



Open Access versus Traditional Journal Pricing: Using a Simple “Platform Market” Model to Understand Which Will Win (and Which Should)

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ABSTRACT

Economists have built a theory to understand markets in which, rather than selling directly to buyers, suppliers sell through a platform, which controls prices on both sides. The theory has been applied to understand markets ranging from telephony, to credit cards, to media. In this paper, we apply the theory to the market for scholarly journals, with the journal functioning as the platform between submitting authors and subscribing readers. Our goal is to understand the conditions under which a journal would prefer open access to traditional pricing and under which open access would be better for the scholarly community. Our new model captures much of the richness of the existing economic literature on journal pricing, and indeed adds some fresh insights, yet is simple enough to be accessible to a broad audience.

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INTRODUCTION

Traditionally, scholarly journals earned most of their revenue from fees charged to subscribers. Recent developments in the markets for these journals have led to dissatisfaction among some scholars and librarians with this subscription-based business model (Willinsky, 2009). The advent of the Internet offered the prospect of nearly zero marginal cost distribution of journals in digital form, potentially much lower than the traditional method of mailing print copies. While such technological advances might be expected to result in lower journal prices, real journal prices continued to rise (Bergstrom, 2001; Dewatripont et al., 2006).

The discontent with rising subscription prices led to the emergence of an alternative strategy: the open access (OA) model. Articles in an OA journal are available over the Internet free of charge to all readers. Revenue to cover publication costs (and generate a profit for commercial publishers) typically comes from fees charged to submitting authors. The number of OA journals has grown rapidly. In September 2003, the Directory of Open Access Journals (doaj.org) listed around 550 titles; today it lists more than 8000.

The growth of OA raises a host of questions that are amenable to formal analysis. Is the growth of OA based on economic fundamentals that can be expected to continue in the future? If so, will the traditional journal disappear? Or will the growth soon stall or indeed reverse? Will the growth be concentrated among society journals or commercial ones; in disciplines that are well-served by journals or ones with less intense competition? These are all positive questions regarding understanding what has happened in the market and what will be expected in the future. Normative questions regard what the market should look like. Would universal OA be better for the scholarly community or do traditional journals fill a valuable role? Are mandates and subsidies worth the costs they impose?

To answer these questions, we build on the theory developed by economists to understand markets in which, rather than selling directly to buyers, suppliers sell through a platform, which controls prices on both sides.¹ The theory has been used to model markets such as telecommunications (Laffont, Marcus, Rey, & Tirole, 2001; Hermalin & Katz, 2004; Jeon, Laffont, & Tirole, 2004), payment-card systems (Rochet & Tirole, 2002; Wright, 2004), and media (Kaiser & Wright, 2006; Wilbur, 2008). In the setting of this paper, the journal is the platform, serving as an intermediary between authors on one side of the market and readers on the other. Each side of the market benefits from the presence of the participants on the other side: an

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¹ See Armstrong (2006) and Rochet and Tirole (2006) for discussions of the core theoretical ideas and Rysman (2009) for a survey of the empirical literature.

author benefits from more readers because this increases impact and citations; a reader benefits from additional articles because articles contain informative content. Authors and readers do not make direct payments to each other, however; the journal controls submission and subscription fees.

The new model we build in this paper captures much of the richness of the existing economic literature on journal pricing yet is simple enough to be accessible to a broad audience. Aside from the complication of a platform market, the model is otherwise quite simple; indeed, we believe it is the irreducibly simplest model that can be used to analyze OA. Using it, we are able to characterize the submission and subscription fees charged by monopoly and competing for-profit journals, by non-profit journals, and by journals using a hybrid strategy of offering both traditional access and open access for an additional premium.

Our paper is most closely related to the three previous economics papers (McCabe & Snyder, 2005; McCabe & Snyder, 2007; Jeon & Rochet, 2010) that study OA using a platform model for scholarly journals.² McCabe and Snyder (2005) extend the basic model to allow journals to vary in quality, analyzing whether a high- or low-quality journals would find it more profitable to adopt OA. McCabe and Snyder (2007) derive conditions under which OA emerges under monopoly and competition that are similar to those derived in the present paper. However, the model in the present paper is far simpler, affording a number of advantages. First, we can make more realistic assumptions here about journal fees, assuming (consistent with practice) that journals post fixed fees rather than submission fees proportional to the number of readers or subscription fees proportional to the number of articles. Second, we can derive a rich set of new results here, in particular on hybrid pricing strategies, on the behavior of non-profit journals, and on several additional normative questions. Third, and perhaps most importantly, the analysis here is accessible to a broad audience. The present paper has a number of differences with Jeon and Rochet (2010). We study both monopoly and competition cases, whereas they restrict attention to the monopoly case. We allow for general pricing strategies, whereas they assume that journals cannot charge both positive submission and subscription fees. We answer many new policy questions that they did not consider.

MODEL

We will model the market for scholarly journals along the lines of the model presented in Panel B of Fig. 1. The model has three types of economic agents: journals, authors, and readers. Journals are intermediaries between authors and readers. Journals acquire articles from authors that exceed a specified quality standard, combine them into an issue, and distribute the issue to subscribing readers. Let $c > 0$ be a journal's cost of sending a single article to a single reader. Assume this single parameter embodies all of the journal's costs.³ By considering different values of c , we can see how a change in technology such as the move from print to online distribution (presumably lowering c) might affect the journal market.

Readers benefit from the articles they read. In reality, this benefit ranges on a continuum from very high levels—perhaps for scholars whose whole research agenda is affected by information in an article—down to low levels—perhaps for a non-expert or student who may have seen the article referenced in a newspaper. To capture this reality

² Other papers—for example McCabe (2004), Jeon and Menicucci (2006), and Armstrong (2009)—that theoretically analyze the market for scholarly journals do not use a model in which different prices can be set for authors and readers, and so cannot address OA questions.

