Opening Access to Research

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Abstract

Traditionally, the scholarly journal market operates so that research institutions are charged high prices and the wider public is often excluded altogether, while authors can usually publish for free and commercial publishers enjoy high profits. Two forms of open access regulation can mitigate these problems: (i) authors are required to publish in a journal which allows readers free and immediate access to their article, or (ii) authors are required to make freely available an inferior substitute to the published paper (and to publish in a journal which permits this). The former policy is likely to result in authors paying to publish, which may lead to a reduction in the quantity of published papers and may make authors less willing to publish in selective journals. The latter policy makes freely available only an inferior version of the published article, but may be consistent with authors publishing for free.

Keywords: publishing, journals, open access, two-sided markets, regulation.

A frequent claim is that many publishers charge readers too much to subscribe to their scholarly journals. High prices have an adverse impact on both distributional and efficiency aims. Even if libraries are just willing to pay them, high subscription charges have a welfare cost if a dollar of library budget is worth more than a dollar of publisher profit, as is plausibly the case when libraries are financed out of public funds.[1] It is inefficient to exclude interested readers when it costs nothing to serve them. It may also be costly in political terms to exclude readers, if those who ultimately pay for public research are denied access to its final product.

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[1] As House of Commons (2004, page 5) put it: "There is mounting concern that the financial benefits from the Government's substantial investment in research are being diverted to an excessive degree into the pockets of publishers' shareholders."

In broad terms, this paper argues that these concerns are valid and judicious policy intervention in the journal market is worthwhile.[2] There are a variety of forms of open access. When a journal article is freely available to all readers at the time of publication, this is usually termed "gold" open access. If an author posts her own version of the paper online (and publishes in a journal which permits this), this is "green" open access. Another variant has the journal article freely available but only after an embargo period, sometimes known as "delayed" open access.[3] An open access policy requires designated authors—for instance, those whose research was publicly funded—to make their research open access in a specified form.

In broad terms, journals are funded in one of two ways. The traditional subscription journal sells its content to readers (usually libraries in universities and research institutions). For instance, the journal *Small* has online institutional subscription for 2015 in the USA for the sizable sum of $5256.[4] Subscription journals often allow authors to publish their work without charge, so that authors have free access to a journal's readers. An open access journal, by contrast, makes its content free to readers at the time of publication. Such journals usually cover their costs by charging authors to publish their work.[5] Thus, anyone can read the article "Jealousy in dogs" in *PLOS ONE* for free, but its authors have paid $1350 to publish there.

[2]Scholarly books are different from journals in a number of respects. For instance, authors are paid to publish (royalty rates of between five and fifteen percent are common), and so have more at stake in making readers pay for access. Relatedly, profits from book sales are in large part passed back to authors, and so stay "in the system" rather than being extracted by external publishers. Hard copy distribution is still dominant, and prices for books have not risen nearly as fast as prices for journals. Policy-makers at present do not usually require open access for scholarly books, although this may change as electronic dissemination of books becomes widespread.

[3]Willinsky (2006, Appendix A) lists ten kinds of open access, which includes situations where the print edition of a journal is paid for while its online edition is free, or when the journal is available for free in poorer countries. Another form of "partial" open access is when an article appears in a subscription journal which is cheap but not free. However, many proponents of open access do not allow any element of delay or price (no matter how short or how low) to count as true open access.

[4]The Association of Research Libraries (2006, Table 2) reports that the median library in the association spent about $6 million on journal subscriptions in 2005.

[5]A number of journals currently have neither subscription charges nor publication fees. Presumably, these journals operate with funding from institutions or charities, and/or by editors and reviewers donating their time. An extreme case was the old *Bell Journal of Economics*, which between 1970 and 1981 offered its content for free to anyone who asked (and this was in the days before electronic dissemination, when it was costly to supply a hard copy to a reader) and paid its authors a substantial fee for publication. The journal's funder, *Bell Labs*, evidently felt it was worthwhile to spend money to attract good papers and to disseminate those papers to the widest audience.

Clearly, there are funding models intermediate between these extremes. Some journals allow delayed open access, where content becomes freely available after an embargo, and charge readers only if they want immediate access. The two most cited journals in the world in 2009[6], *Journal of Biological Chemistry* and *Proceedings of the National Academy of Sciences*, follow this policy (with respective embargoes of twelve months and six months).[7] Journals are collections of articles, some of which could be author-funded and others reader-funded. A "hybrid" journal sells some content to subscribers, but offers its authors an option to pay to make their article open access. Thus, the *Economic Journal* currently has online institutional subscription in the UK for £477, and authors can make their article free to readers by paying £1500.

In the next section, I discuss the journal market in more detail. I discuss how modern technology has reduced journal costs, and helped to boost revenue, so that publisher profits have risen in recent years. I also discuss how the internet acts to disintermediate the interaction between authors and readers. Authors can post their work online, which can be freely accessed by readers using general search tools. Author reputations are increasingly determined by citations as well as where they publish, and readers can use online metrics (citations, downloads, and so on) to guide them to the most important research. As a result, a journal's traditional roles—to disseminate and to certify the importance of research—may be less important now. Section 2 discusses some of the main pros and cons of open access policies, building on a pair of theoretical models which are presented in detail in an appendix in section 5. Section 3 provides a brief history of open access in publishing, including recent policy to widen access to scholarly work in the UK. Section 4 summarises the main arguments concerning the various forms of policy intervention, and suggests that in the near term most of the benefits of open access can be obtained with a partial open access policy, which avoids the disruption that a gold policy with expensive author fees is likely to bring.

[6] See archive.sciencewatch.com/dr/sci/09/aug2-09_2.

[7] The journal *Microbiology of the Cell* currently has an embargo period of just two months before its own content is made freely available, and supplements its subscription revenue by charging authors as well.

1 Traditional Journals and their Alternatives

1.1 The purpose of a journal

Traditional journals provide a number of benefits to their authors and readers, including: (i) preparing the definitive typeset version of a paper; (ii) certifying a paper's quality via the journal's reputation for selectivity; (iii) improving the original manuscript by suggestions from reviewers and editors, and (iv) distributing the published paper to those (and only those) permitted to read it.

Task (i) is useful for readers, and necessary for fellow researchers who need to cite the paper accurately. In the era when authors prepared manuscripts on typewriters, typesetting by publishers was a valuable improvement to the appearance of the paper, especially for technical material. Nowadays, though, word processing software allows authors to prepare clean copy on their own computer, and typesetting by publishers provides less value-added. It remains useful, however, for a reader to know she has the very final version of a paper.

Task (ii) is important to both authors and readers. Traditionally, an author attempts to place her article in the most discriminating journal willing to accept it. As a result, a journal provides a signal of the article's quality, which is important for authors, who benefit from being seen to be able to publish in a top journal, and to potential readers who are guided to the most worthwhile work. Even if they do not have a subscription to the published paper itself, readers have "open access" to the journal's certification service, since it is easy to discover the host journal via an author's CV, journal homepages and the like.

Fellow researchers in an author's field will often have a good idea of her skills, regardless of where her work appears. However, an author cares about her reputation more widely than this. For instance, decisions about salary, tenure, job offers, research grants, and the Nobel Prize are made by people outside this inner circle, who will rely more on external cues such as where the author has published. Moreover, even researchers in the same field may not know of the author, especially if she is located in a "peripheral" department, and placing a good paper in a good journal may be a way to advertise her entry to the field. All in all, many authors would happily pay a good deal of their own money to place an article in a prestigious journal.

The journal in which a paper appears is an important guide also to potential readers. A reader cannot judge how good a paper is until she reads it, so that a paper is an "experience good". Given that reading a paper involves a sunk cost, a reader benefits from *ex ante* information about a paper's quality before deciding to read. In the pre-internet era, searching for useful papers was a hit-and-miss affair, and as a form of triage it was often efficient for a busy researcher to confine her search to a small number of elite and specialist journals. For this reason, being published in a prominent journal helped boost a paper's readership, even among those readers *able* to access most journals at their institution.

The internet provides additional cues about a paper's likely quality. Data about the number of papers which cite a particular article are freely available on scholarly search engines such as *Google scholar*, and these are arguably as good a signal of quality as the host journal's reputation for selectivity once some time has passed.[8] After all, the decision to publish a paper in a journal is typically made by an editor and couple of referees, while a well-cited paper has some kind of approval from many readers.[9] To the extent that the "wisdom of crowds" can certify a paper's quality, the certification role of journals becomes less necessary.

Citation data increasingly play a role in hiring and promotion decisions, and a well-cited paper in a mediocre journal nowadays carries much weight in committees. It is even possible that journal editors use the number of citations a submitted paper has garnered as a working paper to influence their decision whether to accept. Readers as well as employers can use citation and download data on the internet as a guide to likely quality. A good paper which, for whatever reason, failed to appear in a good journal now has a better chance of being picked up by subsequent researchers, if they find it listed high up in the *Google scholar* search results page. There appears to be a trend that the fraction of the

[8] There has been citation data available long before *Google scholar*, for instance on *Web of Science.* However, the former has a number of advantages, including ease of use, the fact it includes working papers and other non-journal material as well as published articles, and the fact that it is currently free. (Institutional subscription costs for *Web of Science* are non-trivial. Cornell University reports it pays $155,000 per year for access—see John Bohannon, "Google scholar wins raves–but can it be trusted?", *Science* 343, page 14, January 2014.)

[9] Moreover, Welch (2014) reports that referees' recommendations are not strongly correlated. He obtained anonymized data from eight prominent economics and finance journals He found that the unconditional probability a referee was positive about a paper was 31%, while if the other referee was positive the conditional probability rose only slightly to 34%.

most-cited articles which appear in the most-cited journals is decreasing.[10] Of course, though, journals will continue to play an important role in determining a paper's impact. For instance, being published in a prestigious journal may generate the early citations, and this early advantage is amplified when later researchers use citations to guide their choice of reading.[11]

A recent development is the entry of so-called "mega" journals (also known as "repository" journals), mostly in the science area. These journals have very broad scope in terms of subject matter, with peer-review policies markedly less stringent, and less costly, than those of a traditional selective journal. The most successful of these is *PLOS ONE*, whose editorial policy states: "Too often a journal's decision to publish a paper is dominated by what the editor/s think is interesting and will gain greater readership — both of which are subjective judgements and lead to decisions which are frustrating and delay the publication of your work. *PLOS ONE* will rigorously peer-review your submissions and publish all papers that are judged to be technically sound. Judgements about the importance of any particular paper are then made after publication by the readership (who are the most qualified to determine what is of interest to them)." This journal currently accepts about 70% of submissions, has a respectable impact factor of 3.73 for 2013, and in 2012 it published 23,464 articles, making it probably the largest journal in the world.[12]

Publishing in a mega-journal is a strategy intermediate between publishing in a traditional selective journal and just posting a working paper on the internet. Readers know they have the definitive version of the paper, and with the modest degree of quality control

[10] For instance, Acharya *et al.* (2014) document with *Google scholar* metrics that the number of the top-1000 most cited articles in a variety of broad subject areas which were published in the top-10 most cited journals has, on average, fallen from 851 to 755 between 1995 and 2013. However, one reason for this trend may be that papers have become longer in recent years, and there are fewer papers now published in the top-10 journals.

