THE DISSEMINATION OF SCHOLARLY INFORMATION: OLD APPROACHES AND NEW POSSIBILITIES

OMAR AL-UBAYDLI & RUFUS POLLOCK

GEORGE MASON UNIVERSITY & UNIVERSITY OF CAMBRIDGE

NOVEMBER 2ND 2009

ABSTRACT. Current methods of disseminating scholarly information focus on the use of journals who retain exclusive rights in the material they publish. Using a simple model we explore the reasons for the development of the traditional journal model, why it is no longer efficient and how it could be improved upon. One of our main aims is to go beyond the basic question of distribution (access) to that of filtering, i.e. the process of matching information with the scholars who want it. With the volume of information production ever growing – and attention ever more scarce – filtering is becoming crucial and digital technology offers the possibility of radical innovation in this area. In particular, distribution and filtering can be separated allowing filtering to be made open and decentralized. This would promises to deliver dramatic increases in transparency and efficiency as well as greatly increased innovation in related product, processes and services.

Keywords: Journal, Open Access, Scholarly Communication, Matching

JEL Classification: D02, L82, D40, L30

1. INTRODUCTION

It is crucial to the progress of any domain of scholarship that those engaged therein are able to communicate their discoveries and activities to others. As such, a variety of systems and institutions have been developed in order to support 'scholarly communication' in one form or another ranging from personal letters to physical meetings. In recent times, the growth of scholarship, combined with its increasing geographical dispersion, have resulted in the centrality of the written word and its dissemination via 'journals'. In this paper we consider the purposes of any system of scholarly communication and consider the current

academic journal system in light of them. This examination highlights several deficiencies and also suggest various possible improvements.

When thinking about the possible mechanisms of scholarly communication it is useful to specify in more detail the criteria against which they should be measured. That is, to put it more succinctly, what do we want a good mechanism for scholarly communication to do? In particular, when we say communicate we must ask ourselves what, to whom, in what form, etc etc. For it is clear that when we talk of communication we usually mean more than the simple transmission of a piece of information. In fact, today, with so much scholarship available, the challenge may often not lie in the transmission from the author to the reader but in the matching of authors and readers – the decision of 'what to read'. This growing focus on choice is a natural one in a world where time and attention are limited and the amount of scholarship available is ever increasing. As such it suggests that there are at least two distinct functions performed by a system of scholarly communication:

(1) Distribution – getting information from authors to readers (and back again)
(2) Selection (filtering) – deciding what to distribute and to whom

In appreciating this distinction it is illuminating to consider how practice has changed over time. Originally communication between scholars, at least in written form, primarily took the form of letters between the individuals involved. As such, the two activities of distribution and filtering would be almost completely identical. Then, as the number of authors and readers grew this became infeasible and dedicated journals would be created which would then disseminate to their particular readers a selection of what was submitted to them. Thus, what was once a direct peer-to-peer relationship became mediated by a new institutional form: the academic journal – though of course journals were often run by the very readers and authors who used them. Finally, today, thanks to digitization and the Internet peer-to-peer is once again a possibility though with important differences: unlike in the past, where a letter writer chooses the recipient, the modern peer-to-peer approach more resembles journals in that the author and reader act independently – the author uploads or publishes his/her work to a repository entirely separately from the reader finding, downloading and reading it. This last discussion suggests breaking down our original two categories a little further:

(1) 'Making available' – publishing material

(2) Discovery – finding out what is available

(3) Choice – choosing from what is available

(4) Reading – getting access to the material (in the form required)

Here, the first and fourth item would come under the 'distribution' heading while the second and third would come under 'selection'. In addition we should mention two other functions performed by such a system, both of which relate to selection: a) improvement of work via peer-review (distinct from filtering process itself); b) 'quality signalling' whereby the selection of work helps signal the quality of its creators which in turn is important for the purpose of resource allocation (jobs, grants etc) within the scholarly community.

With these added to the list we now have a good number of separate goals which a scholarly communication mechanism may seek to satisfy. The next stage is to consider how the current system, largely based on academic journals, fares in respect of them.

1.1. **Goals, Instruments and the Current Journal System.** It is well known that in order to fully address a given number of (independent) goals one needs an equal number of instruments. For example, if one is seeking to address both congestion and pollution in relation to road-traffic, a single instrument such as petrol taxes, will be insufficient.

Here too there are multiple independent goals, most notably distribution and selection (matching). These are clearly distinct goals and require distinct instruments for their achievement but journals are but a single instrument which combine distribution and filtering in one mechanism.