³ We have conducted all of the analysis below including additional parameters for “first-copy” costs, i.e., all the costs involved in processing a submission through to publication (so-called first-copy costs) and for the fixed cost of processing a reader account but have found that this complicates the statements of the results without adding much insight.

as succinctly as possible, we will assume that there are just two types. One type gains a high value from reading, willing to pay $r > 0$ per article read. The other type has a low value, set to 0. To further simplify the analysis, assume that there is exactly one of each type of reader, so two readers in total.

Authors benefit from a large readership. A tangible source of this benefit is from the expected number of citations that each reader generates. Citations benefit authors because they are used as a measure of impact that improves authors' career prospects. Less tangible but still beneficial is the gratification experienced by author when his or her work is read or when he or she influences a scholarly field. To maintain the parallelism between the author and reader sides of the model, assume there are exactly two authors, each endowed with a single article. The articles are of the same quality and exceed the journal's publication standard, implying that rejection is not an issue. One of the authors obtains a high value from readership, willing to pay $a > 0$ for each additional reader. The other has a low value, set to 0.

Journal j charges a submission fee $p_{aj} \geq 0$, in return for which an author's work is distributed to all the journal's readers.⁴ The journal charges subscription fee $p_{rj} \geq 0$, in return for which a reader has access to all the journal's articles. An article can appear in at most one journal, but readers can subscribe to multiple journals.⁵

The model has the following timing. First journals set fees. Then authors each decide to which journal (if any) to submit. Then readers decide whether or not to subscribe to journals with some content.⁶ To rule out trivial cases in which costs are so high that journal operation is unprofitable, assume $c < a$ and $c < r$.

MONOPOLY FOR-PROFIT JOURNAL

We will begin the analysis with the simple case of a single, for-profit journal. The journal chooses its fees to maximize profit, the difference between revenue and cost. In order to earn any revenue at all, the journal must serve at least one author and one reader. Since it can serve at most two authors and two readers, the journal is left with the four possible customer configurations shown in Fig. 2. Each box shows the maximum profit that can be earned while serving that configuration. We will explain how to compute each one in turn.

First consider Box 1 in the upper left, which shows the highest profit that the journal can earn from serving one author and one reader. Anticipating that one reader will subscribe, the high-demand author values publication in the journal at a . This is the most that the journal can charge authors and still obtain a submission. Given that the journal has one article, the high-demand reader would be

⁴ Since articles are of equal quality, it makes no difference whether p_{aj} is taken to be a submission or publication fee: all submitted articles are published in equilibrium. The assumption that fees cannot be negative merits some further discussion. The assumption does not prevent journals from cross-subsidizing authors and readers, in that fees on one side may be set below and the other above marginal cost. The assumption prohibits journals from making explicit cash payments to one side. Few scholarly journals pay authors, perhaps to avoid magnifying the stakes associated with acceptance, perhaps to avoid corruption of the editorial process.

⁵ In the parlance of the economics literature on platform markets, authors would be said to *singlehome* and readers to *multihome*.

⁶ Such sequential models are rigorously analyzed using a method called *backward induction*, that is, first determining what decisions are rational for the agents who are the last to move, then what decisions are rational for the agents who move in the prior stage anticipating the action to follow, and so forth, continuing with the analysis back to the first stage at which point all agents' decisions have been specified. Backward induction yields the *subgame perfect equilibrium*, an important equilibrium concept in game theory due to Selten (1965). Subgame perfect equilibrium is a refinement of the leading equilibrium concept in game theory, *Nash equilibrium* (Nash, 1951). Sequential games can often have many Nash equilibria, some of which work only because of empty threats, such as a later mover's convincing earlier movers to act a certain way with a threat to “blow everyone up” unless they do so. Subgame perfect equilibrium rules out such implausible Nash equilibria. Nash and Selten shared the 1995 Nobel Prize in Economics for these contributions to game theory. The equilibrium we derive is subgame perfect, but we will spare the reader most of the details of the application of backward induction.

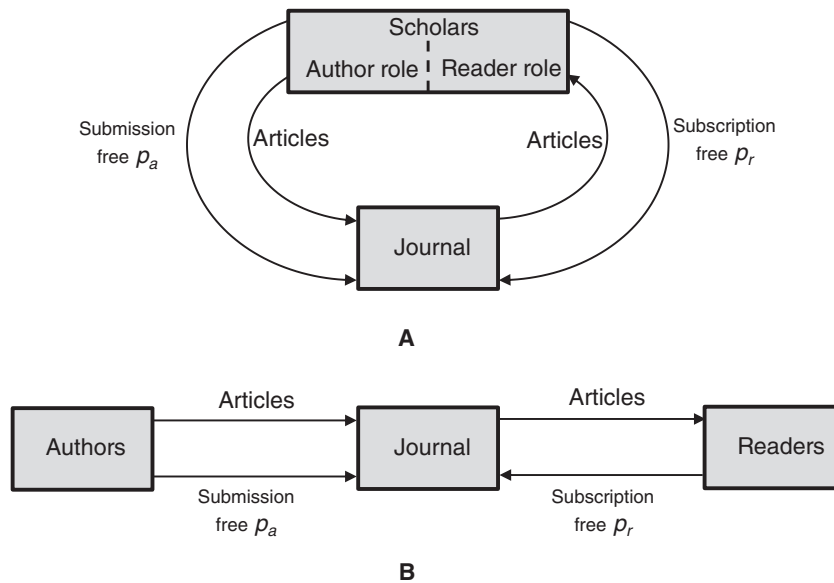


Fig. 1. Scholarly journal modeled as a platform. The same scholar sometimes transacts with a journal as an author (“uploading”) and sometimes as a reader (“downloading”), as shown in panel A. To simplify the model, we treat the scholar’s roles as author and reader separately, transforming panel A into B by pulling it apart at the dotted line. Panel B highlights the journal’s position as a platform between two sides of the market.

willing to pay r to subscribe. Again, this is the most the journal can charge for subscription and still have any readers. The journal’s revenue from these fees is $a + r$. Delivery of the one article to the one reader costs the journal c . The highest profit the journal can earn from serving one author and one reader is thus $a + r - c$.