[11] More generally, in situations with "observational learning"—where an agent is more likely to choose what earlier agents have been seen to choose—early advantages matter a lot, and there is a danger of inefficient herding. Just as people only reading novels on the best-seller list or diners choosing to eat only in crowded restaurants may lead to desirable options being ignored, so might easy access to citation and download data lead to undue focus on a few articles fortunate to gain early prominence. See Bikhchandani, Hirshleifer and Welch (1992) for a model in which agents ignore their own signal of the quality of an option if they see enough earlier agents have made the opposite choice, with the result that a good option may be inefficiently ignored.

[12] See *www.plosone.org/static/information* (accessed 26 February 2014). The journal reports download statistics, reader comments, media coverage and social media "shares" for each of its articles, which help to signal likely quality.

they can be fairly confident that there is nothing "wrong" or duplicative about the paper before they decide whether to read it. Mega-journals also provide efficiency gains in terms of refereeing effort. Since a reasonable paper is likely to be accepted at such a journal, it will be refereed just once. Historically, by contrast, an author would often work her way through journals of decreasing prestige until one agreed to publish her paper, generating a new set of referee comments at each stage.[13] The fact that a paper is more likely to be accepted at the first attempt also means that it is published more quickly than when the author submits sequentially to several journals, which is obviously of benefit to readers. In practice, mega-journals are open access, though one can also imagine a subscription journal having an editorial policy similar to *PLOS ONE*'s.[14]

Some journals do not supply credible certification services at all. There is a market for "vanity" publishing, and many journals will publish almost anything—including plagiarised or self-plagiarised work—in return for a fee from the author. These journals often market themselves as "open access", although they have minimal readership and could not generate much subscription revenue if they tried. Dishonest, desperate, or inexperienced authors are willing to pay to have a plausible publication on their CV which would not get through a peer-review process.[15] (The model in section 5.2 describes an unregulated journal market which has reputable subscription journals and worthless author-pays journals coexisting.)

Task (iii) is not unanimously viewed as a benefit by either authors or readers. In many subject areas the revision process has become increasingly costly for authors, both in terms of time and effort. Ellison (2002a) reports that several decades ago the typical time from submission to acceptance in top economics journals was just a few months, and requests for substantive revisions were rare. In 1999, though, the average time from submission to

[13] In addition, one of the motivating examples in Bikhchandani *et al.* (1992) was sequential refereeing: a referee who knows that the paper was previously rejected elsewhere might be inclined to reject even if she has a positive view of the paper.

[14] A major reason is probably that mega-journals are *new* journals, and most new journals have to be open access to succeed. Because of tight library budgets, a library's margin is usually to decide which journals to cancel rather than which subscription journals to add.

[15] See Beall (2012) for more details. (Beall currently maintains a list of dubious journals on his webpage.) Bohannon (2013) reports the outcome of an interesting investigation. He concocted a flawed paper about a new cancer treatment, which he plausibly suggests would not be passed by a credible peer-review process, sent the paper under a variety of assumed names to 304 open access journals. The paper was accepted by 157 (including journals published by Elsevier, Kluwer and Sage), rejected by 98, while the remaining 49 had not responded by the time the investigation went to press.

acceptance in most top economics journals was two years, plus another wait for publication itself. (If the author has to submit her paper to more than one journal, the delay stretches on further still.) Alongside this, published papers have become longer, and now have lengthy introductions, various extensions of the basic model, and cite more papers.[16] While this process of revisions is costly for authors, it is also costly for readers who want timely access to the latest published research, even if there is free and immediate access to the work when eventually published. While the revision process sometimes improves a paper, especially one submitted from an inexperienced author, a good case can be made that the process has got out of hand. The mega-journals discussed above are a natural vehicle for authors who wish to publish in outlets which allow them to present their work to readers as they see fit and without undue delay. However, there is no reason why a more selective journal could not also follow something like a "limited revisions" policy.[17]

Task (iv) is most directly relevant to the open access debate. Authors typically put a lot of weight on the size and composition of their readership, in order to generate career-enhancing citations and generally increase their visibility. However, while they care about reaching their peers (who are the only readers likely to generate citations), authors plausibly care less about reaching the "wider public" and would be unwilling to pay a substantial publication fee out of their own pocket or limited research funds to do so.[18]

Nevertheless, there are benefits to the wider public gaining timely access to scholarly

[16] Some of this extra length might be because over time the related literature can become larger and more complex. Ellison (2002b, Tables 1 and 2) documents similar trends in other subjects. Although the direction of the trend is similar in most subjects, in many science journals the timescale from submission to acceptance is vastly shorter relative to that in economics. McAfee (2010, page 5) writes: "we have transformed the business of refereeing from the evaluation of contributions with a little grammatical help into an elaborate system of glacier-paced anonymous co-authorship."

[17] See McAfee (2010) for an account of one economics journal's policy to offer authors the option that their paper would either be accepted or rejected as is, without possibility of substantial revision. (This option was requested by 35% of submitting authors.)

[18] House of Commons (2004, page 9) quotes the UK's Royal Society of Chemistry as saying "most authors care where their work is seen and who it is seen by far more than they care about how many people have seen it." Of course, there are many potential subscribers who are intermediate between large research libraries and the wider public. Smaller, or less research-focussed, institutions may be unable or unwilling to pay the high subscriptions asked by publishers. Excluding these institutions is likely to harm authors in terms of lost citations, and likely to cause more harm to these readers than excluding a member of the wider public. Strieb and Blixrud (2013) report the take up of journals by research libraries in North America. While in 2012 almost all (96%) libraries subscribed to some collection of Wiley journals, only 19% obtained its complete set. (The respective figures for Elsevier are 92% and 23%.)

material.[19] For example, a provincial lawyer might learn about relevant case law, journalists write better-informed articles, or history teachers in schools give better classes. Amateur astronomers benefit from access to journals, and in turn contribute to science themselves. Small-scale innovators find it useful to consult scholarly material but cannot afford to pay much for it.[20] Probably the scholarly topic of widest interest to the public is health and medicine, and millions every day search online for up-to-date information in this area.[21]

Not surprisingly, putting content behind a pay-wall does appear to make a significant difference to readership (as proxied by the number of downloads), but less so for citations. Davis (2011) secured the agreement of 36 subscription journals to select randomly about one-quarter of their articles for open access treatment. He found that during the first year after publication, the open access articles were downloaded more (115% more for HTML downloads and 62% more for pdf downloads) than their subscription counterparts, and accessed by 31% more unique visitors. However, he found no significant difference in citation rates for the three years after publication for the two groups. He interprets these results as consistent with readers of scholarly work falling into two groups: those who work in research universities, who provide most of the citations and have access to most journals in any event, and others who consume but rarely contribute to the corpus.[22]

As with task (ii), task (iv) can often be bypassed by authors and readers by means of the internet. An author can post ("self-archive") a version of her paper on a public

[19] See Willinsky (2006, chapter 8) and Suber (2012, section 5.5) for a more detailed discussion.

[20] Houghton *et al.* (2011) conducted interviews with 23 smaller research-oriented businesses in Denmark. Some of these businesses subscribe to the most relevant journals, most regularly consult open access material on the internet (in repositories or in open access journals), and some ask contacts in universities to provide them with content. Most report difficulties gaining access to recent research.

[21] Some try to use the public's interest in heath as an argument *against* open access. House of Commons (2004, page 25) quotes a representative of Wiley as saying "this rather enticing statement that everybody should be able to see everything could lead to chaos. Speak to people in the medical profession, and they will say the last thing they want are people who may have illnesses reading this information, marching into surgeries and asking things."

[22] There is now a huge literature looking at the interaction between ease of access and download/citation rates—see the long footnote 6 in Suber (2012, page 178). A problem throughout is how to isolate the effect of opening access *per se* on subsequent readership. For example, older studies found a large impact on citations from having an article in an open access journal or repository, but this might be due to authors putting their best work in such journals. In the study cited, it is possible that readers mistakenly took the label "open access" as a signal that such papers were particularly good (for instance, because only highly-regarded scholars had research funds to pay for open access). In addition, it is possible that readers who were put off by subscription charges went on to download a self-archived version from elsewhere, so that total downloads from all sources was not so different for the two groups of article.

website, such as her own webpage, her institution's or funding body's repository, or a subject-specific repository.[23] Even if these various websites are not prominent themselves, search tools such as *Google scholar* enable easy location of works by specific authors, titles or topics. Different versions of a published paper which might be self-archived are the "pre-submitted" (or "working paper" or "preprint") version, the "accepted" (or "postprint") version which incorporates reviewer comments but which is still the author's own version in terms of formatting, and the final published version as typeset by the journal.

Of course, an author is always permitted to post a working paper on a webpage before she submits to a journal. (Authors have copyright until they assign it to someone else.) However, many prominent medical journals use the so-called Ingelfinger Rule, and will not consider a paper for publication if it has previously been posted on the internet, which severely deters preliminary circulation of papers.[24] Unless the article is published with open access (either in an open access journal or in a hybrid journal where the author had paid to make the paper open access), a journal will rarely allow an author to post its own version immediately on a public webpage. Whether the author's own version of the accepted paper can immediately be self-archived varies widely from publisher to publisher and over time. If the accepted version is self-archived at the same time as publication (or even before publication), the benefits of task (iii) are freely enjoyed by readers and there is *de facto* open access for readers. A reader can check the likely quality of a paper by discovering which journal it appears in and go on to read the near-identical free version online, much as a consumer gets product advice in a bricks-and-mortar store and goes on to buy the product more cheaply online. In such cases, readers who choose to pay for the published version do so in large part for the limited aesthetic benefits of task (i) and the peace of mind that one is reading the very final version.

Despite the danger of cannibalizing their subscription revenues, traditional subscription journals have an incentive to permit a degree of self-archiving (or alternatively, to make their own content freely available after some delay).[25] This is because this helps to attract

[23] In fact, some subject repositories do charge readers for access. In economics, this is currently the case with NBER and CEPR working papers.

