GENERAL COST ANALYSIS FOR SCHOLARLY COMMUNICATION IN GERMANY

Results of the “Houghton Report” for Germany

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GENERAL COST ANALYSIS FOR SCHOLARLY COMMUNICATION IN GERMANY

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Management Summary

Conducted within the project "Economic Implications of New Models for Information Supply for Science and Research in Germany", the Houghton Report for Germany provides a general cost and benefit analysis for scientific communication in Germany comparing different scenarios according to their specific costs and explicitly including the German National License Program (NLP).

Basing on the scholarly lifecycle process model outlined by Björk (2007), the study compared the following *scenarios* according to their accounted costs:

- Traditional subscription publishing,
- Open access publishing (Gold Open Access; refers primarily to journal publishing where access is free of charge to readers, while the authors or funding organisations pay for publication)
- Open Access self-archiving (authors deposit their work in online open access institutional or subject-based repositories, making it freely available to anyone with Internet access; further divided into (i) CGreen Open Access' self-archiving operating in parallel with subscription publishing; and (ii) the 'overlay services' model in which self-archiving provides the foundation for overlay services (e.g. peer review, branding and quality control services))
- the NLP.

Within all scenarios, five *core activity elements* (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) were modeled and priced with all their including activities.

Modelling the *impacts of an increase in accessibility and efficiency* resulting from more open access on returns to R&D over a 20 year period and then comparing costs and benefits, we find that the benefits of open access publishing models are likely to substantially outweigh the costs and, while smaller, the benefits of the German NLP also exceed the costs.

This analysis of the potential benefits of more open access to research findings suggests that different publishing models can make a material difference to the benefits 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 'author-pays' Open Access publishing and the 'over-lay journals' alternatives ('Gold Open Access'), and for parallel subscription publishing and self-archiving ('Green Open Access'). The NLP returns substantial benefits and savings at a modest cost, returning one of the highest benefit/cost ratios available from unilateral national policies during a transitional period (second to that of 'Green Open Access' self-archiving). Whether 'Green Open Access' self-archiving in parallel with subscriptions is a sustainable model over the longer term is debateable, and what impact the NLP may have on the take up of Open Access alternatives is also an important consideration. So too is the potential for developments in Open Access or other scholarly publishing business models to significantly change the relative cost-benefit of the NLP over time.

The results are comparable to those of previous studies from the UK and Netherlands. *Green Open Access in parallel with the traditional model yields the best benefits/cost ratio*. Beside its benefits/cost ratio, the meaningfulness of the NLP is given by its enforceability. The true costs of toll access publishing (beside the buyback" of information) is the prohibition of access to research and knowledge for society.

Contents

1 Introduction

This study seeks to provide a general cost analysis for scholarly communication in Germany, building on and extending the model used to explore the costs of alternative scholarly publishing models in previous studies in the UK, Netherlands and Denmark (Houghton and Oppenheim et al. 2009; Houghton et al. 2009; Houghton 2009).[1] This has involved:

- Defining the data needs for the model and coordinating with Goethe University Frankfurt as to data needs and availability;
- Fine tuning the modeling framework and adapting it to the German context, especially in relation to the German National Licensing Program (NLP);
- Assessing data sources and items collected against model elements in order to ascertain the availability and quality of the evidence base necessary to support modelling;
- Considering how to address any identified gaps in the evidence base (e.g. through consultation, estimation, etc.);
- Colleagues in Germany collecting the additional data (e.g. through consultation); and
- Creating a national scholarly communication lifecycle process cost model for Germany.

1.1 Approach and methodology

Previous studies have focused on three emerging models for scholarly publishing, namely: subscription publishing, open access publishing and self-archiving (e.g. Bernius and Hanauske 2007, Bernius et al. 2009):

- *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 reader access tolls and restrictions on use designed to maintain publisher control over that 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 the authors, their employing or funding organisations pay for publication, or the publication is supported by other sponsors making publication 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 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 analysis has 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 OA' self-archiving operating in parallel with subscription publishing; and (ii) the 'deconstructed journals' or 'overlay services' model in which self-archiving provides the foundation for overlay services (e.g. peer review, branding and quality control services). Consequently, all of the publishing models explored include all the key functions of

[1] http://www.cfses.com/EI-ASPM/

scholarly publishing (i.e. registration, certification, dissemination / awareness, and preservation). Crucially, all include peer review and quality control.

This study brings the German National Licensing Program (NLP) into the mix of alternative models, comparing the NLP with subscription and open access alternatives. The primary purpose of the NLP is to improve access to scholarly digital resources for German universities, research institutes and academic libraries. Starting in 2004, the NLP is financed through special funds from the German Research Foundation (DFG). The aim is to provide scientists, students and scientifically interested individuals free access to databases, digital collections of texts and electronic journals. The DFG pays to acquire the content and thereby gains full and temporally unrestricted use for the materials.[2] The NLP currently involves around 110 different products, and it is expected to continue until 2012. At the moment, the licensed NLP products and the underlying download statistics are provided through the publishers' servers, but a local hosting through library servers or through third party developers is intended within the next few years. Consequently, hosting costs are included in the comparisons presented herein.

Phase I: Identifying the costs and benefits

The first phase of the UK JISC and subsequent studies sought to 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 adoption of alternative publishing models. In order to provide a solid foundation for analysis, we developed and extended the scholarly communication lifecycle model first out-lined by Bo-Christer Björk (2007).

Björk (2007) developed a formal model of the scholarly communication lifecycle 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 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.

Extending the model outlined by Björk (2007), the scholarly communication lifecycle process model developed for the UK and subsequent Danish and Dutch studies included five core activity elements, 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

[2] See Annex I for details of the NLP.

(v) Study publications and apply the knowledge (Figure 1).

Each of these activities is further subdivided into a detailed description of the activities, in-puts, outputs, controls and supporting mechanisms involved. This formal process modelling was used to identify activities and provide the foundation for activity costing.

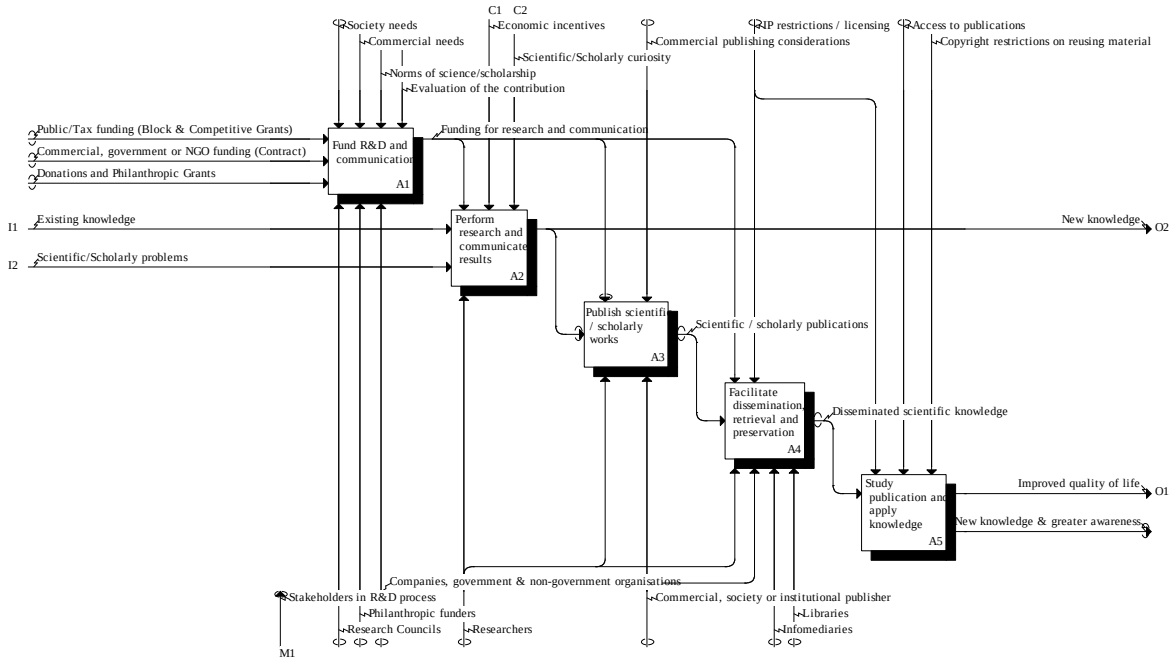


Figure 1: The scholarly communication process (Source: EI-ASPM Scholarly Communication Lifecycle Process Model; http://www.cfses.com/EI-ASPM/SCLCGermany/)

The German NLP provides enhanced access for researchers in Germany through an extended form of consortial purchasing and licensing. While it centralises a number of activities relating to facilitating dissemination, retrieval and preservation (e.g. negotiation and licensing), the NLP does not fundamentally change the activities performed. Since the scholarly communication lifecycle process model focuses on activities, without pre-judging which actors undertake them, incorporating the NLP does not necessitate changes to the underlying lifecycle process model.[3]

Phase II: Quantifying the costs and benefits

The second phase of the studies sought to quantify the costs and benefits identified, identify and where possible quantify the cost and benefit implications for each of the main players in the scholarly communication system and compare the costs and benefits of the alternative models. There are four main steps to quantifying costs and benefits.

- First, we produced a detailed costing of all of the activities identified in the scholarly communication lifecycle model, focusing on areas where there were likely to be activ-ity and, therefore, cost differences between the alternative publishing models.

[3] Details of the entire model in 'browseable' form can be found on the Web at http://www.cfses.com/EI-ASPM/SCLCGermany/.

- Second, we summed the costs of the three publishing models through the main phases of the scholarly communication lifecycle, so we could explore potential system-wide cost differences between the alternative publishing models – looking, for example, at impacts on search and discovery, library handling costs, etc. From this we can explore indirect cost differences and savings.
- Third, we modelled the impact of changes in accessibility and efficiency on returns to R&D using a Solow-Swan model, into which we introduce 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 (Houghton and Sheehan 2006; 2009).
- The final step was to compare costs and benefits, for which we used the three elements outlined: (i) the direct costs associated with each of the models, (ii) the associated in-direct system-wide costs and cost savings, and (iii) the benefits accruing from in-creases in returns to R&D resulting from increases in accessibility and efficiency.

A full description of the modeling approach and details of its operationalisation can be found in Houghton and Oppenheim et al. (2009).

1.2 Data sources and limitations

There are two elements to the activity cost modeling, namely (i) national variables, and (ii) more generic activity costings. While there are important structural differences between national research and scholarly communication systems, research is a global activity and many research-related and scholarly publishing activities are common across countries. Consequently, for preliminary estimations, it is possible to use international sources on research and publishing activities where no local sources exist. This section describes the major sources used and possible limitations, taking each of the five main activity elements identified in the scholarly communication lifecycle model in turn (See Annex II for details). All data are standardised on 2008 expenditures, prices and levels of research and publication activity.

(i) Fund research and research communication

Major sources on research funding in Germany include annual reports and responses to our enquiries received from the major funding agencies and departments (e.g. Deutsche Forschungsgemeinschaft, Alexander von Humboldt-Stiftung, Bundesministeriums für Bildung und Forschung, Volkswagenstiftung, Thyssen-Stiftung, Robert-Bosch-Stiftung, Deutscher Akademischer Austausch Dienst and Bundesministerium für Wirtschaft und Technologie), national and international reporting of R&D expenditures and the number of personnel engaged in research (e.g. EuroStat, OECD, Statistisches Bundesamt Deutschland / DESTATIS, etc.), and reports of the activities of universities and research institutes in Ger-many (e.g. Universitäten, Pädagogische Hochschulen, Fraunhofer Gesellschaft, Hermann-von-Helmholtz-Gemeinschaft, Leibniz Association, Max Planck Gesellschaft, etc.). Drawing on these sources provides sufficient data for preliminary estimation.

(ii) Perform research and communicate the results

Major information sources on the performance of research in Germany include a mix of national and international sources. Local sources include the higher education and research centres, and statistical sources noted above.

