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The Pricing of Academic Journals: A Two-Sided Market Perspective*

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Abstract

More and more academic journals adopt an open-access policy, by which articles are accessible free of charge, while publication costs are recovered through author fees. We study the consequences of this open access policy on a journal's quality standard. If the journal's objective was to maximize social welfare, open access would be optimal as long as the positive externalities generated by its diffusion exceed the marginal cost of distribution. However, we show that if an open access journal has a different objective (such as maximizing readers' utility, the impact of the journal or its profit), it tends to choose a quality standard below the socially efficient level.

Keywords: Academic Journals, Open-Access, Reader-Pays, Two-Sided Market, Endogenous Quality.

JEL numbers: D42, L44, L82

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1 Introduction

The development of electronic publishing and the dissatisfaction with academic journal price escalations has led to an increasing support for the open-access model (also called the author-pays model), where authors pay for submitting and/or publishing their articles, while readers can access published articles at no charge through the Internet. There are (as of October 8, 2009) 4366 open-access journals in all fields (of which 88 in Economics)[1] and open access publishing currently represents approximately 5% of the total market for academic journals.[2]

The report of the Science and Technology Committee of the UK House of Commons (House of Commons henceforth, 2004) gives an overview of issues related to author-pays publishing: the main argument in favor of open-access is greater dissemination of research findings whereas the report expresses concerns that an author-pays model may induce authors to publish less because of problems of affordability. Along similar lines, Dewatripont et al. (2006) recommend funding authorities to create a 'level-playing field' between reader-pays and author-pays models by "allocating money to libraries to subscribe to reader or library-pay journals but also to authors to pay for publication costs in author-pay journals" (p.11). Another type of concern, which is the focus of our paper, is that author fees may induce journal editors to accept a higher proportion of articles, which may have negative implications for quality.[3]

This paper builds a model of an academic journal that fulfills a double role of certification and dissemination of knowledge and studies its pricing from a two-sided market perspective. We aim at generating insights useful to policy makers by conducting both normative and positive analyses. Adopting first a normative viewpoint, we show that, for an electronic journal maximizing social welfare, open access is socially optimal because the marginal cost of providing access to a reader is zero. If subsidizing reading were feasible, it would be even optimal to do so because each reader exerts positive externalities on the rest of society.[4] An example of these externalities is development of innovations inspired by the ideas contained in the articles. Even though authors also exert positive externalities by publishing their articles, there is no need to subsidize authors for submit-

[1]See the Directory of Open-Access Journals' (DOAJ) website (www.doaj.org).

[2]See House of Commons Science and Technology Committee (2004, p.73). Among major open-access publishing initiatives, one can mention the Public Library of Science (PLoS) and BioMed Central.

[3]According to House of Commons (2004), "if author-pays publishing were to become the dominant model, there is a risk that some parts of the market would be able to produce journals quickly, at high volume and with reduced quality control .... " (p. 81)

[4]This implies that open access can also be optimal for a printed journal (that has a positive cost of dissemination) if the positive externalities exerted by readers exceed the marginal cost of dissemination (reproduction and distribution).

ting articles as long as they get substantial benefits from publication, while the submission cost remains negligible.[5]

Then, adopting a positive perspective, we study how the move from the traditional reader-pays model to the open access model affects a journal's quality standard, both for a not-for profit journal and for a for-profit journal[6]. We find that in both cases, but for different reasons, the move might decrease quality below the socially efficient level. We first consider a not-for-profit journal run by an academic association. If the objective of the association were to maximize social welfare, the move to open access would lead to the social optimum. However the association is likely to pursue its own objective. We consider two possibilities for its objective: the total utility of the readers or the impact of the journal.[7] We find that the association tends to choose too high a quality standard under the reader-pays model while it tends to choose too low a quality standard under open access, compared with the second best level. A simple intuition can be given in terms of internalization of costs. First, a social welfare maximizing journal internalizes the publication cost $\gamma(> 0)$ minus the author's fixed benefit from publication $u(> 0)$. It is reasonable to assume $\gamma - u > 0$.[8] Second, a not-for profit journal maximizing readers' utilities under the reader-pays model has to recover γ entirely from subscription revenues, but it does not internalize u, which leads to publishing too few articles. On the contrary, a not-for profit journal maximizing readers' utilities under the open access model internalizes neither γ (since its costs are covered with author fees) nor u, which leads to publishing too many articles. Furthermore, this quality degradation under open access can result in reducing the number of readers compared with the level under the reader-pays model, if publishing too many articles induces many high-cost readers to stop reading the journal. However, we find that as long as the number of readers is larger under open access than under the reader-pays model, the change from the reader-pays model to the open access model unambiguously increases social welfare. In addition, we show that under open access, an impact-maximizing journal chooses the same quality standard (and hence the same number of readers) as the one chosen by a journal maximizing readers' utility.