Originally, the restrictions of reproduction and distribution technologies, meant they were the best instrument available. Today, with the advent of the computer and the Internet, this is no longer true: distribution (the uploading and downloading) can be done by almost anyone and quite separately from recommendations and rating of that material.

As such, the traditional journal system is becoming a serious constraint, particularly in its closed access form. There are two distinct aspects of this constraint. First, on the distribution side, journals delay and restrict access as a result of higher prices arising either from simple monopoly control or the costs of the (inefficient) selection mechanism the traditional model necessitates. Second, on the selection side, the forced combination of selection and distribution and the associated monopoly control of content greatly limit

the efficiency (and utility[1]) of the selection and filtering processes used to match authors and readers together.

Unfortunately, the two-sided nature of the journal market (based on expectations), combined with the current evaluation structure of academia, continue to lock society into this inefficient restriction. Open-access journals provides are an important part of improving the current situation. However, as we discuss below, they are only a first step: in order to reap the full benefits of new technology we must move away from the traditional 'journal' model to a system that allow for full separation between the distribution and selection operations.

1.2. **The Technological Origins of Modern Inefficiency.** At this point it is worth considering in a little more detail why restricted-access journals originally came about. The answer lies in the nature of the technology available in earlier periods to manage distribution (printing and transmission). When many journals were originally started the cost of transmitting information was very high and journals acted as a club good by which the costs of reproduction and distribution could be (efficiently) shared (the efficiency arising here from economies of scale).

At the same time, given the limited 'bandwidth' available, it was natural for journals to take on some filtering role in order to economize on the scarce distribution capacity. In this situation, dissemination is limited and with only one instrument available (journals), it is natural to tie dissemination and filtering together (with filtering in many ways secondary). Once filtering is being done it is natural for journals to 'tie' material to the journal explicitly via copyright – though at an early stage given the scale economies of journals this explicit tying was not actually necessary and was probably done for simple legal convenience.

With the advent of digital communications, in particular the Internet, bandwidth is no longer scarce. What is now scarce is attention. In this setup the importance of a journal is not its role in efficiently sharing reproduction and distribution costs but its role as a filtering mechanism. However, there is now a problem: when distribution is central it is natural to 'add-in' filtering, it is not natural, or necessary, to tie distribution to filtering when filtering is central. In fact, it seems clear that distribution and filtering can be done

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[1]After all what good is it to find an article if you cannot read it.

entirely separately (there are potentially many ways for one to download my paper quite separate from getting it from a journal – and lots of ways to do matching and filtering other than by journal editors and reviewers). The Open Access movement can be seen as largely about achieving this separation: with open access there is no longer a connection between access/distribution (which would be free) and the filtering mechanism (the choice of which articles go in a particular journal).

That said the 'Open Access' movement still has a large focus on journals – albeit open-access ones. This, in our view, is a mistake. Technology has also affected possibilities for filtering. In particular it is no longer clear why the centralized mechanism of official peer-review and journals is superior to alternative decentralized options. The last decade, has witnessed widespread, and often successful, experimentation with distributed voting and evaluation mechanisms (for example Slashdot's story-ratings and Google's link-based site rankings).

Thus, to be more radical, it makes sense not only to remove centralized control of distribution but also centralized control of filtering. A more distributed (market-like?) filtering mechanism would permit the same freedom (and potentially same status) for reviewing and recommendation as it does in the production of scholarly information. At the same time it would deliver greater transparency and, by permitting 'free-entry' in filtering, would permit greater specialization, greater diversity, increased participation and the increasing efficiency flowing from greater competition.[2]

As such, the gains from going 'open' are not simply wider access, but a reduction in the time and energy scholars spend finding and processing research information. Significantly, this second item, which is less frequently mentioned in discussions of 'Open *Access*', may well be the most significant.

2. Background and Existing Literature

Before delving into the model it is worth providing some background especially in relation to what open access is and what relevant analyses already exist in the literature.

Open Access (OA) journals are defined by the absence of exclusive copyright on their contents. In the digital age, this translates to an article delivery price of zero to readers.

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[2]Later in this article we will discuss a concrete system for implementing a decentralized filtering mechanism in relation to scholarly work.

Essentially, the journal's role is reduced to rubber-stamping already available articles that they deem to be of sufficient quality (Bergstrom, 2001; Tenopir et al., 2000).

Technically, OA vs. non-OA journals has nothing to do with profit vs. non-profit. However, the two issues have become somewhat conflated for two reasons. First, for obvious reasons, an OA journal, are almost always non-profit. Second, even non-OA non-profit journals have been shown to charge much less than profit journals (as part of their mandate is to promote readership).