Salaries are based on data reported by EuroStat – dividing R&D expenditure by full-time equivalent (FTE) researchers in those categories reported. The reported number of FTE re-searchers in Germany in 2008 was 299,000 (excluding technicians and support staff), and we estimate that there were around 121,000 researchers in higher education and public sector institutions in 2008. These EuroStat data match those reported by sectoral agencies. The total cost of public research activities is estimated to be around EUR 164,000 per person per year, or EUR 97 per hour, at full economic cost (i.e. including all costs and overheads). This Figure includes the personnel costs of research technicians and support staff as overheads.[4]

Locally sourced publication counts are supplemented by counts sourced from the Web of Knowledge and SCOPUS databases for the calendar year 2008, scaled to account for content not included in those sources using the metrics outlined by Björk et al. (2008). For non-article content, counts for the universities and public centres are supplemented by estimates based on output proportions reported in the UK Research Assessment Exercise (RAE). These sources suggest core peer-reviewed outputs of around 92,000 articles produced during 2008 and around 140,000 outputs of all kinds. More robust information about non-article outputs would improve our estimates.

For much of the researcher activity data we rely on international sources on the activities of researchers in universities and elsewhere. The principal sources include the King and Tenopir tracking studies, which have been undertaken over many years in the US and more recently in a number of other countries (not including Germany). Major sources include Tenopir and King (2000), Tenopir and King (2002), Tenopir and King (2007), Tenopir, King, Edwards and Wu (2009), King, Tenopir and Clarke (2006), Rowlands and Nicholas (2005), Houghton, Steele and Sheehan (2006), CEPA (2008), Björk, Roos and Lauri (2008), etc. Drawing on these sources provides sufficient data for preliminary estimation.

(iii) *Publish scientific and scholarly works*

Scholarly publishing is a global activity and the activities of scholarly journal and academic book publishers are similar around the world. Moreover, the aim herein is to cost activities relating to the publication of scientific and scholarly works researched and written in Ger-many, and German research is published by international as well as local publishers. Consequently, publishing activities and costs can be sourced from a wide range of existing literature and industry consultations undertaken for the previous studies.

For the basic market data relating to STM publishing we rely on EPS/Outsell, while publishing output volumes are sourced from the Web of Knowledge and SCOPUS databases, Ulrich's, The Publishers Association, Björk et al. (2008), etc. Detailed activity costs relating to journal publishing are sourced primarily from Tenopir and King (2000) and their subsequent tracking studies, the ALPSP, CEPA (2008), Waltham (2005; 2006), etc. Activity costs relating to scholarly book publishing are less well reported in the literature, although data can be sourced from Clark (2001; 2008), Watkinson (2001), Greco and Wharton (2008), etc. We have also obtained confidential cost data from book publishers for the previous studies.

These sources provide sufficient data for preliminary estimation. Nevertheless, more information on local publishing costs in Germany would be helpful in informing us as to the need to adjust for local

[4] To the extent that researchers work longer than their official standard hours these costs may be somewhat high and might, perhaps, be thought of as the value of the activity rather than the cost *per se*.

costs structures (e.g. due to publication in German, publication in multiple languages adding translation and additional production costs, possibly higher international distribution costs, etc.). To the extent that such factors add to the costs of publishing the scientific and scholarly content produced by researchers in Germany, the publisher cost estimates herein might be taken as something closer to lower bound estimates.

(iv) Facilitate dissemination, retrieval and preservation

The activities of dissemination, retrieval, and preservation, most notably those of research and special libraries, exhibit greater variation between countries. Moreover, the German NLP adds some unique elements to dissemination, retrieval and preservation activities in Germany.

German research library data from Deutsche Bibliotheksstatistik (DBS) for Wissenschaftliche Universal- und Hochschulbibliotheken and Wissenschaftliche Spezialbibliotheken provide a solid foundation. However, in the absence of detailed local information about activity costs, research library activity costings can be no more than first approximations based on international activity studies (e.g. Swan 2010; Schonfeld et al. 2004; King et al. 2004; etc.), with activity times translated to local costs using average Wissenschaftliche Universal- und Hochschulbibliotheken library staff salaries. Moreover, as electronic journals become the norm and e-book collections are emerging library handling activities are changing rapidly, making data from the international studies no more than an approximate guide to library activities.

Data relating to the operation of the German NLP are sourced directly from the eight operating centres via Goethe University in Frankfurt. Key parameters include acquisition and non-acquisition costs of journal and other content, titles included, usage statistics and institutional coverage (See Annex II). Cost and operational data relating to archiving are highly varied, but there are sufficient data for preliminary estimation from international studies (e.g. Swan 2008, The Driver Report 2008, Bailey 2006, Universities UK 2007, Houghton et al. 2006 and ROAR, etc.). In addition to our own estimates of per article archiving and hosting costs based on these sources, consultation and detailed activity costing, we explored three sources of archiving costs to inform the analysis of the potential NLP hosting costs:

- The LIFE^2 Project (Ayris et al. 2008), which reported life-cycle costs for articles and other items held on institutional archives in the UK, and found costs equivalent to up to EUR 23 per article in the first year, and around EUR 9 per article held per annum in subsequent years;
- Reporting costs on a submissions equivalent basis, NIH (2008) estimated that it would cost USD 4.5 million per annum to host the estimated 80,000 articles from NIH funding circa 2008 and noted that they had spent a further USD 250,000 on policy-related staff costs, implying a per article cost of around EUR 40 per submission; and
- also reporting approximate costs on a submissions equivalent basis, arXiv (2010) noted that their annual budget was USD 400,000 rising to USD 500,000 by 2012 and that 64,047 articles had been submitted in 2009, implying a per article cost of around EUR 5 per submission.

For the purposes of producing preliminary estimates, we explored an average of this range of costs, but used the NIH reported costing for estimation because it is the most directly comparable to the proposed NLP hosting.[5]

(v) Study publications and apply the knowledge

With limited information about the activities of researchers, research and special libraries, and research users outside higher education and specialist public sector research institutions, the analysis of costs relating to studying publications and applying knowledge is limited to the use of research by public sector researchers. This limits the extent to which the possible costs, cost savings and benefits of alternative scholarly publishing models can be examined on a detailed case-by-case basis and has led to our reliance on a macro-modeling of the potential impacts of enhanced access on returns to R&D using a modified Solow-Swan model. This approach provides a basis for estimating the potential value of enhanced accessibility to research findings at an aggregate level.

1.3 Commentary on the methodology and modeling

Commentary on the approach and modeling since the release of the UK JISC study has come from two main sources. While recognizing the inherent limitations in such modelling, academic and professional commentary has been positive. A detailed peer review of the UK JISC report undertaken by Professor Danny Quah, Head of Economics at The London School of Economics, provides an example of the academic and professional reception of the work. He concluded:

> *The report addresses an important and difficult problem, and is clearly the result of a lot of very careful thinking about the issues. The methodology is sound and the analysis is extremely detailed and transparent. The multi-stage model of production that is used is complex, and does require calibration according to a large number of parameters, many of which are necessarily estimates, where possible taken from published sources or the wider literature. If demonstrably better estimates become available, then these could improve that calibration still further. The report represents the best evidence so far on the questions it addresses.*[6]

Comments from some publishers' representatives, including The Publishers' Association, the Association of Learned and Professional Society Publishers and the International Association of STM Publishers, have focused on the modeling assumptions and calibration – implicitly accepting the methodology and underlying analysis. JISC released a response to the publishers' comments dealing with the issues raised and correcting some misunderstandings,[7] a response to publisher lobbyist's comments at the Berlin7 Open Access Conference can be found at the conference website[8], and a debate on the issues has been published in the March and August 2010 editions of the journal Prometheus (Volume 28 Nos. 1 and 2).[9]

The online model produced as a part of the original UK JISC study allows anyone to explore the impacts of using alternative values for key parameters.[10] Our own sensitivity testing suggests that the

[5] The NIH costing was also very close to the average of the costings.
[6] JISC's response to comments from publishers' representative groups. Available http://www.jisc.ac.uk/media/documents/publications/responseoneiaspmreport.pdf.
[7] http://www.jisc.ac.uk/media/documents/publications/responseoneiaspmreport.pdf
[8] http://www.berlin7.org/IMG/pdf/Comments_on_Hall-2.pdf.
[9] http://www.tandf.co.uk/journals/cpro.
[10] An executable MS Excel model is available from http://www.cfses.com/EI-ASPM/.

same overall results are obtained over a wide range of parameter values, and it is difficult to imagine any plausible combination of values for the parameters that would lead to a significantly different result.

2 Summary of results

Drawing on this wide range of German data sources, international activity surveys and tracking studies we estimate costs for activities throughout the scholarly communication lifecycle at the national level and for the public research organizations that are a party to the NLP in Germany. The data, sources, assumptions and parameters used in the modeling are presented in Annex II.

2.1 Impacts of the German NLP

The German NLP has impacts on a number of areas during the scholarly communication life-cycle. Impacts on the five main activity areas include:

- Fund research – The NLP has little or no impact on the activities performed by re-search funders, with the exception of DFG which funds it, and no impacts are included in the modeling.
- Perform research – With the exception of time saving related to permissions and re-search reporting, upon which the NLP has no impacts, the NLP leads to similar time saving as open access, but scaled to the share of worldwide journal content (titles) in the NLP.
- Publish scientific and scholarly works – While it could be seen as a new, additional sales strategy for publishers, the NLP has little or no impact on publisher costs except for possible minor impacts on marketing, the operation of servers and user support. As these activities are still done for current content lying outside the NLP and for the rest of the world outside Germany these minor impacts are excluded.
- Facilitate dissemination, retrieval and preservation – The NLP leads to research library savings in handling, support and purchasing/negotiation activities, scaled to the number of titles in the NLP. The counter-factual to the NLP is cannot be readily identified as we cannot know if the NLP content would have been subscribed to without the NLP. Hence we explore per title impacts, then multiply by the number of titles accessible through subscriptions and through the NLP (combined). It is assumed that the NLP reduces non-negotiation and licensing subscription-related library activities by 50% (i.e. 50% of the non-negotiation and licensing subscription-related activity is handled centrally under the NLP and 50% is still done by the local research libraries).
- Study publications and apply the knowledge – The impacts of the NLP on accessibility and efficiency are modeled as follows:
    - In relation to accessibility, the NLP leads to (i) a marginal increase in returns to German R&D through an increase in German access; and (ii) no increase in access to German research outside Germany, as its published in the same way; and
    - in relation to efficiency, the NLP's impacts are less than those of open access as it has no impact on the speed of publication and facilitates domestic collaboration only.

  Hence accessibility and efficiency impacts are scaled.

Annex II presents details of the parameters and data sources used.

2.2 Scholarly communication system costs

The reading of scholarly publications by German-based researchers and academic staff is a major activity, perhaps costing around EUR 25 billion annually, while reading by those actively publishing (i.e. approximating reading in order to write) cost around EUR 7.7 billion during 2008 (Table 1).[11] We estimate that writing the core peer-reviewed scholarly publications may have cost around EUR 2.5 billion, and preparing and reviewing research grant applications for the major research agencies alone may have cost around EUR 430 million.

The peer review of scholarly journal articles and books conducted by German researchers on behalf of publishers (i.e. external peer review activities) probably cost around EUR 300 million during 2008, and the external journal editorial and editorial board activities of researchers around EUR 200 million. We estimate that publisher costs relating to German-authored core peer-reviewed publications probably amounted to around EUR 675 million (excluding the external costs noted above). Summing these costs suggests that core scholarly publishing sys-tem activities may have cost around EUR 12 billion[12] (See Annex III for detailed activity costings).

