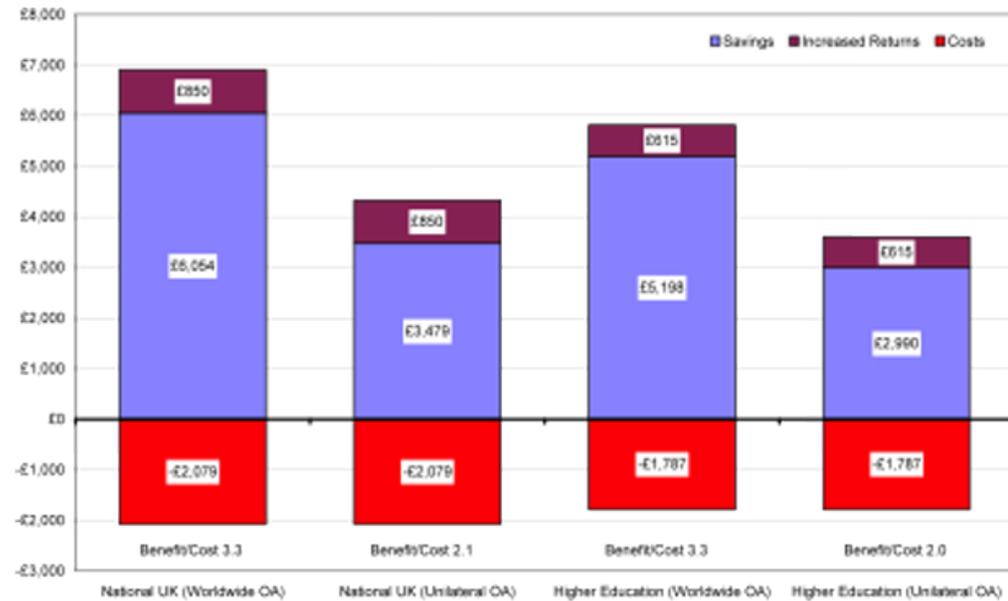


Figure 6: Estimated impact of **gold open access** publishing (British pounds in millions over 20 years)

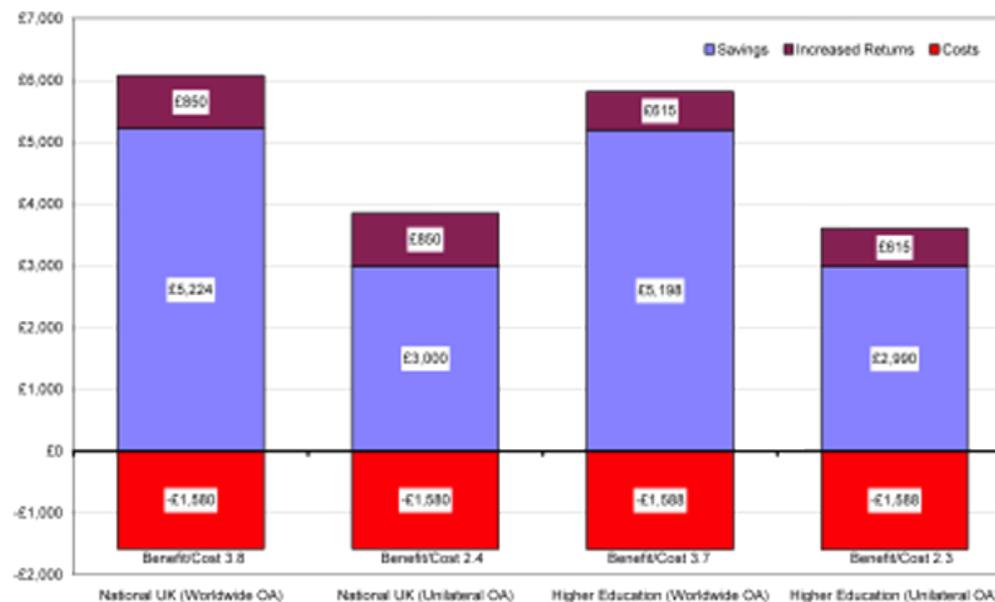


Figure 7: Estimated impact of open access self-archiving with overlay production and peer review services (Pounds sterling in millions over twenty years)