Next consider Box 2, showing the highest profit that the journal can earn from serving one author and two readers. Anticipating two readers will subscribe, the high-demand author is willing to pay $2a$ for publication in the journal. To have two readers, the journal must serve the low-demand reader, which it can only do if it charges no subscription fee, that is, if it adopts OA. Total revenue from both sides of the market is thus $2a$. Delivery of one article to two readers costs the journal $2c$. The highest profit that the journal can earn from serving one author and two readers is thus $2a - 2c$.

Similar arguments show that the highest profit the journal can earn from serving two authors and one readers is $2r - 2c$, shown in Box 3.

Finally consider Box 4, showing the highest profit the journal can earn from serving two authors and two readers. The journal must serve the low-demand author and reader in this configuration. To do so, both its submission and subscription fees must be 0, implying its total revenue is 0. It must make four article deliveries—two articles to each of two readers—at a total cost of $4c$. Its profit in this configuration is $-4c$.

		Number of readers	
		1	2
Number of authors	1	Box 1 $a + r - c$	Box 2 $2a - 2c$
	2	Box 3 $2r - 2c$	Box 4 $- 4c$

Fig. 2. Journal profit from serving different combinations of authors and readers. Each box shows the maximum profit that the journal can earn from serving the numbers of authors and readers indicated in the row and column heading.

To solve for the fees that the journal ends up selecting, we simply need to look for the box that yields the highest profit. It is obvious that Box 4 does not: the journal earns negative profit and would be better off ceasing operation. Any of the three remaining boxes can be the highest depending on the values of the parameters. The following proposition provides the technical conditions under which Box 2 yields the highest profit. Box 2 is the only configuration that involves OA, so knowing when that box is selected tells us when the journal would choose OA.

Proposition 1. *If $a > r + c$, the journal adopts OA, charging a submission fee of $2a$, charging no subscription fee, and serving one author and both readers.*

If $a < r + c$, the journal adopts traditional pricing with a positive subscription fee.

Proposition 1 is a technical result, provided for reference. It is worth some effort to glean the insights it provides for the journal market. Perhaps the most basic question to answer is whether a for-profit, monopoly journal would ever choose OA. Without the benefit of analysis, the answer would be far from obvious. The journal under consideration is assumed to maximize profit, whereas OA is a policy that has been advocated to achieve social goals. By virtue of its monopoly status, the journal can exert considerable control over prices, so it is not clear why it would forgo revenue from the reader side by offering free subscriptions. Nevertheless, the proposition states that there are conditions under which a for-profit, monopoly journal would choose OA. This insight is worth stating again as a result, numbered for reference.

Result 1. *OA may be a profitable strategy even for a for-profit, monopoly journal.*

The journal sacrifices revenue from the reader side in order to expand access, which the high-demand author values, and for which he or she is willing to pay through a higher submission fee.

Another basic question is what market conditions are most suitable for OA. Proposition 1 provides the mathematical condition: $a > r + c$. The next result explains what this mathematical condition means in intuitive terms.

Result 2. *The journal is more likely to adopt OA if the author value of readership (a) is high, if the reader benefit from access (r) is low, and if the cost of distributing articles to readers (c) is low.*

Result 2 contains something of a surprise. One might think that OA, being a policy targeted to readers, should depend on reader benefits and in particular should be attractive for journals when reader benefits are high. Just the opposite is the case. If readers are willing to pay a lot for access, the journal is reluctant to forgo extracting revenue from readers through subscription fees. What drives OA instead are author benefits from readership. Author benefits need to be sufficiently high for the strategy of shifting revenue generation exclusively to the author side. Less surprising in Result 2 is that OA is more likely to be observed when the cost of article distribution is low. Before the advent of online distribution, which substantially reduced distribution costs relative to print, OA was not a serious policy option. For c close to 0, the span of cases under which OA is profitable is quite broad, depending only on the relative values of a and r . While we cannot be sure of these relative values in any particular discipline, it is likely that they line up in the right way in at least a fraction of them. Even if the fraction is small, given the proliferation of disciplines, we should see many for-profit journals adopting OA. A look at the market confirms these expectations. Walters and Linvill (2011) find that a substantial fraction (28%) of their sample of OA journals have commercial publishers.

HYBRID PRICING

The previous section assumed that the journal was restricted to posting a single pair of author and reader fees. Recently, large commercial publishers have moved to a more complicated pricing schedule, where for a standard fee the author's article is posted behind a pay wall but for an additional fee the article is made available via OA. As a result of this form of pricing, which we will refer to as a *hybrid* pricing strategy, some of the journal's articles are available to readers for free and the rest require a subscription to access. Elsevier, Springer, and Wiley have all instituted hybrid pricing, charging authors \$3000 for the OA option.

We can analyze hybrid pricing using our model of a monopoly, for-profit journal. Key to the analysis is to realize that unless different authors select different options, hybrid pricing collapses to pure traditional access or pure OA. In our model, only the high-demand author would pay a premium for OA, so the only case in which different authors select different options is when the low-demand author chooses traditional access and the high-demand author chooses OA. It is easy to determine what the journal's profit-maximizing fees must be. The journal charges no submission fee for traditional access, attracting the low-demand author. Because only one article is available via traditional access, the high-demand reader can be charged at most r for a subscription. The journal charges no subscription fee for OA by definition.