Table 1: Estimated annual national scholarly communication activity costs (EUR, 2008)

German National	*Estimate*
Reading (Published Staff)	7,677,100,000
Writing (WoK based estimate, scaled)	2,429,700,000
Peer Review (Scaled to publication counts)	293,100,000
Editorial activities (Scaled to published staff)	177,800,000
Editorial board activities (Scaled to published staff)	19,700,000
Preparing Grant Applications (major funding agencies)	385,400,000
Reviewing Grant Applications (major funding agencies)	44,800,000
Publisher Costs (Scaled to publication counts)	675,900,000
Total National System	11,703,500,000

Source: German model: Authors' analysis.

Table 2 summarises these same scholarly communication activity costs for the higher education and public research institutions that participate in the German NLP. It shows that reading by academic and research staff probably cost around EUR 14 billion during 2008, while reading by those actively publishing around EUR 6.3 billion. We estimate that writing the core peer-reviewed scholarly publications in higher education and public research institutions cost around EUR 2.4 billion, and preparing and reviewing research grant applications for the major funding agencies alone may have cost around EUR 370 million.

The peer review of scholarly journal articles and books conducted on behalf of publishers by academic and research staff in Germany (i.e. external peer review activities) probably cost around EUR 290 million during 2008, and their external journal editorial and editorial board activities around EUR 157 million. We estimate that university and research institute output-related publisher costs probably amounted to around EUR 670 million (excluding the external costs noted above). Summing

[11] All costs are expressed in 2008 Euros and, where necessary, have been adjusted to 2008 using the national Consumer Price Index and converted to Euros using OECD published annual average exchange rates. All publisher costs include commercial margins.

[12] These activity costings include the cost of publishing German research, but do not include the cost of toll and subscription access to non-German scholarly content.

these costs suggests that scholarly publishing system activities may have cost German higher education and public research institutions almost EUR 10 billion during 2008 (See Annex III for more detailed activity costings).

Table 2: Estimated annual higher education and public research institution scholarly communication activity costs (EUR, 2008)

German Universities & Public Institutions (NLP)	*Estimate*
Reading (Published Staff)	6,301,400,000
Writing (WoK based estimate, scaled)	2,383,300,000
Peer Review (Scaled to publication counts)	291,300,000
Editorial activities (Scaled to published staff)	141,400,000
Editorial board activities (Scaled to published staff)	15,600,000
Preparing Grant Applications (major funding agencies)	329,800,000
Reviewing Grant Applications (major funding agencies)	38,400,000
Publisher Costs (Scaled to publication counts)	668,200,000
Total Higher Education and Public Institutions System	10,169,400,000

Source: German model: Authors' analysis.

2.3 The cost of alternative models

Our analysis focuses on three alternative models for scholarly publishing, namely: subscription publishing, open access publishing and self-archiving, as well as the German NLP. Table 3 summarises costs relating to each of these models.

Table 3: Estimated annual higher education and public research institution scholarly communication related costs (EUR, 2008)

German Higher Education & Public Institutions	*Estimate*
Subscription or toll access publishing	
Library Acquisition (Wissenschaftliche Universal und Hochschulbibliotheken)	319,434,600
Estimated library non-Acquisition (Wissenschaftliche Universal und Hochschulbibliotheken)*	640,000,000
Open access publishing & self-archiving	
Author-pays fees for journal articles produced	184,142,400
Estimated Repository Costs	43,163,000
National Licensing Program	
NLP Acquisition	13,059,000
NLP non-Acquisition (including hosting)	23,721,000

Note: * Library non-acquisition costs are estimated at approximately double acquisition costs.
Source: German model: Authors' analysis.

Subscription and toll access publishing cost the Wissenschaftliche Universal- und Hochschulbibliotheken EUR 320 million for acquisitions during 2008. Negotiation of subscriptions and licensing, access control and other library handling relating to the subscription or toll access model also accounted for a substantial share of university library non-acquisition costs (estimated at around EUR 170 million for journals alone).

Open access publishing all German higher education and public research institution journal article output in 2008 using the author-pays model would have cost around EUR 185 million at EUR 2,000 per article published. Given that it is said that no more than half of open access journals actually charge author fees, perhaps EUR 92 million would have been required for author-side payments.

However, if Germany supported open access publishing in proportion to output, the remaining EUR 92 million would have been paid in other forms of institutional support.

Open access self-archiving costs are based on estimated repository costs, which are necessarily no more than approximate. Nevertheless, we estimate that a system of institutional repositories in higher education and public research institutions, in which every institution had one publications-oriented repository and all publications were self-archived once, might cost around EUR 43 million per annum (at 2008 prices and levels of publication output).

The National Licensing Program costs an annualised EUR 13 million for content acquisition and a further EUR 655,000 in direct operational costs. As hosting is envisaged, we estimate annual NLP hosting costs for all items ingested (estimated at 11.5 million, of which 6.5 mil-lion would be journal articles) at around EUR 23 million per annum, based on NIH reported submission-equivalent hosting costs (NIH 2008). Hence, hosting adds significantly to overall costs.

2.4 Costing activities, objects and functions

The matrix approach to costing lying behind these activity costs enables their presentation in various forms, including as costs for actors, objects and functions.

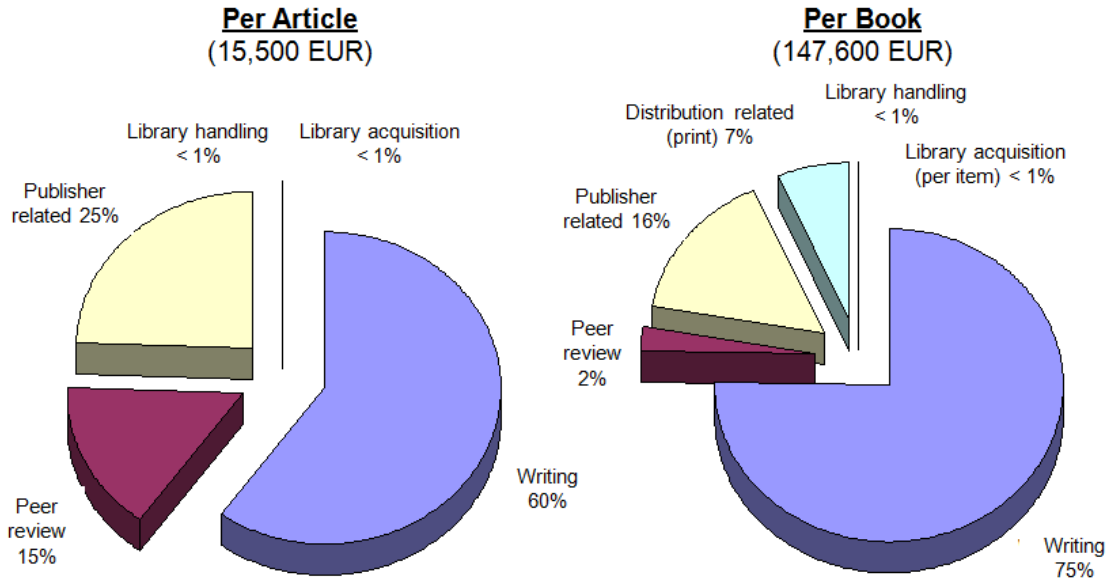
Table 4: Estimated per item object costs (EUR, 2008)

	Estimate
Cost of journal articles (per article)	
Writing	9,300
Peer review (per published)	2,400
Publisher related	3,800
Library acquisition (including free and copyright deposit titles)	0.38
Library handling	0.30
Per article production	*15,500*
Publisher share of production costs	25%
Cost of academic books (per title)	
Writing	111,000
Peer review (per published)	3,600
Publisher related	23,000
Distribution related (print)	9,900
Library acquisition (books per item)	..
Library handling	..
Per monograph production	*147,600*
Publisher and distributor share of production costs	22%

Note: Writing costs include those items that are not published while all other costs are per item published. Acquisition costs include copyright deposit and free materials, but are excluded from the totals to avoid double counting.
Source: German model: Authors' analysis.

For example, combining activity costs to estimate object costs we find that journal articles cost an estimated average of around EUR 15,500 to produce in Germany circa 2008, of which around EUR 9,300 related to the direct cost of writing (excluding input research activities, such as reading), EUR 3,800 related to publisher costs and EUR 2,400 to external peer review costs (per article published) (Table 4 and Figure 2).

Similarly, we estimate that academic books (i.e. authored and edited books) cost an average of around EUR 148,000 to produce in Germany circa 2008, of which around EUR 111,000 related to the direct cost of writing (excluding input research activities, such as reading), EUR 23,000 related to publisher costs and an estimated EUR 9,900 to distribution costs, and EUR 3,600 to external peer review costs (per title published) (Table 4 and Figure 2).



Note: Writing costs include those items that are not published while all other costs are per item published.
Source: German Model: Authors' analysis.

Figure 2: Estimated per item object cost shares (per cent)

Activity costs can also be combined into the cost of specific functions, such as peer review and the functions of quality control and certification.[13] Our activity cost estimates include both internal publisher peer review handling and management related costs and external, largely non-cash, peer reviewer costs. Per article published, these amounted to an estimated EUR 430 and EUR 2,410, respectively, or a total function cost of EUR 2,840 circa 2008.

2.5 Publisher costs per journal article

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 subscription, open access publishing and the NLP models independent of differences between print and electronic formats. Our approach is to estimate costs for print, dual-mode (i.e. parallel print and electronic) and electronic-only formats for subscription and open access business models, and then to compare subscription and open access models as if all models were electronic or 'e-only'. All of these costings include commercial publisher margins (Figure 3).

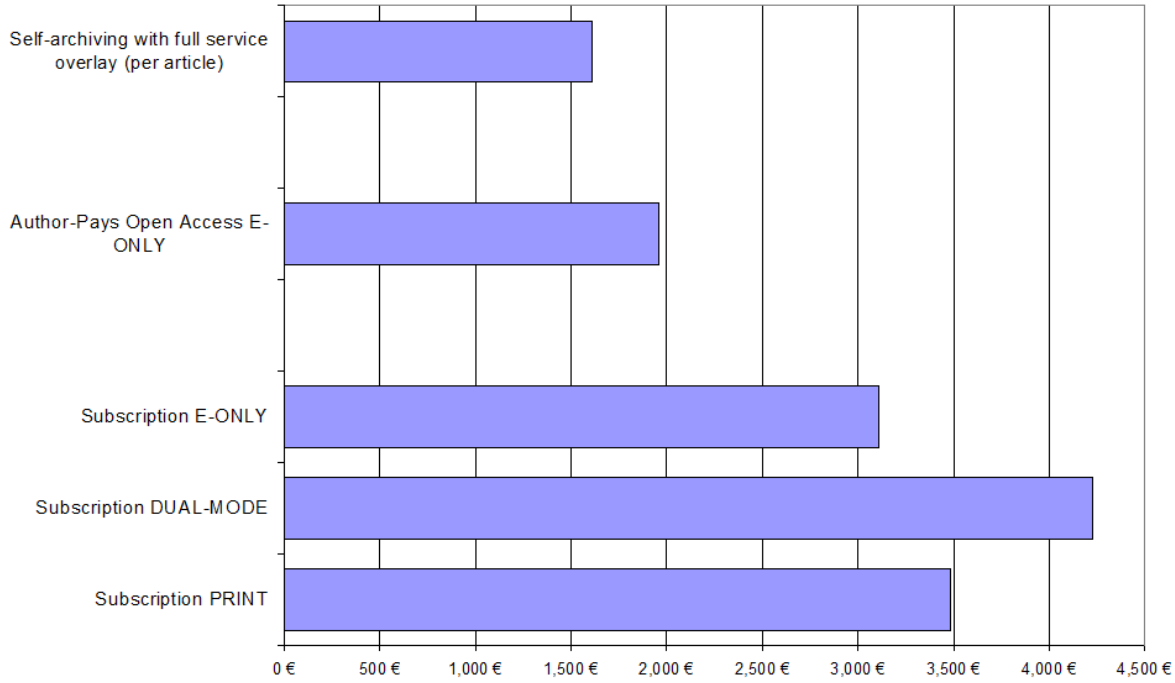
For *subscription publishing*, we estimate an average publisher cost of around EUR 4,230 per article for dual-mode production, EUR 3,485 per article for print only production and EUR 3,110 per article

[13] A number of publisher activities relating to the proofing, checking and editing of manuscripts might also be included in the function of quality control, but have been excluded from this example for the sake of simplicity.

for e-only production (excluding the costs associated with external peer re-view and Value-Added Tax).[14]

For *open access publishing* using the author-pays model, we estimate average per article costs at EUR 1,960 for e-only production. Obviously, the publisher costs of Green OA self-archiving, and those under the National Licensing Program, are the same as those for subscription publishing.

