

Costs and business models in scientific research publishing

A report commissioned
by the Wellcome Trust

DP-3114.p/100/04-2004/JM



The Wellcome Trust

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Compiled by



April 2004

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Preface

In September 2003 the Wellcome Trust published ‘Economic analysis of scientific research publishing’, a report it had commissioned from SQW economic and management consultants to investigate the complex market of scientific publishing. The conclusions that the Trust drew from the evidence presented in that study persuaded it to make public its support for publishing the results of scientific research in an open access format (see www.wellcome.ac.uk/scipubreport).

In response to ongoing discussions about the viability of open access publishing, the Trust decided to commission this follow up report from SQW to assess the actual costs of publishing scientific, technical and medical research in peer-reviewed journals. It compares the costs between the current ‘subscriber-pays’ model, where publishing services are free to authors and the article is published in a journal available via subscription, and an ‘author-pays’ model where the author (or their funder or institution) pays for the publishing services but where the final paper is published in an open access journal, available for free via the Internet to all who wish to use it.

This report provides evidence that an author-pays model offers a viable alternative to subscription journals. Open access publishing should be able to deliver high-quality, peer-reviewed research at a cost that is significantly less than the traditional model while bringing with it a number of additional benefits.

Dr Mark J Walport

Director of the Wellcome Trust

April 2004

Abbreviations

CURL	Consortium of University Research Libraries (in the UK)
HINARI	Health Inter-Network Access to Research Initiative. HINARI was created to ensure that relevant information, and the technologies to deliver it, are widely available and effectively used by health personnel. It was launched by the United Nations in September 2000. It provides a library of more than 2000 scientific publications.
INASP	International Network for the Availability of Scientific Publications. INASP is an Oxford-based cooperative network of partners. Its mission is to enhance the flow of information within and between countries, especially those with less developed systems of publication and dissemination. It was established in 1992 by the International Council for Science.
JISC	The Joint Information Systems Committee. JISC supports UK further and higher education by providing strategic guidance, advice and opportunities to use information and communications technology to support teaching, learning, research and administration. JISC is funded by all the UK post-16 and higher education funding councils.
PLoS	Public Library of Science. PLoS is a non-profit organization of scientists and physicians, first established in the USA, committed to making the world's scientific and medical literature a freely available public resource.
SHERPA	Securing a Hybrid Environment for Research Preservation and Access. SHERPA aims to investigate issues to do with the future of scholarly communication and publishing. It is initiating the development of openly accessible institutional digital repositories of research output in a number of research universities.
STM	Science, Technology and Medicine

Definitions

Costs are incurred in the production of goods or services.

Prices are charged for receipt of a product or for a service provided. Price must normally be greater than cost for a product to continue in production, or for the continued delivery of a service.

Fixed costs do not change as output changes.

Variable costs are directly related to output.

First-copy costs is the term used in journal publishing to describe costs incurred in getting a copy of a given article into the state required for it to be published in the journal.

Opportunity cost is the activity foregone in order to undertake a particular task. For example, the opportunity cost incurred by an academic member of staff in acquiring an article, is the reading, research, teaching or other activities which the academic would have undertaken if the article had not been acquired.

Marginal cost is the cost of the last unit produced. This does not include fixed costs because those are borne whether or not the last unit is produced. For some systems, for example, the electronic distribution of articles, marginal costs are low for wide ranges of output – simply the cost of sending the relevant e-mail attachment. They do not include fixed costs such as the cost of maintaining the electronic system. When capacity limits are reached, marginal costs rise and new investment in electronic equipment is required.

Subscriber-pays is used here as a shorthand for the business model in which journals are paid for by readers, libraries and similar institutions. The payment is frequently through an annual subscription or licence but can also include a one-off payment for a particular edition or a fee for the delivery of a specific article. Such journals can be produced in paper or electronic format and for STM publishing are usually in both formats. It is possible to have a mix of subscriber-pays and author-pays elements (see below).

Author-pays is used here as a shorthand for the business model in which publication is paid for by the author, the author's institution or research programme. The payment would normally be a publication fee but could include a submission element and a publication element. Such journals are usually produced in electronic format though paper versions are frequently available. It is possible to have a mix of author-pays and subscriber-pays elements (see above).

All currency figures used in the text are in US dollars. The rate of exchange used here is £1:US\$1.66. This is the conversion rate which has been used throughout this report and represents a broad average of the exchange rates which have operated during the period from which examples are drawn.

Executive summary

Introduction

1. This report assesses the costs of publishing scientific, technical and medical (STM) research articles. In particular it looks at the cost implications of the two business models which are currently in use, characterized here as ‘subscriber-pays’ and ‘author-pays’. The intention is to provide estimates which can form a foundation on which to conduct a debate about the efficacy and efficiency of the two business models. The report cannot avoid engaging in some elements of the debate but it does not undertake a full evaluation of the different models. There are aspects of each model which have little to do with costs but involve assessments of the potential responses of different players in the STM journal market. We have taken up such issues only to the extent they are necessary to understand the costs which are associated with the different approaches.
2. Cost estimates are based on discussions with individuals in senior positions from across the range of journals and approaches to STM publishing, plus a careful assessment of the literature on publishing costs.
3. Public and merit goods are those which the public values but which markets find it difficult to allocate because individuals cannot, or should not, be excluded from their consumption. Scientific research falls into this category and society as a whole is made worse off if access to scientific results is restricted.
4. The benefits of research are derived principally from access to research results. To the extent that the dissemination of research results is less than it might be from given resources, we can argue that the welfare of society is sub-optimal. Currently, access to research is restricted and the means to gain access are determined by a market in which a small number of publishers have a dominant position.
5. The market for STM journals and articles is complex. Different players in the market respond to different variables. It is important to recognize that the academic journal publishing market is very different from conventional models of markets. Conventionally, supply and demand in a market are brought into equilibrium through changes in price. Market clearing mechanisms for STM publishing are inefficient, however, because different parts of the market cannot be brought together through the manipulation of a simple, single variable such as price. The potential for market failure, therefore, is very high. In other words, the market, as it is currently structured, finds it difficult to satisfy the requirements of both those supplying articles and those demanding them.
6. One way to simplify this is to think of two markets. The first is the academic market. Here the supply of and demand for articles are determined by factors relating to current research concerns and the quality of output. The second is the commercial market, which shadows the first, and is a relatively conventional market with publishers providing a product to libraries. The publishers are a mixture of profit-maximizing companies and companies, or other organizations, seeking a *satisfactory* profit or surplus. The libraries respond to price by increasing or reducing purchases until their budget limit is reached.
7. The products, for which costs need to be calculated, are not homogeneous. They include internationally renowned journals with a large subscription base, high-quality journals with international reputations for excellence, but lower subscription bases, and more specialized journals which can vary widely in their impacts on the scientific community. The size of the subscription base for the latter varies enormously. With the onset of online access the notion of a single and easily identifiable product becomes more difficult as opportunities for different mixes and combinations proliferate. The cost of publishing is not therefore a simple concept.
8. The role of libraries and the costs that they bear are directly related to different business models for STM journal publishing.

