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An evidence-based assessment of the 'author pays' model

Much discussion of author payments as a means to Open Access lacks consideration of evidence on their potential impact on the scholarly journal system. Our recent work perhaps sheds new light on both favourable and unfavourable aspects of this option.

We emphasize the diversity of communication communities among authors, and between the authors and the extensive non-author reading community. We also take a broad system perspective, given that the author payment model will potentially impact not only authors but also, for example, R&D funders, university and other organization staff and library budgets, publishers, and readers. This raises several issues. Who should fund author payment? Can subscription and author payment models co-exist? How should new author payment journals be financed?

Communication communities are diverse

Science involves communication within communities having common interests. Authors acquainted with one another, where communication tends to be oral as well as written, is one form. Then there are groups of readers who are largely recipients of information through journals. One can think of the overall picture as concentric circles (see Figure). The inner circle includes local communities, such as a university, where groups of researchers, teachers and students communicate in a variety of ways including article preprints, author websites and refereed articles. Emerging international laboratories might also be included in this group.

The second circle involves scientists separated by distance but are acquainted with each other's work and communicate in many ways, including refereeing, preprints and, ultimately, formal articles. Formal publication is less important for current awareness in these 'invisible colleges' of acquaintances. The outer circle of communities of authors and readers are linked mainly by formal journal publication, and where readers far outnumber authors.

Much reading has traditionally been from copies of articles as preprints, reprints and photocopies distributed by authors and colleagues. This tradition is enhanced by e-prints from author websites, e-print archives and, potentially, institutional archives, and cuts across all the circles.

COMMUNICATION



COMMUNITIES

Although only 10 to 20% of scientists in the United States are employed in universities¹ they account for about 75% of articles published. On the other hand, they account for less than 25% of all reading. Our 37 readership studies in industry (e.g., AT&T Bell Labs), government (e.g., National Institutes of Health) and national laboratories (e.g., Oak Ridge National Laboratory) show that the scholarly literature has substantial use, usefulness and value^{2,3}. This diverse nature of science communication communities will clearly affect and be affected by the author payment model.

A systems perspective

It is useful to consider the entire science journal system, including its total cost, to provide context for discussion of Open Access. Our most recent estimate of the cost in the United States is about \$45 billion in human, system, equipment, facilities and other resources⁴. The largest contributor to this cost is scientists' time (i.e. 10% as authors and 78% as readers). Publishers contribute about 6% of the costs, and libraries and other intermediaries about 5% and new initiatives about 1%. We will show later that the most change in these costs due to author payment affects not publishers, but libraries and their parent organizations.

The total cost described above excludes transfer of funds among participants (e.g., payment for subscriptions by libraries) in order to avoid duplication of system resource costs. To put the \$45-50 billion system cost into context, the total R&D funding in the US is \$265 billion¹ of that amount, about \$40 billion is applied to research that leads to scholarly articles (i.e. \$30 billion performed in universities, \$5.8 billion performed by federally funded R&D centres administered by universities, and \$10-15 billion performed elsewhere). This means that most research does not contribute to the literature, whereas it nonetheless uses the information as an essential resource^{2,3}.

Another important system perspective that has been neglected is the flow or transfer of funds among system participants. A common refrain is that universities fund research, and the scientists' time required to prepare scholarly manuscripts, only to give the manuscripts to publishers, who in turn sell them back to the universities, sometimes at exorbitant prices. Such a simplistic description of the transfer of funds ignores the complexity of funds transfer among system participants.

Some examples of transfer include:

- from R&D funders (e.g. government, foundations, industry, universities) to research performers such as universities and industry
- from performers to scientists who perform the research and authors (in payment of salaries, etc.)
- from scientists to publishers to purchase personal subscriptions and occasionally author payments made by them out of pocket
- from university and other organization funders (e.g. state government, student tuition, endowers, etc.) to their operational budgets
- operational budgets to their libraries and scientists and authors not externally funded
- from libraries to publishers
- from publishers to staff (many of whom are scientists), sometimes referees, other resources, lenders, and investors (who are sometimes scientists)
- from profit to government
- from government to R&D and other funding

It seems that proponents of author payment, or other alternative system initiatives, should consider the cause and effect of their initiatives on fund transfer among participants. For example, some suggest that universities should fund author payment and others propose that the initial R&D funders should. Either way, such payments reduce the amount of funds available to them for other applications. Below we provide some evidence that can show how OA author payment might affect or be affected by transfer of funds.