It is noteworthy, especially in light of our later discussions, that there is clear evidence that commercial publishers are exploiting their market power. Studies by Bergstrom and Bergstrom (2004) and Dewatripont et al. (2007) demonstrate that commercial publishers charge approximately three times as much as journals produced by non-profit scientific organizations. These studies employ a wide variety of controls, including quality (via citations).

This evidence is also supported by the trend in prices. Tenopir et al. (2000) trace the trend in rising prices from the late 1970s through to the 1990s – a period of immense consolidation in the industry, and McCabe (2002) also demonstrates that part of the recent price increases can be attributed to merger activity among the leading commercial publishers.

Of course, open access, whether via journals or otherwise, can have problems. In theory, the principal criticism levelled at OA journals is that charging publication fees creates an incentive to 'over-publish' as publishing is the source of revenue. On the other hand if revenues come from readers, then the incentive is to be more selective since readers' willingness-to-pay will be increasing in article quality. In terms of the dynamic consistency literature, the temptation to publish substandard articles is greater under OA revenue schemes. McCabe and Snyder (2005) and Jeon and Rochet (2007) also offer some more subtle potential drawbacks of relying on publication fees based on formal modelling of the interplay between author and reader demand.

However it takes no more than a straightforward application of the Folk Theorem to note that, given a sufficiently long horizon, reputation effects can overpower any static temptation to defect. This point was stressed by the UK Commons (2004) report on the academic publishing industry.

This possibility has been borne out in practice, where the PLoS OA journals have achieved high impact factors in a short period of time. It is also worth noting that the incentives to 'defect' are arguably much higher for the many firms that exist purely to rate other firms' products (e.g., consumerreports.com), yet these firms persist rather than collapsing under the temptation of endorsing the highest-bidder among the firms that they are rating.

As mentioned above, in the digital age, the marginal cost of delivering articles is virtually zero. This is an addition to the fact that digital journals can generate total savings or approximately 30% (Tenopir et al. (2000)). This implies that any positive reader price generates deadweight loss (DWL) on the reader's side. Similarly charges on the author side (as are often proposed for the OA model) may generate costs by limiting what gets published. These potential inefficiencies, and their minimization, have been the main focus of the economic literature so far (e.g. McCabe (2002); McCabe and Snyder (2005); Jeon and Rochet (2007)).[3]

Here, as already indicated by our introduction, we wish to leave these 'access' question largely to one side and focus instead on what we have termed 'selection'. Specifically, we wish to examine what additional selection and filtering costs (or benefits) arise from the closed access model and the associated monopoly control of content. As our survey above indicates this particular point has so far received little attention.

3. Model

This model is obviously, and intentionally, heavily simplified. Its aim is to capture the key features of our argument not to provide a complete and exact model of the mechanisms of scholarly information production and dissemination.

Our focus will be on the distribution and filtering of scholarly information and we therefore begin by abstracting entirely from the production side and assume, simply, that there is a single piece (or set) of information to be disseminated which we will term 'A'

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[3]Some other points have been raised, albeit relatively minor, for example, the advantage to OA journals ns eliminating reader-pricing administration costs (UK Commons (2004), Willinsky (2005)). Though these must obviously be replaced with account management on the author side, when publication fees are used this still translates to a substantial cost saving.

(to stand for 'article' or set of 'articles').[4] This 'article' has a quality value q which follows some probability distribution G (which is common knowledge). There are N scholars who wish to have access to scholarly information. A scholar's utility from having access to an article is:[5]

$$U = E_G(q) - c$$

Where c is the cost of obtaining (and 'using') the article. Scholars' outside options, that is their payoff if they do not obtain the article, is normalized to 0.

Our analysis proceeds in stages. First, we analyse the case without a Journal[6] and without filtering (termed 'direct access'). Next we analyse the case with a Journal but without filtering and finally the case of both a Journal and filtering. The salient points we seek to highlight with the model are that:

- A Journal offers economies of scale in distribution. When direct access is costly this makes a Journal an efficient distribution mechanism.

- Filtering may be attractive even without a Journal but it is naturally bundled with a Journal since the activities of collation for distribution and collation for filtering are naturally complementary.

- However as direct access costs drop the value of a Journal as a distribution mechanism erodes but its monopoly (based on expectations) in filtering may remain.

3.1. **Basic Case: Direct Access without Filtering.** With direct access individual scholar receives article directly (i.e. without going via journal) at cost i. We shall ignore the possibility of filtering for the time being and thus in this case the expected quality is just the average $\bar{q}$ and we have:

$$U^D = E_G(q) - i = \bar{q} - i$$

The scholarly information is then disseminated if and only if If $U^D \geq 0$.