9. An analysis of the costs of journal publishing must also take into account the costs incurred by readers and authors.

Costs of journal publishing

10. For paper subscription journals, fixed costs are editorial costs involved in the selection and review of articles, the manuscript management system, page and illustration preparation and copy editing/rewriting, plus fixed costs unrelated to articles but required by the journal, such as the provision of covers, editorial and news content. Variable costs are the cost of paper, subscription management, licensing, distribution (including postage, packing and shipping costs), sales and some marketing. In addition there are overhead costs which would be borne even if the article or journal were not published. These cover premises, some management costs, depreciation on plant and other company wide activities.
11. For electronic subscription journals the pattern of costs is the same. There is no cost of paper or conventional distribution costs. The cost of maintaining (or renting space on) an appropriate electronic system replaces conventional distribution costs. For journals in science, technology and medicine an electronic version is now considered essential. Electronic journals are generally slightly cheaper than paper journals but the relative cost of paper and electronic journals varies according to the type of journal and its circulation. A cautious, and conservative, approach is to assume that the total costs of paper and electronic articles of a given quality are broadly the same.
12. For author-pays journals, most cost elements remain the same as for subscription journals. No subscription or licensing costs are incurred but there is a small addition to fixed costs to cover the administration of the charging system to authors.
13. The relative balance between fixed and variable costs can make substantial differences to prices charged to consumers in both subscription and author-pays business models.
14. Since variable costs can be covered easily within subscription rates, a key issue for subscriber-pays journal publishers is to manage fixed costs and to spread them across as wide a subscriber base as possible. First-copy costs are a high proportion of fixed costs.
15. On the basis of estimates of costs in the literature and the evidence from surveys and data made available in preparing this report, it is possible to make some assertions about the range and proportion of costs of STM journal publishing.
 - First-copy costs have a range of roughly \$250–\$2000. The cost of producing the first copy for a good-to-high-quality journal is approximately \$1500. These costs apply to subscription and author-pays business models.
 - Fixed costs, which include first-copy costs, are approximately \$1650 per article for a good-to-high-quality *subscription* journal.
 - Based on first-copy costs, the total cost of producing an article for a good-to-high-quality *subscription* journal is of the order of \$2750 plus a contribution to overheads and profits.
 - Total costs for author-pays journals are likely to be lower. They include some extra cost for managing the charging system for authors but do not carry any costs for subscription management, licence negotiations, or many sales costs. A conservative estimate of the charge per article necessary for author-pays journals lies in the range \$500–\$2500, depending on the level of selectivity used by the journal, plus a contribution to overheads and profits.
 - Different publishers will have different ideas about the appropriate figure to add for overheads and profit. One major, profitable, UK-based commercial publisher generates an average *revenue* per

paper published across all its journals, which include a wide range of journal types and many different forms of delivery, of just under \$2000. This average revenue figure covers all fixed and variable costs including overhead and profit.

16. All journals will need to attract revenue which covers the fixed costs of articles plus variable costs. For *subscriber-pays* journals, the greater the number of subscribers, the lower the cost per subscriber.
17. Costs have different implications for *author-pays* journals. The fixed costs borne by subscription journals are, in virtually all cases, also incurred by author-pays journals. Both types of journals also carry costs for the maintenance, or rental, of an electronic distribution system. No subscription management, licensing or (some) rights costs are incurred by author-pays journals. Distribution costs are not negligible but, unlike subscription journals, many of them are fixed, that is most distribution costs do not vary with the number of articles or journals distributed. The marginal cost is close to zero across very wide ranges of output.
18. *Author-pays* electronic journals must recover their costs, most of which are fixed, by charging a fee to authors. The cost to an author will vary according to the journal in which an article is submitted. In the business model currently operating, costs will be recovered entirely from authors of accepted articles.
19. It is possible to separate the cost of submission, namely peer review costs for all articles both accepted and rejected, from cost of publication in an author-pays system. It is feasible, to set up a price system which levies a submission fee and a publication fee. In such a system all authors would pay for their articles to be peer reviewed. Those authors whose articles were accepted would then pay an additional publication fee. A submission fee of no more than \$175 is a likely median figure and a publication charge of around of \$250–\$750 might then be feasible. Undoubtedly some journals will fall outside this range. Very few are likely to do so. The total cost figures available in the literature and through discussion with publishers indicate that this scale of costs is broadly realistic.
20. Table 1 summarizes this data in the form of cost estimates for a good-to-high-quality journal and a medium-quality journal. The estimates are based on data collected for this report and referred to in section 2. The qualifications set out there apply.

Table 1 Estimates of costs per article for typical subscriber-pays and author-pays journals

Cost element	Subscriber-pays journal Cost in US\$		Author-pays journal Cost in US\$	
	Good-to-high-quality journal	Medium-quality journal	Good-to-high-quality journal	Medium-quality journal
First-copy costs per article	1500	750	1500	750
Fixed costs per article	1650	825	1850	925
Variable costs per article	1100	600	100	100
Total costs per article	2750	1425	1950	1025
Possible submission fee			175	175
Total submission fees			1400 (8 articles reviewed for each article accepted)	350 (2 articles reviewed for each article accepted)
Possible publication fee			550	675

21. Costs of *accessing* and *reading* articles, for both subscriber-pays and author-pays, are borne by libraries and readers. Journals are likely to continue to exist under both business models because they minimize these costs by providing well known criteria on which to search for articles and a means by which articles can be quality approved.
22. Electronic archiving could enable very speedy access to articles and remove the costs associated with delays in access to research outputs. It also has very low marginal costs. For wide ranges of output the cost of article delivery is close to zero. A question then arises about the appropriate source of funds to establish and maintain electronic archives.

Costs, prices and business models

23. In general, economic efficiency – resources being used in the places that maximize the return to society – is achieved more effectively if individuals who demand products or services bear the cost of supplying them.
24. Total system costs are lower in an author-pays system because licensing, and other activities aimed at restricting access to articles, are unnecessary.
25. When readers are required to pay high prices, for accessing research outputs, they would be expected to abandon high-priced journals and substitute them from other sources, but readers are ‘protected’ from these price implications through the library system. The market is, in this respect, highly inefficient.
26. A charge to authors would potentially act as a disincentive to publication. The extent of the disincentive would depend largely upon the opportunities for alternative publication routes.
27. Publishers are unlikely to favour a system which makes it more difficult for them to achieve their objectives. For some publishers the present system works extremely well and there may be disincentives for them in an author-pays alternative. Others are concerned that a move to author-pays will leave them vulnerable to competition from continuing subscriber-pays journals. Some doubt that authors will be able to pay the charges they regard as necessary to cover costs though the figures reported here do not justify that concern.
28. Whether or not an efficient, centrally-funded electronic archive is established, it is likely there will be a *de facto* archive in existence in the medium term. The effect of such an open archive is to provide open access to journal articles. The question facing journal publishers is how to position their journals so that they are able to continue to play an important part in a world in which open access, through an open archive and very cheap or free document delivery, is the norm.
29. Work is more widely disseminated, in principle, in an author-pays system than in a subscriber-pays system, but that outcome rests on an assumption that journals would exist in much the same volume in each system. If, for some reason, an author-pays system produced a tendency to reduce the number of journals, then this conclusion would be less clear. There may be a disincentive for publishers, and a corresponding reduction in the number of journals, if they believed the opportunity for profit or for growth were restricted in author-pays systems.
30. A number of agreements currently exists for subscribers who find subscription fees prohibitive, primarily subscribers from developing countries. Such schemes are admirable and it is feasible that similar arrangements could be made for academics from these countries in an author-pays system.
31. In terms of costs of production, system costs and the implications of those for levels of fee, the author-pays model is a viable option. Open-access, author-pays models appear to be less costly and to have the potential to serve the scientific community successfully.