[5]We focus on the dissemination of research articles and do not model the prior stage where these articles are produced. Needless to say, subsidizing production of articles is socially desirable.

[6]In the price search engine on internationally published journals (www.journalprices.com), maintained by Ted Bergstrom and Preston McAfee, 63% of 9002 journals in 11 fields are for profit journals.

[7]The missions stated by some not-for profit journals are "to advance science and serve society" (Science), "to publish highly selective, widely cited articles of current relevance" (Journal of Political Economy), "to publish original articles in all branches of economics" (Econometrica). The objectives we consider are consistent with the above missions.

[8]Otherwise, it might be socially optimal to publish all articles and then the journal would not have any certification role.

In the case of a for-profit journal, we also find (see Appendix) that it tends to choose too high a quality standard under the reader-pays model while it can choose too low a standard under open access. Under the reader-pays model, publishing low quality articles that give readers a benefit smaller than their reading cost only reduces the journal's profit. On the contrary, under open access, the journal does not internalize inframarginal readers' costs of reading, as long as they are willing to read the journal. Therefore the journal can have an incentive to publish low quality articles in order to increase its profit from author fees. In summary, in the case of a for-profit journal, quality degradation is caused by the non-internalization of reading costs while in the case of a not-for-profit journal maximizing readers' utility (and hence internalizing reading costs), quality degradation is caused by the non-internalization of publication costs.

Our paper builds on two strands of the literature. First, it builds on the literature on two-sided markets (see for example Rochet and Tirole, 2002, 2003, 2006, Caillaud and Jullien, 2003, Evans, 2003, Anderson and Coate, 2005, Armstrong 2006 and Hagiu 2006). Two-sided markets can be roughly defined as industries where platforms provide interaction services between two (or several) kinds of users. Typical examples are payment cards, software, Internet and media. In such industries, it is vital for platforms to find a price structure that attracts sufficient numbers of users on each side of the market. Our paper has two novel aspects. First, in addition to choosing a price for each side, the platform (i.e. the academic journal) can choose a minimum quality standard. Second, the externality from authors to readers is not always positive: as the number of published articles increases (and hence as the quality standard decreases), the net utility that a reader obtains from the platform increases up to a maximum and then decreases.

Second, our paper builds on the literature on the economics of academic journals, that has initially adopted a one-sided perspective, focusing on library subscriptions (McCabe, 2004, Jeon and Menicucci, 2006 and Armstrong 2009). For instance, Jeon and Menicucci (2006) show that bundling electronic journals makes it difficult for small publishers to sell their journals. To our knowledge, McCabe and Snyder (2005a,b, 2006, 2007) are the first papers to study the pricing of academic journals from a two-sided market perspective. McCabe and Snyder (2006, 2007) study pricing of academic journals under different industry structures (monopoly, duopoly, free entry) but in their model all articles have the same quality and hence journals do not provide any certification function.[9] Our model is closer to McCabe and Snyder (2005a,b), who consider a monopoly journal providing certification services. However, there are significant differences with our approach. McCabe and Snyder (2005a,b) take the quality standard of the journal as given (it is determined

[9] An exception is section 5.4 in McCabe and Snyder (2007) where they consider free entry and quality certification and obtain a specialization result: articles of different qualities are published by different journals.

by the talent of its editors) and examine how this quality standard affects the subscription price and thereby the adoption of open access.[10] By contrast, we endogenize the quality standard of the journal and study how the move from the reader-pays model to open access affects this quality standard and the readership size of the journal.[11]

The rest of the article is organized as follows. Section 2 presents our model. Section 3 characterizes the first-best allocation. Section 4 characterizes the second best allocation, defined as the one that maximizes social welfare under the constraint that reading cannot be subsidized. Section 5 studies the policy chosen by a not-for-profit journal maximizing readers' utility under the reader-pays model and under open access. Section 6 performs a comparison among four different outcomes. Section 7 considers, as robustness checks, a hybrid model (charging both author fee and subscription price) and an impact-maximizing journal. Section 8 concludes. Appendix includes proofs and the analysis of a for-profit journal.

2 The model

We consider a single academic journal, modelled as a platform between a continuum of authors and a continuum of potential readers. The mass of authors is normalized to one. Each author has one article, which embodies "ideas" that may be useful to readers, for example because they allow them to develop innovations. The benefit from each innovation is not fully appropriated by the reader/innovator but also spills over to the rest of society, including to the author herself, through peer recognition.

The only way in which authors and readers can interact is through the academic journal.[12] Three conditions are required for this interaction to occur:

- authors must submit their articles to the journal;
- the journal must referee them and publish only those that meet its quality standard;
- readers must read the published articles.

[10] They find that open access is more likely to be chosen by a journal with poor editorial talent.

[11] There are three other differences. First, they do not consider a not-for-profit journal. Second, they consider binary support for an article's quality. Last, they assume that every author has the same prior belief about the quality of her article.