[24] Franz Ingelfinger was the editor of the *New England Journal of Medicine* who formalized this policy in 1969, in part to maximize the "newsworthiness" of articles at the time of publication and in part to limit the circulation of medical research before it has been peer-reviewed.

[25] Self-archiving can be done with or without permission from the journal. Indeed, authors have an

authors and also because wider readership will boost citations and impact factors, which in turn helps publishers market their journals to libraries.[26] Conceivably, the author's version and the publisher's version might even be complements, if a reader "samples" the author's version for free and if she likes it she goes on to read the published version.[27]

While publishers often permit self-archiving, it is quite another matter for authors voluntarily to do so. Self-archiving involves a modest cost of time and effort to the author (especially the first time it is done), and if an author believes that her article is disseminated to her desired audience by the journal anyway, she may not view the task as worthwhile. Economics is something of an outlier, along with mathematics, physics and computer science, in having a widespread "working paper culture", and this is one reason why discussions about open access are more muted in economics than in other subjects. Presumably, one reason why economists are more likely to self-archive is the long delay in publishing in their journals, as discussed earlier.[28]

1.2 The cost and revenue of a journal

These tasks cost money. Indeed, in the past even the most prestigious journals had difficulty making ends meet.[29] Throughout much of the last century, journals in scientific disciplines

incentive to be "careless" about their copyright obligations, since they do not receive the subscription income and illegal distribution will boost their visibility and citations. Many economists appear to post the journal article itself on their own webpage, in most cases in conflict with the copyright agreement made with the publisher. A grey area is what counts as the "accepted version" of a paper. If a journal stipulates that the accepted version can be self-archived only after 24 months embargo, an author in practice might immediately self-archive a version which is in essence the final version minus some minor revisions which are immaterial to the reader.

[26] For similar reasons, suppliers of music, movies or software may be prepared to tolerate a degree of piracy. In markets with network effects, for instance, allowing some piracy to occur causes a firm to expand its base of users, which enables it to charge more to legitimate buyers. See Peitz and Waelbroeck (2006) for a survey of this literature.

[27] Finch *et al.* (2012, para. 7.67) reports evidence that "providing access to articles via repositories with high-quality metadata may lead to a marginal increase in downloads from the publisher's site". Suber (2012, section 5.3) discusses the complementarity between electronic and hard-copy book formats.

[28] Bergstrom and Lavaty (2007) investigate a number of economics journals to discover the proportion of published papers which were freely available online in some form. They find that the proportion tends to fall off for less prestigious journals, but for the top 15 journals about 90% of articles were available as working paper versions (though not necessarily the accepted version). They find less propensity to self-archive in political science, where only 30% of published articles at that time were freely available.

[29] Berg (1971, p. 799) writes that in "the 1880s, university subsidies and voluntary labor were essential to the financial viability of the *Quarterly Journal of Economics* and the *Journal of Political Economy*."

levied charges on *both* sides of the market to boost their revenues.[30] However, changes in technology mean that important aspects of costs have fallen dramatically in recent years, while a journal's ability to generate revenue has grown.

It is now essentially costless to distribute journal articles to additional readers over the internet, while before publishers had to print and send hard copies. Likewise, a library's storage costs for electronic journals is zero. Electronic distribution is now the dominant way for readers in developed countries, and increasingly in poorer countries, to access journal articles. Editorial software is nowadays cheaply available, which reduces the costs of managing the submission and peer-review process (perhaps removing the need for a secretary and office premises).[31] Word processing software means that most authors can prepare their own documents in a professional manner, which could reduce a journal's typesetting costs.

As discussed in more detail in section 2, the monopoly nature of each article enables a subscription journal to set high prices to readers which need not be related to underlying costs, and this was true even before the internet. The entry of commercial publishers into the journal market during the second half of the last century has led to a greater focus on profits, and less squeamishness in generating those profits.[32] Since it costs nothing to supply electronic journals to additional readers, a commercial publisher's ideal outcome is to serve all readers and to fully extract each reader's surplus from its journals, the strategy known as "first degree" price discrimination. Such a strategy not only yields maximum revenue to the publisher from its readers, but achieves the maximum audience for its authors.

While this outcome cannot be perfectly achieved, publishers often get close. A publisher can condition its subscription charge on the size and nature of the institution it supplies

[30] In the context of the model in section 5.1, this situation corresponds to the case where expression (2) is not satisfied. Barton (1963) reports how the *Physical Review* faced financial difficulties in the 1920s. ("Dues and subscription rates had been increased, but this process could not be continued [...] without risking so great a decline in members and subscribers that the total income would be reduced rather than raised.") As a result, in 1930 the journal introduced an author per-page charge of $2. In subsequent decades, the practice was followed by several other journals in physics, chemistry and biology.

[31] For instance, the licence for Editorial Express, journal management software used by many journals in the social sciences, costs just $2000 per year. (See *editorialexpress.com*, visited 20 March 2014.)

[32] Dewatripont *et al.* (2006) document how journal prices were rising faster than book prices in the pre-internet era, and argue this may be due to the increased share of journals owned by commercial publishers.

or the wealth of the country. Electronic distribution means that a publisher can monitor download activity, which helps it finely tune its prices to institutions over time. Electronic distribution also makes it easy for publishers to bundle their journals into a collection which they sell as a package to libraries. For the same reason that a diversified portfolio has a more predictable return to investors, a publisher is better able to predict a library's willingness-to-pay for a large collection of journals than for any individual title. As such, a publisher with many journals is better able to extract a library's surplus from the collection without much risk of the library cancelling its subscription. The result of all this price discrimination is that libraries' budgets are squeezed, but more journals are available in libraries than ever before.[33]

One necessary input for a journal does *not* cost it anything, and that is the paper itself. Since the birth of scientific publishing, the norm is not to pay authors for their articles, although it is not precisely clear from where this norm arises or why it persists.[34] (Perhaps if one journal breaks rank and offers to pay authors to publish, it would attract a disproportionate fraction of duplicative or low quality work from authors?) Because journals do not pay authors for their work, the revenues from selling subscriptions to libraries are not passed back to authors but retained as super-normal profits. Commercial publishers can indeed be highly profitable. Reed-Elsevier's *2013 Annual Report* (page 12) shows that its "scientific, technical and medical" division made profit of £826m on revenues of £2126m, a margin of 39%.[35]

A journal's cost per article published will vary substantially, depending on how selective the journal is. Some time ago, House of Commons (2004, page 74) reported that Wiley

[33] Association of Research Libraries (2006, Graph 2) shows that in the period 1986-2004, their member libraries' expenditure on journals rose by more than 300%, while the average number of journals available in a library rose by 42%. Bergstrom *et al.* (2014) reveal, via freedom of information requests, some of the prices charged by publishers for their bundles of journals, which vary widely from institution to institution. (For example, they find that the average research-intensive library pays about $1.2 million for Elsevier's collection.)

[34] This is not to say that authors are not financially rewarded when they publish, only that the payment does not come from the publisher. Shao and Shen (2011, Table 1) describe an incentive scheme at Zhejiang University in China which rewards authors according to an explicit scheme based on the impact factor of the journal. (For instance, the lead author of a paper in *Nature* or *Science* would receive 200,000 RMB, the current equivalent of about £20,000.) More common is an implicit incentive scheme, where scholars who publish well get promoted or offered better jobs.

[35] Page 14 of the *Annual Report* says there were about 700 million downloads in the year, so that its average revenue per download was around £3.

suggested $1500 would be the lowest cost per article, and its more selective journals would have higher costs than this. *Nature* suggested that its cost per article was in the range $10,000 to $30,000 because of its 90% rejection rate. Author fees at open access journals provide some guide to the cost of publishing an article; these fees at the various PLOS journals currently vary between $1350 for the *PLOS ONE* mega-journal and $2900 for the highly selective *PLOS Biology*.

It is something of a puzzle why more journals, especially very selective journals, do not use non-refundable submission fees to deter speculative submissions which stand little chance of eventual success and which apparently are so costly to process. If submitting is free, even an author who believes it is unlikely her article will be accepted may try her luck with an elite journal. If a submission fee is imposed, the pool of submissions will be tilted towards papers which are more likely to be accepted, and so reduce the journal's costs per article published.[36] Relatedly, the long process of extensive revisions discussed in the previous section is presumably costly, and a move towards pure certification rather than "referee co-authorship" will reduce journal costs, as well as provide other efficiency gains.

2 Some Pros and Cons of Open Access

Like several other problematic markets the journal market is an instance of what I have elsewhere termed a "competitive bottleneck".[37] Authors provide content to interested readers, and gain exposure and citations by being read, and journals traditionally mediate much of the interaction between the two sides. However, there is an important asymmetry between authors and readers, which is that the peer-review process usually ensures an article is only published in a single journal and is strongly differentiated from other published articles.[38] Each published article thus constitutes a mini-monopoly, and a journal enjoys

[36] See section 3 of the 2004 Wellcome Trust report on *Costs and business models in scientific research publishing* for further discussion of this point.

[37] See Armstrong (2002, section 3.1, and 2006, section 5), as well as Rysman (2009) for an overview of two-sided markets.

[38] This asymmetry is masked in theoretical models of publishing with just a single journal. In the jargon of two-sided markets, authors "single-home", while readers must "multi-home" (i.e., have access to several journals) if they wish to see a range of content. The peer-review process also forces authors to cite relevant articles, which drives up demand—by authors—for access to published work.

market power in providing access by readers to its articles.[39] For this reason, a journal is able to set high subscription charges which bear little relation to its cost of running a journal, and to use some of the resulting profits to offer free service to authors.[40]

As mentioned earlier, an important feature of the journal market is that publishers do not usually pay authors for their work. As a result, the most generous deal a publisher can offer is that an author can publish for free. Since authors are not paid, the large revenues from selling subscriptions to institutions are not easily dissipated and commercial publishers can enjoy super-normal profits. From this perspective, high subscription fees and excess publisher profits are due mostly to the monopoly nature of each individual article, not to some more aggregate measure of concentration in the journal market.[41]

Other markets with similar features include credit cards (which consumers can often use for free if they pay in full each month, while merchants pay high fees on each transaction), shopping malls (which consumers can enter for free, while retailers pay high rents for access to these consumers), search engines (where people can search for free, but advertisers pay high prices to appear prominently in their search results), and call termination on telephone networks.[42] In most of these markets, there is a constraint that the side which is treated

[39] As it was put in the opening editorial to the open access journal *PLOS Biology* (Brown *et al.* (2003, page 2)): "each journal has a monopoly on a resource vital to scientists–the unique collection of articles it has published. Anyone who depends on the information in a specific article has no choice but to pay whatever price the publisher asks."