We include the implied publisher costs of *overlay services to open access self-archiving* (i.e. elements of publisher activity that could provide value adding overlay services to open access repositories), with the same commercial management, investment and profit margins applied. This suggests that operating peer review management, editing, production and proofing as an overlay service would cost around EUR 1,415 per article excluding hosting, or EUR 1,610 including hosting.



Note: These costs exclude the external costs of peer review and VAT. Overlay services include operating peer review management, editing, proofing and hosting, with commercial margins.
Source: German model: Authors' analysis.

Figure 3: Estimated average publisher costs per article by format and model (EUR, 2008)

2.6 The impact of alternative scholarly publishing models

Summing the costs of production, publishing and dissemination per article in electronic-only format suggests that:

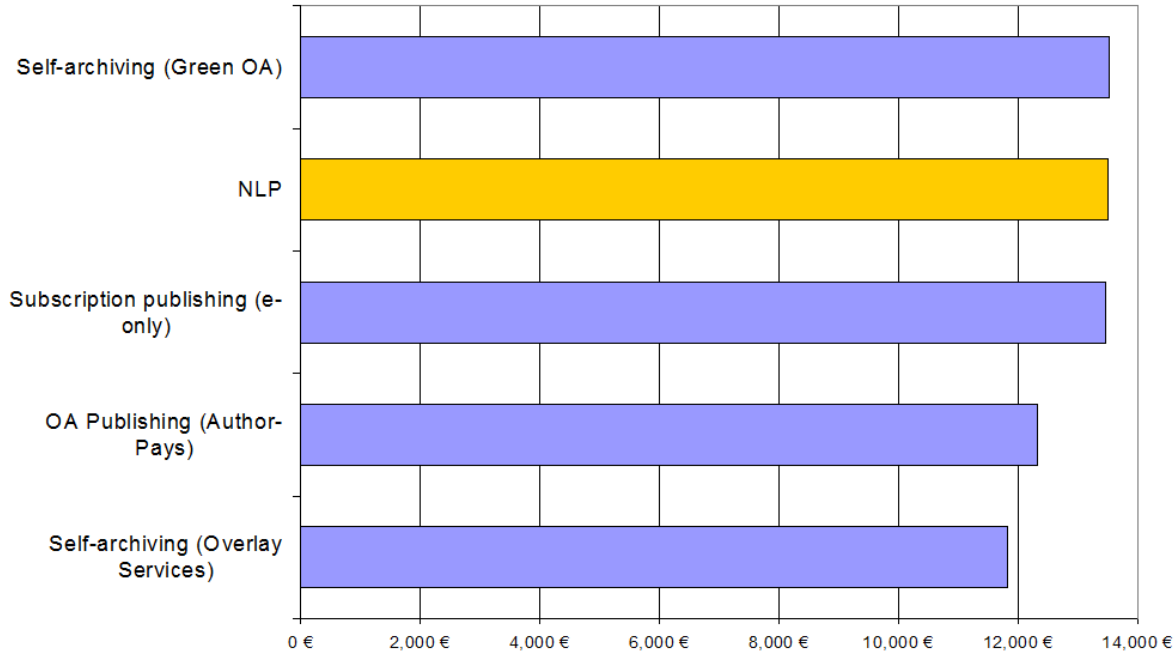
- Average subscription publishing system production costs would amount to around EUR 13,460 per article (excluding Value-Added Tax);
- Average Green OA self-archiving would amount to EUR 13,520 per article;
- Average open access publishing costs using the author-pays model would amount to EUR 12,310 per article;

[14] These publisher costs are derived from those reported in the various original studies, inflated as necessary to reflect CPI, converted to Euros at annual average exchange rates and expressed in 2008 prices.

- Average open access self-archiving costs would amount to EUR 11,825 per article (including overlay review and production services with commercial margins); and
- Average NLP costs would amount to an average EUR 13,500 per article – with the NLP contributing a relatively minor per article library handling saving and compensating higher hosting cost.

At these costs, open access publishing would be around EUR 1,150 per article cheaper than subscription publishing, and open access self-archiving with overlay services around EUR 1,635 per article cheaper. With local hosting, the NLP might be around EUR 40 per article more expensive and Green OA self-archiving around EUR 60 per article more expensive (Figure 4).

For higher education and the public research institutions that participate in the NLP, these journal article production cost differences would have amounted to savings of around EUR 105 million per annum circa 2008 from a shift from subscription access to open access author-pays publishing, and EUR 150 million from a shift to open access self-archiving with overlay services.



Note: 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).
Source: German model: Authors' analysis.

Figure 4: Scholarly communication system-wide production costs per article (EUR, 2008)

In addition to direct (*production*) cost differences there are potential system-wide (use) cost savings. These can be presented as cost comparisons relating to: (i) the costs associated with alternative publishing models (i.e. asking which is the most cost-effective model), or (ii) the cost implications of alternative publishing models for Germany (i.e. asking what are the cost implications of the models for Germany). Herein, we present the latter.[15]

In a highly simplified form, the following Figures summarise the estimated impacts for Ger-many nationally and for the higher education and public research institutions participating in the NLP in Germany of unilateral national and worldwide adoption of alternative open access journal/article

[15] In contrast, previous national studies in the UK, Netherlands and Denmark presented the former comparison.

publishing models, including: (i) 'Green OA' self-archiving in parallel with subscription publishing; (ii) 'Gold OA' or author-pays journal publishing; and (iii) the 'overlay services or overlay journals' model of self-archiving with overlay services. The fourth Figure relates to the impacts of the German NLP. Reported increased returns to R&D expenditure are for combined public sector and higher education R&D spending, and are recurring gains from one year's expenditure expressed in Net Present Value, lagged and discounted over the useful life of the knowledge.

As many of the potential cost savings cannot be fully realised unless there is worldwide adoption of open access alternatives, in the unilateral national adoption of open access scenarios funder, research, library handling and subscription cost savings are scaled to Germany'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 Germany). In the 'Green OA' model, self-archiving operates in parallel with subscription publishing, so there are no publisher, library handling or subscription cost savings. In the NLP model, where research impacts occur, they are scaled to the share of worldwide journal titles accessible through the NLP.

Box 1: Estimating the impacts of enhanced access on returns to R&D

To explore the impacts of enhanced access on returns to R&D we modify a basic Solow-Swan model, by introducing 'accessibility' and 'efficiency' as negative or friction variables, and then calculating the impact on returns to R&D of reducing the friction by increasing accessibility and efficiency.

We find that with a 20% return to publicly funded R&D, for the major categories of research expenditure in Germany in 2008, a 5% increase in accessibility and efficiency would have been worth:

- EUR 1,345 million per annum in increased returns to gross national expenditure on R&D (GERD); and
- EUR 406 million per annum in increased returns to public sector R&D (*i.e.* government and higher education).[16]

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

Note: Estimates of the returns to R&D are based on aggregates, such as national or public sector expenditure, for which they can be reasonably accurate. Their application specific fields of research and smaller aggregations will be subject to greater uncertainty and should be treated with caution.

Separating modelled increases in returns to R&D resulting from enhanced accessibility and/or efficiency from the cost impacts, the following Figures also present the net cost impacts of the alternative 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 and realise the benefits).

We estimate that:

- *'Gold OA' open access publishing* using the author-pays model for journal articles might bring cost savings of around EUR 383 million per annum nationally in Germany in a worldwide

[16] The rationale behind the use of a 20% return to R&D and a 5% increase in accessibility and efficiency for open access is discussed in detail in Houghton and Oppenheim *et al*. (2009, pp193-208). See http://www.cfses.com/EI-ASPM/

open access system, or EUR 24 million if Germany adopted open access unilaterally (at 2008 prices and levels of publishing activity), of which around EUR 311 million and EUR 19 million, respectively, would accrue in higher education and public research institutions;

- *Open access self-archiving without subscription cancellations* ('Green OA') would save around EUR 210 million per annum nationally in a worldwide Green OA system, or EUR 13 million if Germany adopted Green open access unilaterally, of which around EUR 138 million and EUR 8 million, respectively, would accrue in higher education and public research institutions;
- The *open access self-archiving with overlay services* model explored is necessarily more speculative, but if libraries treated overlay journals the same as OA journals a repositories and overlay services model may produce comparable cost savings to the 'Gold OA' model of around EUR 383 million nationally in an all OA world, of which around EUR 311 might accrue in higher education and public research institutions; and
- it is estimated that the *German National Licensing Program* produces savings of around EUR 85 million in higher education and public research institutions – excluding subscription cost reductions arising from centralise negotiations.

These savings can be set against the cost of open access journal/article publishing alternatives, which if all journal articles produced encountered author fees of EUR 2,000 per article published would have been around EUR 185 million nationally in 2008. Similarly, estimated repository costs would have been around EUR 62 million nationally and EUR 42 million for higher education and public research institutions. Thus, in an open access world, the 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. For the NLP, annual costs of EUR 37 million (including hosting) produce savings of EUR 84 million in higher education and public research institutions.

Figure 5 summarises the potential cost impacts of 'Green OA' self-archiving in parallel with subscription publishing circa 2008. Indicatively, it suggests that in an all open access world, 'Green OA' to all journal articles produced in Germany during 2008 might have generated an approximate net benefit of around EUR 449 million (per annum), including a net cost saving of around EUR 148 million. Whereas, the unilateral national adoption of 'Green OA' in Ger-many may have generated net benefits of around EUR 252 million, while incurring a net cost of around EUR 49 million (i.e. an additional cost, effectively the investment required to realise the benefits).

Figure 6 summarises the potential cost impacts of 'Gold OA' publishing through the author-pays model, and Figure 7 the cost impacts of self-archiving with overlay production and re-view services (i.e. the deconstructed or overlay journals model).

Figure 8 summarises the cost impacts of the German National Licensing Program (NLP), showing that for the higher education and public sector research institutions the NLP gener-ates annual net cost savings of around EUR 47 million and might be expected to increase re-turns to public sector R&D spending by around EUR 64 million per annum.