1 Introduction

- 1.1 This report assesses the costs of publishing STM research articles. In particular it looks at the cost implications of the two business models currently in use, characterized here as ‘subscriber-pays’ and ‘author-pays’. Subscriber-pays refers to the business model in which journals are paid for by readers, libraries and similar institutions. The payment is frequently through an annual subscription or licence but can also include a one-off payment for a particular edition or a fee for the delivery of a specific article. Such journals can be produced in paper or electronic format and for STM publishing are usually in both. Author-pays is used to refer to the business model in which publication is paid for by the author, the author’s institution or research programme. The payment would normally be a publication fee but could include a submission element and a publication element. Such journals are usually produced in electronic format though paper versions are frequently available. It is possible to have a mix of author-pays and subscriber-pays elements.
- 1.2 The intention is to provide cost estimates which can form a foundation on which to conduct a debate about the efficacy and efficiency of the two business models. The report cannot avoid engaging in some elements of the debate but this is not an evaluation of the different models. There are aspects of each model which have little to do with costs but involve assessments of the potential responses of different players in the STM journal market. We have taken up such issues only to the extent they are necessary to understand the costs which are associated with the different approaches.
- 1.3 The cost estimates are based on discussions with individuals in senior positions from across the range of journals and approaches to STM publishing. We have also looked carefully at the literature on publishing costs and have checked our estimates with experienced participants in the field.
- 1.4 Estimating the costs of journal publishing is an elusive task. It is apparently straightforward: add up the costs of production of different elements such as manuscript management, peer review and editorial costs, copy editing and page preparation, sales, distribution and marketing, and work out the total. However, the total will be different for different products and the implications of cost for the behaviour of journal publishers, libraries (or other information management institutions), authors and readers can only be understood by looking at costs in a more sophisticated way.
- 1.5 This report begins, therefore, in this section, with a brief review of the context in which costs need to be analysed. It then moves on to an assessment of the scale and range of cost elements and finally, evaluates some of the implications for where, and by whom, costs are borne in different business models of the journals market.
- 1.6 The terms ‘cost’ and ‘price’ need to be carefully distinguished in this debate. Costs are incurred in the production of journals. Prices are charged by publishers to institutions, libraries, authors or readers for receipt of a product or for a service provided. Price must normally be greater than cost for a product to continue in production, or for the continued delivery of a service, but that is the only relationship between them. When we refer to ‘cost’ below this should not be taken to mean ‘price’ to the consumer, even though the words are sometimes used as synonyms in conversation.
- 1.7 A discussion of this kind addresses big questions. It is not simply a technical issue. What precisely is the product which is being costed when we are considering different models for delivering the final stages of scientific endeavour? Given the nature of the costs which arise in publishing scientific work, who *should* pay in order to maximize opportunities for promoting social welfare? And we must also recognize that the world is dynamic and that actions taken here will have consequences elsewhere and at other times.

Market failure and public and merit goods

- 1.8 Public and merit goods are those which the public values but which markets find it difficult to allocate because individuals cannot, or should not, be excluded from their consumption. Scientific research falls into this category and society as a whole is made worse off if access to scientific results is restricted. It is therefore better to produce research according to some collective measure of its value. Such measures currently relate to publication output (related to peer review and impact factors) and a mixture of public and private research funding.
- 1.9 The benefits of research are derived principally from access to research results. To the extent that the dissemination of research results is less than it might be from given resources, then we can argue that the welfare of society is sub-optimal. Currently, access to research is restricted and the means to gain access are determined by a market in which a small number of publishers have a dominant position (Wellcome Trust, 2003).
- 1.10 The market for STM journals and articles is complex. Different players in the market respond to different variables. It is important to recognize that the academic journal publishing market is very different from conventional models of markets. Conventionally, supply and demand in a market are usually brought into equilibrium through changes in price. Market clearing mechanisms for STM publishing are inefficient, however, because different parts of the market cannot be brought together through the manipulation of a simple, single variable such as price. The key players do not respond to price changes as conventional analysis would suggest. Academics respond to impact factors and quality measures. Libraries in general spend the whole of their budgets to meet the needs of the academic community they serve. Some commercial publishers attempt to maximize profits. Not-for-profit publishers attempt to acquire a satisfactory return. The potential for market failure, therefore, is very high. In other words, the market, as it is currently structured, finds it difficult to satisfy both the requirements of those supplying articles and those demanding them.
- 1.11 One way to simplify this is to think of two markets. The first is the academic market. Here the supply of and demand for articles are determined by factors relating to current research concerns and the quality of output. The second is the commercial market, which shadows the first, and is a relatively conventional market with publishers providing a product to libraries. The publishers are a mixture of profit-maximizing companies and companies, or other organisations, seeking a *satisfactory* profit or surplus. The libraries respond to price by increasing or reducing purchases until their budget limit is reached.
- 1.12 The academic market can reach an equilibrium relatively easily – a position in which the supply of articles and the demand for them reflects the research community’s sense of what is appropriate. Articles will be supplied so long as research is funded and the output of the research is regarded as valuable by the senior members of the profession – those who review articles and edit journals. Demand for articles will also be based on professional views of the value of the research, and hence access to research funding, promoting further research and refinement of ideas. In its ideal form this is a virtuous circle and it reflects the nature of scientific output as a public good.
- 1.13 The commercial ‘shadow’ market, however is vital to the success of the first academic market. Without it the first cannot operate since an essential feature of the first market is that work is disseminated and evaluated. The problem is that the variables which influence behaviour in the commercial market (price and profit or surplus) are not directly connected to the variables which enable the academic market to work efficiently. Such variables do not have a strong relationship with the concerns of the academic market (peer review and impact on scientific outputs), nor the wider community, in the context of the furtherance of science as a public good.

- 1.14 Since the academic and commercial markets barely touch it is unlikely that the concerns of the commercial market, in its current form, will succeed in producing an optimally-disseminated output from the academic market. This is the reason for the widely expressed dissatisfaction with the current position.
- 1.15 By understanding costs, who bears them and how they might relate to price, it is possible to get a clearer sense of the options which are available to best meet the needs of academics and publishers.

Publishers' objectives

- 1.16 Publishers' behaviour in the market will be determined by their objectives. The objectives of any one publisher will not be uni-dimensional and in some cases there are likely to be a number of complex, even mutually exclusive, reasons for engaging in the publishing market. Furthermore there are many different kinds of publisher, some of which publish large numbers of journals, each of which may contribute in different ways to the fulfilment of the publisher's objectives.
- 1.17 We can simplify, in order to develop an analytical framework. Publishers of academic journals fall into three broad groups: commercial publishers, university presses and learned societies. They are sometimes stylized in the following way: commercial publishers seek to maximize profit through publishing, university presses seek to publish high-quality work and make a profit in so doing, learned societies are non-profit institutions whose objectives are usually linked to furthering the interests of their research or discipline areas. This is too simple but it is a useful starting point. In seeking to maximize profits commercial publishers argue, with good evidence, that they provide a good service to the academic community. University presses must have an eye to their net revenues and cannot publish solely for publishing's sake, and many learned societies make substantial surpluses out of their publishing ventures so that they can undertake other activities to support the work of the society. In addition learned societies frequently publish with one of the commercial publishers or university presses. They outsource many aspects of the publishing task, including, in some cases, the administration of peer review and other quasi-academic functions.
- 1.18 It is not straightforward, therefore, to characterize the objectives of, say, a particular commercial publisher, which may, for example be publishing journals which it owns alongside those owned by a learned society, where the price and distribution policy of the latter are determined largely by the society. The commercial publisher wishes to fulfil its own objectives, but, in this example, must, at the same time, enable its society customers to fulfil their needs too. At the opposite end of the spectrum, a learned society may be involved in publishing solely to disseminate the work of its specialist area to a relatively small group of subscribers, or may have a very large subscription base, publishing a broadly based journal of high quality, from which it earns substantial revenue enabling it to give bursaries, put on conferences and workshops, establish small research grants and promote its discipline to the public at large.