[40] This pattern of cross-subsidy would be reversed in an alternative world in which readers each subscribed to a single journal, and authors had to place their work in multiple journals in order to reach a large readership. In that world, readers would be courted by journals, and authors pay high fees for access to the captive readers. This alternative situation is akin to the newspaper market, where most people read a single newspaper, and advertisers have to place their advert in multiple outlets to reach the desired number of eyeballs.

[41] However, having a portfolio of many journals may help a publisher obtain yet higher profits, due to its ability to engage in bundling. Dewatripont *et al.* (2006, Table 3) reports market shares in terms of citations received for the major publishers. In a few subject areas (chemistry, engineering) there is significant concentration, but otherwise concentration does not seem extreme.

[42] Consider this last market in its parallels with journal publishing in more detail. People usually subscribe to a single mobile telephone network (just as an author publishes her article in one journal), and anyone who wishes to call a particular subscriber has to pay whatever "termination charge" is demanded by that subscriber's network (just as anyone who wishes to read a published article has to pay what that journal demands). Telephone subscribers may care about the volume of calls they receive (just as authors care about the size of their readership), which will induce their network to temper high prices for call termination somewhat. Without regulation, revenues from call termination in a competitive market are passed back to subscribers in the form of a subsidized or free handset (just as profits from readers fund free publishing for authors).

generously cannot actually be *paid*, although the reasons for this constraint seem easier to grasp than why authors cannot be paid by journals.

A model of an unregulated publishing market with these elements is presented in detail in section 5.1. While that model allows for an elastic supply of authors and readers, its essence is captured in the following simple example. Imagine first a world without journals. Author A obtains a benefit of \$10 when reader R sees her article, while R gains benefit \$10 from reading A's article. It costs A some small but positive amount to deliver the article to R (say, the effort of posting the article online), and so she is willing to do this. The joint surplus from this exchange, which involves no monetary transfer, is therefore about \$20. Now introduce a journal J, who offers to deliver the article to R without charge to A, an offer A accepts as it reduces her own costs of delivery. J then can charge R a fee of \$10 to gain access to A's article. The combined surplus of A and R falls from about \$20 to \$10 (all of which is enjoyed by A), the difference being siphoned off by J.[43] While in this simple example overall efficiency is not affected by the journal's pricing, more generally high prices set by journals will inefficiently reduce readership.

A gold open access regime, in which regulated authors must publish in journals which make their articles freely available at the time of publication, entirely overcomes the problem of monopoly pricing by journals. Journals would then usually have to cover their running costs by charging regulated authors a fee to publish their paper. Like more familiar "one-sided" markets, journals would then compete for custom from authors in terms of publication fee, quality of articles accepted, turnaround time, value-added from the refereeing process, and so on, and there is a greater chance that only normal profits would be observed.[44]

[43] Suppose that journals can pay A for her article. If there were several journals competing for A's article, each with the same small cost for delivering the article to R, competition forces them to offer the maximum payment compatible with breaking even, which involves a payment to A of just under \$10. Journal profits are zero, and the joint surplus of A and R remains unchanged at the pre-journal level of about \$20, although now the author enjoys all the gains from the interaction.

[44] As Brown *et al.* (2003, page 2) put it: "Open access would eliminate monopolies over essential published results, diminishing profit margins and creating a more efficient market for scientific publishing". There remains the danger that network effects may lead to market power. (See the "parable of the anarchists' annual meeting" in Bergstrom, 2001.) For instance, if many readers only look at a few journals because they think all the good articles are published there, an author of a good paper must publish in one of those journals if her article is to be noticed and such journals could charge high publication fees to authors. Open access policy on its own can do little to overcome this coordination problem.

While a gold policy deals with monopoly pricing, the fact that authors will likely have to pay to publish introduces its own problems. Paying to publish will deter some authors at the margin from publishing at all.[45] Even if many authors have access to funds which can be used to cover a publication fee, there will often be an opportunity cost when paying to publish a paper.[46] (Paying to publish an article might mean the author can attend one less conference, say, or the available funds might be sufficiently for only a subset of the author's papers.) Scholars will have differential access to subsidies to pay for publication charges, with much science research being funded from grants which build in publication fees, while scholars in the humanities more rarely have research grants. Of course, not publishing at all is even more harmful to potential readers than paying a high price for access.

A partial (that is, a green or delayed) open access regime, which instead focusses on making freely available an inferior version of the published article, partly overcomes the problems of high subscription charges and excluded readers.[47] That an inferior substitute is freely available implies that libraries have a reasonable outside option, and publishers are forced to charge less if they wish to continue selling subscriptions.[48] The wider public has free access to an inferior variant of the published article, while before they may have been excluded altogether. Nevertheless, if the inferior variant is not too close a substitute, publishers may still be able to extract sufficient revenue from libraries willing to pay for the premium published version to cover costs, albeit with less to spare, and so a partial open access policy may be consistent with authors continuing to publish for free. In the model in section 5.1 we see that a gold open access policy dominates a partial policy if the

[45] To take an extreme example, if authors of economics textbooks had to pay to publish, rather than be paid, the supply of new textbooks would surely diminish.

[46] Solomon and Björk (2012, Tables 5 and 6) report that significant number of authors do pay publication fees out of their own pocket, especially when the fee is below $1000 and when the author comes from a poorer country.

[47] Another "partial" policy is to permit regulated authors to publish in cheap, though not quite free, journals. Such a policy reduces the prices paid by institutions and opens up access to smaller or poorer institutions, but is unlikely to open access all the way to the wider public.

[48] Finch *et al.* (2012, para. 7.67) mentions a survey of librarians asked for their response if journal content became freely available after a six month embargo period. Apparently 10% would then cancel all subscriptions to science, technology and medicine journals and 23% would cancel all subscriptions to humanities and social science journals. Of course, though, we would expect publishers to react to such a policy by cutting prices in order retain their subscribers.

supply of articles is inelastic, while the partial policy (if consistent with free publication by authors) dominates the gold policy when the supply of articles is sufficiently elastic.[49]

This discussion in this section so far has focussed on the role of journals to distribute content from authors to readers (task (iv) in the above taxonomy). Journals also add value to the raw content, for instance in terms of certifying quality, attractive formatting, providing feedback from referees to authors, and generally in "polishing" papers for publication (task (iii)). Some of this added value benefits readers. If a journal is not permitted to charge readers, as in the gold regime, it cannot appropriate the extra benefit it provides readers in the form of higher prices, and so will have less incentive to spend resources on such activities. Thus, we expect that an open access journal will provide expert feedback from referees and editors and go through multiple rounds of revision only to the extent this is valued by its authors (including the indirect impact on boosting readership insofar as this is valued by authors), and the direct benefit of such activity on readers is ignored in the journal's calculus.

If gold open access induces journals to scale back their activities aimed at adding value, this may bring efficiency benefits. Recall from section 1.1 that there has been a trend in many subjects towards more polishing of papers, arguably to an excessive extent. If journals cannot charge readers, their revenue may not cover the costs of polishing without charging authors a particularly high fee. As such, a gold policy might stimulate a move to something more like a "pure certification" role for journals, which is less costly to perform and which will plausibly deliver research to readers more quickly.[50]

There is a downside, however, to authors bearing the costs of processing papers, which

[49] These policy conclusions are similar to those corresponding to the regulation of call termination on telephone networks, as discussed in Armstrong (2002, section 3.1). There, when the number of telephone subscribers is inelastic it is optimal to regulate the price of call termination to be equal to marginal cost, while if the supply of telephone subscribers is elastic it is optimal to set the price for termination above cost and use the resulting profits to fund better deals for those subscribers.

[50] To illustrate, suppose there is single journal, and if it makes its authors expend effort e on polishing its cost per article is $C(e)$ and its subscription revenue per article is $R(e)$. If it charges authors a publication fee p, as well as requiring effort e, suppose the number of authors willing to publish is $N(p+e)$. The journal's total profit is therefore $N(p+e) \times (p + R(e) - C(e))$. If we write $P = p + e$ for the total cost to authors, this profit is $N(P) \times (P + R(e) - C(e) - e)$. Thus, the journal chooses e to maximize $R(e) - C(e) - e$, which involves strictly positive e if R increases sufficiently steeply. If regulation prohibited the journal from charging readers, so that $R = 0$, the journal's profit is $N(P) \times (P - C(e) - e)$, and choosing $e = 0$ maximizes profits.

is that some authors may be unwilling or unable to pay even for a pure certification service (task (ii)). More selective journals are likely charge higher author fees than less selective journals in the gold regime, since they follow a more rigorous and costly peer-review process. (By contrast, in the traditional subscription model, the extra costs of peer-review are covered by readers.) As such, some authors with good papers may be less willing or able to publish in selective journals. The result is that the quality signal in a journal's name becomes less precise, which harms readers and (good) authors.

A model of a market for article certification services is presented in section 5.2. However, the issue can be illustrated as follows. An author has a paper which might be good or bad. Readers in aggregate are willing to pay $10,000 to read an article known to be good, and willing to pay nothing for an article known to be bad. An author knows the quality of her paper, while readers cannot directly observe quality without investing in the costly effort of reading.[51] Journals come in two forms: a discriminating journal will only publish a good paper, while a non-discriminating journal will publish anything. Because of its reputation, readers know whether a journal is discriminating or not. It costs a discriminating journal $2,000 to determine if a paper is good or bad, but all other journal costs are zero. An author enjoys some intrinsic benefit from being seen to publish a good paper (if she has one), and if she has a bad paper she will not submit to a discriminating journal since she knows her paper will be rejected.

In an unregulated subscription-funded market, the outcome is that discriminating journals compete for good papers, a journal which attracts a good paper charges readers $10,000 to read the paper certified to be good, and allows an author to publish for free when she has a good paper. Readers infer that a paper which appears in a non-discriminating journal is bad, and won't read it (even if it is free). By contrast, if the author must publish in a journal which allows free access to readers, a discriminating journal will charge her $2,000 to publish if she has a good paper. If her intrinsic benefit from being seen to publish a good paper is above her opportunity cost of funding the $2,000 publication fee, the outcome is as before and good papers are all published in discriminating journals. However, if this benefit is below her opportunity cost, an author prefers to submit a good paper to a

[51] The assumption that an author accurately knows the quality of her article implies that there is no difference to an author between a submission fee and a publication fee.

non-discriminating journal which charges her nothing.[52] In this case, a reader must consult a non-discriminating journal if she wants the article. If an uncertified article is relatively likely to be good, it is worthwhile for readers to take the gamble of reading a paper in a non-discriminating journal, although they suffer the disutility of having to read some bad papers alongside the good. If an uncertified article is unlikely to be good, though, readers have no incentive to read undiscriminating journals at all, and some good papers will go unnoticed.[53]

As before, a partial open access regime can overcome this danger. If the inferior variant is not too close a substitute for the published article, a discriminating journal will be able to cover its costs (including its costs of peer review) out of its subscription income, and authors of good papers do not need to pay to have their article certified. As such, a green policy may be compatible with authors continuing to publish in the most selective journal that will accept their paper.