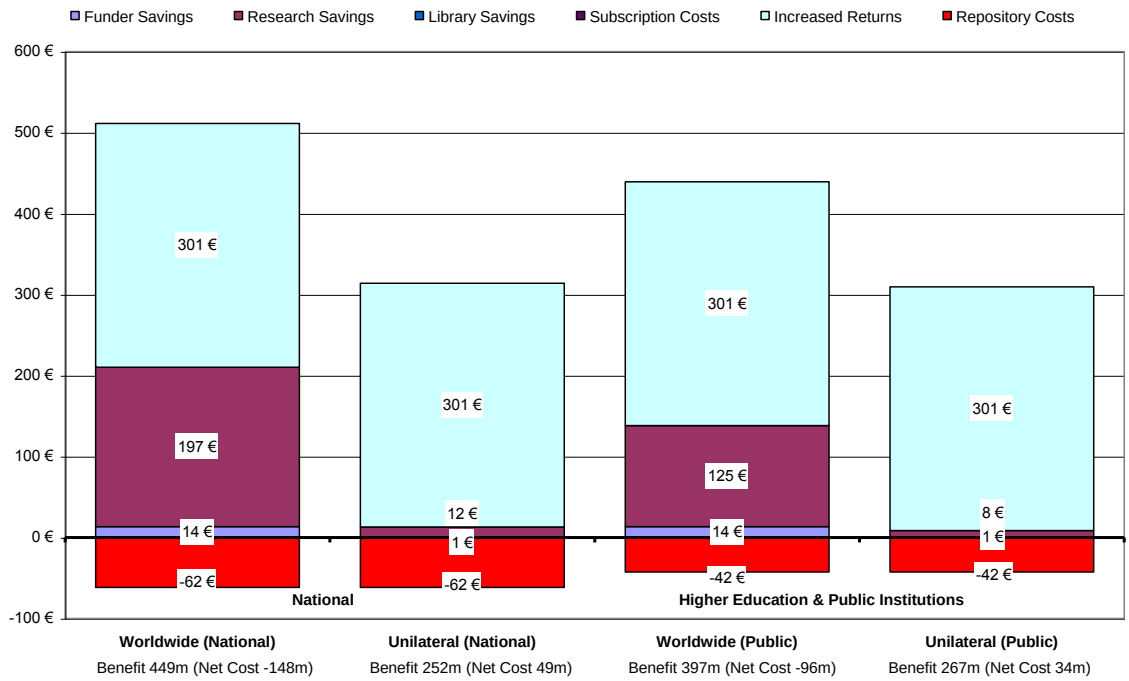


Figure 5: Estimated impact of "Green OA" self-archiving (EUR millions per annum, 2008; Source: German model: Author's analysis)

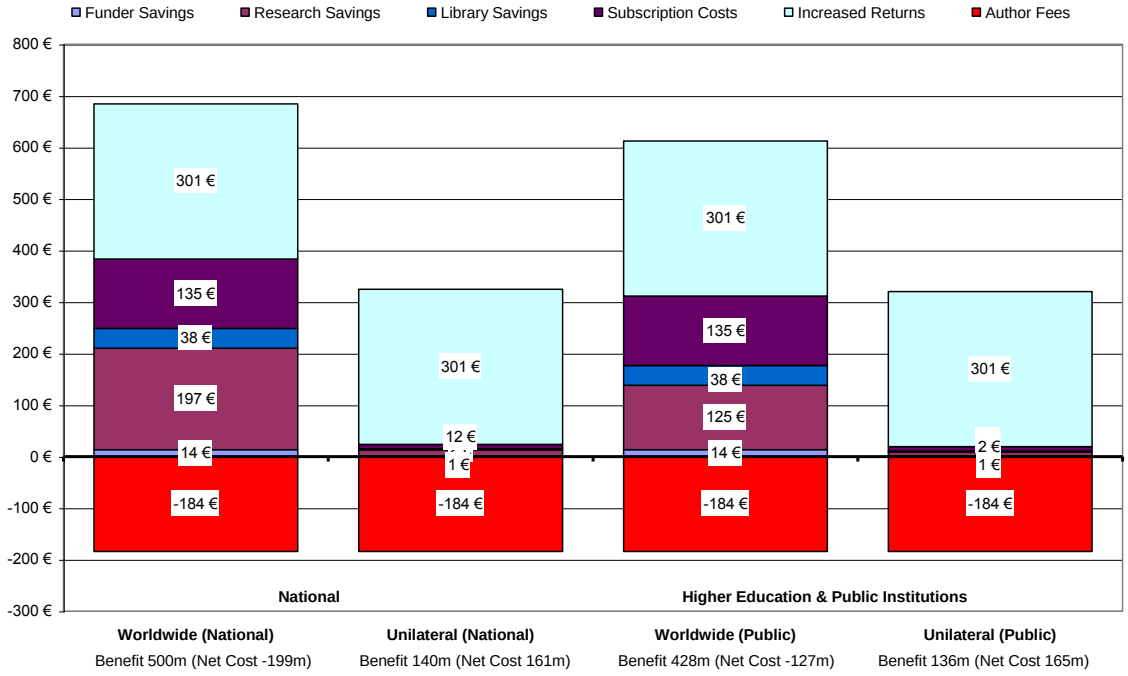


Figure 6: Estimated impact of "Gold OA" publishing (EUR millions per annum, 2008; Source: German model: Author's analysis)

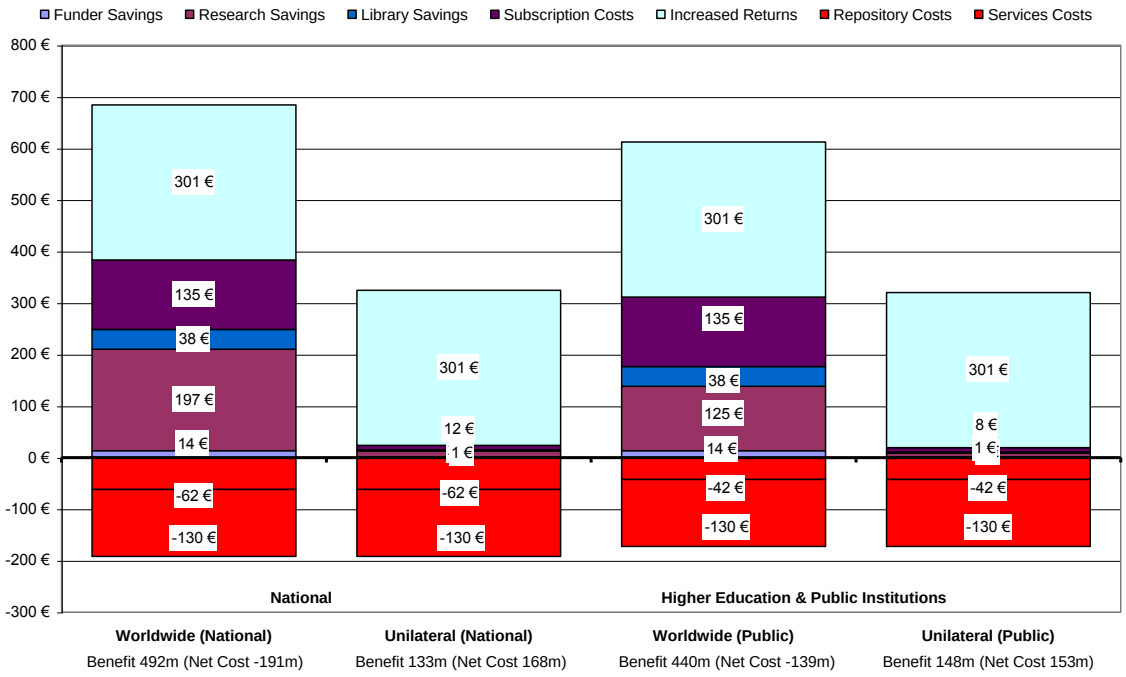


Figure 7: Estimated impact of OA self-archiving with overlay production and peer review services (EUR millions per annum, 2008; Source: German model: Author's analysis)

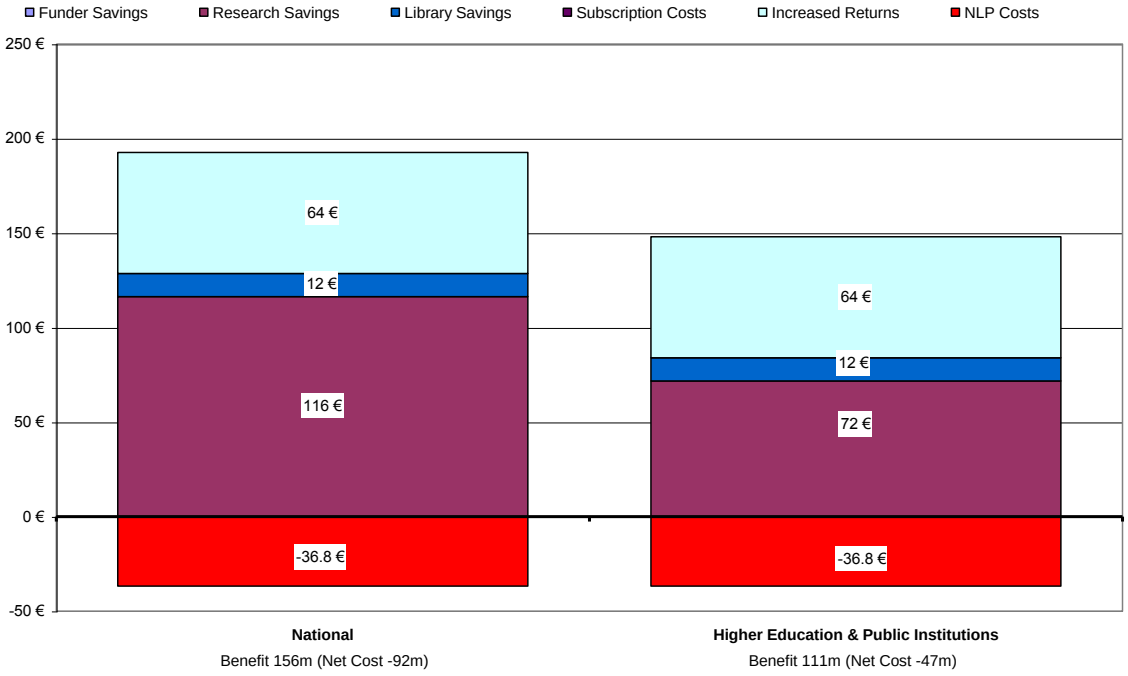


Figure 8: Estimated impact of German NLP (EUR millions per annum, 2008; Source: German model: Author's analysis)

2.7 Comparing costs and benefits

Modelling the impacts of an increase in *accessibility* and *efficiency* resulting from more open access on returns to R&D over a 20 year period and then comparing costs and benefits, we find that the benefits of open access publishing models are likely to substantially outweigh the costs and, while smaller, the benefits of the German NLP also exceed the costs.

Box 2: A brief description of the returns to R&D model

Main characteristics: A spreadsheet model to estimate the impacts of increases in '*accessibility*' and '*efficiency*' on returns to R&D over 20 years in a 20 by 20 matrix, with three data inputs: (*i*) R&D expenditure, (*ii*) annual costs associated with the publishing model, and (*iii*) annual savings resulting from the publishing model (in the net cost scenarios only).

Assumptions and parameters: All the parameters can be changed in order to explore various scenarios and test sensitivities. Key parameters include: (*i*) the rate of return to R&D, (*ii*) the rate of depreciation of the underlying stock of knowledge, (*iii*) the discount rate applied to costs and benefits to estimate net present value, (iv) the rate of growth of R&D expenditure, (*v*) the rate of growth of costs associated with the alternative publishing scenario being explored, (*vi*) the average lag between publication or self-archiving and returns to R&D in years, and (*vii*) the average lag between R&D expenditure and publication in years.

Transition versus 'steady-state' alternative: 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 (by 10 years in the base case scenario) and the value of those returns discounted accordingly. This reflects that fact that a shift to OA publishing or self-archiving would be prospective and not retrospective, and the economic value of impacts of enhanced accessibility and efficiency would not be reflected in returns to R&D until those returns are realised.

An alternative approach would be to model a hypothetical alternative '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.

The model used herein focuses on the transition and explores alternative models through a series of scenarios over a 20 year transitional period. However, the possible impacts in a hypothetical 'steady-state' alternative system are explored indicatively by introducing the estimated annual increase in returns into year one. This effectively removes the lag, but is no more than indicative because it does not include the recurring gains from historical expenditures occurring before year one.

Source: Houghton, J.W., Rasmussen, B., Sheehan, P.J., Oppenheim, C., Morris, A., Creaser, C., Greenwood, H., Summers, M. and Gourlay, A. (2009) *Economic Implications of Alternative Scholarly Publishing Models: Exploring the Costs and Benefits*, London & Bristol: The Joint Information Systems Committee (JISC), p211.

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). Then we explore the implications of open access publishing and self-archiving as alternatives to current activities, by adding the estimated system savings to estimated in-creases in returns to R&D (i.e. net cost scenarios).[17] In both cases, the comparisons focus on the cost-benefit implications for Germany (i.e. setting the cost of alternative models against subscription expenditure savings), rather

[17] Of course, the scenario adding "Gold OA" open access publishing to current activities is 'unrealistic', as parallel publishing all articles in open access and subscription journals simultaneously would not be possible given the copyright demands of subscription publishing.

than comparing the models as alternative publishing systems (i.e. the topic of the UK JISC and subsequent national studies in the Netherlands and Denmark).