[12] This is because we assume that the average quality of the unpublished articles that are directly accessible through Internet is so low that readers prefer to look only at published articles. The academic journal plays thus a fundamental certification role: it filters out "junk" articles.

Thus, in our model, the academic journal plays two crucial roles: it **disseminates** academic production (i.e. articles) and **certifies** the quality of these articles in order to convince readers to read the journal. Since time is costly to readers, they will indeed read the journal only if they anticipate that the average quality of articles is good enough. Symmetrically, the benefit that an author obtains from publication increases with the readership size of the journal. Thus we are in a "chicken and egg" situation, characteristic of two-sided markets, where the platform (here the academic journal) has to attract both sides (here authors and readers) to be successful. However, by contrast with most of the literature on two-sided markets, the platform controls not only the number of interactions but also their quality, through its certification function.

The quality of each article is measured by a number q that is independently drawn from the same distribution, with support $[0, q_{\max}]$. We assume that the quality of an article is privately observed by its author. The journal has a perfect refereeing technology: by incurring a cost γ_R, it can perfectly observe the quality of a submitted article. Since our focus is on electronic journals, distributed through the Internet, we assume that the marginal cost of distribution is zero.[13] The journal incurs a publication cost γ_P per published article; it includes the cost of making the first (electronic) copy and any fixed cost of distribution per article (such as the cost of buying capacity to post an article). The journal commits to publish all submitted articles of quality $q \geq q_{\min}$, where $q_{\min}$ is the minimum quality standard chosen by the journal. In addition, the journal chooses its pricing policy. It charges p_S to all submitted articles, an additional p_P to all published articles and a subscription fee p_R to each reader.

Readers cannot observe the quality of an article before reading it but observe its quality after reading it. We assume that an article's quality cannot be verified ex post by a third party and therefore the journal's pricing scheme cannot be conditioned on realized quality[14].

The mass of readers is also normalized to one. All readers obtain the same expected benefit q after reading an article of quality q but differ in their "reading cost" c, which is independently drawn from a distribution with support included in $[0, \infty)$. Readers' benefit includes not only the increase in their knowledge but also the utility that they obtain from its use (such as production of other scientific articles, patents, commercial applications). As already mentioned, when an article is read, some utility from its potential applications also spills over to the rest of society, including to the author herself. More precisely,

[13] However our arguments can also be applied to a print journal, provided the marginal cost of printing and distributing copies is not too big.

[14] McCabe and Snyder (2005a,b) assume it as well. It can be justified by the fact that a Court cannot perfectly verify the quality of scientific articles.

when an article of quality q is published by the journal, the total (that is, monetary and non-monetary) benefit that the author obtains is given by

$$u + \alpha_A q n_R,$$

where $u(>0)$ and $\alpha_A(>0)$ are constants and n_R represents the number of readers. u is a fixed component: it corresponds to the utility from having one article published in the journal. For instance, if a tenure decision depends solely on the number of articles published in particular journals, a tenure-track professor derives some utility from publishing her article in those journals, this independently of the quality of the article.[15] By contrast, $\alpha_A q n_R$ is a variable component: it depends on the quality of the article. We interpret $q n_R$ as the impact of the article, proportional to the number of subsequent citations or to the number of patents that are subsequently based on the article. The constant $\alpha_A(>0)$ measures the strength of the relation between publication impact and authors' utility. A similar term $\alpha_S q n_R$ with $\alpha_S(>0)$ represents the benefit that spills over to the rest of society. We denote by $\alpha = \alpha_A + \alpha_S$ the total externality term.

The timing of the game is as follows:

1. The journal announces its editorial policy ($q_{\min}$) and its prices (p_S, p_P, p_R).
2. Authors decide whether or not to submit their articles to the journal.
3. The journal referees all submitted articles and accepts or rejects each of them.
4. Readers decide whether or not to buy the journal and read the articles.

Since both the author and the journal perfectly observe the quality q of a submitted article, the author perfectly knows whether or not her article will be accepted. Therefore, if $q < q_{\min}$ and $p_S > 0$, she will not submit the article. By contrast, if $q > q_{\min}$, the article will be accepted and she will have to pay the author fee $p_A(\equiv p_S + p_P)$. This implies an indeterminacy between p_S and p_P: only p_A matters. The fact that only articles of quality superior to $q_{\min}$ are submitted in our model[16] also implies that what matters for the journal is only the sum of the publication cost per article (γ_P) and the refereeing cost per article (γ_R), not its composition. Let $\gamma \equiv \gamma_P + \gamma_R$. We assume $\gamma > u$, implying that even when the reading cost is zero, publishing the lowest quality article (i.e. the one with $q = 0$) is not socially optimal. This assumption captures the certification role of the academic journal: by rejecting articles of low quality, the journal allows readers to concentrate on important articles and avoid proliferation of bad ones.