This simple model assumes that the journal's name is the only signal of quality available to readers. As discussed in section 1.1, though, nowadays readers have additional cues for quality, including the number of citations an article receives. As a result, the certification function of journals may be less important, and the danger of moving to the gold regime in this regard may not be so severe. Nevertheless, *early* readers may rely on the journal name as a signal. If non-discriminating journals are not read by early readers since they do not contain a sufficient proportion of good articles, good articles in these journals do not pick up citations and downloads, and so go unread by later readers as well. In this situation,

[52]For instance, within the PLOS group of open access journals, the highly selective *PLOS Biology* charges authors $2900, while the less selective *PLOS ONE* charges $1350. It seems plausible that some good biology papers are published in the latter due to the financial constraints of some authors.

[53]This discussion focusses on how a differential ability to pay a publication fee will cause some authors with good papers to submit to non-discriminating journals in a gold regime, while in the subscription-funded market they would submit to a discriminating journal. A similar outcome is seen in an alternative framework where authors have only an imperfect signal of the quality of their article. In a subscription-funded market, it is plausible that discriminating journal allow submission and publication for free, so that even an author who thinks it unlikely her article will be accepted will try her luck. The result is that all good papers appear in discriminating journals (although with possibly a significant cost of peer review). In a gold regime, the plausible outcome is that discriminating journals will charge for submission (and also charge for publication if accepted). In this regime, an author who thinks it is unlikely her article is good will not submit to a discriminating journal, with the result that some good papers will appear in non-discriminating journals. In this alternative model, set against the welfare costs of less certification are the possible efficiency gains of not peer-reviewing papers which are unlikely to be good.

journal certification continues to play an important and desirable role in determining a paper's eventual impact, and policy should not undermine the incentives to provide this service.

3 The Evolution of Open Access

A full account of how access to scholarly knowledge has widened over time would include the invention of the printing press, the adoption of vernacular language by scholars, the birth of scientific journals in the seventeenth century to document new discoveries, the introduction of public libraries and free museums, and the advent of radio and television.[54] For our purposes, it is convenient to start in the 1990s when researchers first used the internet to distribute their work on a large scale.[55]

In 1991, the physicist Paul Ginsparg launched *arXiv*, a subject-based online repository for physics, and later for mathematics, computer science and statistics. This currently hosts nearly a million papers and has around six million article downloads per month. Three years later was cognitive scientist Stevan Harnad's "subversive proposal" that scholars should make their research freely available on the internet, writing: "For centuries, it was only out of reluctant necessity that authors of esoteric publications made the Faustian bargain to allow a price-tag to be erected as a barrier between their work and its (tiny) intended readership because that was the only way to make their work public in the era when paper publication [was] the only way to do so" (Harnad, 1995).

Gold open access, in which journal articles themselves are freely available at the time of publication, received a major boost with the launch in 2003 of the Public Library of Science (PLOS) journal *PLOS Biology*, which was free to readers and which originally charged $1,500 to authors. This journal has the highest impact factor in the biology subject area in 2013 according to Thomson Reuters Citation Reports, belying suggestions sometimes made that open access journals must be low quality. BioMed Central is another open access publisher (now a subsidiary of Springer) which launched around the same time, and it now has more than 250 open access journals in the science and medicine

[54] See Willinsky (2006), especially chapter 13, for an account of these developments.

[55] A much more detailed timeline of developments in open access is provided by Peter Suber at legacy.earlham.edu/~peters/fos/timeline.htm.

area, with author fees mostly in the range £1000 to £1500. In 2004, Springer allowed authors of articles in its subscription journals to pay $3,000 to make an article open access, thus introducing hybrid journals. Similar open access options are now offered by many subscription journals, although it is by no means universal.[56]

A landmark for green open access was Elsevier's decision in 2004 to permit an author to self-archive the accepted version of her published paper (but not the publisher's typeset version) on her own website or home institution's repository without an embargo period. (Depositing the accepted version in a centralised subject repository was generally not permitted.) A representative from BioMed Central, which follows the rival gold route, claimed that "this kind of archiving is in many ways useless to the majority of scientists, mainly because no one will know the copies exist at all or where to find them." However, Stevan Harnad was warmer, writing "there will be the predictable cavils form the pedants [...]. I, for one, am prepared to stoutly defend Elsevier on all these counts, and to say that one could not have asked for more, and that the full benefits of open access require not one bit more - from the publisher".[57]

In the United States, the National Institutes of Health (NIH) is the principal public funder of research in the biomedicine area, and its policies toward research dissemination have played a large role in the open access debate. In 2005, after consultation (and lobbying) in 2004, the NIH announced its new *Policy on Enhancing Public Access to Archived Publications Resulting from NIH-Funded Research*, which stated "NIH-funded investigators are requested to submit an electronic version of the author's final manuscript [...] as soon as possible (and within twelve months of the publisher's official date of final publication)." The relatively lengthy embargo period and the fact that authors were merely "requested" to comply meant the policy had relatively little bite, and levels of compliance were low. In 2008, the NIH tightened its policy so that grant-holders were *required* to self-archive their published research (again, with a twelve month embargo), and compliance substantially

[56]For instance, at the time of writing none of the "top 5" economics journals (*American Economic Review*, *Econometrica, Journal of Political Economy*, *Quarterly Journal of Economics* and *Review of Economic Studies*) offer this option.

[57]Both this and the previous quote were reported in an article titled "Reed allows academics free web access" in *The Guardian* on 3 June 2004. Somewhat sourly, House of Commons (2004, pp. 57-8) suggested that "We are in little doubt that Elsevier timed the announcement of its new policy on self-archiving to pre-empt the publication of this Report."

increased.[58] Many other research funders follow variants of this approach now, although often with a six rather than twelve month embargo period.

Universities can also encourage their employees to self-archive. For example, since 2008 Harvard University has tried to ensure that its faculty deposit their work in the university's open access repository. However, the policy appears to be relatively weak, since faculty are not strictly obliged to self-archive in the university's repository, and there are no consequences for failing to comply. As of 2011, half of the Harvard's Faculty of Arts and Sciences had deposited some document to the repository.[59]

In 2004, the UK's House of Commons Science and Technology Committee investigated the market for scientific publications (House of Commons, 2004), and recommended following a green open access approach. Specifically, they suggested (paragraph 115) that universities be funded to establish institutional repositories, and wrote (paragraph 117) that "authors currently lack sufficient motivation to self-archive in institutional repositories. We recommend that the Research Councils and other Government funders mandate their funded researchers to deposit of a copy of all their articles in their institution's repository within [...] a reasonable period to be agreed following publication, as a condition of their research grant." The Government essentially refused to implement any of the main recommendations in this report, and the committee clearly believed that business interests had "neutralised" its recommendations.[60] In retrospect, this was a missed opportunity, since the committee's recommendations were close to current policy in the UK.

In 2012, the UK's Finch group published its report on expanding access to journals, which had been commissioned by government. This report, by contrast with the earlier UK report and with most international policy, suggested following the gold route, and its central recommendation was that "a clear policy direction should be set towards support for publication in open access or hybrid journals, funded by [author publication fees], as the main vehicle for the publication of research, especially when it is publicly funded".

[58] In Richard Poynder's website *Open and Shut* (visited 24 March 2014), the entry titled "Open access mandates: ensuring compliance" reports that in the voluntary era before 2008, compliance with the NIH request to self-archive was only 19%, while in the compulsory era the compliance rate was 75% by 2012.

[59] See Brand (2012) for further details of the Harvard policy. See Suber (2012, chapter 4) for an overview of various mandate policies used by funders and universities.

[60] See paragraph 7 of *Responses to the Committee's Tenth Report, Session 2003-04, Scientific Publications: Free for all?*

Moreover, the report was cautious when it came to any green policies, suggesting that "funders' limitations on the length of embargo periods [...] should be considered carefully, to avoid undue risk to valuable journals that are not funded in the main by [author publication charges]" and that "it would be unreasonable to require embargo periods of less than twelve months".[61] In contrast to the previous report in 2004, the Government agreed in 2012 to implement this report.[62]

There followed a period of confusion in UK policy, with the Research Councils changing their stated policy a number of times. A subsequent Parliamentary report[63] was strongly critical of the government's adoption of the Finch Report, writing that "At a time when the budgets of [universities] are under great pressure, it is unacceptable that the Government has issued, without public consultation, an open access policy that will require considerable subsidy from research budgets in order to maintain journal subscriptions and cover [author publication fees]. Signification public investment has already been made in institutional repositories [...] and they could represent a more cost-effective and sustainable route to full open access", and "We recommend that the Government and [Research Councils] reconsider their preference for Gold open access."

At the time of writing, the policy of the UK's Research Councils is that a grant-funded researcher must either follow the gold route, i.e., publish in a journal which allows immediate and free access to the published article, or a green route by publishing in a journal which allows her to self-archive the accepted version of her paper no more than six months after publication (twelve months for humanities and social science subjects).[64] In addition, the Research Councils will make its contribution towards author publication fees directly to universities (researchers cannot claim for publication fees in the grant itself), who will then distribute these funds to researchers as they see fit. There is also a clause

[61] See Finch *et al.* (2012, pp. 7, 8, 10).

[62] See the announcement gov.uk/government/news/government-to-open-up-publicly-funded-research.

[63] See House of Commons (2013, paras. 63 and 70).

[64] The justification for having longer embargoes for humanities and social science subjects is that articles in these subjects often have longer "half-lives" than articles in many science subjects, and hence that readers wish to consult these journals for longer. Thomson Reuters Citations Reports show that subjects such as history, law or economics have citation half-lives (that is, the median age of a cited article in the reference year) of more than 10 years, while medical subject areas such as endocrinology, oncology, geriatrics have half-lives in the 6-7 year range. A journal with a long half-life will plausibly be commercially hurt more with a given embargo period than one with a shorter half-life.

stating that if funds for publication fees are not "available" to the author, the author can self-archive with longer embargo periods (12 months, or 24 months for humanities and social science).[65]

Finally, open access will be required for the next "research excellence framework" in the UK, which covers most important journal articles from authors based in the country published after 2016. Similarly to the Research Councils' policy, for a journal publication to be submitted for the next review, the article must either appear without embargo from the publisher itself, or the author's accepted version must be available from a suitable repository no longer than 12 months after publication (24 months for humanities and social sciences).[66] In essence, this will make most of the journal articles originating in the UK open access in some form, albeit with what seems like a very lengthy delay in many subjects.