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[4]We could allow the number of articles to be a choice parameter but it adds little to the analysis except complexity. What is important, and is also omitted by this assumption, is article/scholar heterogeneity in tastes. We shall return to this question below.

[5]A natural extension to this approach would be to allow heterogeneity across scholars, for example by including a parameter θ in the utility function to capture variation (whether in value or costs). In fact it would then be natural to invert the setup slightly to define a reduced form demand function $D(q^e, c)$ depending on expected quality q^e and costs c. However, for the time being we stick with this simpler formulation.

[6]In what follows we shall assume only a single Journal for simplicity. Where this assumption has important consequences for the analysis it will be noted.

3.2. **A Journal.** Now suppose there exists a Journal to which scholars can subscribe for a fee p and which in return distributes the article(s) to them. The main feature of a Journal (initially) will be its access to an distribution/reproduction technology exhibiting economies of scale. In particular we assume that a Journal has fixed costs H and marginal costs of $j < i$. So total costs with N users are $H + jN$ and thus the Journal's profit is:

$$\Pi = Np - (H + jN)$$

The Journal has no means to alter quality so a scholar's utility from purchase is:

$$U^J = \bar{q} - p$$

At this point we shall not make an explicit assumption about the Journal's pricing approach (it can be anything between a shared club run by the scholars and just breaking even and a fully profit-oriented enterprise). Nevertheless we can determine whether the Journal can charge a price sufficient to cover costs and thus whether the Journal is feasible. The Journal's cost per user (with N users) is clearly:

$$c^J = \frac{H}{N} + j$$

Thus for the Journal to be feasible its price $p \geq c^J$. The Journal's upper bound on price is set by the scholars' outside options which are either direct access yielding $(U = U^D)$ or of not accessing any information $(U = 0)$. Thus, for scholars to use the Journal requires:

$$p \leq \min(i, \bar{q})$$

Thus, assuming the Journal prices to ensure it is used, a Journal will exist and be used whenever:

$$\frac{H}{N} + j = c^J \leq \min(i, \bar{q})$$

In terms of comparative statics this suggests that Journals emerge as:

- The scholarly community grows (N increases).
- The technology of large-scale production and distribution improves relative to that of direct access ($j << i$) – e.g. consider large-scale printing versus hand-written or hand-typed missives.

It is noteworthy that many of the first academic Journals emerged in the late nineteenth and early twentieth century in an era which saw both a substantial increase in the size of the academic scholarly community and a significant improvement in commercial printing and distribution technologies over those available to private individuals.

3.3. **Stand-Alone Filtering.** We now add to the model the key concept of 'filtering'. The idea of 'filtering' is that by incurring some cost (of effort, money, etc) $f(q)$ it is possible to provide an article set of expected average quality q. Note that by retaining $\bar{q}$ to be the expected quality under the original distribution we have $f(\bar{q}) = 0$. To take this into account define $q' = q - \bar{q}$ and re-define f in terms of q', $f \equiv f(q')$, so that $f(0) = 0$. We shall assume that once a set of articles has been selected there is no additional cost to providing it to an additional user (other than the cost of communication).

Let us consider first the case without a Journal. Let p^f be the price for a filtered set then the utility of a scholar using this filtered set is:

$$U^f = q - 2i - p^f$$

The extra i cost here represents the cost of acquiring the filtered information from the filterer in addition to the cost of subsequently obtaining the relevant articles. For the present we shall ignore the structure of the filtering market and simply assume that filtering is provided at its socially optimal level, i.e. where the quality level q^* satisfies $f'(q^*) = N$.[7]

The surplus generated by filtering (excluding distribution costs i) equals $q^* - \bar{q} - \frac{f^*}{N}$. It will be convenient to have a single symbol to denote this value and we shall use ϕ. Then in the case of competition (i.e. all gains accrue to scholars) a scholar's utility is given by:

$$U^f = q^* - \bar{q} - \frac{f^*}{N} - i + \bar{q} - i = \underbrace{\phi - i}_{\text{Filtering Gain}} + \underbrace{\bar{q} - i}_{\text{Initital Situation}}$$

3.4. **Filtering with a Journal.** We now turn to filtering with a Journal. In this case we shall assume that the Journal can do filtering in-house at cost $f_J(q)$. We explicitly differentiate Journal filtering costs from independent filtering because it is assumed that

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[7]Note because of the linearity of the relationship of quality and price, assuming that producer and consumer surplus are equivalent, it does not matter how the price is set as it just affects the allocation of surplus between 'filterers' and scholars.