Conclusions

The costs and benefits associated with alternative scholarly publishing models demonstrate that research and research communication are major activities and the costs involved are substantial. Our preliminary analysis of the potential benefits of more open access to research findings suggests that returns to research are also substantial and that different scholarly publishing models might make a material difference to the returns realised as well as the costs faced. It seems likely from this preliminary analysis that more open access could have substantial net benefits in the longer term and, while net benefits may be lower during a transitional period they would be likely to be positive for both open access journal publishing and self-archiving alternatives.

It must be emphasised, however, that these calculations are not a prediction of what will occur in the future, and nor are they necessarily a recommendation that governments, funders or scholars follow a particular course of action. We merely illustrated the likely economic impacts of alternative scholarly publishing models. Finally, we emphasise that many of the figures we input into the model were derived from or estimates based on the literature. A version of the model we used is available on the Web ([Economic implications of alternative scholarly publishing models \(EI-ASPM\)](#)) for third parties to input other data and explore other scenarios.

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Note

A related paper was presented at the [ELPub conference in 2009](#)

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Appendices

Appendix I: Journal publisher activities 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
<i>Article processing (first-copy costs)</i>	<i>Costs associated with production of an article</i>
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
<i>Non-article processing</i>	<i>Costs associated with non-article journal content</i>
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
<i>Production and distribution</i>	<i>Costs of (re)production and distribution</i>
Quality assurance	Costs of quality assurance(incl. e-content, multimedia, metadata, etc.)
Issue compilation	Costs of compiling the issue, embedding content, etc.
Print: Printing and binding, etc.	Costs of paper, printing and binding
Print: Packaging and postage	Costs of packaging and postage
On-line: Operation of systems and servers	Operation of servers and systems (incl. hosting, upload, upgrades, etc.)
On-line: Attaching DOIs	Costs of generating and attaching DOIs
On-line: Authentication and access control	Costs of access control (toll access only)
On-line: Technical and customer support	Customer support costs (technical, claims, etc.)
On-line: 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 or 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

Appendix II: Modelling parameters and assumptions

Parameter	Basis	Value
Publish journals		
Pages per article	Tenopir and King (2000) and tracking studies, CEPA (2008), King et al. (2008)	11.7 to 14.3, estimate 12.4
Articles per issue	Tenopir and King (2000), CEPA (2008)	10 to 20, estimate 10
Issue per year	Tenopir and King (2000) and tracking studies, CEPA (2008)	8 to 16, estimate 12
Articles per title per year: Median (location of average article)	Tenopir and King (2000) and tracking studies, Björk et al. (2008)	50 to 150, estimate 120
Non-article content pages	King (2007), King et al. (2008)	10% to 20%, estimate 14%
Article rejection rate	Consensus from literature	40% to 60%, estimate 50%
Subscriptions per title	Tenopir and King (2000), CEPA (2008)	300 to 3,000, estimate 1,200
Management and investment margin	CEPA (2008)	20% to 25%, estimate 20%
Surplus or profit margin	CEPA (2008) adjusted	10% to 30%, estimate 20%
Open access rights management (relative to toll)	Authors' estimate	20%
Open access user support (relative to toll)	Authors' estimate	20%
'Author-pays' marketing and support costs (relative to toll)	Authors' estimate	33%
Open access hosting (relative to toll)	Authors' estimate	50%