4 Conclusions

Without intervention, the scholarly journal market is likely to offer limited access to the wider public, alongside high subscription charges for research institutions, while authors can publish for free and many publishers reap high profits. The reason why publishers can charge high subscriptions is not primarily due to aggregate concentration in the publishing market, but rather that each peer-reviewed article makes a unique contribution and libraries must pay whatever the journal asks to obtain access to this contribution. Since authors care somewhat about the readership for their work, a publisher may not precisely maximize revenue from readers, but temper its prices to ensure the journal is seen by the people the author wants. Nevertheless, most authors do not care a great deal about being read by the wider public, nor do they care particularly what libraries pay for their article so long as they do subscribe, and the result is that journals can set high prices to libraries and remain attractive to authors.

[65] See www.rcuk.ac.uk/research/outputs (accessed 25 March 2014) for details. It is a crucial detail whether the 12 month or 24 month embargo period applies for a subject like economics. Many economics journals allow self-archiving only after 24 months, and in such cases an author must either pay for gold open access if that option is offered, or if that option is not available the author cannot submit to that journal at all.

[66] See hefce.ac.uk/whatwedo/rsrch/rinfrastruct/oa/policy accessed 31 March 2014, for further details.

This outcome has two related drawbacks: library budgets are siphoned off by commercial publishers, and smaller institutions and the wider public are excluded from research findings. These problems would be mitigated if many authors voluntarily self-archived their papers, by posting the accepted version on the internet. However, the evidence is that—beyond a few subjects (including economics)—many authors do not go to the trouble to do this, which is not surprising if their article is anyway being distributed to their desired audience by a journal.

These drawbacks are plausibly large enough to make some form of policy intervention worthwhile, costly though that is in itself.[67] Several forms of intervention can be contemplated. For instance, copyright on journal articles could be abolished, as suggested by Shavell (2010). Libraries could be encouraged to form large consortia and use their resulting buyer power to mitigate the monopoly power of publishers. Alternatively, regulated authors could be required to publish in journals which were "cheap" but not necessarily free, so that some upper bound on subscription charges is enforced.[68]

However, the two main kinds of intervention currently being implemented or considered around the world are the "green" and "gold" routes to open access. Green open access (as well as delayed open access) ensures that an inferior version of the published article is made freely available to all readers, while gold open access makes the published version freely and immediately available. If the inferior version is not too close a substitute to the premium published version—for instance, if the relevant embargo period is not too short—keen readers will still be willing to pay enough to cover the journal's costs and most authors can still publish for free. An open access policy requires regulated authors to make their work available in the stipulated manner. This mandate might come from the researcher's grant funder, from her university, or at the national level. A funding body can reasonably implement a more stringent policy than, say, a nationwide policy, since a researcher's decision to apply to a particular funder is voluntary, while a strict national policy would unduly limit a researcher's publishing options.

[67] Policy intervention might not be required if campaigns to boycott some commercial publishers (in terms of withdrawing refereeing or editing services or by making it socially unacceptable to publish in certain outlets) become sufficiently widespread to force these publishers to reduce subscription prices.

[68] For instance, the American Economic Association's collection of seven journals, including the premier *American Economic Review*, currently offers online institutional subscription for just $735. Likewise, a high proportion of humanities journals are cheap but not open access.

If an open access policy applies to significant numbers of authors, publisher profits will be affected and publishers are likely to lobby against such policies (as we have already seen). But this is not really a downside if an aim of policy is to transfer profit from publishers back to the scholarly community. However, it is not only commercial publishers which benefit from high profit margins, but also many scholarly associations. Such associations often run journals which are distributed by commercial publishers, with the profits from subscriptions largely passed back to associations. These associations can use these profits to fund conferences, scholarships, public awareness campaigns, and the like. Because many associations depend so heavily on journal subscription income, they often actively lobby against open access regulations.[69] However, a principle of competition policy is that exploitative conduct cannot be justified by the use subsequently made of monopoly profits, however benign. In any case, if the activities of the association are valuable, it should be able to obtain funds directly from funding bodies rather than indirectly from libraries. It would be a pity if the special interests of associations were an impediment to widening access to research.[70]

There are a number of downsides specifically to a green open access policy. While not expensive, operating a repository for self-archiving involves some outlay,[71] and it is costly for a regulator to monitor compliance with a self-archiving mandate. Mandated self-archiving imposes some limited costs of effort on authors, and if only a subset of journals comply with the requirements a mandate restricts an author's options for where to publish. The hope is—and much past experience suggests—that most journals will adapt to a new regime by allowing authors to self-archive within the stipulated period. But if the body making policy is small relative to the world market, an international journal may not find it

[69] House of Commons (2004, page 13) quotes the British Pharmacological Society as saying "in 2002-03 we spent over £850,000 on promoting and advancing pharmacology. Nearly £800,000 came from our publishing activities. Without this income we should either have to raise funds in a different way or cease to provide most of our current activities." See Willinsky (2006, chapter 4) for further discussion of this topic.

[70] A similar point can be made with regard to university presses, some of which pass their excess profits back to their university. Such universities may therefore be harmed by the widespread adoption of open access.

[71] It currently costs about $800,000 per year to run the *arXiv* repository, and revenue for this comes partly from large donations from Cornell University and the Simons Foundation, and partly from smaller donations from a large number of member institutions. See *arxiv.org* for more information.

worthwhile to change its policy.[72] It is possible, though not inevitable, that a green policy will result in fewer people reading the publisher's version than before. This could mean that readers do not always know which journal published a paper, and hence do not see the quality signal the journal imparts. However, discovering the paper via *Google scholar* almost always reveals the host journal, and so this cost to readers may not be great.

A gold policy brings greater benefits, but also greater potential drawbacks. It is surely of some benefit to the reader to read the journal article itself: the format may be somewhat more attractive, and she automatically knows the name of the journal which published the paper and that she has the final version. A subscription price which is precisely zero (rather than merely cheap) will reduce some journal costs, notably the selling costs associated with negotiating contracts with libraries. Relatedly, it is easier for regulators to ensure that authors are complying with their open access obligations relative to a green regime.

Set against these benefits, though, are potential problems caused by authors having to pay to publish. First, there are sound public finance reasons why readers should contribute something to the cost of publishing. Taking a parochial perspective, most readers of journal articles written by authors in a small country will be overseas, and it is not obvious that national taxes should be used to fund free access for these readers. Many readers of scientific research are in the industrial and corporate sector, and it is unclear why all such readers should free ride on a subsidised author-pays regime.[73]

If an author-pays policy is not to have a major impact on the supply of published articles, many authors will need to have their publication fees subsidised. The details for how to administer these fee subsidies are difficult to formulate, and it is unclear how well arrangements will work.[74] If authors have publication fees paid automatically, there is a

[72] However, a journal could make exceptions to its prevailing copyright policy, for instance by allowing papers funded from a particular source to be self-archived more quickly than other papers.

[73] House of Commons (2004, paragraph 175) reports that Elsevier obtains 20% of its journal revenue from this sector, and quotes the Biochemical Society as saying "in the open-access world it would appear that the only real winners are going to be corporate pharmaceutical companies who would no longer have to pay to access information."

[74] My university will receive £1.1 million from the Research Councils for the year 2013/14 to deliver the Councils' policy on open access. The university plans to devote 80% of this to support publication fees, which it suggests will cover one-third to one-half of the relevant publications. It will prioritise applications for these funds from grant-funded authors who wish to publish in an open access (not hybrid) journal or wish to publish in a hybrid journal which has an embargo period for self-archiving beyond the Councils' stated limits. That is, low priority will be given to authors wishing to pay for open access in a subscription

danger of "moral hazard", and authors will choose to publish in expensive, high production-standards journals with little regard for the extra cost in doing so. Perhaps more likely, though, is that many authors *will* incur a personal cost in publishing a paper, either directly out of their own pocket or in terms of having to use research funds which they value for other purposes. The discouraging impact of publication fees is likely to felt more strongly in some subject areas (such as the humanities, where research is rarely grant-funded) than in others (such as biomedicine, where much research is supported by grants which include payments for publication).

A claim is often made that an author-pays regime gives rise to a conflict of interest for journals, since they make money every time they accept a paper, and this will drive down standards.[75] This argument often reflects special pleading by subscription journals, who in any case also make more money (from libraries) when they publish more articles.

Perhaps a better way to think about this issue is that the demand for journal certification by authors may fall when authors pay to publish (as illustrated in the model in section 5.2). In a subscription-funded market, authors of good papers can publish at lower cost (or at least no higher cost) than authors with mediocre papers, and so an author has an incentive to place her article in the most discriminating journal willing to accept it. The result is that potential readers, as well as members of tenure and promotions committees, obtain a relatively precise signal of article quality from the journal in which a paper appears. In an author-pays regime, it becomes *more* expensive to publish a paper in a discriminating journal since peer-review costs are higher. As a result, some authors with good papers—particularly younger researchers with less access to research funds or researchers in poorer countries—may not be able to afford the extra expense, and choose to submit to a less prestigious journal. Readers and committees then have a less precise signal of quality than before, and good papers may be lost amongst the mediocre. Nevertheless, it is possible—though far from inevitable—that the certification role of journals may diminish over time, as potential readers gain easy access to other cues of a paper's quality (such as

journal when that journal permits adequate self-archiving. See openaccess.ox.ac.uk/applying-for-funding-from-oxfords-rcuk-open-access-block-grant (accessed 26 March 2014) for details.

[75] In House of Commons (2004, page 80), Harold Varmus, a founder of PLOS, said this argument was "rubbish [...]. We have reviewers who make the determinations about what we are going to accept, who have no direct interest in the fate of our journal, but the most important thing is that we [...] want our journals to be high quality. It is the only way we are going to succeed".

citations), in which case a decline in journal certification induced by author fees may not be too costly.

In sum, there are good arguments to support both the green and gold routes to open access. For the present, though, I suggest that a green (or delayed open access) policy which makes research available to the public without undue delay delivers most of the benefits of full open access, without the significant disruption involved in moving to a high-fee author-pays regime. A policy whereby a regulated author is permitted to publish in a journal with a cheap, rather than free, subscription also seems to merit more consideration than it receives currently.