These cost-benefit comparisons 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 ('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 alternatives the benefits exceed the costs, even in transition. Indicative modelling of post-transition 'steady-state' alternative systems (Box 2) suggests that, once established, alternative open access publishing and/or self-archiving systems would produce substantially greater net benefits.

For example (Table 5), during a transitional period of 20 years we estimate that, in an open access world:

- The combined cost savings and benefits from increased returns to R&D resulting from open access publishing (i.e. 'Gold OA') all journal articles produced in Germany's higher education and public sector institutions using the 'author-pays' model might be around 2.7 times the costs (1.1 times with unilateral national adoption);
- The combined cost savings and benefits from open access self-archiving in parallel with subscription publishing (i.e. 'Green OA') might be around 7.4 times the costs (4.4 times with unilateral national adoption);
- The combined cost savings and benefits from open access self-archiving with overlay production and review services (i.e. 'overlay journals') might be around 2.9 times the costs (1.2 times with unilateral national adoption); and
- The combined cost savings and benefits from the German National Licensing Program (NLP), which is necessarily a national rather than worldwide model, might be around 3.3 times the costs.[18]

Indicative modelling of post-transition 'steady-state' alternative systems returns significantly higher benefits – around 12 times costs for the open access 'Author-Pays' publishing and 'overlay journals' models, up to 40 times the costs for the 'Green OA' open access self-archiving model, and around 12 times the costs for the German NLP.

[18] In Table 5, the net savings reported for Germany nationally are likely to be slightly understated due to incomplete data on national subscription expenditure.

Table 5: Transitional model: Summary of benefit/cost comparisons by scenario (EUR millions over 20 years and benefit/cost ratio)

Transitional Model			*Benefits*	*Benefit/Cost*
	Costs	*Savings*	*Returns*	*Ratio*
Open Access				
Ceteris Paribus Scenarios				
OA Publishing in HE & Public (unrealistic)	1,898	..	1,863	1.0
OA Publishing Nationally (unrealistic)	1,900	..	1,863	1.0
OA Repositories in HE & Public (Green OA)	445	..	1,863	4.2
OA Repositories in HE & Public (Overlay Services)	1,779	..	1,863	1.0
OA Repositories Nationally (Green OA)	647	..	1,863	2.9
OA Repositories Nationally (Overlay Services)	1,979	..	1,863	0.9
Net Cost Scenarios				
Scenario (German National OA)				
OA Publishing in HE & Public	1,898	197	1,863	1.1
OA Repositories in HE & Public (Green OA)	445	88	1,863	4.4
OA Repositories in HE & Public (Overlay Services)	1,779	197	1,863	1.2
OA Publishing Nationally	1,900	243	1,863	1.1
OA Repositories Nationally (Green OA)	647	133	1,863	3.1
OA Repositories Nationally (Overlay Services)	1,979	243	1,863	1.1
Scenario (Worldwide OA)				
OA Publishing in HE & Public	1,898	3,208	1,863	2.7
OA Repositories in HE & Public (Green OA)	445	1,425	1,863	7.4
OA Repositories in HE & Public (Overlay Services)	1,779	3,208	1,863	2.9
OA Publishing Nationally	1,900	3,950	1,863	3.1
OA Repositories Nationally (Green OA)	647	2,166	1,863	6.2
OA Repositories Nationally (Overlay Services)	1,979	3,950	1,863	2.9
National Licensing Program				
NLP in HE & Public	379	866	399	3.3
NLP National (Hypothetical)	379	1,326	399	4.5

Note: Compares alternative models against subscription or toll access, with costs, savings and benefits expressed in Net Present Value over 20 years (EUR millions). Increased returns to R&D relate to combined higher education and national public expenditure on R&D. The NLP transition is modelled in the same way as open access alternatives for comparative purposes even though the NLP has been in operation for four years.
Source: German model: Authors' analysis.

In interpreting these results, there are a number of considerations and limitations to be borne in mind. The NLP and other access and dissemination models perform different roles and there are some limits to the extent to which they can be compared directly. For example, subscription and open access publishing perform very different roles. To the limits of affordability, subscription publishing seeks to provide an institution's or country's researchers with access to the worldwide research literature; whereas open access seeks to provide worldwide access to an institution's or country's research output. These are very different things, but to compare cost-effectiveness it is necessary to compare like with like. Consequently, the UK, Dutch and Danish studies compared the publisher costs associated with publishing national article output under different models – including subscription publishing. In contrast, this study compares the costs of operating within alternative models, by setting the costs of alter-native models against subscription expenditures. This does not

compare the cost of using alternative models to achieve a comparable task; rather it compares the cost implications of the alternative models for a particular actor or actors (in this case for Germany).

A related consideration is the extent to which performing this latter comparison misses some of the costs associated with subscription publishing, as it substitutes subscription expenditures for subscription publishing costs, and subscriptions do not cover the costs of subscription publishing where there are also advertising revenues, page and plate charges, revenue from re-prints and others forms of subsidy to subscription journals. Hence, while providing a more directly relevant comparison of costs for stakeholders in Germany, in contrast to the pervious national studies, this study does not compare the cost-effectiveness of alternative models, but rather the cost implications for Germany of operating within the alternative models.

It is also important to note that the German NLP is a relatively long-term commitment made during a period of change. As such, there is the potential for developments in open access or other scholarly publishing business models to significantly change the relative cost-benefit of the NLP over time. We considered reflecting this risk in adjusted discount rates in the model-ling, but in the absence of any real guide as to the level of risk associated with the NLP relative to that of the other publishing models we did not make any risk adjustment. On the other hand, our core comparisons were of costs and benefits over a transitional 20 years from implementation of the alternative publishing and dissemination model. As the NLP had already been in operation for four years in 2008-09, this leads to a marginal understatement of the cumulative benefits.

2.8 An international comparison

For the purposes of international comparison we have re-worked the UK modelling and analysis to make it comparable to that performed in this study (i.e. so that both compare the cost implications of alternative publishing models for the country concerned). Table 6 presents the results.

It should be noted that there are many factors that affect the modelled comparisons for different countries. For example:

- Activity costs and cost structures relate to the specific countries, being generated from the bottom-up in each individual case, and there are many differences in individual activity costings;
- The UK study focussed on 2007 prices and levels of activity, whereas the German study focuses on 2008 prices and levels of activity;
- Exchange rates used for conversion in the two studies were different and there are many inter-currency variations and fluctuations year-to-year (e.g. converting a US dollar cost to British pounds and inflating it by UK CPI to express it in 2007 GBP can produce a result that is not the same, on current cross rates, as converting to Euros and inflating by Germany's CPI to express it in 2008 EUR);
- Institutional structures vary (e.g. the implied number of institutional repositories reflects the number of higher education institutions, and relative institutional sizes);
- The UK study focused on higher education, whereas the German study attempts to encompass the coverage of the NLP by including higher education and public re-search institutions;
- Different countries have quite different ratios of journal article output to R&D spending (e.g. due to different disciplinary mixes and mixes of sectoral performance of R&D);

- Different countries account for different shares of the world's article output; and
- Author fees of GBP 1,500 per article published in the UK study and EUR 2,000 in the German study are not strictly comparable as exchange rates vary from year-to-year.

Table 6: A comparison of German and UK results (EUR millions over 20 years and benefit/cost ratio)

	Savings	*Increased Returns*	*Costs*	*Net*	*Cost / Benefit*
GERMANY					
OA Publishing (Gold OA)					
National German (Worldwide OA)	3,950	1,863	-1,900	3,913	3.1
National German (Unilateral OA)	243	1,863	-1,900	206	1.1
Higher Education & Public (Worldwide OA)	3,208	1,863	-1,898	3,173	2.7
Higher Education & Public (Unilateral OA)	197	1,863	-1,898	162	1.1
OA Self-archiving with overlay services					
National German (Worldwide OA)	3,950	1,863	-1,979	3,834	2.9
National German (Unilateral OA)	243	1,863	-1,979	127	1.1
Higher Education & Public (Worldwide OA)	3,208	1,863	-1,779	3,292	2.9
Higher Education & Public (Unilateral OA)	197	1,863	-1,779	281	1.2
OA Self-archiving (Green OA)					
National German (Worldwide OA)	2,166	1,863	-647	3,382	6.2
National German (Unilateral OA)	133	1,863	-647	1,349	3.1
Higher Education & Public (Worldwide OA)	1,425	1,863	-445	2,843	7.4
Higher Education & Public (Unilateral OA)	88	1,863	-445	1,506	4.4
United Kingdom					
OA Publishing (Gold OA)					
National UK (Worldwide OA)	3,827	1,155	-2,826	2,156	1.8
National UK (Unilateral OA)	325	1,155	-2,826	-1,346	0.5
Higher Education (Worldwide OA)	3,282	836	-2,429	1,688	1.7
Higher Education (Unilateral OA)	279	836	-2,429	-1,315	0.5
OA Self-archiving with overlay services					
National UK (Worldwide OA)	3,827	1,155	-2,489	2,493	2.0
National UK (Unilateral OA)	325	1,155	-2,489	-1,009	0.6
Higher Education (Worldwide OA)	3,282	836	-2,118	2,000	1.9
Higher Education (Unilateral OA)	279	836	-2,118	-1,003	0.5
OA Self-archiving (Green OA)					
National UK (Worldwide OA)	1,782	1,155	-374	2,564	7.9
National UK (Unilateral OA)	152	1,155	-374	934	3.5
Higher Education (Worldwide OA)	1,238	836	-298	1,777	7.0
Higher Education (Unilateral OA)	105	836	-298	643	3.2

Notes: UK costs and benefits are converted to Euros using 2007-08 average annual exchange rates.
Source: JISC EI-ASPM and German models: Authors' analysis.

Nevertheless, the results for the two countries are similar. Open access publishing costs appear somewhat higher in the UK, and the benefit/cost ratios for the 'Gold OA' author-pays and overlay services models are somewhat lower as a result. Conversely, a higher number of institutions and lower average article output per institution suggest higher archiving costs in Germany, and the 'Green OA' model of self-archiving without subscription cancellation produces somewhat lower benefit/cost ratios. Overall, however, the results for the two countries are similar.

3 Conclusions and implications

The analysis summarised in this report compares three scholarly publishing models and the German NLP as if they were alternatives. In reality, of course, there are a number of variations and hybrids (e.g. delayed open access, open choice/author choice, etc.) and the models co-exist in various mixes in different fields of research and different countries. Nevertheless, these models do have some key defining characteristics, and those characteristics have cost implications for producers, intermediaries and the users and consumers of the content. They also have implications for the efficiency of research, the accessibility of research findings and their impacts, and, thereby, for returns to investment in R&D.

This analysis of the potential benefits of more open access to research findings suggests that different publishing models can make a material difference to the benefits 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 'author-pays' open access publishing and the 'over-lay journals' alternatives ('Gold OA'), and for parallel subscription publishing and self-archiving ('Green OA').

The German National Licensing Program (NLP) returns substantial benefits and savings at a modest cost, returning one of the highest benefit/cost ratios available from unilateral national policies during a transitional period (second to that of 'Green OA' self-archiving). Whether 'Green OA' self-archiving in parallel with subscriptions is a sustainable model over the longer term is debateable, and what impact the NLP may have on the take up of OA alternatives is also an important consideration. So too is the potential for developments in OA or other scholarly publishing business models to significantly change the relative cost-benefit of the NLP over time. Self-evidently, the future is uncertain. The comparisons presented herein simply compare the costs and benefits for Germany of the alternative publishing models against each other and against the NLP. In interpreting the results, readers should consider whether any of the alternative publishing and dissemination models is more or less uncertain than the others.