Products

- 1.19 Given the examples above, the products we need to cost, are not homogeneous. They include internationally renowned journals, such as *Nature* and the *Lancet*, which include primary research, and other content (sometimes referred to as value-added content), including editorials, letters (which in some cases advance knowledge themselves), educational and review articles and general news and comment. Their subscription base is very large. Alternatively, very high-quality journals, with international reputations for excellence, frequently include primarily original research and no news or review articles. They have smaller numbers of subscribers and cover a broad area of knowledge. More specialized journals may publish articles seen as unsuitable for these broader-based journals; they may accept articles which are less mould-breaking and the size of their subscription base can vary enormously.

- 1.20 Increasingly publishers are not simply providing a journal. The ‘product’ for them can be a collection of inter-linked journals sold under licence, where the price charged for the licence is greater than the price of any individual journal but less than the combined price of the total number of journals taken separately. Sales through licensing in this way are often referred to as the ‘big deal’ and a crucial element for other players in the market is the flexibility within which different options can be negotiated within the total package.
- 1.21 Other products include reprints, the free provision of articles through open access policies (sometimes immediately, sometimes after six to 18 months), the free provision of some elements of the journal while other elements are withheld, the provision of some elements of the journal in different bundles, at different prices, to different consumers, for example elements of journals may be available in different combinations to educational institutions as compared with other subscribers. With the onset of online access the notion of a single and easily identifiable product becomes more difficult as opportunities for different mixes and combinations proliferate (Dryburgh, 2002a). The cost of publishing is not therefore a simple concept.

Library costs and opportunity costs

- 1.22 The role of libraries and the costs that they bear are directly related to different business models for STM journal publishing. Precise calculations are not available but there have been a number of assessments of the implications for libraries (see for example, Cooper, 2000; Friend, 1996; Montgomery and Sparks, 2000). The costs borne by libraries need to be taken into account as part of the total costs of the system of scientific dissemination.
- 1.23 An analysis of the costs of journal publishing must also take into account the costs incurred by readers and authors. It is not possible to carry out a survey of the implications of different business models at this time but it is important to reflect on the implications of different models for readers and authors. Frequently such costs will be opportunity costs – for example, activities foregone as a result of searching for, acquiring and reading an article, rather than an actual financial outlay.

Unintended consequences considered, and not considered, in the report

- 1.24 Finally, what possibility exists for unintended consequences? How likely is it that consequences will arise which damage (or sustain) scientific endeavour as a result of particular actions in the STM journal market? Any answers are necessarily speculative but the analysis needs to take the changing nature of the publishing world into account and to assess potential consequences of any actions. Costs conventionally relate to the static picture – how many resources were needed to produce a particular article – but must also reflect the dynamic picture – how will the provision of scientific knowledge be changed by particular activities and how can we ensure adequate investment to cover future requirements. We take these issues up briefly in section 3 of the report.
- 1.25 Some consequences are not taken up here. The report is about costs. It is not a full analysis of the two primary business models. There are potential consequences of the business models which do not have a direct bearing on costs, except insofar as they may have implications for the nature of scientific endeavour. For example, one concern of those who are wary of an open access, author-pays approach is the possibility that some journals may become driven by authors and out of touch with readers’ needs, another is the possible proliferation of journals which publish poor-quality work – a scientific version of the worst of vanity publishing. Such arguments can be countered. In general academic researchers are eager for their work to be read and it is not in their interest to publish in journals of dubious quality if they wish to be taken seriously. On the other side of the debate it is clear that, in principle, open access models have the potential to give unrestricted access to research findings, which is what the whole

endeavour is about. However, unrestricted access is two-edged if new approaches result in the closure of significant journals or the abandonment of important practices. At a more abstract level, the term ‘market distortion’ sometimes appears in debates about appropriate models. In the context of the market for STM journals this is a curious term to use. As we have set out above, this market does not behave conventionally. It is not well positioned to deliver the benefits of unfettered free markets and if left as it is could produce outcomes which are in the interests of very few (Wellcome Trust, 2003).

- 1.26 The report does not address the latter issues directly. It attempts to build a clear picture of what is known about costs so that evaluations about appropriate business models can be carried out on a more informed basis.

2 Costs of journal publishing

Elements of cost

- 2.1 Notwithstanding the complexity outlined in the previous section, it is helpful to begin with a simple, static version of costs – that is a snapshot of costs at a particular point in time. Costs can be broken down into *fixed* costs and *variable* costs. Fixed costs do not change as output changes. Variable costs are directly related to output. In the traditional publishing model in which subscriptions are paid for access to a paper or electronic journal, fixed costs relate principally to the preparation of the articles which go into the journal. They remain the same whatever the total circulation of the journal. Variable costs vary according to the number of copies of the journal in circulation.
- 2.2 For paper journals, therefore, fixed costs are editorial costs involved in the selection and review of articles, the manuscript management system, page and illustration preparation and copy editing/rewriting. There are some fixed costs unrelated to articles but required by the journal, such as the provision of covers, editorial and news content. Variable costs are the cost of paper, subscription management, licensing, distribution (including postage, packing and shipping costs), some sales costs and some marketing. In addition there are overhead costs which would be borne even if the article or journal were not published. These cover premises, some management costs, depreciation on plant and other company-wide activities.
- 2.3 For electronic subscription journals the pattern of costs is similar. There is no cost of paper or conventional distribution costs. The cost of maintaining (or renting space on) an appropriate electronic system replaces conventional distribution costs. We must recognize that for journals in science, technology and medicine an electronic version is now a requirement. Many subscription and author-pays journals produce paper and electronic versions. Some are solely electronic. The consensus in the literature, and in interviews with publishers of many different kinds of journals, is that electronic journals are generally slightly cheaper than paper journals. The figures available, while not sufficiently extensive to draw strong conclusions, are consistent with this view. The relative cost of paper and electronic journals varies according to the type of journal and its circulation. A cautious, and conservative, approach is to assume that the total costs of paper and electronic articles of a given quality are broadly the same. Journals which publish in both formats thus incur extra costs equivalent roughly to an extra set of distribution costs.
- 2.4 In a system in which the author, or an institution on behalf of the author, pays, most cost elements remain the same. Fixed costs relate essentially to article receipt and management and variable costs relate to the distribution of the journal itself. For author-pays no subscription or licensing costs are incurred but there is a small addition to fixed costs to cover the administration of the charging system to authors. (The output of the author-pays model can be defined as a published article, in some cases, not a journal and this changes the definition of some costs. To keep the analysis simple, this complication will be ignored at this stage.)
- 2.5 The relative balance between these different elements of fixed and variable costs can make substantial differences to prices charged to consumers in both subscription and author-pays business models.

Cost estimates

- 2.6 The actual costs of any particular activity will, of course, be determined to a large degree by the extent to which that activity is carried out in the production of a journal. Some journals carry out some activities more extensively than other journals. In particular, very high-quality journals will undertake more peer

review than other journals. This is usually measured by the ‘rejection rate’ – how many articles submitted are rejected as unacceptable. Internationally renowned journals may reject as many as 90 per cent of submitted articles. The costs of journals cannot be fully generalized, therefore, but it is possible to come up with broad orders of magnitude and estimates of the range of costs incurred within any category.