the filtering is tied to the Journal.[8] The other difference from stand-alone filtering is that the Journal can distribute its filtering information at no additional cost – it is embodied in the selection of articles. Journal profits with filtering then are given by:

$$\Pi^{Jf}(p,q) = Np - (H + jN + f_J(q))$$

By the linearity of the utility function $U^{Jf} = q - p$ the first order condition for Journal quality is the same as that just discussed in the case of stand-alone filtering:

$$f'_J(q^*_J) = N$$

A scholar's utility from the Journal is:

$$U^{Jf} = q - p = q^*_J - p$$

A Journal maximal profits are then:

$$\begin{aligned}
\Pi^{Jf} &= Nq^*_J - (H + jN + f(q^*_J)) \\
&= N\left(q^*_J - \bar{q} - \frac{f^*_J}{N} + \bar{q}\right) - (H + jN) \\
&= N(\phi^J + \bar{q}) - (H + jN)
\end{aligned}$$

Thus a journal is feasible if:

$$\phi^J + \bar{q} \geq \frac{H}{N} + j \equiv c^J$$

Conversely, the maximal possible utility for users is (setting price so that the Journal just breaks even):

$$q^*_J - c^J - \frac{f(q^*_J)}{N} = \phi^J + \bar{q} - c^J$$

A Journal will be used in preference to the stand-alone option if:

$$\underbrace{\phi^J - (\phi - i)}_{\text{J Filtering 'Advantage'}} + \underbrace{(i - c^J)}_{\text{Distribution 'Advantage'}} \geq 0$$

Implications:

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[8]One could allow a Journal to buy-in 'filtering' from outside. However given the centrality of filtering to the identity of a Journal as well as the nature of the reviewing process (largely done by the scholarly community) it is likely that the filtering will be explicitly associated with the Journal. More on this issue can be found below.

- A Journal will always performing filtering (ϕ_J is positive) and filtering increases the likelihood that the Journal is feasible.

- The complementarity in distribution of articles and information on quality gives the journal a significant advantage if costs of stand-alone distribution (i) are high. In particular, the journal can be worse at filtering (ϕ^J versus ϕ) but still have a filtering advantage (as long as $\phi^J \geq \phi - i$).

- When communication costs are important a journal may also have a significant cost advantage in the filtering 'technology' as there will be obvious complementarities between receiving and processing articles for filtering and doing so for distribution. In this case $\phi^J > \phi$. Assuming a journal is at least as cost efficient a distribution mechanism as stand-alone distribution this implies that a Journal will always be used in preference to the stand-alone option.

Again this fits the historical record: once journals came into existence they performed filtering. Furthermore, if a journal offers significant distribution cost advantages (stand-alone distribution is costly) it is also probable that is has significant filtering advantages based both on the complementarity of distributing filtering information and articles and the complementarity of the filtering process and normal article distribution operation.

Lastly, it is important to note that there are other reasons to inter-link filtering and distribution than simple economies of scope. Naturally filtering providers may wish to assert exclusivity. This can be difficult to operate effectively without a Journal (one would need to be able to assert monopoly control over the selection list which might be difficult). However once filtering is associated with a Journal the matter is simple. Since the Journal obtains copyright over the articles contained therein the Journal is able to prevent anyone accessing those articles other than through the Journal.

4. Digitization and Filtering

We now wish to consider what happens with the advent of modern digital communication and computer technologies. In our model, this will equate to the cost of transmission,

and hence the cost of distribution, dropping to zero:[9]

$$c^J = i = 0$$

By removing 'distribution' from the equation this has the result of reducing the discussion to a comparison of selection (filtering) mechanisms.[10] In particular, in our case, a comparison of the stand-alone and journal models becomes a comparison of their filtering technologies: $f(q)$ and $f_J(q)$. As such, it is now important for us to go into more detail both about what these technologies involve and how they are affected by the institutional mechanisms of which they are part in which they operate (e.g. as part of a journal).

4.1. **Centralized and Distributed Filtering.** We begin by observing that, for scholarly information, a large part of filtering is provided directly by scholars themselves in the form of reviewing.[11] The need for filtering to be done by scholars themselves is obvious: it is only someone doing research who is able to judge the type and quality of another's work. Furthermore, this reviewing is considered sufficiently important to the community at large that it is frequently done for 'free'.[12] In this sense then, the creation of 'filtering' begins as a form of 'peer-production' across a distributed network (the scholarly community) utilizing the efficiencies arising from the clear complementarities between research and reviewing. However, as it stands, the system is ultimately a centralized one in that reviews are not publicly available but provided to, and solicited by, a journal, which then processes the information as it sees fit (usually non-transparently), and makes available filtering information only in the form of the journals decision to carry (or not) a particular article.