To gain some insights concerning potential transfer of funds for OA author payment, a 2003 University of Pittsburgh readership survey of scientists⁵ showed that research leading to authors' most recent article was funded by the following sources: government (33% of funded research), industry (25%), foundations (7%), and the university through internal grant or salaries for those not externally funded (35%). Some personal subscriptions were paid from grant funding (i.e. 15% of the university scientists' subscriptions) and the rest out of pocket.

In the future there may also be an international 'balance of information' funding issue among countries concerning where the articles that scientists read are originally funded. The 2003 University of Pittsburgh survey provides some evidence from the US perspective. This survey shows that 69% of articles read by these scientists are authored by US scientists, 24% by non-US scientists and 7% are through collaboration by US and non-US scientists⁵.

Author participation

Only about 15 to 20% of scientists in the United States have authored a refereed article. There are many reasons scientists decide to write articles, including to advance one's career, to contribute to the body of knowledge in a discipline, to protect the integrity of research findings, to establish oneself in posterity, and so on. Authors also make an important decision as to where to submit their manuscript.

Typical reasons for choosing a journal include circulation (i.e. size and composition of audience), acceptance rates, perceived quality and reputation, and speed of publishing³. Motives for writing and choice of journals in which to publish have not changed a great deal over the past 25 years, although impact factor has been introduced as a consideration⁶. It remains to be seen whether these reasons for authoring and journal selection will affect the author payment model in the future, but they should be kept in mind.

The 2003 University of Pittsburgh survey of science faculty and staff provides some additional insights concerning authorship. These scientists (about 2,500 of them) average 1.2 refereed articles published per year (far more than any other type of publication). Some (about 8%) say they have never authored a refereed article. The authors and co-authors together average spending 95 hours per article, which amount has increased since 1977.

Thus, universities (and other research organizations) spend more in a scientist's compensation allocated to authorship, perhaps about \$7,000 per article, than is likely to be spent on author payment to publishers. In deciding on author payment, universities and original research funders perhaps should consider the relative amount expended on the research, documenting research results, and author payment for disseminating research findings. This provides a context as to the amount of author payment that is necessary.

Reader participation

Nearly all scientists consult scholarly journals and read on average more articles now than 25 years ago, and from a much broader range of titles. Nevertheless, annually they spend about the same amount of time reading, which suggests that there may be a ceiling as to how much time they can spend reading. Readers currently have many more sources of articles they can choose from than in the past, including personal subscriptions (print or electronic), library collections (print or electronic), colleagues, authors, websites, e-print archives.

They tend to choose personal subscriptions based on society membership, interest in information content, and quality (assured by editing and refereeing). However, choice from the other set of sources depends on purchase costs, reader time and effort required to obtain articles, format of journals, age of articles read, awareness of the sources and their availability^{7,8}. About 80% of reading from library collections is electronic due to ease of use and saving of time spent accessing articles from one's office, laboratory, home, etc. On the other hand nearly 90 percent of reading from personal subscriptions remains from print issues.

It is difficult to see how author payment can change reading patterns other than broadening the scope of reading further, but capacity of time may have had some bearing on the use of other new sources of articles. The University of Pittsburgh survey of scientists revealed that only 1.2% of reading was from author websites, and that e-print archives accounts for less than one percent of reading by scientists. Interest and use of author websites and e-print archives are growing; but evidence suggests that they have a long way to go before they make an appreciable impact on the system in many disciplines.

Publisher participation

Many have recently estimated or reported on the unit cost of processing articles for formal publication. Our estimate of the direct article processing cost of a typical journal is about \$1,700 per article, recognizing that there are substantial indirect costs of administration, marketing, rights management, financing, electronic infrastructure and so on³. The relative indirect costs to direct costs appear to vary substantially by the size and type of publisher; indirect costs average about 77% of the direct cost but can be much higher due to addition of service features.

Thus, the total publishing cost that must be recovered through author payment could be in the \$3,000 to \$4,000 per article range, which is what authors or their funders would have to pay for the publisher to break even. Comparison of traditional subscription and author payment journal costs should be made using comparable characteristics. That is, either journal could be published and distributed in print and/or electronic, have similar features (e.g., citation, numeric database, and image links or retrospective electronic conversion, etc.), and be subjected to the same review, editing, and formatting processes.

Furthermore, support processes of administration, infrastructure, research, financing, and so on would also be comparable. With this in mind, it is difficult to see how the cost of publishing a subscription journal would be much different than that of publishing a comparable author payment journal. Only the revenue source would be different, with a constraint that the amount of revenue from either source be large enough to cover the cost of publishing the journal.