[15] u can also represent recognition from non-peers who do not read the journal.
[16] We assume however that the journal commits to effectively referee all submitted articles.

In summary, when an article is published in the journal, its author gets a fixed utility u while the journal incurs a fixed cost $\gamma(> u)$. When an article of quality q is read by a reader of cost c, the reader gets net utility $(q - c)$, and the rest of society (including the author) gets utility αq.

Each potential reader decides whether to read the journal or not, based on his expectation of the quality of published articles and on his (unit) cost of reading c. If the n_A best articles are published, the net utility of a reader of cost c is:

$$U_R = n_A[Q^a(n_A) - c] - p_R,$$

where $Q^a(n_A)$ is the (anticipated) average quality of the articles published in the journal.[17] This average quality can be inferred perfectly from the minimum quality standard $q_{\min}$ announced by the journal. Indeed, let us denote by $q(n_A)$ the n_A-th quantile of the distribution of articles' qualities (ranked by decreasing quality: $q(\cdot)$ is thus decreasing). This distribution is supposed to be common knowledge. We have by definition:

$$\Pr(q \geq q(n_A)) = n_A, \tag{1}$$

$$Q^a(n_A) = \frac{\int_0^{n_A} q(x)dx}{n_A}, \tag{2}$$

while

$$q_{\min} = q(n_A). \tag{3}$$

Similarly the number n_R of readers can be perfectly anticipated by authors, since the distribution of readers' costs is also supposed to be common knowledge. Let $c(n_R)$ denote the n_R-th quantile of the cost distribution (ranked by increasing cost: $c(\cdot)$ is thus increasing). We have by definition:

$$\Pr(c \leq c(n_R)) = n_R. \tag{4}$$

Moreover the utility of the marginal reader is zero, and thus:

$$n_A[Q^a(n_A) - c(n_R)] = p_R. \tag{5}$$

Thus knowing $q_{\min}$ and p_R (and the distributions of costs and qualities) each author can infer the number n_A of published articles, the average quality $Q^a(n_A)$ of these published articles, and thus by (5) the number of readers. Figure 1 describes the journal as a platform mediating authors and readers.

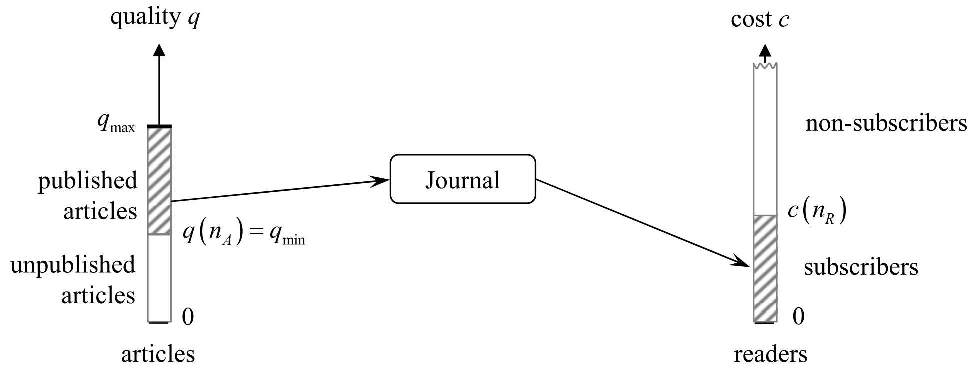

Figure 1: The journal as a platform.

3 The first-best allocation

In this section, we derive the first-best outcome, that would be implemented by a social planner who could choose who reads the journal and which articles are published. Obviously, if there are n_A articles published and n_R readers, efficiency requires that these are the articles with the highest qualities ($q \geq q(n_A)$) and the readers with the lowest costs ($c \leq c(n_R)$). Social welfare, denoted by $W(n_A, n_R)$ is then given by:

$$W(n_A, n_R) \equiv (1+\alpha)n_R \int_0^{n_A} q(x)dx - n_A(\gamma - u) - n_A \int_0^{n_R} c(y)dy. \tag{6}$$

In formula (6), the first term represents social benefit (readers + authors + the rest of society) when the n_A best articles are published and read by the n_R most efficient readers, the second term represents the total cost of publishing the journal, minus the total fixed benefit of authors and the last term represents the aggregate cost of reading the journal.