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[9]Of course many (perhaps most) journals still provide 'print' versions. However: a) such a facility is not essential to a journal and could always be provided separately b) we are concerned with the cheapest feasible options for communication c) the majority of communication in this area is now online (even if much material is then subsequently printed out).

[10]One could argue that there are still concerns about, for example, storage of material. However, while this is not costless it is relatively so cheap to provide as part of standard academic infrastructure that it is free for the community to use (cf. `http://arxiv.org/`, `http://repec.org`, the myriad of institutional repositories).

[11]Here we are subsuming reviewing within filtering. Clearly reviewing may also lead to the improvement of the quality of work and not just selection (as implied by the term 'filtering'). However the difference is not great and makes little difference to this analysis.

[12]Of course there are reasons that scholars review for free other than simple public-spiritedness. The ability to influence what is read and accepted in the community can be personally valuable (and can even, on occasion be abused). Similarly, especially for junior scholars, reviewing may be a necessary way to earn credit with their elders particularly on the more powerful journals and to ensure that their own work is considered.

Thus, in its present form, filtering, at least at the formal level,[13] is almost all journal based, and journal driven, and as such centralized.

There are, however, much more decentralized, or 'distributed', mechanisms available. In particular, 'reviewing'[14] could be made independent of journals and itself opened up (i.e. review information becomes public). With this basic information now available (rather than hidden behind the centralized filterer), a myriad of aggregation possibilities open up. For example, one could imagine the usage of the types of voting processes already used on Internet news sites such as Slashdot, Digg, and Reddit which allow for the simultaneous aggregation of large number of votes weighted by reliability/credibility metrics. Alternatively, individuals could utilize 'reviews' directly using their own weightings or decide to use the reviews and weightings of a specific group (what we term NotAJournals). These possibilities, together with a detailed description of how a distributed mechanism would work, are discussed at greater length in an appendix. Here, the key point we want to make is that the distributed model offers some major benefits relative to the traditional centralized journal one.[15]

First, it reduces information wastage. In a centralized system the filtering information reaching the community via journals is much coarser than that originally being produced in the form of reviews whereas in the decentralized system all that basic information is available to all.[16] Furthermore, the many 'reviews' produced outside of the journal system are not used – for example, scholars read, and form opinions on, a large amount of material in the course of their research yet in the current system there is little opportunity for that information to be used.[17]

Second, in a centralized, journal-based system, there is significant wastage of effort. This occurs because of duplication: the same article being processed by two (or more)

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[13]Of course we all use our personal experience to form opinions about what to read but this is an informal process seldom extending beyond ourselves, or at most, a small group of colleagues.

[14]We should emphasize that once considering more distributed mechanisms it is necessary to expand the concept of reviewing to include any expression of meaningful opinion be that a simple vote or detailed commentary.

[15]A useful analogy here is the contrast between centrally planned (or firm-based) versus market-based production. In a centrally planned system information (prices, capacities, demand) may be obtained from multiple sources but it is processed and disseminated centrally. In the market-based system this information is distributed throughout the market network.

[16]The Journal system does have different incentive effects on reviewers: quality decisions are anonymized to some extent which can help in soliciting honest appraisals (though it can also lead to abuse). However, a distributed system can also provide for anonymization if necessary – see below.

[17]Other than, one might argue, in the very crude form of citations.

different journals; and because of the administrative burden of managing the submission and reviewing process.[18]

Third, reviewing becomes a first-order, and more prestigious, activity with greater opportunity for specialization – at the present time, reviewing, is generally considered a very secondary activity, providing rather limited credit within the community.

Fourth, transparency is improved as there is now a clear separation of the reviewing and aggregation process. Fifth, and finally, it allows for competition and innovation in the aggregation (and reviewing) process. Entry as a filtering service is very easy and services are free to experiment with different algorithms, methods and types of reviews (and there is a pressure to improve provided by the users).[19]

Of all of these factors the most important, we think, are the first and last. These both deal with the information loss under a centralized model and imply significant efficiency gains from a distributed approach. Given the supposed attractiveness then, of the distributed approach, we must ask why the centralized journal model is currently dominant.