There has also been speculation of how the article processing costs break down by activities performed. We believe that the direct costs above are sub-divided roughly as follows: manuscript receipt processing, disposition decision-making, identifying reviewers or referees and review processing - 26% of \$1,700; subject editing, formatting, copy editing, processing author approval, indexing and redaction - 39%; preparation of master-images and special graphics - 35%. These proportions vary, of course, by rejection rates, number of special graphics and so on, but do reflect the activities that might take place. Some suggest that some of these activities should be eliminated, which

could reduce article processing costs to as low as \$500², which has encouraged many to advocate alternate versions of author payment. However, again, the relative cost (whether \$500 or \$5,000 per article) is moot because a subscription journal or author payment journal could eliminate the same activities and therefore have similar costs.

There are two characteristics of journals that generally require high prices: low circulation and large size in number of articles/pages. Based on our detailed cost model³, the large cost of processing and assembling articles in a typical journal of 150 articles means that a small circulation journal, say with 500 subscribers, must charge nearly \$1,000 to break even (with typical indirect costs included). The subscription price necessary to break even tends to decrease rapidly with increasing circulation, approaching an asymptote of the marginal distribution costs at about 5,000 to 10,000 subscribers.

A large journal with double the number of articles would require nearly double the price at 500 subscriptions to break even (recognizing that there are some fixed costs associated with article processing). Since most of the concern with growth in price of journals involves large and/or low circulation journals, one could argue that author payment should focus on the large-size, low-circulation journals.

Since personal subscribers continue to prefer print versions, there is reason to continue the subscription means of payment, at least for high circulation journals, which should have lower unit cost and prices. The print price would be slightly more than the modest cost of print reproduction and mailing. If the price is still too high, they can choose the lower cost electronic subscription. Libraries would be required to pay a similar amount for print subscription and/or minimum amounts for electronic subscriptions. Note that author payment would eliminate subscription maintenance costs (about \$10 per subscription), but would require costs for processing author payments.

One characteristic of journal (and book) publishing is that circulation and reading tend to follow a highly skewed distribution. For example, some articles tend to be read a great deal while many are infrequently read, reflecting the size of readership audience. Thus, topics covered by many journals may have a very small audience, while others, such as *Nature*, may have a very large audience. Similarly, the audience size of articles within a journal may vary appreciably. This implies that some articles subsidize others in a journal, which helps ensure that high quality articles that have a small audience will be published. The problem with high quality journals that have small audiences is that they must have high prices and/or be subsidized, as sometimes is done, by other popular journals in a publisher's portfolio of titles.

One author payment issue is whether publishers will continue to accept high quality manuscripts that have a small audience which would yield lower impact factors and whether they will accept manuscripts from authors who do not have the means to pay. Some authors, for example those located in developing countries, have expressed the concern that they will not be able to meet author payment. One must assume that publishers will charge author payment amounts that will cover subsidy of such authors as has traditionally been done by them in the past with subscription prices.

University and library participation

One popular notion is that universities will fund author payments. Several Universities have compared how much they might pay in author payments based on the number of articles published by faculty and staff with the purchase cost of subscriptions and licenses. However, library collection costs include not only purchase cost, but also the library cost of processing and maintaining subscription journals and the cost of using either subscription or author paid journals. At the University of Pittsburgh¹⁰ the annual science serials expenditure is about \$3.1 million, about half being electronic journals.

The cost of processing (and sometimes storing) these journals is nearly \$1.5 million or in total about 48% higher than the purchase costs. The total annual number of articles written by the scientists at Pittsburgh is about 3,000. Thus, any average author payment above \$1,500 would mean that the cost to the university of author payment would be higher than purchasing and processing the journals. An additional cost is due to library support such as training and user instruction, reference and research, online bibliographic searching and photocopying, and re-shelving for print versions. These costs are currently about \$1.3 million, which would be incurred for either subscription or author payment journals, but may be higher with the OA initiatives, if reference capabilities are not retained.

Funder subsidy of author payment is probably a more realistic way of determining how author payment will affect universities (and other research organizations) and libraries. Referring to the Pittsburgh experience, the university would be responsible for paying 35% of author payment (i.e. about 1,050 articles). However, the 65% external funding would probably make the author payment out of the R&D funds, thereby reducing the funded amount of scientists' research time accordingly, which would be paid by the university budget for other purposes. Comparing the cost of subscription collection (i.e. \$4.6 million) and article payment for 1,050 articles means that author payment costs below \$4,400 would be to the advantage of author payment.