Open access management and investment (relative to toll)	Authors' estimate	75%
Open access surplus or profit (relative to toll)	Authors' estimate	75%
Change in accessibility		
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%
Percentage change in accessibility (open access citation)	(i) 25% of the 20% of the stock of knowledge that is (ii) 25% of the 40% of the stock of knowledge that is publications	5% to 10%
<i>Combined estimate of the percentage change in accessibility to be modelled</i>	<i>Conservative consensus of the above</i>	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%
<i>Combined estimate of the percentage change in efficiency to be modelled</i>		5%
R&D assumptions		
Social returns to R&D	Conservative consensus from literature (Arundel & Geuna 2004)	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)	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
Scenario assumptions		
<i>Fund research</i>		
Funder operational costs as a share of funding	UK S&T Budget document	3%
Evaluation and reporting as a share of operational costs	Authors' estimate	50%
Potential savings in these costs from enhanced access	Authors' estimate	5% to 10%, estimate 5%
Improved allocations increase returns to R&D	Authors' estimate	1% to 5%, estimate 2.5%
		1% to 5%,

Increase in allocations to R&D	Authors' estimate	estimate 2.5%
Perform research		
Search, discovery and access time saving through more open access	Authors' estimate	5% to 10%, estimate 5%
Permissions time saving through more open access	Authors' estimate	40% to 60%, estimate 50%
Peer review time saving through more open access	Authors' estimate	5% to 20%, estimate 10%
Writing and preparation time saving through more open access	Authors' estimate	5% to 10%, estimate 5%
Publish		
UK share of worldwide scholarly publishing output (articles)	Björk et al. (2008)	Estimate 8.5%
Competition reduces publisher costs and margins	Authors' estimate	5% to 10%, estimate 5%
Disseminate		
Share of UK HEIs subscribing to journal titles in which UK academic authors publish (i.e. duplicate subscriptions)	Authors' estimate based on total, mean and median titles subscribed to by SCONUL libraries 2006-07	50% to 100%, estimate 75%

Appendix III: Summary of benefit/cost comparisons (Millions of Pounds sterling and benefit/cost ratio)

Scenario (UK unilateral adoption)	Costs	Benefits		Benefit/Cost
		Savings	Increased returns	Ratio
Transitional Model:				
Open access publishing in HE	1,787	1,174	615	1.0
Open access repositories in HE (Green open access)	189	67	615	3.6
Open access repositories in HE (Overlay services)	189	1,421	615	10.8
Open access publishing nationally	2,079	1,366	850	1.1
Open access repositories nationally (Green open access)	237	96	850	4.0
Open access repositories nationally (Overlay services)	237	1,653	850	10.5
Simulated steady state model:				
Open access publishing in HE	1,787	1,174	6,876	4.5
Open access repositories in HE (Green open access)	189	67	6,876	36.7
Open access repositories in HE (Overlay services)	189	1,421	6,876	43.8

Open access publishing nationally	2,079	1,366	9,505	5.2
Open access repositories nationally (Green open access)	237	96	9,505	40.4
Open access repositories nationally (Overlay services)	237	1,653	9,505	47.0
Scenario (Worldwide adoption)				
Transitional Model:				
Open access publishing in HE	1,787	3,382	615	2.2
Open access repositories in HE (Green open access)	189	786	615	7.4
Open access repositories in HE (Overlay services)	189	3,326	615	20.8
Open access publishing nationally	2,079	3,941	850	2.3
Open access repositories nationally (Green open access)	237	1,132	850	8.3
Open access repositories nationally (Overlay services)	237	3,875	850	19.9
Simulated Steady State Model:				
Open access publishing in HE	1,787	3,382	6,876	5.7
Open access repositories in HE (Green open access)	189	786	6,876	40.5
Open access repositories in HE (Overlay services)	189	3,326	6,876	53.9
Open access publishing nationally	2,079	3,941	9,505	6.5
Open access repositories nationally (Green open access)	237	1,132	9,505	44.8
Open access repositories nationally (Overlay services)	237	3,875	9,505	56.4

(Note: Compares Open Access alternatives against subscription or toll access, with costs, savings and increased returns expressed in Net Present Value over 20 years in GBP millions. Increased returns relate to public sector and higher education expenditure on R&D.)



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