- 2.7 There has been a number of articles and books which have addressed this issue. Tenopir and King (2000) has become the classic text. Bergstrom discussed costs in economics journals and prompted a discussion including responses from Elsevier Science (Bergstrom et al, 2002). Odlyzko (1997) was an early and influential contributor to the debate. The most recent account is Dryburgh’s report on benchmarking for the Association of Learned and Professional Society Publishers (Dryburgh, 2002b). The literature is not entirely consistent but it gives guidance on the orders of magnitude involved and the balance between different elements of cost. Information has also been gathered for this report but is, in some cases, commercially confidential and in those cases is quoted anonymously or as part of a range.

First-copy costs

- 2.8 ‘First-copy costs’ is the term used in journal publishing to describe costs incurred in getting a copy of a given article into the state required for it to be published in the journal. They are made up of the fixed costs of article production referred to above: editorial costs involved in the selection and review of articles, the manuscript management system, page and illustration preparation and copy editing/rewriting. Many of these costs are very similar for different journals. The quality of illustrations and copy editing may vary but the most substantial source of variation is editorial costs and peer review. This is not because some journals are inadequate in this regard. They would not survive if they were. It relates to the efforts undertaken to select the best possible articles for the journal in question including the rejection rate. The average rejection rate is around 40 per cent. Some journals have a rate as high as 90 per cent, as referred to above. Each article submitted must go through the peer review process and where large numbers of articles are rejected this, in effect, adds to the first-copy cost of those accepted.
- 2.9 First-copy costs are essentially the same for subscription and author-pays models.
- 2.10 The normal range of estimates for first-copy costs goes from \$250 to \$2000. Figures have been quoted from outside this range – as high as \$4000 – but it seems clear that they include other elements of publishing costs and not just the fixed costs referred to here. For example, Tenopir and King estimate first-copy costs as \$1545. Figures for a major publisher-owned journal of high quality indicate a first-copy cost of \$2200; for a smaller mid-range journal from the same publisher the first-copy cost is \$350. Electronic versions of these two journals have first-copy costs of \$2000 and \$475 respectively. *PLoS Biology*, a highly selective journal, incurs first-copy costs of \$1067 per article plus the cost of PLoS professional editors. The allocation of professional editing time is difficult at this stage in the development of PLoS journals. It will raise first-copy costs but is unlikely to take them beyond the range suggested here. Dryburgh’s survey of primarily smaller publishers produced a range for first-copy costs of \$350 to \$2000 with a median of \$750. Bergstrom’s estimates for a number of internationally-recognized economics journals ranges from approximately \$1200 to \$2400 but Bergstrom is confident that the actual figure lies at the lower end of this range. BioMed Central, the commercial, author-pays, open access publisher, charges \$525, \$1000 or \$1500 per article published depending on the selectivity of the journal in which the article appears. BioMed Central is a commercial operation which wishes to generate profit from this operation and is unlikely, therefore, to be charging a fee substantially below its costs, notwithstanding its need to break into the market at this early stage in the development of such journals. (BioMed Central charges subscriptions or other forms of pricing for paper versions of its journals or for commissioned articles.)
- 2.11 Some of the reasons for such a range of estimates arises from the range in the extent of peer review in different journals. Rowland (2002) estimates reviewing costs at \$200 per paper published. Tenopir and

King estimate review costs as \$20 per paper reviewed. At \$20 per paper reviewed, a rejection rate of 90 per cent would result in a reviewing cost of \$200 per paper published. These figures appear relatively low on the basis of perceptions reported in interviews with key figures in the publishing world and it may be that the peer review process includes some staff time and activities which are not easily categorized from balance sheet figures. Reviewing costs – acknowledging the wide variations in practice in this area – thus comprise approximately 10 per cent to 30 per cent of first-copy costs and are frequently one of the biggest, if not the biggest, single items. Academics who carry out reviews are not normally paid. Such costs refer entirely to the publishing element of the activity and do not include the ‘opportunity cost’ of academics’ time.

Other costs

- 2.12 Other fixed costs fall into two categories: those associated with the production of the journal, rather than the article, and those, over and above product-related costs, which are necessary to keep the company in its current line of business. Examples of the former are comment and news sections, book reviews and review articles plus technical matters such as cover design. Marketing costs, for the journal, would also be included in this category. The second category is overhead which cannot be easily allocated to products.
- 2.13 Variable costs cannot easily be given a typical figure as a proportion of total costs, for all journals, because they vary with output. They include subscription management, most sales costs and distribution. A journal with a very large circulation will have high variable costs but a correspondingly large customer base from which to draw revenue.
- 2.14 The size of the subscription base is important. The price or subscription charged for a journal will cover variable costs and will make a contribution to covering fixed costs. Since fixed costs do not vary with numbers of copies sold, a bigger circulation will mean that fixed costs can be covered more easily – that is each subscriber will need to pay only a small sum to cover fixed costs compared with the amount which would have to be paid with a low number of subscribers. The higher the circulation, the cheaper the cost of each copy because fixed costs are being shared between more subscribers. In general, therefore, high circulation journals have lower prices, reflecting lower costs per unit. But low price in this context is not an indication of low profit. Usually high profits can be made in such circumstances. Even a relatively low profit per subscriber sums to a significant amount when subscriber numbers are high. In general, society journals have high circulation rates because the membership subscription usually includes a copy of the journal.
- 2.15 Conversely, low circulation or specialist journals must cover their fixed costs from a small base of subscribers. Fixed costs therefore form a higher proportion of total cost. Prices are likely to be higher and total profit relatively small.
- 2.16 Since variable costs can be covered easily within subscription rates, the key issue for journal publishers is to manage fixed costs and, if possible, to spread them across as wide a subscriber base as possible. As already discussed, first-copy costs are a high proportion of fixed costs. Dryburgh (2002b) reports the proportions set out below. His figures are in line with most estimates. It is important to recognize that the variable costs he quotes are an average for the seven publishers he studied and that the balance between fixed and variable costs will vary significantly depending on the size of a journal’s subscriber base and other elements of scale. Taking these figures as typical, it is possible to acquire an overview of the order of magnitude and balance of costs involved.

Cost element	Proportion of costs
1. Refereeing	22%
2. Editorial and typesetting (i.e. from acceptance to first copy)	33%
3. Subscription management	7%
4. Physical production and distribution (including postage)	23%
5. Sales and marketing	13%
6. Promotion to authors	2%
Total	100%

- 2.17 Most fixed costs (items 1, 2 and 6 above) total 57 per cent of total costs. Some marketing costs (item 5) are also fixed. In round figures fixed costs are thus 60 per cent of total costs for the seven publishers studied. Journal revenues will be expected to cover these fixed costs, variable costs and make a contribution to overheads. Journal publishers are thus concerned with keeping fixed costs down, since they form a high proportion of their total outlay.
- 2.18 But to emphasize the points made earlier, a major international journal such as *Nature* will have a different breakdown of costs. It has higher fixed costs than most journals, firstly because it includes large amounts of editorial copy, comment, news and reviews in each edition, and secondly, because as a journal of high standing, it places a high value on peer review and employs professional staff to carry out some parts of the review process as well as more conventional academics. It has a high rejection rate. This is an expensive process. Such a journal also has high variable costs because it has a high circulation. *PLoS Biology* is also a journal of high selectivity. It carries high fixed costs for peer review because it too employs professional editors and has a high rejection rate. It also carries substantial amounts of editorial material, though significantly less than a journal such as *Nature*, which also adds to fixed costs. While it is an open access, author-pays journal (and authors therefore bear these fixed costs), it is in many respects a more typical academic journal than *Nature*. It does not carry high circulation costs in the conventional sense because it operates an open access policy. The implications of these differences are taken up again below.