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5 Annex

5.1 Annex I The German National Licensing Program

Within the frame of its infrastructural support of literature and information supply the German Research Association (DFG) is funding the system of diversified special collections.

It is the objective of the special collections program, to give access to scientific literature and sources to every person in Germany who needs it for research or related work, including in those cases where the documents are not available via the own institution or its library.

Lack of supply was especially notable in the case of digital text documents, archival journal data offered via different publishers (i.e. backfiles), and specialized databases. To cover the most urgent needs, the DFG started a special grant program in 2004 and 2005 to purchase national licenses for digital publications within the frame of the special collections program.

How Were the Proposals for a Grant Prepared?

For the preparation of requests for grants the libraries participating in the special collections program were asked to list digital products necessary for the improvement of information supply within a special discipline. Eight libraries with long experience in the acquisition of large amounts of traditional and digital objects started to collect offers and to prepare license contracts with different providers. During this process 68 packages were selected for which a grant was applied.

What is the Content of the DFG National License Program?

The DFG National License includes the right of the libraries within the special collection pro-gram (licensees) to use the products of different publishers (licensers) on the basis of a non-exclusive and non-transferable license. The license includes the right to use the product not only within the licensee's in-house network but also in wide area networks of universities and other research institutions, and to give access to other users with scientific interest without any restrictions as long as they are officially registered in Germany. In the latter case (i.e. private usage) access is normally possible via personal registration in combination with passwords. Institutional access for publicly funded scientific institutions is organized via IP ranges.

The licenses are focused on a perpetual usage of the digital publications. Therefore the con-tracts include the possibility to undertake all necessary efforts to start with technical issues concerning long term archiving. Also, if access is primarily possible via technical infrastructure of the provider, the physical data will be transferred to the licensee.

For digital text and electronic journals the delivery of metadata for individual titles or contributions is part of the contract. Metadata imported into all local, regional, and supra-regional catalogues and other non-commercial information systems (e.g. vascoda) must be allowed in such a way that a direct link from the catalogue entry to the digital document is possible.

How are National Licenses selected that were accepted for grant?

The applications for grants are requested through the eight libraries involved in the negotiation processes. With their requests these libraries have committed themselves to purchase the licenses and to guarantee access on a national level.

The review board is made up of experts of the DFG committee for academic libraries and research information systems, as well as of members of its subcommittees.

Basic criteria of the review process are:

- The discipline specific value, content and quality of the digital publications;
- The technical quality of digitisation and the underlying infrastructure;
- The degree of overlapping of the offered license with the basic funding criteria of the DFG national license program; and
- The value/price relationship.

Beyond this the following criteria are also of relevance:

- Sustainability of the purchases. That means the warranty of long time access on the digital documents.
- Integration into the information systems of the special collections program and their "virtual discipline specific digital libraries" and the local ILS of libraries in universities and research institutions.
- Fulfilment of highly specialized requests as basic criteria of the whole nationwide system of information supply. The focus is not only on the content of the digital publications, but also on possibilities of access on the digital publications. Basic request was assumed where access is already realized on a broad level without DFG funding.
- The coverage of a differentiated spectrum of disciplines, which also represents the humanities. Especially languages and cultures outside the Anglo-American sphere should be represented too.
- The price factor of a national license compared with those of institutional or regional contracts especially by estimating the expected number of possible contracts for individual licenses. Additionally for the evaluation of a reasonable price structure the costs per page or per information unit are part of the decision process.

Further Perspectives of the Nationwide Information Supply with Digital Publications and the Pilot Program "Current Journal subscriptions"

From the perspective of the evaluators it is necessary to allow seamless access to all issues of digital journals for universities and research institutions. This is based on the advantages of access to digital journals from users' perspectives, and taking into consideration the savings of shelve space in libraries and the reduction of inter-library loans. The purchase of national licenses also affords the opportunity to offer an equal level of supply for all German researchers. Moreover, significant cost savings can be achieved via national licenses, compared with the purchase of individual licenses.

An additional program began in 2007 and lead to contracts with 12 different publishers for the period 2008 to 2010 as a test phase. For this period, three of the contracts follow the pattern of the existing licenses, which includes total funding via the DFG. The nine other packages are organized on the basis of an opt-in model, where academic institutions can participate by partial self-financing. With some delay, the archival data of those journal packages are available also to those institutions not participating in the license of the current issues.

5.2 Annex II Model parameters

Data for preliminary estimations are draw from a range of German and international sources. The following Tables describe the main parameters used and their sources.

5.2.1 Cost estimation parameters

Table A1: Cost estimation parameters

Parameter	***Basis***	***Value***
FUND RESEARCH		
R&D expenditure in 2008	EuroStat	GERD 65.6 bn, HERD 10.7 bn, GovERD 9.1 bn.
Grant applications, grants and reviews	Deutsche Forschungsgemeinschaft, Alexander von Humboldt-Stiftung, Bundesministeriums für Bildung und Forschung, Volkswagenstiftung, Thyssen-Stiftung, Robert-Bosch-Stiftung and Deutscher Akademischer Austausch Dienst	41,650 applications, 31,640 grants, 92,000 reviews
External peer review of grant applications	Tenopir and King (2000) time to review a journal article	3 to 6 hours each, average 4.5 hours
Peer reviews per grant application	Reported reviews received over applications	2.2 per application
Peer review costs, per hour, based on academic salaries and overheads	EuroStat expenditure over FTE researchers	Average EUR 97 per hour
PERFORM RESEARCH		
Researchers (FTE) (Excludes technicians & support)	EuroStat	299,000 (121,000 in higher education and public institutions)
Articles published (Core peer-reviewed articles only)	Web of Knowledge and SCOPUS scaled to account for share of peer reviewed journals not listed (Björk *et al*. 2008)	Approx. 92,200
Time to write a journal article	Tenopir and King (2000), King (2004)	90 to 100 hours, average 95
Time to peer review an article	Tenopir and King (2000), King (2004)	3 to 6 hours, average 4.5 hours
Number of peer reviewers per article	Tenopir and King (2000)	2 to 3 reviewers, average 2.5
Rejection and resubmission (articles)	Authors' estimate based on a consensus from the literature	50% rejected of which 60% are sent for external review and 40% rejected without review, and of which 75% are resubmitted once
Number of peer reviewers per monograph	Industry consultation	2 to 3 reviewers, average 2
Rejection and resubmission (monograph)	Authors' estimate based on a consensus from the literature	20% rejected of which 50% are resubmitted once

Parameter	*Basis*	*Value*
PERFORM RESEARCH (cont'd)		
Number of peer reviewers per monograph	Industry consultation	2 to 3 reviewers, average 2
Rejection and resubmission (monograph)	Authors' estimate based on a consensus from the literature	20% rejected of which 50% are resubmitted once
Time spent on editorial activities	Industry consultation and authors' estimate	10 to 30 days per annum, average 20
Time spent on editorial board activities	Industry consultation and authors' estimate	½ to 1 day per year, average ¾
Percentage of authors who are editors and/or on editorial boards	Rowlands and Nicholas (2005)	8% and 24%, respectively
Number of readings per researcher per year	Tenopir and King (2000), subsequent tracking studies and Tenopir *et al*. (2008)	Industry/higher education: • Articles 130/280 • Books 53/48 • Reports 65/46 • Trade literature 51/74 • Other items 22/14
Time spent reading an article	Tenopir and King (2007) and Tenopir *et al*. (2008)	34 minutes falling to 31, but slightly higher for research, estimate 31
Time spent searching for and accessing an article	Tenopir and King (2007), CEPA (2008) and Tenopir *et al*. (2008)	8 to 17 minutes, average 12.5 but falling, estimate 12.5
Article requests per reading	Tenopir and King (2000), CEPA (2008)	1.3 to 1.4
Time spent by author obtaining permissions per article	Halliday and Oppenheim (1999)	1 to 4 hours, average 2
Percentage of articles photocopied or printed	CEPA (2008) and Tenopir *et al*. (2008)	20% print, 69% electronic
Cost of printing and copying per page	Authors' estimate	10 cents per page
Time spent printing or copying an article	Authors' estimate	1 to 5 minutes, average 3
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 (Location of average article)	Tenopir and King (2000) and tracking studies, Björk *et al*. (2008)	Average 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% (20% rejected without review)
Subscriptions per title	Tenopir and King (2000), CEPA (2008)	Estimated average 1,200

Parameter	*Basis*	*Value*
PUBLISH JOURNALS (cont'd)		
Management and investment margin	CEPA (2008)	20% to 25%, estimate 20%
Surplus / profit margin	CEPA (2008) adjusted	10% to 30%, estimate 20%
E-only delivery and fulfilment (relative to print)	CEPA (2008), Waltham (2005), etc. adjusted	25%
E-only content processing (relative to print)	CEPA (2008), Waltham (2005), etc. adjusted	25%
OA rights management (relative to toll)	Authors' estimate	20%
OA user support (relative to toll)	Authors' estimate	20%
'Author-pays' marketing and support costs (relative to toll)	Authors' estimate	33%
OA hosting (relative to toll)	Authors' estimate	50%
OA management and Investment (relative to toll)	Authors' estimate	75%
OA surplus/profit (relative to toll)	Authors' estimate	75%
DISSEMINATION		
University library expenditure, acquisitions and stocks	HBZ: Deutsche Bibliotheksstatistik	Wissenschaftliche Universal- und Hochschulbibliotheken Acquisitions EUR 320 million, and estimated non-acquisition costs EUR 640 million
Library staff salaries	HBZ: Deutsche Bibliotheksstatistik	Average EUR 39,560 per annum, EUR 36 per hour
Library activity and journal handling times	Schonfeld *et al.* 2004; King *et al*. 2004	Minutes reported converted to EUR at average library staff salaries
Annual NLP journal acquisition costs	Goethe University Frankfurt	Annualised, EUR 12 million
Annual NLP acquisition costs for other content	Goethe University Frankfurt	Annualised, EUR 1.13 million
Annual NLP non-acquisition costs	Goethe University Frankfurt	Annualised, EUR 655,140
Number of NLP participating institutions	Goethe University Frankfurt	Average across all current package content, 167
Number of current journal titles	Goethe University Frankfurt	Current packages, 11,975 In system, 12,293
Hosting costs for NLP	NIH (2008) reported archiving costs	Approximately EUR 40 per article (submission-equivalent)
Author fees	Sample of OA journals	EUR 2,000 per article published
Repository counts	http://archives.eprints.org/	Current & estimated system

Source: Authors' analysis.

5.2.2 Scenario parameters

Table A2: Scenario parameters

Parameter	*Basis*	*Value*
FUND RESEARCH		
Funding, evaluation and reporting as a share of operational costs	Authors' estimate	50%
Potential savings in these costs from open access	Authors' estimate	5% to 10%, estimate 5%
Potential savings in these costs from NLP	Authors' estimate	None
Returns to publicly funded R&D	Literature review (conservative consensus from the literature)	20% to 60%, estimate 20%
Improved allocations increase returns to R&D	Authors' estimate	1% to 5%, estimate 2.5%
Increase in allocations to R&D	Authors' estimate	1% to 5%, estimate 2.5%
PERFORM RESEARCH		
Search, discovery and access time saving through OA/NLP	Authors' estimate	5% to 10%, estimate 5% 5% to 10%, estimate 5%
Permissions time saving through OA/NLP	Authors' estimate	40% to 60%, estimate 50% None
Peer review time saving through OA/NLP	Authors' estimate	5% to 20%, estimate 10%
Writing and preparation time saving through OA/NLP	Authors' estimate	5% to 10%, estimate 5% 5% to 10%, estimate 5%
PUBLISH		
Share of worldwide scholarly publishing output (articles)	Web of Knowledge, SCOPUS and Björk *et al*. (2008)	6.1%
OA competition reduces publisher costs and margins	Authors' estimate	5% to 10%, estimate 5%
DISSEMINATE		
Time for self-archiving per item	Harnad, Swan (2008), etc. adjusted	10 minutes
Self-archiving performance	Done by researcher at average cost per hour	EUR 16.25

Source: Authors' analysis.