Who should fund author payment?

The cost of author payment is small when compared with the total cost of the journal system or compared with research funding leading to articles and the cost to authors of writing the articles. On the other hand, while research funders might support author payment, not all of the research reported in articles comes from external funding. Some have suggested that if universities made the payment they would still benefit because the

cost for them to pay the author fees is less than they now pay in library journal purchases.

Yet, evidence suggests that current author payment would exceed library costs (even considering both purchase and operational costs) unless publisher article processing costs are substantially reduced⁹. Furthermore, universities would end up subsidizing reading by scientists located in industry and other non-university organizations (unless author payment is higher for these organizations), which some university administrations may not be willing to do.

One can make a strong argument that the value of research is achieved not only from what is learned by the researchers, but even more by subsequent use made of research results. That is, the more research results are subsequently used in research and teaching, the greater its value (assuming the information is not false or misleading). This is a posture long taken by government agencies¹¹ and is one that universities and research funders should also seriously contemplate when considering Open Access initiatives.

Can subscription and author payment models co-exist?

Perhaps the greatest difficulty with subscription and Open Access initiatives is how they might co-exist since similar approaches haven't worked in the past. One way is to have author payment for high-cost, low circulation journals and traditional subscription for high circulation ones. The success of Open Access, limited or otherwise, must be agreed upon by all participants. Publishers, including commercial publishers, might collectively determine how to proceed, recognizing that there are scientists who are willing to pay for their articles, largely to facilitate Open Access.

Actually, while believed by many as being new, the general concept of author payment was prevalent with society publishers 25 years ago in the physical sciences (physics and chemistry), environmental sciences and engineering and, to a lesser degree, in other science fields¹². Most author payment came in the form of page charges, but also submission fees, reprint or preprint fees and/or manuscript revision fees. The average fee for authors for all the fees was about \$750 per article in current dollars.

The practice declined sharply during the 1980s due to competition by other publishers (particularly commercial publishers) for manuscripts that did not require author payment. The society publishers tended to recover the relatively small marginal printing and mailing cost of member subscriptions in the member fees, while article processing costs (less author payment) were recovered by revenue from library subscriptions and other sources such as advertising. With declining revenue from authors, the society publishers were forced to continually increase prices to library subscribers to make up for this loss in revenue. This contributed to the many reasons prices rose so rapidly over a 20 -year period.

Author payment can eliminate barriers caused by high prices required for large journals and/or those with low circulation. However, co-existence of subscription and author payment models may be questionable since the past prevalent practice of author fees in some fields of science has dwindled due to competition for manuscripts from other publishers, and the current authors appear unwilling to pay reasonable amounts^{6, 13}.

How should new author payment journals be financed?

Some recent initiatives, such as the Public Library of Science, BioMed Central, SPARC and author payment advocates imply that many current subscription-based publishers and their journals should be replaced by author payment-based journals. As mentioned by Odlyzko¹⁴, such new journals will require investment for start up, continued operations and capital investment.

Some investment or source of borrowing is necessary to support staff and other resources because revenue often lags behind the cost of article processing, which begins when manuscripts first arrive. Sometimes a society or university subsidizes such investment for their publications. Investment is also needed to start new journals because it often takes up to six years for a new journal to break even¹⁵ and substantial investment is required for capital improvement and R&D to keep up with advanced features, such as linkage and provision of older articles. Such investment is necessary and probably about equal for both traditional publishing and OA with author payment.

Investment that is subsidized by organizations and foundations deny use of the funds for other purposes. For example, the invested funds could otherwise be used for additional research, teaching, improved communication, and so on. Investment funded through loans requires interest payments, say 8 to 12%, which is 'profit' to the lending institution. With commercial publishers, the investment comes from founders and individuals (including scientists) who are willing to take a risk in science publishing. The gross profit (i.e. revenue less costs) is used to pay back loans, capital requirements (e.g. equipment, facilities), investment in developing new features, and disbursement to investors. The US government typically receives about 50% of net profit in taxes (which perhaps ought to be dedicated to science research) and capital gains received by investors are taxed as well.

Investment required to start a new journal can be as high as \$50,000 and operational investment can reach \$20,000 with additional capital investment of perhaps \$30,000 (Tenopir & King, 2000). Thus, total investment for a typical science journal could be as

much as \$100,000 at given periods in time. To replace, say, commercial journals would require hundreds of millions in future investment.

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