Fixed, variable and total costs

- 2.19 On the basis of estimates of costs in the literature and the evidence from surveys and data made available in preparing this report, it is possible to make some assertions about the range and proportion of costs of STM journal publishing. The figures below are unlikely to apply directly to the costs of any specific journals. For example, journals such as *Nature* and the *Lancet* are at the extreme end of the range. (They are highly selective and have lots of value-added content.) The costs quoted can be used, however, to understand better the cost elements of the parts of those two (and similar) journals which are equivalent to a high-quality journal publishing exclusively primary research. The costs quoted must be interpreted in the light of the particular reach and style of any specific journal.
- First-copy costs have a range of roughly \$250–\$2000. A conservative estimate for the cost of producing the first copy for a good-to-high-quality journal is therefore \$1500. First-copy costs form approximately 55 per cent of total costs, excluding overheads. These costs apply in all business models.
 - Fixed costs, which include first-copy costs, are roughly 60 per cent of total costs for a *subscription* journal, excluding overheads, or approximately \$1650 per article for a journal of this quality.

- Based on first-copy costs, the total cost of producing an article for a good-to-high-quality *subscription* journal is therefore of the order of \$2750 plus a contribution to overheads.
- Author-pays systems will bear different total costs. Total costs for author-pays journals are likely to be lower. They include some extra cost for managing the charging system for authors but do not carry any costs for subscription management, licence negotiations, or many sales costs. We have assumed, conservatively, that electronic and paper versions of articles cost the same. Author-pays journals tend to publish many fewer items in a paper format, and where such items are produced they are frequently sold on a subscription basis or as an off-print. The balance of costs in an author-pays system is therefore different from subscription models and this is taken up again below.
- The necessary contribution to overheads cannot be assessed in any realistic way. It depends on the nature of the journal-publishing business and the other products to which overhead can be allocated. An element for profit, or surplus, will also need to be added to these figures. Different publishers will have different ideas about the appropriate figure to add.
- As a guide to the orders of magnitude involved, Blackwell Publishing is one of the world's largest journal publishers with a total of over 600 journals within physical sciences, life sciences, medicine, social sciences and humanities. It represents over 500 learned societies and generated an average *revenue* from libraries per paper published across all its journals of £875 or \$1425 in 2003 (Campbell, 2004). If revenue from consortia, copyright fees, advertising, reprints, supplements, sponsored subscriptions, document delivery and members' subscriptions are added to this figure the total average revenue per article, for Blackwell, in 2003 is £1200 or just under \$2000. This average revenue figure covers all fixed and variable costs including overhead and profit.

2.20 Table 1 summarizes the data discussed above, and includes estimates of appropriate submission and publication charges discussed in paragraph 3.15 below. The qualifications already set out apply to these estimates: they will be unlikely to apply to any specific journal but give guidance on typical magnitudes. The estimates are speculative but are not guesswork. The relative costs for subscriber-pays journals are based on the balance of costs in Dryburgh's estimates (Dryburgh, 2002b). The good-to-high-quality journal is costed on an assumption of an 80–90 per cent rejection rate, the medium-quality journal on a 40–50 per cent rejection rate. For author-pays journals, the estimates begin with the same first-copy costs as the equivalent subscriber-pays journal but cautiously assume higher fixed costs to take into account the possibility for a greater requirement for reader support in the distribution of articles and possible higher depreciation charges, if more sophisticated electronic systems are required. Variable costs for author-pays journals are very low. A contribution to overheads and profits should be added to these estimates.

Table 1 Estimates of costs per article for typical subscriber-pays and author-pays journals

Cost element	Subscriber-pays journal Cost in US\$		Author-pays journal Cost in US\$	
	Good-to-high-quality journal	Medium-quality journal	Good-to-high-quality journal	Medium-quality journal
First-copy costs per article	1500	750	1500	750
Fixed costs per article	1650	825	1850	925
Variable costs per article	1100	600	100	100
Total costs per article	2750	1425	1950	1025
Possible submission fees				
Possible submission fee			175	175
Total submission fees			1400 (8 articles reviewed for each article accepted)	350 (2 articles reviewed for each article accepted)
Possible publication fees				
Possible publication fee			550	675

The implications of fixed and variable costs for journal publishers

- 2.21 In many respects the important figure is the fixed cost figure per article. For a good-to-high-quality subscription journal, \$1650 is a cautious estimate. Many mid-range or specialist journals will incur much lower costs than this. For example at the bottom end of the cost range, a subscription journal with a first copy cost of \$350 will be unlikely to carry more than \$500 of fixed cost per article.
- 2.22 All journals will need to attract revenue which covers the fixed costs of articles plus variable costs (which primarily relate to distributing the articles to readers). For subscriber journals, the greater the number of subscribers, the lower the cost per subscriber.
- 2.23 The minimum price charged for a subscription journal will fall, therefore, for a given quality – i.e. a given level of fixed costs – as subscriber numbers go up. The maximum price will depend upon what the market can bear and this in turn relates to the journal’s approach to its market. Some journals will wish to keep prices down, others will be keen to push prices to as high a level as they can.
- 2.24 Costs have different implications for electronic author-pays journals. As before, total costs of production are made up of fixed and variable costs. The fixed costs borne by subscription journals are, in virtually all cases, also incurred by author-pays journals. Both types of journals also carry costs for the maintenance, or rental, of an electronic distribution system. The system must be kept up to date and, for some journals, provide services such as help desks for readers. No subscription management, licensing or (many) copyright costs are incurred by author-pays journals however, though the issue of copyright is controversial and there are different views on this latter point. Distribution costs are not negligible but, unlike subscription journals, many of them are fixed. That is most distribution costs do not vary with the number of articles or journals distributed. What economists call the marginal cost – the cost of the last unit sold – is close to zero across very wide ranges of output.
- 2.25 As an aside, we should mention briefly the investment required to set up an electronic distribution system (whether subscription or author-pays). Publishers need to invest in major, robust systems and the set-up costs of such systems are not trivial. Such set-up costs do not have any direct relation to the costs of any particular journal. Journal publishers have to fund the investment but it is not directly related to the

journal. It is an overhead. Conventionally such an overhead would be depreciated over a number of years and the cost of the investment (including the cost of funds, i.e. interest rate payable or foregone) would be allocated to all activities for which it was relevant. The simplest way to consider this is to regard the cost of depreciation as equivalent to a rental payment, fixed per year. It then forms part of fixed costs in the given period and must be recovered in any charging system. For many journals this is precisely what it is, since they contract out this aspect of delivery to a commercial publisher or university press.

- 2.26 An appropriate and conservative estimate of the charge per article necessary for author-pays journals thus lies in the range \$500–\$2500, that is first-copy costs plus other fixed costs and an element to cover the variable cost of running the distribution system. A contribution for overheads and profit will need to be added to this figure. Most journals are likely to fall nearer to the middle of the range than the extremes and their total costs including overhead and profit will be well below \$2500, as evidenced by the average Blackwell revenue figure quoted above of \$2000. It is technically feasible to add all sorts of bells and whistles to the electronic version of an article and increase costs by so doing, or to keep the open-access element of the system spartan and therefore relatively cheap, but these items are not the primary elements of cost. The primary elements, as with subscription journals, are essentially first-copy costs.
- 2.27 The cost to an author in such a system will vary according to the journal in which an article is submitted. Journals with high rejection rates will need to recover high reviewing costs, those with lower rejection rates will have fewer costs to recover. In the business model currently operating, costs will be recovered entirely from authors of accepted articles. Assuming prices are closely related to costs, authors will pay more for an article to be accepted by a higher quality journal than they will for a lower quality journal. The price per article is likely to be in the range set out in the previous paragraph: \$500–\$2500 (plus a contribution to overhead and profit).
- 2.28 It is possible to separate the cost of submission, namely peer review costs for all articles both accepted and rejected, from cost of publication in an author-pays system. It is feasible, therefore, to set up a price system which levies a submission fee and a publication fee. In such a system all authors would pay for their articles to be peer reviewed. Those authors whose articles were accepted would then pay an additional publication fee. Such a system, while not currently in operation, would narrow the range of author charges significantly. Authors would pay a publication charge which, if related to costs, would be directly related to the services they received from the publisher and the quality of the publication system in place. This point is taken up again in the next section.