We assume that the parameters are such that the maximum of W is interior: the proportion of published articles is strictly between 0 and 1. Then, from the first order condition with respect to n_A, we have:

$$(1+\alpha)n_R q(n_A) = (\gamma - u) + \int_0^{n_R} c(y)dy. \tag{7}$$

Given that the n_R readers with $c \leq c(n_R)$ read the journal, condition (7) means that the optimal number of articles published, n_A, is determined by equalizing the social marginal

[17] This formula presumes that the readers who subscribe to the journal read all the articles it contains. It is indeed optimal for them to do so since the cost of reading articles is proportional to the number of articles and articles' qualities are indistinguishable a priori. Our analysis could be extended to the case where partial reading can be optimal because reading cost is strictly convex in the number of articles or because the journal signals the quality of published articles by ranking them ("lead" article).

benefit from publishing an article of quality $q(n_A)$, i.e. $(1+\alpha)n_R q(n_A)$, to the social marginal cost, which is equal to the sum of the net cost of publishing an article $(\gamma - u)$ and the aggregate cost of reading an article $\int_0^{n_R} c(y)dy$. (7) can be rewritten as:

$$(1+\alpha)q(n_A) = \frac{\gamma - u}{n_R} + C^a(n_R), \tag{8}$$

where

$$C^a(n_R) = \frac{\int_0^{n_R} c(y)dy}{n_R}$$

denotes the average cost of readers.

From the first order condition with respect to n_R, we have:

$$(1+\alpha)\int_0^{n_A} q(x)dx = n_A c(n_R). \tag{9}$$

Given that the n_A articles with quality $q \geq q(n_A)$ are published by the journal, condition (9) means that the optimal number of readers is determined by equalizing the social benefit from having one additional reader to the total cost of reading incurred by this marginal reader. (9) is equivalent to

$$(1+\alpha)Q^a(n_A) = c(n_R). \tag{10}$$

Since the externality term α is positive, condition (10) implies that for the marginal reader, the average utility from reading an article of the journal is lower than her cost of reading it. Thus, as we shall see below, the marginal reader should be subsidized. This is because she generates positive externalities on the rest of society by increasing the impact of articles and/or the number of innovations derived from them. Let $\left(n_A^{FB}, n_R^{FB}\right)$ denote the first-best allocation, characterized by (8) and (10).

We now study the minimum quality standard $q_{\min}^{FB}$ and the prices $\left(p_A^{FB}, p_R^{FB}\right)$ that implement the first-best outcome $\left(n_A^{FB}, n_R^{FB}\right)$ when the social planner has to satisfy the participation constraints for both authors and readers. Obviously, $q_{\min}^{FB}$ must be equal to $q(n_A^{FB})$. Given n_R, let $U_A(n_A : n_R)$ denote the utility that the n_Ath author derives from publishing her article in the journal. We have:

$$U_A(n_A : n_R) = \alpha_A q(n_A) n_R + u - p_A. \tag{11}$$

In order to induce the submission of all articles of quality superior to $q(n_A^{FB})$, the following constraint must be satisfied:

$$(PC_A)\ U_A(n_A^{FB} : n_R^{FB}) = \alpha_A q(n_A^{FB}) n_R^{FB} + u - p_A \geq 0;$$

which is equivalent to

$$p_A \leq \alpha_A q(n_A^{FB}) n_R^{FB} + u \equiv p_A^{\max}.$$

Given n_A, let $U_R(n_R : n_A)$ denote the utility that the n_Rth reader derives from subscribing to (and reading) the journal. We have:

$$U_R(n_R : n_A) = [Q^a(n_A) - c(n_R)]\, n_A - p_R. \tag{12}$$

In order to align each reader's incentive to subscribe to the journal (and to read it) with the social incentive (i.e. in order to induce only those with $c \leq c(n_R^{FB})$ to subscribe to the journal), the following incentive constraint[18] has to be satisfied for the marginal reader:

$$(IC_R)\ U_R(n_R^{FB} : n_A^{FB}) = \left[Q^a(n_A^{FB}) - c(n_R^{FB})\right] n_A^{FB} - p_R = 0,$$

which is equivalent to

$$p_R = \left[Q^a(n_A^{FB}) - c(n_R^{FB})\right] n_A^{FB} \equiv p_R^{FB}.$$

From (10), we have

$$p_R^{FB} = -\alpha Q^a(n_A^{FB}) n_A^{FB} < 0. \tag{13}$$

Therefore p_R^{FB} must be strictly negative. By contrast, p_A^{FB} can be strictly positive: this is because an author derives a strictly positive utility from publishing her article in the journal but incurs no submission cost. This implies that charging a small (but positive) price is compatible with the submission of all articles of quality higher than $q(n_A^{FB})$. In fact, any $p_A \leq p_A^{\max}$ achieves it. By contrast, each reader must incur a cost of reading the journal. Since reading generates positive externalities to the rest of society, it is optimal to subsidize readers by charging a subscription price that is lower than the marginal distribution cost. For an electronic journal, this distribution cost is zero, so that the subscription price must be negative. Summarizing, we have:

Proposition 1 *(First-best) (i) The first-best allocation $\left(n_A^{FB}, n_R^{FB}\right)$ is characterized by:*

$$(1+\alpha) q(n_A) = \frac{\gamma - u}{n_R} + C^a(n_R),$$
$$(1+\alpha) Q^a(n_A) = c(n_R).$$

(ii) To implement the first-best allocation, the social planner has to choose a minimum quality standard equal to $q_{\min}^{FB} \equiv q(n_A^{FB})$ and prices $\left(p_A^{FB}, p_R^{FB}\right)$ satisfying

$$p_A^{FB} \leq \alpha_A q(n_A^{FB}) n_R^{FB} + u \equiv p_A^{\max};\ p_R^{FB} = -\alpha Q^a(n_A^{FB}) n_A^{FB}.$$

Therefore, the subscription price must be strictly negative.