The last step in the analysis is to determine the premium charged to the author for OA. While the high-demand author values OA at $2a$, the premium for OA cannot be that high. The author can always decline the OA option, choosing the traditional option instead, thereby obtaining a net benefit of a because the traditional option involves no submission fee and attracts one reader. The author can be charged at most the marginal benefit of OA above and beyond traditional access. The author's marginal benefit is a for the one additional (low-demand) reader that is attracted by OA. Thus the highest premium that can be charged for OA is a . Adding the revenues from authors and readers in both the traditional and OA options, and subtracting the total cost of $3c$ for the three article deliveries (the one traditional article to the high-demand reader and the one OA article to both readers) yields total profit from the hybrid strategy of $a + r - 3c$. We can see right away that the journal would not choose the hybrid strategy. The profit

is less than that from just serving one author and one reader via traditional access Box 1 of Fig. 2.

Result 3. *A for-profit, monopoly journal would not adopt hybrid pricing in our model. Traditional pricing is more profitable.*

Hybrid pricing is problematic for the journal because the different options offered to the author in effect compete with each other. The presence of the cheap traditional option limits the premium for OA. It is better for the journal just to charge a high submission fee for traditional access. This generates the same revenue but saves on the costs of wider distribution associated with hybrid pricing.

Some caveats should be kept in mind regarding (Result 3). First, the result is somewhat special to our model with two types of authors, the lower type having no benefit. In an extended model with more types or with the low type having positive benefit, cases can be generated in which the journal finds hybrid pricing attractive. However, the result remains that the set of cases for which that happens is quite limited, for the reasons we have discussed. Second, even within our current model, if the distribution cost c is close to 0, the profit gap between hybrid and traditional pricing disappears. The fact remains that hybrid pricing is not *more* attractive than traditional pricing.

Result 3 presents something of a puzzle. The prediction is that the for-profit journal would not pursue a hybrid-pricing strategy, yet in practice we see all of the largest publishers doing so. One way to resolve the puzzle is to imagine that the caveats from the previous paragraph apply in the real-world market. This is not completely satisfying: the caveats suggest that the hybrid model cannot be completely ruled out, not that it should be widespread. Furthermore, left unexplained is why the major publishers have only recently moved to the hybrid model when they could have done so a decade earlier. Some feature of the market may have recently changed that forced publishers' hand. A likely candidate is the threat or actual imposition of an OA mandate by governments, foundations, and other institutions. Such a mandate can be analyzed in the context of our model.

To keep the analysis as simple as possible, suppose the mandate prevents our for-profit, monopoly journal from using pure traditional pricing.⁷ Its remaining strategies are either pure OA or hybrid pricing. As shown in Box 2 of Fig. 2, the journal earns profit $2a - 2c$ from pure OA. We showed above that the journal earns $a + r - 3c$ from hybrid pricing. Since other strategies are prevented by the mandate, we are left to compare these two profits. The following proposition gives the technical conditions under which the journal chooses OA or hybrid pricing.

Proposition 2. *Suppose a for-profit, monopoly journal is faced with a mandate to offer some form of OA, either pure OA or hybrid pricing with an OA option. If $a + c > r$, the journal offers pure OA. If $r > a + c$, it offers hybrid access.*

Since the journal is only resorting to hybrid pricing as a substitute for the traditional pricing it would like to have implemented if not restricted, not surprisingly the condition in Proposition 2 dividing hybrid from OA outcomes is identical to the condition in Proposition 1 dividing traditional from OA cases.

Some of the empirical implications of the proposition can be broken out in a series of results.

⁷ If the mandate were a regulation placed on the journal, a cunning strategy that respects the letter but not the spirit of the regulation would be to offer an OA option but at a prohibitively high price. This strategy would be equivalent to pure traditional pricing. In practice, the mandate is not placed on journals but on funded authors. Funded authors can be captured in the model by assuming they are represented by our high-demand authors. A mandate that high-demand authors must publish in OA outlets would effectively eliminate the journal's option of using pure traditional pricing, equivalent to the restriction in the regulation we study.

Result 4. *An OA mandate provides an important motive for a commercial journal to adopt hybrid pricing.*

An OA mandate provides one solution to the puzzle of why hybrid pricing was found to be dominated by other strategies in the original model yet is prevalent among commercial publishers in the real world.

Result 5. *In the presence of an OA mandate, a monopoly for-profit journal is more likely to adopt hybrid pricing the higher is the reader benefit (r) and the lower are the author benefit (a) and distribution cost (c).*

The conditions in [Result 5](#) under which the journal chooses hybrid pricing are the same as the conditions under which it chooses traditional pricing in [Proposition 1](#) and the opposite from the conditions under which it chooses OA in [Result 2](#).

COMPETITION

The case of a monopoly journal provided a good starting point because it is simple to analyze. In the real world, however, authors often have the choice of several, and perhaps many, alternative outlets in which to publish. This motivates our analysis of the case of competing journals in this section. Before doing so, it is worth providing a few points in defense of the monopoly analysis. First, the monopoly case is not completely unrealistic. The leading journal in a discipline may have a special position. Other journals may cover niche topics or perspectives for which there are few good alternatives. Second, as we will see, the qualitative insights from the monopoly case will carry over to other market structures.

To model competition, we will assume there are a number of journals which post their fees at the same time. Then the model proceeds as before with authors making their submission decisions followed by readers making their subscription decisions. The only change from the previous section is the number of journals. Continue to assume they are commercial, operating with the goal of maximizing profits. To streamline the analysis, return to the case in which journals post a single submission fee rather than a schedule, relieving us of the need to analyze the hybrid strategy.