Other system costs

- 2.29 Two other areas of cost need to be addressed at this stage: access and archiving. They are systems costs, not costs necessarily borne by publishers, and have a bearing on the overall assessment of different business models. Some work has been carried out in these areas and there is a literature on them. Issues in the literature have not been taken up here. We simply note the existence of the costs for possible further analysis.
- 2.30 Costs of accessing and reading journals and articles are borne by libraries and readers. Journals provide a framework through which readers assess the value of articles and it is difficult to conceive of a system without a journal-like institution. A collection of articles without the quality measure given by publication in a journal would be less valuable. Articles could be individually kite-marked but readers would not have the sense of perspective and orientation which a journal gives and, without the journal, search costs for readers would be much higher. This feature of journals is particularly beneficial if there is a risk of some elements of vanity publishing in an author-pays model. Readers would be clear about which journals were using acceptable forms of quality review and would approach them accordingly. Journals are likely to continue to exist, therefore, because they offer a significant and well known

criterion on which to search for articles and a means by which articles can be quality approved whatever system of payment is adopted.

- 2.31 For the subscriber-pays system, libraries incur charges for subscriptions, document delivery, storage or electronic access and incur costs in negotiations over licences. Readers who have easy access to academic libraries will find their access to the relevant literature largely unhindered. Articles can be received at their desktop, in many cases, or delivered via inter-library loan or some other document delivery system, if not available on the library shelves. If the library is unable or unwilling to enter into an agreement with a particular publisher however, it may be extremely difficult to gain access to the scientific literature. For those without access to such libraries access can be a difficult and time-consuming process.
- 2.32 In an author-pays system, the libraries would have an information management role. Very few negotiations would be required and interested parties could obtain access to articles whether members of the relevant institution or not, subject to some small charge or vetting system. Access would be easier and resources currently spent on complex arrangements over licensing, for example, could be spent elsewhere. In terms of costs to readers and libraries, this system is less onerous.
- 2.33 Archiving in the UK is carried out for paper journals by the deposit libraries. Other libraries keep their own archives and publishers also keep copies of journals. A form of open access exists via inter-library loan, though it is not free. It is not a speedy system and the reader, or the reader's institution, pays for delivery. Partly because of its relative inconvenience and cost, this form of archiving has never been a controversial element of the traditional system. It is seen as a beneficial and essential service. Costs are borne largely by libraries.
- 2.34 Archiving of electronic journals does not yet have established practices. Collecting together the output of scientific endeavour is an important activity for any sophisticated society. Electronic archives have major implications for business models in journal publishing because they remove the two negative characteristics which are currently typical of their paper-based equivalents. Electronic archiving could, in principle, enable very speedy access to articles and remove the costs associated with delays in access to research outputs. It also has very low marginal costs. As in the author-pays model, for wide ranges of output the cost of extra article delivery is close to zero. There are clearly questions about the source of funds for investment to establish and maintain electronic archives and there is a literature on some aspects of this issue. The point here, however, is to note that the cost characteristics of such an archive promote a model in which readers have easy and wide access to the literature, because they do not create extra variable costs, and payment for the archive is drawn from elsewhere.

3 Costs, prices and business models

- 3.1 A number of issues arise from the previous section. Does the location of costs have any bearing on who *should* pay for scientific publishing? Do different pricing systems bring consequences with them which create costs for the system? In particular is there a risk of unintended consequences which might be damaging (and therefore costly) to the production and dissemination of scientific output? Are there implications, from the source and nature of costs, which have a bearing on the reproduction and sustainability of the system?

Who should pay?

- 3.2 There are no clear-cut answers to this question. Value judgements about who should bear the cost of dissemination of scientific work depend on the standpoint of the individual. However, there are a number of relatively uncontentious guidelines which can provide assistance in reaching a conclusion.
- 3.3 In general, economic efficiency – resources being used in the places that maximize the return to society – is achieved more effectively if individuals who demand products or services bear the cost of supplying them. In the context of STM journal publishing, what product or service is being supplied to whom? Authors are being supplied with a service which enables them to disseminate their work. Readers are being supplied with the means to acquire new research outputs. Both readers and authors require the work to be published in order to fulfil their needs. Neither one nor the other is dominant and in the research community all authors are readers, and some readers are authors.
- 3.4 There are implications which can be drawn from this guideline, however. Once it is clear who will bear the prime cost of publication, given the public/merit good nature of scientific research, it is inefficient to restrict access to others. Thus in a subscriber-pays system, publication services for authors should be largely free; similarly in an author-pays system, services to readers should be largely free and unrestricted.
- 3.5 A different way into the question is to ask what are the total system costs and how might they be minimized. Are there any implications for the distribution of costs between players? Total system costs are lower in an author-pays system because licensing and other activities aimed at restricting access to articles, in order to protect copyright and profit or surplus, are unnecessary.¹

Incentives to publishers, authors and readers

- 3.6 The previous discussion is based on the principle that individual authors, readers and publishers will interpret the costs they bear as incentives, or disincentives, to carry out particular actions. In general for economic efficiency, it is better for individuals to incur the true cost of their activities. They will then modify their behaviour in some way so that the costs they incur from those actions is in some measure balanced by the benefit they receive.
- 3.7 When readers are required to pay high prices for accessing research outputs, they may begin to abandon the high-priced journals and substitute them from other sources – but as we know, readers are ‘protected’ from these price implications through the library system. The market is, in this respect, highly inefficient.

¹ There is a continuing debate about the appropriate ownership of copyright in a system of this kind. To the extent copyright is restricted, and therefore requires protection, system costs will rise.