[18] We call it an incentive constraint instead of calling it a participation constraint since a participation constraint is usually defined by an inequality.

4 The second-best allocation

In the previous analysis of the first-best allocation we have made the somewhat implausible assumption that the social planner could induce a marginal reader of type $c(n_R^{FB})$ to read the journal by subsidizing it. However, charging a negative subscription price would not, in practice, necessarily induce the marginal reader to read the journal. This is because it is hard to monitor whether or not someone effectively reads the journal. Consequently, a negative subscription price would induce fake readers who have no or very weak interest in reading the journal to subscribe to it only to obtain the subsidy. Therefore, we consider here the second-best outcome in which the social planner is constrained to charge a non negative subscription price ($p_R \geq 0$).

Given p_R, the marginal reader is determined by

$$U_R(n_R : n_A) = \int_0^{n_A} q(x)dx - c(n_R)n_A - p_R = 0.$$

Therefore, requiring $p_R \geq 0$ is equivalent to requiring

$$c(n_R)n_A \leq \int_0^{n_A} q(x)dx. \tag{14}$$

Hence, in the second best outcome, the social planner maximizes $W(n_A, n_R)$ subject to (14). Again we assume that the parameters are such that in the (second-best) optimum, the proportion of published articles is strictly between 0 and 1. Define $L^{SB} = W - \lambda_1 \left[c(n_R)n_A - \int_0^{n_A} q(x)dx\right]$ where $\lambda_1 (\geq 0)$ represents the Lagrange multiplier associated with (14). The first-order conditions with respect to n_A and n_R are:

$$(1+\alpha)n_R q(n_A) = (\gamma - u) + \int_0^{n_R} c(y)dy + \lambda_1 \left[c(n_R) - q(n_A)\right]; \tag{15}$$

$$(1+\alpha)\int_0^{n_A} q(x)dx = n_A c(n_R) + \lambda_1 c'(n_R)n_A. \tag{16}$$

When condition (14) binds, we find from (16)

$$\lambda_1 = \frac{\alpha c(n_R)}{c'(n_R)} > 0.$$

Inserting $\lambda_1 = \frac{\alpha c(n_R)}{c'(n_R)}$ into (15) gives

$$(1+\alpha)n_R q(n_A) = (\gamma - u) + \int_0^{n_R} c(y)dy + \frac{\alpha c(n_R)}{c'(n_R)}\left[c(n_R) - q(n_A)\right] \tag{17}$$

The fact that (14) binds implies that

$$c(n_R) = Q^a(n_A). \tag{18}$$

In other words, the marginal reader's reading cost is equal to the average quality of the articles published in the journal. This, together with $Q^a(n_A) > q(n_A)$ implies that when we compare (7) with (15), the social marginal cost of publishing one more article is larger in the second-best allocation than in the first-best (this is because the additional term $\lambda_1 [c(n_R) - q(n_A)]$ is positive). Similarly, comparing (9) with (16) shows that the social marginal cost of having one more reader is larger in the second-best than in the first-best. Let $\left(n_A^{SB}, n_R^{SB}\right)$ denote the second-best allocation, characterized by (17) and (18). The previous arguments imply that $n_A^{FB} > n_A^{SB}$ and $n_R^{FB} > n_R^{SB}$, at least if W is quasi concave. These inequalities will be established formerly in Section 6, in the case of iso-elastic distribution functions.

Let $\left(p_A^{SB}, p_R^{SB}\right)$ denote a price vector implementing $\left(n_A^{SB}, n_R^{SB}\right)$ when the social planner chooses the quality standard $q^{SB} \equiv q(n_A^{SB})$. Since (14) binds, we have $p_R^{SB} = 0$. Therefore, open-access is second-best optimal. p_A^{SB} has to satisfy the participation constraint of the marginal author, implying :

$$p_A^{SB} \leq \alpha_A q(n_A^{SB}) n_R^{SB} + u.$$

Proposition 2 *(Second-best) When a negative subscription price is not feasible:*

(i) Open-access is socially optimal.

(ii) In this case, the second-best allocation $\left(n_A^{SB}, n_R^{SB}\right)$ is characterized by (17) and (18). In particular, the marginal reader's cost is equal to the average quality of published articles.

(iii) If W is quasi-concave in (n_A, n_R) then the second-best allocation involves less publications and less readers than the first-best: $n_A^{SB} < n_A^{FB}$ and $n_R^{SB} < n_R^{FB}$.