Economic logic dictates that journals compete more intensely for articles than readers. The reason is that a journal has exclusive rights over its articles, and it can use this monopoly power to generate considerable revenue, which is a powerful inducement to compete to attract submissions from authors. A journal does not have exclusive control over readers, who can subscribe to any number of journals. Competition to attract authors need not generate low submission and high subscription fees. For those authors who value readership highly, low subscription fees can be more attractive than low submission fees.

As an analytical device, we will consider competition for journals targeting the low-demand author separately from those targeting the high-demand author. The analysis may end up showing that the same journal attracts both authors, but we want to at least allow for the full range of possibilities before we know what the case is.

Start by considering competition for the low-demand author. Since this author does not value readership, he or she would reject all but a 0 submission fee. This pins down the submission fee that “wins” the competition. The winning subscription fee is not pinned down as precisely. It must be positive—moreover, high enough to cover cost c —or else the winning journal would be unprofitable and better off not operating at all. The winning subscription fee can be as high as r for a journal with one article, indeed as high as $2r$ for a journal with two articles, while still attracting the high-demand reader.⁸ For subscription

fees between c and these higher values we cannot say more; any subscription fee in this range may win the competition because any of them would attract the high-demand reader. For fees close to c , the winning journal ends up making little profit; for fees far away from c , the winner can be quite profitable.

The indeterminacy of the competitive subscription fee and profit is an interesting result in and of itself. Even the intense competitive forces we are allowing for in the model—our journals are perfect substitutes for each other and there are no other competitive frictions assumed—do not fully constrain subscription fees; only submission fees are constrained. The insight is worth emphasizing because it is new in the economics literature.

Result 6. *Competition in the journal market, even between perfect substitutes, does not necessarily squeeze subscription fees down to cost or journal profit to 0.*

Next consider competition for the high-demand author. Our preceding analysis of competition for the low-demand author has already shown what competitive prices must be for a journal that uses traditional pricing. We are left to solve for competitive OA prices. Of course the subscription fee is 0 by definition. All that remains to be computed is the submission fee. The competitive submission fee is easy to compute, however, because we know that competition will end up reducing submission fees to cost. Since OA results in the delivery of the author's article to two readers, the total cost is $2c$. This is the competitive submission fee.

Would the high-demand author choose the competitive traditional journal or OA? The author's surplus from the competitive traditional journal is a : he or she pays no submission fee and the article gets one reader. The author's surplus from the competitive OA journal is $2a - 2c$: he or she pays a submission fee of $2c$ and gets the $2a$ total benefit of two readers. If $2a - 2c > a$, or upon rearranging $a > 2c$, an OA journal wins the competition for the high-demand author.

Combining all of the analysis of competition, we have the following proposition.

Proposition 3. *If $a > 2c$, two journals are active in the market. One offers traditional pricing with no submission fee and a subscription fee which can range anywhere from c to r . The other offers OA, charging authors a submission fee of $2c$. The traditional journal may earn positive profit; the OA journal earns no profit.*

If $a < 2c$, all active journals offer traditional pricing, charging no submission fee and a positive subscription fee ranging anywhere from c to $2r$. Journals may earn positive profit.

Embedded in [Proposition 3](#) is a rich set of intuitive results listed and discussed in turn.

Result 7. *Market forces need not weed out one business model—traditional pricing or OA—over the other.*

We saw such a case [Proposition 3](#) when $a > 2c$. Under that condition, the market is served by two journals, one traditional, one OA. The implication of [Result 7](#) is that we should expect to see both pricing models to continue over the long run. The reason is that they serve different market segments. Traditional access attracts the segment of authors with low willingness or ability to pay for submissions by charging no submission fee. The journal assembles its articles to attract readers who are charged a positive subscription fees. OA journals are attractive to the segment of authors that put a high value on readership.

Result 8. *Every competitive journal market (regardless of subject area or quality levels) will feature some journals using traditional pricing.*

[Proposition 3](#) does not guarantee that a competitive market will feature OA. In particular, there is no OA if $a < 2c$. However, the presence of traditional pricing is guaranteed in all cases. The intuition for this

⁸ Technically, there are equilibria in which the low-demand author submits to a journal with such a high submission fee that it obtains no subscribers. Because the author obtains no value from readership, he or she would still be willing to submit an article to this journal. We will ignore this trivial case, focusing on cases in which journals must have at least some of both articles and readers to be identified as market participants.

result is that traditional journals provide an important function, providing an outlet for authors that cannot afford high fees or do not place much value on publication. As long as these authors continue to write articles of value to readers, there will be profit in collecting such articles and charging readers to access them.

Result 9. *Among competitive commercial journals, the ones using traditional pricing are likely to be more profitable than OA, which will generally operate near the break-even margin.*

This result highlights an asymmetry between the competitiveness of traditional and OA journals. There is a sense in which OA amplifies the intensity of competition. Since OA journals charge no subscription fees by definition, the only margin they compete on is author fees. This can be a particularly intense margin for competition because authors can easily shop among substitute journals for the one with the lowest fee. On the other hand, there is a limit to the competitiveness of traditional journals, even ones which are perfect substitutes for each other. Once they have attracted a set of articles, readers cannot freely shop among alternatives. The only way to obtain access to the articles controlled by these journals is to subscribe to them.

Result 9 should not be taken to imply that an OA journal cannot possibly turn a profit in real-world markets. To the extent that these markets are not perfectly competitive, and thus journals have some market power, it is not only possible that OA journals earn a profit but also likely that they do so. For example, in the case of a monopoly journal, we can refer to Fig. 2, in particular the upper right box, to see that an OA journal will be profitable if $2a - 2c > 0$, or rearranging, $a > c$. This condition may quite plausibly hold if we think online access reduces c to near 0.