In the longer term, though, the cost of processing journal submissions may fall to such a degree that a gold policy will not require high fees from authors. A move towards journals offering a pure certification service, rather than requiring multiple rounds of revision, will reduce journal costs (and the required publication fees) and lessen the time spent on writing referee reports. A "light touch" editorial process will also reduce the delay from submission to ultimate publication, and arguably accelerating access by readers to research is as important as ensuring that the research is freely available once eventually published. Certification could take the minimal form which ensures a paper is "correct" and does not duplicate existing work—the importance of a paper could then be gauged more by its citations, say, than by the name of the journal—or certification could be awarded only to the very best submissions. Either way, open access journals which offer an unbundled certification service are a vehicle for free and prompt access to research by readers, and at a cost which should be affordable—one way or another—to the majority of authors.

5 Appendix: Models of Journal Publishing

5.1 A model of dissemination

The model presented here illustrates three issues: why the traditional "reader-pays" business model is the equilibrium outcome in an unregulated journal market; why the "reader-pays" model leads to prices which might greatly exceed associated costs and to supernormal publishing profits, even in an unconcentrated journal market, and why regulatory intervention to achieve open access can help to overcome the monopoly pricing problem.

There are an unlimited number of identical journals which publish papers submitted by authors and distribute them to readers. Each journal incurs a cost f for processing each article, but there is no cost for distributing an article to readers. The peer-review process ensures that a published article is strongly differentiated from every other article, and so a reader's willingness-to-pay for one article does not depend on whether the reader has access to other articles. We assume that a reader values each article equally, and a type-v reader is willing to pay up to v for each article they read.[76] (In section 5.2 we discuss a scenario where articles differ in quality.) There are two kinds of reader: "libraries", of which in the relevant jurisdiction there are n in number and which are each prepared to pay up to v_H for any published article, and "the wider public", who are m in number and who are each prepared to pay v_L per published article. We suppose that information or arbitrage constraints mean that a journal must charge all readers the same price.[77]

A number of authors in the relevant jurisdiction each have a paper. Authors care that their article reaches the libraries. For instance, an author cares that fellow researchers can read her article, and researchers have access to journals via their libraries. However, we assume authors gain no further benefit from reaching the wider public. Given that journals are available in libraries, authors view journals as perfect substitutes as vehicles to disseminate their work and will choose the journal with the lowest publication fee. We suppose that a journal cannot pay an author when it publishes her article, and it charges the publication fee $p \geq 0$ to its authors. If authors have to pay p to publish their paper in equilibrium, suppose that $N(p)$ authors choose to publish. In general, $N(\cdot)$ is a decreasing function, reflecting that authors may have heterogeneous access to funds or obtain different benefits from publishing. Suppose that $V(p)$ is the associated net aggregate surplus of authors in the jurisdiction when the publication fee is p, which satisfies $V'(p) \equiv -N(p)$.

An author can bypass the dissemination function of journals by self-archiving a version of their paper. However, suppose that authors incur a small private cost when self-archiving their work, and so will not voluntarily do so if their article is anyway available in libraries

[76] The simplifying assumption that a reader has the same willingness-to-pay for each article implies there is no incentive for publishers to bundle articles or journals. Relatedly, it implies we can consider open access regulations for each article separately.

[77] If a publisher could set different prices to the two kinds of reader, first degree price discrimination would be possible, and all readers would be served (although all their surplus would be extracted).

and they can publish for free.

Suppose that

$$nv_H > (n+m)v_L \ , \tag{1}$$

which ensures that a journal obtains more revenue from selling only to libraries than it does from selling to all readers. Suppose also that

$$nv_H > f \ , \tag{2}$$

so that the revenue from selling to libraries covers the cost of running a journal.

The unique equilibrium in an unregulated market is easily derived. Given assumption (1), a journal makes the most revenue from readers by selling only to libraries. Moreover, an author obtains no benefit from reaching the wider public, nor does she care intrinsically about the price a library pays, and so a journal obtains no competitive advantage from offering to supply the wider public or from offering to set a low price to libraries. We deduce that each journal will choose a subscription charge $P = v_H$ to extract all library surplus. Since each article then generates profit $nv_H - f$, a journal has a strong incentive to attract authors. Since an author will choose the journal with the lowest publication fee, it is clear that the only equilibrium publication fee is zero. (If not, then a publisher has an incentive to undercut the prevailing positive fee a little, and attract all authors.)

The outcome in the unregulated market favours authors at the expense of readers: authors can publish for free, while readers either have all surplus extracted or are not served at all. Journals make profit $nv_H - f > 0$ per article published.[78] Suppose that publisher profit is worth nothing in the welfare calculation, and we are only interested in the sum of author and reader surplus in the jurisdiction. Therefore, welfare when authors are not regulated is

$$W_1 = V(0) \ , \tag{3}$$

[78] If there was an exogenous constraint that authors cannot be paid, the equilibrium would instead be that publisher profits are passed back to authors, who are paid $nv_H - f$ for their article. The outcome for readers is unchanged. In the model presented, the equilibrium is somewhat "knife-edge", in that authors are precisely indifferent between all journals, and if a journal could somehow improve its offer to authors it could attract much profitable business. (For instance, a journal might compete on its turnaround time, or attractive layout, or by giving a mug to an author.) This drawback could be overcome in an extended model where authors viewed journals as being slightly differentiated, say. The fact remains that many commercial publishers are highly profitable, suggesting that there is some barrier to profit dissipation in this market.

since readers obtain no surplus in equilibrium.

Note that an open access journal cannot succeed in this unregulated market. If it does not charge readers, it must cover its costs by charging authors instead, and no author would be prepared to pay a positive price instead of publishing for free.[79] A journal would not wish its authors to self-archive their paper since that would reduce a library's willingness-to-pay for access (see below). But since authors incur a small cost to self-archive and enjoy no extra benefit from doing so, there is no need for a journal to prohibit self-archiving.

Consider a "partial" open access regime in which regulated authors in the jurisdiction are required to make an inferior version of the published paper freely available, either by publishing in a journal with delayed open access or by self-archiving their own version of the article. (In the latter case, since there is a small cost involved in self-archiving, authors need to be mandated to do this.) If a reader has valuation v for the published version of a paper, suppose that this reader has valuation γv for reading the inferior variant instead, where $\gamma < 1$ is the same for all readers. If the reader charge is P, a reader with valuation v will pay for the published version rather than read the free version if $v - P \geq \gamma v$, i.e., if $P \leq (1-\gamma)v$. Under the same condition (1), a journal prefers to sell only to libraries, but its subscription charge can now be no higher than $(1-\gamma)v_H$. The parameter γ captures the extent to which the free version cannibalises a journal's revenue from libraries.

If γ is small enough that

$$n(1-\gamma)v_H \geq f \ , \tag{4}$$

this reduced revenue from libraries is still sufficient to cover the journal's cost. The equilibrium with this form of regulation is that regulated authors are still charged nothing to publish, libraries pay the reduced price $(1-\gamma)v_H$ to have access to the premium published version, while the wider public can access the inferior version for free. Putting this together implies that total welfare in this regime is[80]

$$W_2 = V(0) + N(0)\gamma[nv_H + mv_L] \tag{5}$$

Thus, since the extra term in (5) is positive, a requirement to make an inferior version

[79] If some authors did intrinsically care sufficiently about reaching the wider public, some journals would voluntarily set a low enough reader price to induce all readers to subscribe.

[80] We suppose that the author's cost of self-archiving, where relevant, is small enough that it can be ignored when calculating welfare.

freely available boosts total welfare in this model. The gain comes from two sources: the wider public is able to read the inferior version, while before they were excluded altogether, and a library is charged $(1-\gamma)v_H$ to access the published version, and so enjoys net surplus γv_H. The policy has no significant impact on authors, who can publish for free and reach their desired audience in any case. In sum, this partial open access policy both expands readership and transfers a fraction γ of profits from publishers to libraries.[81]

Consider next the "gold" open access regime, where regulated authors must publish in journals which offer readers immediate access for free. Here, journals will emerge to cater to the regulation-induced demand by authors for open access, and the equilibrium involves authors paying the cost of the journal, so that $p = f$, and these journals obtain no profit. The welfare of readers and authors in the jurisdiction is now

$$W_3 = V(f) + N(f)[nv_H + mv_L] \ . \tag{6}$$

The impact of the policy is that all readers have free access to published research, publisher profits from distributing these regulated papers are eradicated, but the number of published articles may fall. If the supply of articles is inelastic, so that $N(f) \approx N(0)$, then $V(f) \approx V(0) - N(0)f$, and (6) implies

$$W_3 \approx V(0) + N(0)\left[nv_H + mv_L - f\right] \ .$$

Given (4), welfare with the gold policy is then higher than in both the unregulated market (3) and the partial regime (5). Publisher profits obtained in the unregulated market are fully transferred to the academic sector of authors and libraries (although within this sector there is a transfer from authors to libraries), and the wider public has free access to the published version of research.

However, this welfare ranking is changed if the supply of articles is sufficiently elastic. Since authors are worse off in the gold regime relative to the partial regime, a sufficient condition for welfare to be lower in the gold regime than the partial regime is that readers are worse off. However, readers are worse off in the gold regime if and only if

$$N(f)[nv_H + mv_L] < N(0)\gamma[nv_H + mv_L] \ ,$$

[81] If the jurisdiction is small, then the policy will have an impact on the rest of the world too, in that readers elsewhere will have access to the inferior variant of the regulated author's paper, and the journal will have to reduce its prices to libraries in the rest of the world.

i.e., if the "quality adjusted" number of published articles is higher in the partial regime so that $N(f) < \gamma N(0)$. This condition is satisfied if the supply of articles contracts sufficiently when author fees are introduced.

In practice, in a partial open access regime, the policy-maker can choose how inferior the free version is, so that γ is endogenous. For example, the length of embargo period determines how close a substitute the free version is to the published paper. As γ varies from 0 to 1, the partial policy nests the unregulated market ($\gamma = 0$) and the gold policy ($\gamma = 1$) as polar cases. This analysis shows that policy should at least choose γ high enough that (4) just binds and authors can continue to publish for free. So long as there is no impact on the supply of published articles, welfare is improved when the wider public can enjoy a better version of the research and when more profit is transferred to libraries. It is possible that welfare can be improved further by choosing γ even higher, so that authors are required to contribute to journal costs, but that calculation requires a more delicate analysis of the elasticity of article supply.

5.2 A model of certification

The previous model focussed on the dissemination task performed by journals. Another important task is to certify the quality of papers they publish. Journals earn a reputation for being selective, and the fact that a paper is published in a particular journal is informative about its likely quality. As discussed in section 1.1, *ex ante* information about an article's quality is valuable to readers because that helps them better target their reading efforts. Likewise, certification is valuable to authors of good papers, as being published in a discriminating journal enhances this author's reputation among those who do not already know the author's work directly and also makes people more likely to read and cite their paper.