4.2. **The Existence and Persistence of the Closed, Centralized Model.** To understand the persistence of the 'closed', 'centralized' model recall that 'closed' journals necessarily tie distribution and filtering by asserting exclusive rights (using copyright) in the articles they carry. As discussed at the end of section 3.4, this tying is necessary because otherwise there would be no effective way to control access to their filtering service. This has a dramatic impact: without access to the underlying articles filtering is both less valuable (what good is knowing about an article if you cannot access it) and much harder to perform (how can one assess an article if one has not read it). Thus, by asserting exclusivity over articles, these 'closed' journals automatically and directly undermine any kind of distributed filtering scheme. One of the great benefits then of an 'open-access' approach, even if still in the form of a journal,[20] is that it does not do this. Open-access

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[18]This is not to say there would not be some costs of a similar kind in an alternative system but these would likely be significantly less – there would be no manuscript processing,

[19]Concrete examples, including such possibilities as using reviews of reviews, personal weightings, can be found in the appendix.

[20]It is important to note here that a large part of the 'open-access' effort is directed not at journals but simply at building institutional repositories wherein articles can be deposited and then made openly available. This is obviously perfectly compatible with the distributed approach – and in fact some kind of article repository is a clear prerequisite for the distributed filtering to function (see appendix).

journals therefore are compatible with distributed filtering approaches even if not directly supportive of them.[21]

This is only half of the explanation however. 'Closed' journals can prevent distributed filtering happening but why do they exist in the first place and continue to persist? The answer to the first part is provided by our work in the previous sections. When communication costs are high journals are highly attractive as distribution mechanisms. Furthermore, they will naturally evolve to provide filtering (and in any case distributed filtering would be entirely impractical without (almost) zero-cost digital communications). Thus, initially, journals are the only feasible mechanisms. However, as we discussed at the start of this section technology has changed so we come to the second part: why does the (closed) journal model persist in the digital environment?

The answer here too is simple: lock-in. As filterers, journals gradually evolve market-power because of the build-up of expectations on the two sides of its operations (authors and readers). Authors wish to submit to 'good' journals (with lots of readers) and readers want to access 'good' articles. Furthermore, the journal system is no longer simply about communication but also has complex inter-linkages with the mechanisms for reward and advancement within the academy. Since, expectations are persistent and once established are slow to change it is very hard to move away from the existing equilibrium – neither authors nor readers will wish to deviate unless convinced the other party will simultaneously do so (and authors, even those with a preference for open-access or distributed models, have the added pressure to submit to 'good' journals in and of themselves).[22] As a result, it is very hard to switch from a 'closed' journal model to an alternative – even if it offers significant advantages.[23]

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[21]The one obvious way an open-access *journal* detracts from the distributed model is that it obfuscates the reviewing information. However, this could at least be partially addressed by open-access publications giving reviewers the option to have their review made public (with the option for anonymization or redaction if requested).

[22]This kind of lock-in is standard to all indirect network effect (two-sided platform) models of which journals are a classic example. See on indirect network effects and two-sided platforms, Church et al. (2003); Nocke et al. (2007); Pollock (2009), on specific application to journals see McCabe and Snyder (2007); Jeon and Rochet (2007).

[23]In addition there are also some basic political economy considerations. The very existence of lock-in engenders market-power and, hence, at for-profit journals, very substantial profits. This in turn generates strong incentives for those organizations to preserve the current system. At the same time, the benefits from a distributed model would largely accrue to the scholarly community as a whole. That community, though large, is uncoordinated and some of its members, especially its more senior ones, already have a large investment in the existing system.

5. Conclusion

In this paper we set out the basic goals of the scholarly communication system. We compared the current, journal dominated system, against those goals and found it wanting, and explored in detail alternative options in which distribution and filtering are separated and centralized filtering is replaced by a distributed, decentralized approach.

Using a simple model we explored the factors underlying the development of the current journal paradigm. There were two main factors: a) the high costs of information transmission in the pre-digital era (and, associatedly, fixed costs and economies of scale in transmission which make journals an effective club good) b) the natural complementarity of filtering to distribution which leads journals to act as filtering as well as distributional mechanisms.

With the collapse of transmission costs in the era of the Internet these original rationales for journals have disappeared. It is now possible for distribution and filtering to be separate and for the development of richer, and more complex filtering models based on decentralized, distributed mechanisms – with this latter process dependent on the first (if distribution and filtering are tied – as in the traditional journal model – distributed mechanisms make little sense).

We explored the various benefits of such alternative distributed mechanisms – and also provide a detailed description of how such a mechanism would function in appendix A. One of the main implications of our work discussion is that a crucial benefit of the open-access approach, in addition to the obvious one of reducing the deadweight loss to access, is that it permits the development of radically new matching mechanisms based on a richer set of information which offer major efficiency (and other) advantages. This second benefit, though often overlooked, is a major one, and is, in the long run we believe, likely to be the most significant.