5.2.3 Modelling parameters

Table A3: Modelling parameters

Parameter	***Basis***	***Value***
CHANGE IN ACCESSIBILITY		
Percentage change in accessibility (OA 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 (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%
Estimated percentage change in accessibility due to OA	***Conservative consensus of the above***	***5% to 10%, conservative 5%***
Change in accessibility due to NLP	***Small increase in German access, but no increase in worldwide access as its published in the same way***	***0.2%***
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%
Estimated percentage change in efficiency due to OA		***Conservative 5%***
Percentage change in efficiency (wasteful expenditure: duplicative research and blind alleys)	Authors' estimate, same as OA but scaled to NLP share of titles	As OA 1% to 5% (2%) Scaled is 1.28%
Percentage change in efficiency (new opportunities: collaborative opportunities)	Authors' estimate, half OA because it impacts domestic collaboration not international	0.5% to 2.5%, estimate 1%
Percentage change in efficiency (speeding up the process)	Authors' estimate, NLP has no impact on publishing	0%
Estimated percentage change in efficiency due to NLP	***Scaled to share of NLP to world titles***	***Conservative 2%***
R&D PARAMETERS		
Returns to R&D	Conservative consensus from literature (Geuna & Arundel 2003; Hall *et al*. 2009)	20% to 60%, estimate 20%
Rate of growth in R&D spending	EuroStat (public sector)	2.8% per annum (current prices)
Average 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	Scaled to public sector R&D spending growth	2.8% per annum (current prices)

Source: Authors' analysis.

5.3 Annex III Additional data Tables

The following Tables report more detailed preliminary cost estimates for various scholarly communication related activities in annual costs at 2008 prices and levels of activity.

5.3.1 Perform research and communicate the results

Table A4: Estimated annual costs: research related activities (EUR, 2008)

Activity / Item	*Estimate*
READING	
Reading per year (National)	***24,767,300,000***
Papers (journal)	5,559,800,000
Books (monographs + edited books)	13,820,300,000
Other (Conference papers, Reports, etc.)	5,387,200,000
Cost of reading by authors (National)	7,677,100,000
Reading per year (Public Research)	***14,217,200,000***
Papers (journal)	3,846,800,000
Books (monographs + edited books)	7,658,200,000
Other (Conference papers, Reports, etc.)	2,712,300,000
Cost of reading by authors (Public Research)	6,301,400,000
WRITING	
Writing per year (National)	***2,429,700,000***
Papers (journal & conference)	916,600,000
Books (monographs + edited books)	1,363,100,000
Chapters	150,000,000
Writing per year (Public Research)	***2,383,300,000***
Papers (journal & conference)	895,100,000
Books (monographs + edited books)	1,346,400,000
Chapters	141,800,000
SEARCH & DISCOVERY	
Search and Discovery (National researchers)	3,924,400,000
Search and Discovery (Public researchers)	1,588,100,000
PRINTING & COPYING (Public Research)	
Print and copying	84,400,000
Total including time spent	302,500,000
PERMISSIONS	
Cost to authors (National researchers)	34,200,000
Cost to authors (Public researchers)	33,600,000

Source: German model: Authors' analysis.

Table A5: Estimated annual costs: publisher related activities (EUR, 2008)

Activity / Item	*Estimate*
PEER REVIEW	
Peer review per year (National)	***293,100,000***
Papers (journal & conference)	229,300,000
Books (monographs + edited books)	44,400,000
Chapters	19,500,000
Peer review per year (Public Research)	***291,300,000***
Papers (journal & conference)	229,000,000
Books (monographs + edited books)	43,800,000
Chapters	18,500,000
JOURNAL EDITORIAL	
Editorial activities (National)	***197,500,000***
Editor activities	177,800,000
Editorial board activities	19,700,000
Editorial activities (Public Research)	***157,100,000***
Editor activities	141,400,000
Editorial board activities	15,600,000

Source: German model: Authors' analysis.

Table A6: Estimated annual costs: research grants related activities (EUR, 2008)

Activity / Item	*Estimate*
RESEARCH GRANTS	
Grant applications (National)	***534,870,000***
Preparation of grant applications (National)	385,400,000
Review of grant applications (National)	44,800,000
Reporting grant project (National)	92,500,000
Administering grant projects (National)	12,170,000
Grant applications (Public Research)	***457,710,000***
Preparation of grant applications (Public Research)	329,800,000
Review of grant applications (Public Research)	38,400,000
Reporting grant project (Public Research)	79,100,000
Administering grant projects (Public Research)	10,410,000

Note: Includes grants relating to major agencies only. Local and agency differences in reviewing and reporting practices are such that these estimates can be no more than approximate.
Source: German model: Authors' analysis.

5.3.2 Publish scientific and scholarly works

Table A7: Estimated average publisher costs per article by format and model (EUR, 2008)

	Estimate
Subscription Journal Publishing	
Per article costs PRINT	3,485
Per article costs DUAL-MODE	4,229
Per article costs E-ONLY	3,109
OA Journal Publishing	
Per article costs E-ONLY	1,959
OA Self-archiving	
Peer review management as an overlay service	567
Editing and proofing as an overlay service	846
Hosting as an overlay service	193
'Full service' overlay (per article)	*1,606*

Note: These costs exclude the external costs of peer review and VAT. Overlay services include operating peer review management, editing, proofing and hosting, with commercial margins. Estimates for print and dual-mode OA publishing exclude print or subscriber related costs, assuming that the content is produced print ready and print is an add-on.
Source: German model: Authors' analysis.

Table A8: Estimated publisher costs of German research output (EUR, 2008)

Source & type of publication	*Estimate*
Public Research (Published Outputs)	***668,200,000***
Journal articles	349,900,000
Conference papers	3,200,000
Books	279,400,000
Chapters	29,400,000
Other	6,300,000
National Research (Published Outputs)	***675,900,000***
Journal articles	350,300,000
Conference papers	4,300,000
Books	281,800,000
Chapters	30,600,000
Other*	8,900,000
Book distribution	
Total Public Research authored and edited	119,730,000
Total National authored and edited	120,790,000

Notes: Book publisher costs are based on research monographs costs, despite the fact that a small percentage of the books produced will be textbooks, which have very different costs. Hence, these costs are no more than indicative.
Source: German model: Authors' analysis.

Table A9: OA versus toll access for journals: cost estimates by mode and model (EUR, 2008)

	Estimate
Costs per article	
Current mix of formats and models	3,800
All print subscription	3,480
All e-only subscription	3,110
All e-only OA publishing	1,960
All e-only OA self-archiving and overlay services	1,410
E-only impacts	380
OA publishing impacts	1,150
OA self-archiving and overlay impacts	1,700
OA publishing impact from current position	1,840
Costs of articles published (Public Research)	
Current mix of formats and models	349,900,000
All print subscription	320,900,000
All e-only subscription	286,200,000
All e-only OA publishing	180,300,000
All e-only OA self-archiving and overlay services	130,100,000
E-only impacts	34,600,000
OA publishing impacts	105,900,000
OA publishing impact from current position	169,600,000
Costs of articles published (National)	
Current mix of formats and models	350,300,000
All print subscription	321,200,000
All e-only subscription	286,600,000
All e-only OA publishing	180,500,000
All e-only OA self-archiving and overlay services	130,200,000
E-only impacts	34,700,000
OA publishing impacts	106,000,000
OA publishing impact from current position	169,700,000

Note: These estimates were derived entirely from the bottom up, but they triangulate well with simple top down checks.
Source: German model: Authors' analysis.

5.3.3 Facilitate dissemination, retrieval and preservation

Such estimates can be no more than approximate (See section on Data Sources and Limitations).

Table A10: Estimated journal related Wissenschaftliche Universal und Hochschulbibliotheken library activity costs per title (EUR 2008)

Activity	*NLP (e-only)*	*Open Access (e-only)*	*Electronic*	*Print*
Collection development	1.39	..	2.77	4.83
Negotiation & licensing	..	..	1.39	0.15
Subscription processing	1.91	..	3.82	10.86
Receipt & Check in	0.07	..	0.14	16.29
Routing	..	..	..	0.60
Cataloguing	3.47	3.47	3.47	13.27
Linking	0.52	0.52	0.52	0.60
Physical processing	0.07	0.07	0.07	15.20
Stacks maintenance	..	..	..	8.90
Circulation	1.39	1.39	1.39	16.29
Reference	9.02	9.02	9.02	16.29
User instruction	1.21	2.43	2.43	1.81
Preservation	0.07	0.07	0.07	1.21
Other	3.12	3.12	3.12	6.03
Total	***22***	***20***	***28***	***112***

Note: Approximate activity times reported by Schonfeld *et al.* (2004) and King *et al.* (2004) converted to 2008 Euros based on university library staff costs, with electronic staff costs 15% higher than print to reflect different skill levels (as per the studies mentioned). Such estimates can be no more than approximate.
Source: German model: Authors' analysis.

Table A11: Estimated journal related Wissenschaftliche Universal und Hochschulbibliotheken library activity costs (EUR, 2008)

Activity	*Electronic*	*Print*
Collection development	5,830,000	2,730,000
Negotiation & licensing	2,920,000	90,000
Subscription processing	8,020,000	6,150,000
Receipt & Check-in	290,000	9,220,000
Routing	..	340,000
Cataloguing	7,290,000	7,510,000
Linking	1,090,000	340,000
Physical processing	150,000	8,610,000
Stacks maintenance	..	5,040,000
Circulation	2,920,000	9,220,000
Reference	18,960,000	9,220,000
User instruction	5,100,000	1,020,000
Preservation	150,000	680,000
Other	6,560,000	3,420,000
Total	***59,270,000***	***63,590,000***

Note: Approximate activity times reported by Schonfeld *et al.* (2004) and King *et al.* (2004) converted to 2008 Euros based on university library staff costs with electronic staff costs 15% higher than print to reflect different skill levels, and scaled to library acquisitions. Such estimates can be no more than approximate.
Source: German model: Authors' analysis.

Table A12: Estimated OA self-archiving costs (EUR, 2008)

	Estimate
Cost per year per repository	100,000
Operational costs of current reps per year (National)	10,800,000
Operational costs of current reps per year (Public Research)	8,100,000
Cost of depositing per article	16.23
Cost of posting counted publications (National)	3,035,600
Cost of posting counted publications per year (Public Research)	2,163,000
Cost of posting journal articles (National)	2,006,800
Cost of posting journal articles (Public Research)	1,494,700
National system of OA repositories:	
Total cost of OARs per year (National)	62,764,400
Total cost of OARs per year if all HEIs had one	43,163,000

Note: National system costs include the cost of a single deposit of all published outputs.
Source: German model: Authors' analysis.

5.3.4 System costs (article production)

Table A13: Estimated costs by publishing model per article (EUR, 2008)

	Toll Access	*OA Publishing*	*OA Archiving (Green OA)*	*OA Archiving (Overlays)*	*NLP*
FUND	..	..		..	
PERFORM					
Write	9,253	9,253	9,253	9,253	9,253
Review	1,096	1,096	1,096	1,096	1,096
PUBLISH					
Publish e-only	3,109	1,959	3,109	1,413	3,109
Distribute	..	..	..	..	..
DISSEMINATE					
Handle e-only	0.23	0.17	0.23	0.17	0.19
IR operation	..	..	45	45	40
Deposit	..	..	16	16	..
USE	..	..	..	..	..
Total	**13,458**	**12,308**	**13,519**	**11,823**	**13,489**

Note: Includes e-only average estimated costs for each publishing model, and excludes toll access acquisition costs to avoid double counting (*i.e.* assuming that acquisition costs recoup publisher and distribution costs). VAT is also excluded. The costs of writing and reviewing are per manuscript written and reviewed, whereas other costs are per manuscript published and disseminated. The OA self-archiving with overlay services models are necessarily rather speculative, especially for books.
Source: German model: Authors' analysis.