Proposition 2 characterizes the situations where open-access is optimal: when the positive externalities generated by readers (for instance through the innovations derived from academic articles) exceed the cost of distributing articles (which is zero for an Internet journal) and when subsidizing reading is not feasible (so that the first-best is not attainable), it is optimal to charge a zero subscription price. This reduces the number of readers with respect to the first-best allocation, which in turn reduces the net social benefit from publishing an article. Therefore the minimum quality standard is higher in the second-best allocation than in the first-best. Note that the second-best allocation coincides with the Ramsey optimum as long as the marginal author's benefit from publication is larger than γ.[19] Figure 2 describes the first-best and the second-best allocations.

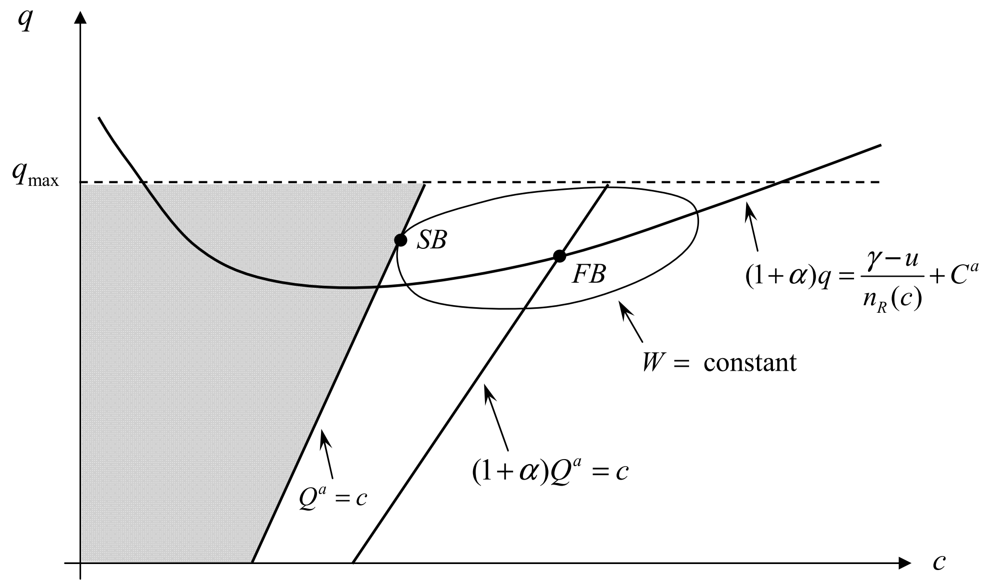

Figure 2: The first-best (FB) and the second-best (SB) allocations.
The shaded area corresponds to the region $p_R \geq 0$ (non negative reader price).

5 Positive analysis

In this section, we adopt a positive viewpoint and analyze the consequences of the move from reader-pays to open access for a not-for-profit journal run by an academic association. If the objective of the association were to maximize social welfare, this move would lead to the (second best) social optimum. However the association is likely to pursue its own objective. We consider two possibilities for the objective function of the association: the total utility of the readers[20] (in this section) or the impact of the journal (in Section 7.2). Our main result, that open- access is likely to lead to a decrease in the quality of academic

[19]In footnote 29, we give the condition under which the marginal author's benefit from publication is larger than γ for an open access not-for profit journal, in the case of iso-elastic distribution functions. We also show later on that the journal's quality is higher under the second-best than under the open access not-for-profit journal. Thus, if the condition holds, the marginal author's benefit is larger than γ in the second-best as well.

[20]We here have in mind a situation in which the association maximizes its members' utilities and one becomes a member by subscribing to its journal. In a more general framework, the association would internalize some fraction of authors' utilities as well, since some members are also authors. Our formulation here captures in a simple way the bias in the objective of the association toward the readers, as compared with that of the social planner.

journals, holds for both objective functions. We start (in Section 5.1) by explaining the basic intuition behind this result, and then characterize formally the outcomes under reader-pays (RP) and open access (OA).

5.1 The basic intuition

Recall that the readership of the journal is determined by the indifference of the marginal reader:

$$U_R(n_R : n_A) \equiv [Q^a(n_A) - c(n_R)]\, n_A - p_R = 0.$$

In the reader-pays model, the author fee is zero, and the budget breaking condition of the journal is

$$p_R n_R \geq \gamma n_A.$$

Eliminating p_R between these two conditions, we obtain the inequality characterizing the feasible set of the journal in the reader-pays model:

$$Q^a(n_A) \geq c(n_R) + \frac{\gamma}{n_R}. \tag{19}$$

Note that the feasible set under open access (where $p_R = 0$) corresponds to the same condition where γ is set equal to 0 (since γ is recovered by author fees) and the inequality is replaced by equality:

$$Q^a(n_A) = c(n_R). \tag{20}$$

Since $\gamma > 0$, we see that in order to attract the same number of readers, a RP journal has to offer a higher quality than an OA journal. This is the basic intuition behind our main result: the RP model imposes more discipline on quality choice.