Unfortunately, it is hard for new approaches to take hold because of the lock-in to the traditional 'closed' journal model engendered by the mutual expectations of authors and readers. Given the potential benefits afforded by innovation in this area, it is crucial that the potential of new approaches be thoroughly considered so that the scholarly community can adequately assess the options and, if necessary, take collective action to achieve mutually beneficial change.

Appendix A. Distributed Filtering: A Proposal

Here we give a concrete proposal as to how a distributed filtering mechanism for scholarly information would function:

- All papers are uploaded to 'open' repositories from which free access is allowed. Each paper receives an identifier.

- All members of the community (or anyone in fact) are allocated identifiers by the Reviewing/Filtering network

- There exist Reviewing/Filtering servers where people can log on and make a 'review' of a paper. A review could consist of a single vote or a proper detailed critique.

- Review weighting and ranking. Given review weighting (and perhaps author ranking) one can produce a 'quality' value for each paper. The weighting system would be one of the most obvious places for innovation and competition to deliver efficiency improvements. We discuss this in more detail below but do mention one important aspect:

- Ranking and Reviewing/Filtering by groups (NotAJournals). One major innovation permitted is that one need not have one single ranking/weighting algorithm. Instead one could allow groups to form which supplied their own weights and ranking (most obviously they could have a weighting in which only reviews by the group mattered – this corresponds to a traditional journal).

A.1. **Reviews.** At its simplest a review is a 'vote' (this could either be discrete e.g. one of $1, 2, 3, 4, 5$ or it could continuous e.g. any number $\in [1, 5]$.)[24] However it can also include full commentary in the traditional manor. The more detailed this commentary the more valuable the review. Reviews could also be non-anonymous. Non-anonymous reviews could be given higher weight than a non-anonymous review.

A.2. **Ranking and Review Weighting.** As discussed already it is suggested that there could be many different ranking and weighting functions. However, it is still worth considering some of the general attractive properties. For example, weighting should probably be higher for non-anonymous reviews – though this weighting would be interacted with

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[24]We wish to explicitly using a range such as $[-1, 1]$ that contains zero as we wish to reserve that for the case where no rating has been provided.

the valency of the review with negative non-anonymous reviews getting a higher weighting than positive non-anonymous reviews. The weighting would be higher for detailed reviews than non-detailed reviews. Of course this may be difficult to implement in an automated way. To remedy this it might make sense to take the whole reviewing mechanism a step back and 'review' reviews. That is, just as scholars can vote on articles, they can vote on reviews of articles. These reviews of reviews would then used to generate (or alter) the weighting system for reviewers and hence of reviews. Users would not be confined to using the default weighting system but could design their own. This issue is considered in the next section.

A.3. **NotAJournals.** A given user could decide that they only care about non-anonymous reviews provided by a particular group of people – this would correspond to a weighting of zero for the rest of the reviewing population. Extending this it is natural for groups to develop to review in particular areas. Members of such a group would review particular sets of articles (with efforts to ensure that each article gets reviewed by at least several members of the group). At the same time the group could make available a weight-set corresponding exactly to that group as well as a selected articles set – members of the group likely also review outside of the area of this group and so a weight-set is not sufficient information to permit others to just get the group's set of recommended articles. The group would thus be making available a particularly set of reviewed articles. In this sense the group would function, at least on the filtering side of things, much like a traditional journal. However they would not have exclusivity over the articles. For this reason we have christened them **NotAJournals.**[25]

A.4. **Formal Mechanism.** Formally we could describe the system as consisting of scholars s_i $(i = 1, 2, ...)$, articles a_j, reviews by scholar of articles r_{ij} (note that a review and just be a single number of could be considered as a tuple of rating plus other attributes such as comments). A weight-set is then a tuple of weights $\{w_i\}$ together with a review evaluation function f (which is a function of the computable attributes of the review, the

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[25]This name, to our knowledge, was originally coined by David Levine who started his NAJ Economics in 2001.

article and the scholar). A overall weight function is then:

$$W(a_j) = \sum_i w_i f(r_{ij}, a_j)$$

Some examples:

- Simplest linear case. The only attributes of the review are a rating which with simple linear weighting would give:

$$W(a_j) = \sum w_i r_{ij}$$

- Give value for detailed comments, so r_{ij} is a tuple consisting of 'numeric' rating plus indicator of whether review was detailed or not.
- Limiting to only caring about reviews from reviewers with expertise in that area etc. This is similar to first example but where w_i are set to 0 for all reviewers without expertise.

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