Result 10. *In general, one cannot say whether increased competition makes OA more or less likely. If one is willing to assume that the Internet has reduced c close to 0, then it is definitively the case that competition makes OA more likely.*

Deriving this result requires one to compare Propositions 1 and 3. Proposition 1 states that OA arises under a monopoly when $a > r + c$. Proposition 3 states that OA arises under competition when $a > 2c$. Whether one or the other condition is stronger depends on the relative values of r and c . However, if one is willing to assume that c is close to 0, then the latter condition guarantees that OA arises under competition. For OA to arise under monopoly still requires a further condition that $a > r$, which may or may not hold.

NON-PROFIT JOURNALS

So far, the analysis has focused on for-profits, yet non-profits account for a perhaps larger share of the journal market. For example, of Walters and Linvill's (2011) sample of OA journals, as noted, 28% are published by commercial entities; of the remainder, 32% are published by university presses, 21% by societies, and 16% by governments or non-government organizations. This section extends the analysis to non-profit journals.

Modeling non-profits is difficult because they have multifaceted goals which vary from organization to organization. To make some headway, we will adopt the plausible assumption that non-profit journals try to make the scholarly community as well off as possible, welfare measured by the sum of the benefits of all authors and readers served by the journal net of any payments for submissions and subscriptions. To capture the limit to a journal's resources, further assume that its revenues must at least cover its costs.

Begin with the simple market with a single non-profit journal. We will analyze this case with the aid of Fig. 3. Fig. 3 resembles Fig. 2 but instead of listing profit, it lists the welfare generated when the journal serves different combinations of authors and readers.

		Number of readers	
		1	2
Number of authors	1	Box 1 $a + r - c$	Box 2 $2a + r - 2c$
	2	Box 3 $a + 2r - 2c$	Box 4 n.a.

Fig. 3. Welfare of the scholarly community for different combinations of authors and readers. Each box shows the welfare generated when the journal serves the numbers of authors and readers indicated in the row and column heading. Welfare is the sum of author and reader benefits in excess of fees paid to the journal. Box 4 is labeled "not applicable" because the outcome requires the journal not to charge fees, but then the journal cannot cover its costs.

To see the expression in Box 1 in the upper left, note that serving one author and one reader generates gross benefits a for the author and r for the reader. However they are divided between the author and reader, the fees in total must cover the total cost c of serving them. Subtracting total fees of c from the other benefits yields the listed expression for welfare (incidentally the same as the expression for profit in Fig. 2).

To see the expression in Box 2, the high-value author obtains gross benefit $2a$ from the two readers, and the high-value reader obtains gross benefit r from reading the single article. The only pricing structure that induces the low-value reader to subscribe is OA. Therefore the journal earns revenue solely through a submission fee, which must cover the total cost $2c$ of delivering a single article to two readers. Putting these terms together gives the listed expression. Note this is different from the expression for profit in Fig. 2. The high-demand reader's benefit did not factor into profit in Fig. 2 because the commercial journal cannot charge for that in an OA regime, but the non-profit publisher considers this r in its welfare calculations.

One can derive the expression in Box 3 using reasoning similar to the previous paragraph, but we will spare the reader the details.

By construction, the non-profit journal breaks even in all boxes but 4. To see which of the other three boxes the journal would choose is a simple matter of comparing the listed expressions. The next proposition provides the technical conditions.

Proposition 4. *Under the maintained assumptions $c < a$ and $c < r$, a single, non-profit journal never chooses to serve just one author and reader.*

If $a > r$, the journal charges a submission fee of $2c$, charges no subscription fee, and serves one author and both readers.

If $r > a$, the journal charges no submission fee, charges a subscription fee of $2c$, and serves both authors and one reader.

As before, we will unpack the implications of the technical proposition in a series of intuitive results.

Result 11. *Non-profit journals do not always prefer OA.*

We saw such a case in Proposition 4 when $r > a$. Under that condition, the non-profit journal prefers traditional pricing because this induces the low-demand author to submit his or her paper, which gives the high-demand reader a benefit of r . The logic here is so potentially counterintuitive it bears repeating. The non-profit journal prefers traditional pricing because of the benefits it confers *not to authors, but to readers*. High-value readers prefer traditional pricing to OA because the low submission fee associated with traditional pricing generates more publications.

We assumed that the non-profit journal acts on behalf of the scholarly community. Hence, whatever policy the non-profit journal chooses must also be the one that is best for the community. This insight leads directly to the next result.

Result 12. *In some cases, traditional pricing is better for the scholarly community than OA.*

The cases were identified in the immediately preceding discussion. When readers' benefits are high, it is important for authors to publish as much as possible, which traditional pricing encourages.

There are alternative means to accomplish this goal in an OA regime. The scholarly society, government, or funding agencies could provide direct subsidies to the journal, allowing it to reduce its submission fee so as not to deter submissions. For example, the Public Library of Science, whose flagship journals, *PLoS Biology* and *PLoS Medicine*, are now among the most highly cited in their fields, was founded with a \$9 million grant from the Moore Foundation. In spite of the substantial subsidy, author fees are still relatively high (\$2900 per accepted article) for these journals. *PLoS Medicine* currently offers a reduced submission fee of \$500 to authors from middle-income countries (such as Columbia) and free submission to authors from low-income countries (such as Bangladesh). Such targeted price discounts have an important rationale in our model in reducing distortions associated with high OA submission fees. To the extent that country income is an imperfect proxy for author income (or author funding), however, such price-discount schemes will not avoid all the associated distortions. Furthermore, to the extent that the original \$2900 was set to cover costs, discounts off that price require the journal to receive an external subsidy.