- 3.8 A charge to authors would potentially act as a disincentive to publication. The extent of the disincentive would depend largely upon the opportunities for alternative publication routes. If there were free alternatives, there would be an incentive to move to those. But if the free alternatives were lower quality or had a much lower readership, because, for example they were inaccessible to readers, charges for publication may have very little disincentive. If all journals charged a fee to authors which reflected their publication costs, such disincentives would be reduced to a search for the most suitable place for publication, on the basis of traditional academic measures, of quality, impact, timeliness etc. The absolute size of the fee would be an issue. Clearly, in general, the greater the fee, the more likely it will act as a disincentive. This factor is addressed again below. We should also acknowledge that for most authors the charge is likely to be paid out of research budgets or various research allowances. Such authors will not be financially worse off but would, in this system, still have an incentive to seek out the best value publication on the range of requirements they regard as important, including level of fee. In principle, therefore, this is a more efficient market solution than subscriber-pays.
- 3.9 Publishers and editors are unlikely to favour a system which makes it more difficult for them to achieve their objectives. For some publishers the present system works extremely well and there may be disincentives for them in an author-pays alternative. Publishers who attract top authors, in some cases by seeking them out and providing them with outstanding service, will feel threatened by a suggestion that authors should pay. This would represent a major switch in the way they carry out business. Others are clearly concerned that a move to author-pays will leave them vulnerable to continuing subscriber-pays journals. Some doubt that authors will be able to pay the charges they regard as necessary to cover costs though the figures reported here do not justify that concern.
- 3.10 It is important to reflect on the long-term implications for existing publishing models. Open archives have an important part to play. If any kind of extensive open archive is established, a subscriber-pays system cannot easily survive. It will not be in the interest of the archive, nor of the research community and society more widely, to place significant restrictions on the use of the archive. It is inconceivable that in the long term the archive would not supply copies of articles to *bona fide* researchers (probably at their desktops). The marginal cost of doing this over wide ranges of output is close to zero. It would be a questionable use of resources to set up and operate schemes to prevent the widest possible use of the archive.
- 3.11 A key question then is, how likely is an open archive? SHERPA (Securing a Hybrid Environment for Research Preservation and Access), based at the University of Nottingham, and launched in November 2002, now (in February 2004) has 20 partners representing the major proportion of UK research-led universities. It is funded by JISC and CURL and is working to build institutional repositories. They will not form a single open archive but the level of take-up indicates a desire for such an archive within the research community. A number of learned societies and funders are also actively engaged in establishing electronic archives including the digitization of back copies of journals. Whether or not an efficient, centrally funded archive is established, it is likely there will be a *de facto* archive in existence in the medium term.
- 3.12 The effect of such an open archive is to provide open access to journal articles. In the medium to long term therefore, that is the time it will take to establish an effective open archive or series of interlinked, searchable open archives, (assuming the supposition that such archives will be set up is accurate) the question facing journal publishers is not whether to offer open access or not, but how to position their journals so that they are able to continue to play an important part in a world in which open access, through an open archive and very cheap or free document delivery, is the norm.

Transition

- 3.13 For STM journal publishers, transition from a subscriber-pays system to an author-pays system is not about establishing electronic versions of their journals. Virtually all STM journals distribute their articles electronically. The implications for such journals relate to the potential loss of authors and the viability of the journal, should they move to an author-pays system. If many good journals remain as subscription journals, authors may choose to submit their articles to them rather than pay a publication charge. It is not easy to judge how authors will interpret a shift to author-pays. A great deal depends upon which journals operate in that way, how funders respond and the direction in which the journals market is moving. As indicated in the previous paragraph an effective open archive could make a significant difference. Issues relating to disincentives to authors are taken up again in the next section.
- 3.14 A small number of journals are now offering authors a choice of open access, author-pays submissions and free subscriber-pays options (Prosser, 2003). This can act as a transitional model to open access publishing more widely and allows authors to consider directly the costs and benefits for them.

Possible unintended consequences of an author-pays system

Disincentives to authors

- 3.15 One consideration to minimize the disincentive effect of author charges is to consider a submission fee and a publication fee. Such two-part tariffs are common in other spheres and are used when the production of a product incurs high fixed costs and a variable cost, for example telephone tariffs and fuel tariffs typically operate in this way. In economic efficiency terms this is a sensible option for publishers. It will discourage unrealistic submissions and make it possible to reflect the ‘true’ cost of publication for any successful article. Refereeing costs make up around 22 per cent of total costs or 40 per cent of first-copy costs, excluding overheads. Median first-copy costs are \$750 (Dryburgh, 2002b). Reviewing costs per article-accepted are therefore approximately \$300. Typical rejection rates are around 40 per cent. A submission fee of no more than \$175 is therefore likely to be a median figure. If such a fee were charged to all authors submitting papers the publication fee for successful authors could be reduced. By implication, for a top-quality journal with a 90 per cent rejection rate, submission fees at this level would bring in \$1750. Since the total costs for such journals fall in the range \$2000 to \$2500, a publication charge of around of \$250–\$750 might then be feasible. Undoubtedly some journals will fall outside this range. Very few are likely to do so. The total cost figures available in the literature and through discussion with publishers indicate that this scale of costs is broadly realistic.
- 3.16 Multiple submission fees may have to be paid by authors who found themselves submitting (serially) to a number of journals. For example, an article submitted to three journals would give rise to total submission fees of \$525, given the price suggested above. If the publication charge were \$450, the total fee for publication would be \$975. This is still substantially below the cautious estimate for the author charge of \$1500 required, to cover review costs for rejected and accepted articles, for a good-to-high-quality journal.

A reduction in the number or quality of journals

- 3.17 Work is more widely disseminated, in principle, in an author-pays system than in a subscriber-pays system, but that outcome rests on the assumption that journals would exist in much the same volume in each system. If, for some reason, an author-pays system produced a tendency to reduce the number of journals, then this conclusion would be less clear. There may be such a disincentive for publishers if they believed the opportunity for profit or for growth were restricted in author-pays systems.

- 3.18 Journals might be unable to produce the range of services currently offered and would need to think about different charging systems for different sections of the journal. This is sensible in principle but could be complex in practice. Charging systems become inefficient – and costly – if they are complex and purchasers, in effect, fail to understand them. Some journals may decide to close down or carry out their work differently, to the overall cost of the scientific community.
- 3.19 In an author-pays system journals might see ‘their’ authors attracted by journals charging a lower fee. Journals under this competitive pressure may be tempted to reduce their fees and consequently need to reduce their cost base. A reduction in the cost base may result in lower quality, that is less editorial and peer review activity. Such activities may be seen as a primary source for cost cutting because they form a high proportion of total costs. A downward spiral might then occur, where journals reduce price to compete for authors, reduce quality and then go round the cycle again in a series of competitive price reductions. Such a response is particularly likely where profit, or surplus, is a key objective for journals. A submission fee and publication fee system would reduce the potential for this damaging spiral.

Systems for those who cannot pay

- 3.20 A number of agreements, such as HINARI and INASP, currently exist for subscribers, primarily from developing countries, who find subscription fees prohibitive. HINARI, for example, is a UN initiative led by the World Health Organization. Eligibility is based on gross national product per capita; institutions in countries where GNP per head is below \$1000 are given free access to literature and there is a sliding scale up to GNP of \$3000 per head. Such schemes are admirable and it is feasible that similar arrangements could be made for academics from these countries in an author-pays system. No system of this kind will be perfect. For example under existing schemes, given overseas postage rates and worries of journal ‘leakage’ to better-off countries, Indian academics actually pay charges for subscription journals higher than American academics. Author-pays systems could well have less regressive consequences because there would be no need to police potential leakages.

4 Concluding comments

- 4.1 Our intention has been to provide estimates which can form a foundation on which to conduct a debate about the efficacy and efficiency of different approaches to STM journal and article publishing. The estimates are based on discussions with individuals from across the range of journals and approaches in scientific, technical and medical publishing. We have also looked carefully at the literature on publishing costs and have checked our estimates with experienced participants in the field.
- 4.2 It is clear that the market for STM publishing is changing. Electronic publishing is now taken for granted and pressure to make articles more easily accessible is growing. No-one wishes to damage a well-trying publishing model which has served the research community well over many years. However, it is also clear that the traditional subscriber-pays model is no longer able to meet the needs of the scientific community as effectively as in the past. It is open to pressures which are not always aligned with the scientific community's own objectives and aspirations. Furthermore, an author-pays system has the potential to be more economically efficient both in terms of the allocation of resources between competing uses and in the level of total system costs. It is also likely that the provision of open, electronic archives will effectively create an open access system for readers which could fatally damage subscriber-pays systems in the long term.
- 4.3 In these circumstances, in terms of costs of production, system costs and the implications of those for levels of fee, the author-pays model is a viable option. Open access, author-pays models appear to be less costly and to have the potential to serve the scientific community successfully.

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ISBN 1 84129 051-3

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DP-3114.p/500/04-2004/JM