Suppose that there are two kinds of article, "good" ones with quality q_H and "mediocre" ones with quality q_L. An author knows the quality of her article *ex ante*, but has no control over whether her article is good or mediocre. By incurring cost $c > 0$, which might be interpreted as the cost of a peer review process, a journal can accurately determine an article's quality. A journal can be one of two types: a "discriminating" journal publishes only good articles and incurs the evaluation cost c per submission and cost f per publica-

tion, while a "non-discriminating" journal publishes any article submitted, and so incurs only the cost f per publication. Readers and authors are assumed to be able to observe which journals are discriminating and which are not, perhaps because they have consulted journals in the past or because they know a journal's impact factor or similar. We assume that an author of a mediocre paper will not submit to a discriminating journal, so that that journal's cost per article published is $f + c$.[82] (This assumption can be justified by supposing that authors dislike delay in publication, and the author of a mediocre article knows she will not succeed at a discriminating journal.) There is an unlimited supply of both types of journal.

Suppose that an author obtains reputational benefit $b(q)$ if she publishes an article which is perceived to have (average) quality q, where $b(\cdot)$ is an increasing function, and authors do not care directly about the readership of their article. Suppose that a journal can extract revenue r_H from the population of readers for an article known to be good, and revenue r_L from an article known to be bad. All articles published in a discriminating journal are known to have quality q_H, while an article in a non-discriminating journal has expected quality which depends on the proportion of good and mediocre articles submitted in equilibrium. We focus on the case where

$$r_H \geq f + c \ , \tag{7}$$

so that an article in a discriminating journal generates sufficient revenue from readers to cover its cost of publication and peer review.

The equilibrium outcome in an unregulated market is for all good papers to appear in discriminating journals. Given assumption (7), competition for authors with good papers by discriminating journals implies that the author fee is driven down to zero and such an author obtains payoff $b(q_H)$. Such an author could instead choose to publish in a non-discriminating journal. In this candidate equilibrium, readers believe that a paper in a non-discriminating journal is surely mediocre, and so publishing in a non-discriminating

[82] A subtle issue for the model as described is that, given it infers that all its submissions will consist of good papers, a discriminating journal actually need not go to the costly effort of peer-review and could simply publish all submitted papers. However, a richer model would overcome this problem. (For instance, an author plausibly is unsure of the quality of her article, and so will try her luck at a discriminating journal if it is free to submit there.)

journal yields the author reputational benefit $b(q_L)$. As a result, the payoff to the author is at most $b(q_L)$ since she might also have to pay a publication fee. Therefore, in this candidate equilibrium the author of a good paper has no incentive to deviate and to publish in a non-discriminating journal. (The author of a mediocre article cannot publish in a discriminating journal since her article will be rejected, and that deviation need not be considered.) It is thus an equilibrium for all good papers to appear in discriminating journals. A related argument shows there can be no equilibrium in which some good papers appear in non-discriminating journals, and so this is the unique equilibrium.

What happens to authors of mediocre papers in this equilibrium depends on how much revenue such a paper generates. If $r_L \geq f$, then even a mediocre article generates revenue from readers sufficient to cover a non-discriminating journal's cost. In this case, all authors can publish for free. However, if $r_L < f$, then authors of mediocre papers will have to contribute to the cost of publication, and in equilibrium they are each charged $p = f - r_L$. In the extreme case where an article known to be mediocre is of no interest to readers, so that $r_L = 0$, these authors must cover the full cost of publishing. A non-discriminating journal can then style itself "open access" without losing reader revenue. In an unregulated market, the equilibrium then involves good articles being published in discriminating reader-pays journals for free, while authors of mediocre articles pay for their work to appear in non-discriminating open access journals.

As in section 5.1, suppose that a partial open access policy requires an inferior version of the published paper to be made freely available, where this inferior version is viewed by a reader who values the published article at v as having value γv. (In particular, in the case of a green policy where the author makes her own version of the published paper available, we assume that a reader who is considering whether to read the self-archived paper knows the journal in which it is published, either by checking directly or because the author is required to state the journal when she self-archives.) As a result, for $i = L, H$ revenue is shifted down from r_i to $(1 - \gamma)r_i$. In this case, a similar equilibrium to that in the unregulated market is seen, provided that γ is small enough that

$$(1 - \gamma)r_H \geq f + c \ ,$$

so that a discriminating journal can cover its costs without charging authors. In particular,

all good papers appear in discriminating journals, and potential readers have an accurate signal of quality from the journal in which the article appears. Provided that it allows discriminating journals to cover their costs from subscriptions alone, a partial policy has no adverse impact on the certification services provided in the market. As before, the policy enables all potential readers to access the research and transfers profit from publishers to those readers who choose to pay for the published version.

With gold open access regulation, an author bears the cost of publishing and certification. Competition between journals implies that the author publication fee at a discriminating journal is $f + c$, while at a non-discriminating journal the fee is f. Thus, a crucial difference between a reader-pays and an author-pays regime is that in the former case publication fees tend to be lower at discriminating journals, while the latter has the opposite pattern.

With the gold policy, an author with a good paper will choose to publish in a discriminating journal only if the additional reputational benefit of publishing in a discriminating outlet outweighs the disutility of paying the extra publication fee. Such an author may choose to publish in a non-discriminating journal if her opportunity cost of research (or private) funds is sufficiently high.[83] Since now some good articles are published in non-discriminating journals, readers have a less precise signal about articles quality than they did in the unregulated market. For instance, if mediocre articles are worthless, no one would ever read a non-discriminating journal in the unregulated market. In the gold open access regime, though, a reader will either have to sift through these journals to find the fraction of good papers they contain, or ignore these journals altogether, which means the good articles in them go unnoticed.

5.3 Related economic models of publishing

Shavell (2010) presents a model of the academic market which is similar to that in section 5.1. In particular, he also focusses on the case where the journal market is competitive, and where potentially high revenues from selling the journal to readers are passed onto authors in the form of a subsidised charge for publishing. Shavell supposes that all authors write

[83] Alternatively, different authors may place different weight on reputation, so that the function $b(q)$ may be less steep for some authors, who then are not prepared to pay the extra for a better reputation.

articles of equal quality (that is, readers have the same demand function for each article) but differ in how much they value readership. Authors who value having many readers will choose a contract with a low reader price (and so relatively large publication fee), while authors who care little for readers opt for a contract with a revenue-maximising reader price and are paid for their work. In contrast to the model in section 5.1, Shavell does not impose the constraint that authors cannot be paid to publish, and so his publishers make zero profits in equilibrium and some authors are paid to publish.

In the model in section 5.1, I assumed that authors cared only about their work being read by a subset of high-value readers. In technical terms, this was a device to ensure that journals had no incentive to attract authors by offering a wider readership. (If authors cared about reaching each additional reader, journals would be forced to dissipate all profits by offering authors the widest audience.) Another way to shut down competition for authors via readership is to suppose that journals cannot commit to their subscription charge, as in McCabe and Snyder (2014). (For instance, publishers might negotiate terms with individual libraries, and there is no "public" subscription price which authors can observe.) In their model, excess profits are again retained by subscription journals.

McCabe and Snyder (2005) present a model of a monopoly profit-maximizing journal that chooses which articles to publish and how much to charge the two sides of the interaction. (They assume that authors do not know the quality of their article at the time of submission.) They find that the better the journal is at picking out the good articles the higher is its charge to readers (and the lower its charge to authors). They interpret this as implying that a less expert journal is more likely to offer open access.

Jeon and Rochet (2010) also consider a market with a single journal, which chooses the quality threshold for the papers it accepts. In their model, they find that the socially optimal way to price to the two sides is to have open access (see their Proposition 2). One reason for this unambiguous result, however, is that they do not require the journal to break even; if revenues from the two sides must cover the journal's cost, it may be optimal to charge readers for access so that authors are not unduly discouraged from publishing by high publication fees. The rest of their paper mostly studies the case where the journal aims to maximize its readers' welfare. However, closer to the focus in the current paper, in their appendix they also study a for-profit monopoly journal. (The framework I present

in section 5.2 is quite similar to Jeon and Rochet's model. Articles are either good or bad—where a "bad" paper has benefit to the reader which is below her reading cost—and they assume that an author knows her quality in advance.) They find that a subscription journal will never accept bad papers, since that diminishes a reader's willingness-to-pay for the journal. However, in an author-pays regime the journal may accept a portion of bad papers, as it cares less about pandering to reader interests. As a result, open access may be associated with a fall in standards, just as the competitive market studied in section 5.2 exhibited a noisier signal of quality in an author-pays than a reader-pays regime.[84]

McCabe, Snyder and Fagin (2013) study a model with two authors and two readers. One author cares about reaching readers (valuing each reader at a) while the other does not and publishes only if it costs nothing to do so; one reader has a value r from seeing any article, while the other does not and can be reached only with open access. Suppose it costs f to process each paper and disseminate it to any number of readers.[85] There are five strategies that a profit-maximizing monopoly journal might follow: (i) publish one article and sell to one reader, which yields profit $a+r-f$; (ii) publish one article but with open access to both readers, which yields profit $2a-f$, (iii) publish two articles and sell both to one reader, which yields profit $2r-2f$, (iv) publish two articles with open access, which yields negative profit $-2f$, or (v) follow a "hybrid" strategy, and offer the author who does not care about readers free publication and whose article can be read by one paying reader, and offer the author who does care about readership open access in return for a publication fee, which yields profit $a+r-2f$.[86] Thus, the journal has no incentive to follow the hybrid strategy, which is dominated by strategy (i).[87] However, if policy forced the journal to offer some form of open access, i.e., to follow one of the strategies (ii), (iv) or (v), the journal may prefer the hybrid option to the full open access policy.

[84] Jeon and Rochet do not investigate whether an author-pays or reader-pays regime (or a mixture of the two) is observed in an unregulated monopoly market, but rather they derive the price to one side given an exogenous constraint that the other side has free access.

[85] In fact, McCabe *et al.* suppose there is a constant cost of distributing the paper to each reader.

[86] Since the author who cares about readership could mimic the other author (who has access to a single reader for free), the journal can only charge a publication fee of a to this author.

[87] In richer frameworks it would be optimal to offer a different readership to different authors, i.e., to follow a "hybrid" strategy. A general version of this situation would have authors differing in their "demand" for readers and readers differing in their demand for papers, and a monopoly journal solves a two-sided screening problem in which the volume of demand on the two sides must coincide. For a model with this flavour, see Gomes and Pavan (2014).

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