Juxtaposing Propositions 1 and 4 allows us to compare when a single for-profit journal would choose OA relative to when a single non-profit journal would do so. According to Proposition 1, the required condition for a for-profit journal is $a > r + c$. According to Proposition 4, the required condition for a non-profit journal is $a > r$. It is immediate that a non-profit journal would adopt OA under a larger set of conditions.

Result 13. *A non-profit journal is more likely to adopt OA than a for-profit journal.*

As discussed, the non-profit journal's choices are also the ones that are best for the scholarly community in our model. Therefore, Result 13 leads immediately to the next result.

Result 14. *A for-profit journal adopts OA in fewer cases than would be good for the scholarly community.*

A monopoly for-profit journal that switches to OA loses revenue r that could have been earned from the high-demand reader. As long as its costs are covered, the non-profit journal does not care about this revenue loss, appreciating that this reader is still enjoying the benefit of access regardless of whether he or she is paying for it.

The comparison between for-profit and non-profit journals was done in the case of a single (monopoly) journal. To be confident in these conclusions, we would like the results to extend to the case of multiple journals and hybrid journals. They do. The fairly technical arguments are relegated to the appendix.

CONCLUSIONS

The paper introduced a simple economic model to help understand trends in OA in the market for scholarly journals, both from a *positive* perspective—explaining what has happened and predicting what will happen—and from a *normative* perspective—suggesting what changes have benefited the scholarly community and what further changes might generate further benefits.

From a positive perspective, the analysis suggests that unless external mandates or other pressures are brought to bear, standard market forces will likely leave room for both traditional and OA pricing models (Results 1 and 11). The fall in distribution cost due to online access likely made a big contribution to the growth of OA up to this point, and this and further technological advances will likely contribute to its continued growth (Result 2). We should observe some expansion of OA among for-profit journals, more expansion of OA the more competitive the market (Result 10), and more expansion among non-profits than for-profits (Result 13). An expansion of OA can have a feedback effect, on intensifying competition in the market (Results 6 and 9). Competition can be more intense than with traditional access because the side that pays the fees, the author side, is able to shop across journals. With traditional access, readers have less opportunity to shop because the journal has exclusive rights to the articles they publish.

Despite the expansion of OA that has been experienced and may continue in the future, our results suggest that traditional journals will continue to serve a niche in every subdiscipline/market (Result 8). The niche is in serving those authors who, though they may care about having their quality certified by a journal, either do not care about wide readership or have limited resources to fund high submission fees (low-demand authors in the model). In every market, a traditional journal can serve low-demand authors by charging low submission fees and then profit from subscription fees from the high-value readers of these articles. The only way such a strategy might be squelched is if OA journals apply external subsidies to fund discounts to authors with low ability or willingness to pay for submissions. The Public Library of Science has implemented a version of such a policy, providing discounts based on average incomes in the author's country. However, it is difficult to exactly target something as hard to measure as ability/willingness to pay. Such a policy requires an external subsidy, to which not all journals have access.

From a normative perspective, our results suggest that a universal call for OA may be misguided (Result 12). The higher submission fees offsetting the lower subscription fees introduce their own distortion, leading to fewer submissions for low-demand authors. The major side effect from the introduction of OA is not what one might at first think. It is not authors who suffer the most potential harm as a group but readers, in particular high-demand readers who would have valued the articles that are deterred by the high submission fee. While at first this result may seem counterintuitive, it is standard insight from "platform-market" models.

Though *universal* OA may not be efficient, more OA than what commercial journals find profitable to offer would be good for society (Result 14). Mandated OA could help improve welfare (Results 3 and 4) but may overshoot the mark if it eliminates traditional access entirely.

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APPENDIX. MULTIPLE NON-PROFIT JOURNALS

The central result from *Non-Profit Journals* is that non-profits are more likely to adopt OA than for-profits. We showed this by comparing the pricing policy of a single for-profit to that of a single non-profit. In this appendix we expand the range of comparisons, determining whether competing non-profits exhibit more OA than competing for-profits. We also allow multiple non-profits to coordinate their operations to varying degrees and to use hybrid pricing strategies. The appendix is rounded out with a discussion of competition between non-profits and for-profits.

A. INDEPENDENT NON-PROFIT JOURNALS

Begin with the case in which several non-profits offer competing journals. The meaning of the term “competing” is unclear when applied to non-profits because they are certainly not trying to profit by stealing business from each other as for-profits would. Non-profits share the same social objectives in the model. What we will take “competing” to mean is that the non-profits choose their fees independently, without coordinating with each other.

Proposition 3 stated that OA emerges from competition among for-profit journals when $a > 2c$. We will show that OA emerges with independent non-profits under this same condition.

Proposition 5. *Suppose independent non-profit journals can enter the market. If $a > 2c$, then at least one of them adopts OA.*

To prove the proposition, begin by supposing that one of the non-profit journals offers OA. This pins down the subscription fee. The submission fee is pinned down by the journal’s non-profit status: a submission fee of $2c$ is required to cover the cost of delivering the article to the two readers ensuring the journal earns exactly zero profit. It is not a stable outcome for this journal to operate alone: a second non-profit can enter and increase welfare. The second journal can offer traditional access, charging a submission fee of 0 and a subscription fee of c . Welfare increases by $r - c$, the excess of the high-demand reader’s benefit above the submission fee he or she pays. This is an increase because $r > c$ by maintained assumption.

If this entering traditional journal lures the high-demand author away from the OA journal, then OA is not stable. The high-demand author obtains net surplus $2a - 2c$ from submitting to the OA journal because he or she has two readers and pays a submission fee of $2c$. The high-demand author would obtain net surplus a from submitting to the traditional journal. If $a > 2a - 2c$, or rearranging, $2c > a$, then the high-demand author is lured away. If $a > 2c$, the high-demand author is not lured away and OA is stable. This completes the proof of the proposition.

Proposition 5 does not imply that independent non-profits are strictly more likely to adopt OA than competing for-profits but does imply that they are not strictly less likely to do so. So the case of independent non-profits is not inconsistent with Results 13 and 14 as long as they are construed as “weak” results, stating that there is no less OA with non-profits than with for-profits.

B. LOOSELY COORDINATING NON-PROFITS

The case analyzed in this section involves non-profit journals that can coordinate their entry and pricing decisions, but cannot cross-subsidize each other. All active non-profits have to at least break even on their own. We will show that this loose form of coordination expands the amount of OA. The following proposition provides the technical conditions.

Proposition 6. *Suppose non-profit journals coordinate entry and pricing decisions but cannot make side payments to each other. At least one of them adopts OA if $a > 2c$ or if $r < a < 2c$.*

To prove this proposition, note first that if $a > 2c$, we saw in the proof of Proposition 5 that at least one non-profit journal offers OA if they do not coordinate. If they coordinate, this is still the case, verifying the first condition.

So suppose $a < 2c$. There can still be OA when non-profits can coordinate. Other non-profits besides the OA journal can agree not to serve the market with a traditional journal. This allows the OA journal to charge a submission fee high enough to cover the $2c$ cost without fear that the high-demand author would be lured away by a traditional journal. OA can always break even if journals coordinate in this way. It remains to check that OA generates more welfare than

traditional access. This will be the case if Box 2 in Fig. 3 has a higher associated welfare than Boxes 1 or 3. We saw the condition for this in Proposition 4, namely, $a > r$. This completes the proof of Proposition 6.

Putting Propositions 3 and 6 together, we see that if $r < a < 2c$, there is OA with cooperating non-profits but not with competing for-profits. Overall, then, there is strictly more OA with loosely coordinating non-profits than competing for-profits.

C. TIGHTLY COORDINATING NON-PROFITS AND HYBRID PRICING

This section considers even closer coordination among non-profits, allowing them not just to coordinate fees and entry decisions but also to make side payments among each other. This relaxes the constraint that each journal has to break even individually. All that is needed is for the sum of their profits to be 0. This tight form of coordination is no different than having a single non-profit operate all of the journals in the market. Furthermore, having a single non-profit operate a portfolio of journals is no different than having it operate a single journal as long as it can use a hybrid pricing scheme. Thus we will use the framework of hybrid pricing by a single non-profit for the analysis of this section.

The following proposition provides a formal statement of the comparison that we are after in this section.

Proposition 7. *A single non-profit journal adopts hybrid pricing (with an OA option that at least some authors elect) if $a + r > 3c$. This condition holds more often than the condition under which competing for-profits adopt OA ($a > 2c$).*

To prove the proposition, consider each option in the non-profit’s hybrid scheme. The non-profit need not exactly break even on the traditional-access option. It can earn a profit on the option by charging a submission fee of 0 and a subscription fee of r . This will give it a surplus it can use to subsidize its OA option. OA can be offered for a submission fee of $3c - r$. Its revenue across both offerings sums to $r + 3c - r = 3c$, which covers its costs of three article distributions (one associated with its traditional-access operation and two with its OA). The high-demand author opts for OA if his or her surplus for that option exceeds his or her surplus from the traditional-access option. His surplus from OA equals gross benefit $2a$ from having two readers minus the submission fee $3c - r$, or rearranging, $2a + r - 3c$. This expression exceeds his or her surplus from traditional access, a , if $a + r > 3c$.

It remains to show that this last condition holds more often than $a > 2c$. But $a > 2c$ implies $a + r > 2c + r > 3c$, where the first inequality holds because the same r is added to both sides and the second because $r > c$ by maintained assumption. This completes the proof of the proposition.

As discussed above, hybrid pricing by a single non-profit is equivalent to cooperative pricing among several non-profits who can make side payments among themselves. Thus Proposition 7 has the corollary that there is more OA with multiple tightly coordinating non-profits than with competing for-profits.

Proposition 7 also has implications for the comparison between the amount of OA chosen by a monopoly for-profit compared to a single non-profit. We already argued (see Result 13) that a single non-profit journal adopts OA more often than a monopoly for-profit journal when hybrid pricing is excluded from the analysis. When hybrid pricing is included, we will argue the result becomes stronger. Result 3 states that the for-profit journal never uses hybrid pricing in our model (absent a mandate). Proposition 7 indicates that the non-profit journal sometimes uses hybrid pricing. Since hybrid pricing involves some OA, adding hybrid pricing increases the measure of cases in which a single non-profit adopts some form of OA but a for-profit does not.

D. COMPETITION AMONG BOTH NON- AND FOR-PROFITS

So far we have studied competition among just non-profits or just for-profits. In this section we study competition among both types simultaneously. To reduce the number of subcases to analyze, assume that there are many potential journals of both types, that the non-profits operate independently rather than coordinating, and that journals use simple rather than hybrid pricing strategies.

Before performing any formal analysis, one might naturally ask whether the outcome is similar to Proposition 3, proved for the case in which competing journals were all for-profits, or Proposition 5, proved for the case in which competing journals were all non-profits, or some combination of them. In fact, the outcome is exactly as stated in Proposition 3. The presence of for-profit journals eliminates any outcomes that generate high levels of welfare by having journals forgo opportunities to earn a profit. Such outcomes are sometimes stable when only non-profit journals are present on the market, leading to the broader range of outcomes consistent with Proposition 5. Eliminating such outcomes reduces the set of possibilities to exactly those in Proposition 3.

Nevertheless, competition from non-profits does not necessarily dissipate all profits for commercial journals. The low-demand author may decide to submit to a commercial journal charging a high subscription fee, possibly generating a profit for this journal, leading to the range of subscription fees and profits stated in Proposition 3.

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