Figure 3 below represents the two feasible sets and the indifference curves of the association. Under fairly general conditions the optimal choice of the association will entail higher quality (and possibly larger readership) under reader-pays than under open access.

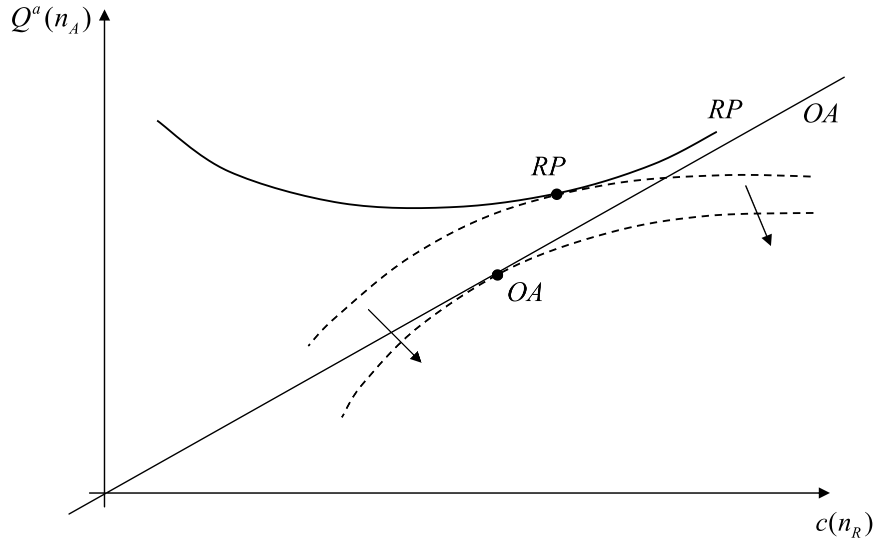

Figure 3: The reader-pays (RP) and the open-access (OA) allocations. The dashed lines correspond to the indifference curves of the association. The utility of the association increases in the direction of the arrows.

Of course, Figure 3 does not imply that open access always leads to a suboptimal level of quality. In fact, as we already noted, open access is indeed second best optimal when the association maximizes social welfare. This is why we now characterize formally the outcomes of reader-pays and open access, in order to compare them with the first best and second best outcomes. In this section, we consider that the association's objective is to maximize the sum of the readers' utilities given by:

$$TUR = \int_0^{n_R} \{[Q^a(n_A) - c(y)]\, n_A - p_R\}\, dy, \tag{21}$$

where TUR means total utility of readers. Since n_R and p_R satisfy the indifference condition of the marginal reader, i.e.

$$U_R(n_R : n_A) = [Q^a(n_A) - c(n_R)]\, n_A - p_R = 0,$$

we can replace p_R by $[Q^a(n_A) - c(n_R)]\, n_A$ in (21). We find:

$$TUR\,(n_A, n_R) \equiv n_A \int_0^{n_R} [c(n_R) - c(y)]\, dy.$$

5.2 Reader-pays

As we already saw, the feasible set of a reader-pays journal is characterized by:

$$c(n_R) + \frac{\gamma}{n_R} \leq Q^a(n_A). \tag{22}$$

The left-hand side of (22) is U-shaped in n_R. If its minimum is higher than the maximum quality $q_{\max}$, the feasible set is empty. We have therefore to assume that $q_{\max}$ is large enough to avoid this problem. In this case, for a given n_A, there may be two values of n_R that satisfy (22) with an equality: it is always optimal to choose the highest.

Therefore, the association maximizes $TUR\,(n_A, n_R)$ with respect to (n_A, n_R) subject to (22). Define $L^{RP} = TUR - \lambda_2 \left[n_A c(n_R) n_R + \gamma n_A - n_R \int_0^{n_A} q(x)dx\right]$ where λ_2 represents the Lagrangian multiplier associated with (22). Then, the first-order conditions with respect to n_A and n_R are given by:

$$\int_0^{n_R} \left[c(n_R) - c(y)\right] dy = \lambda_2 \left[c(n_R) n_R + \gamma - n_R q(n_A)\right], \tag{23}$$

and:

$$n_A n_R c'(n_R) = \lambda_2 \left[n_A c(n_R) + n_A c'(n_R) n_R - \int_0^{n_A} q(x)dx\right]. \tag{24}$$

Since (22) is binding at the optimum, we have

$$c(n_R) n_R + \gamma = n_R Q^a(n_A). \tag{RP}$$

From (RP), (23) and (24), we obtain:

$$C^a(n_R) = q(n_A) + \frac{\gamma}{n_R}\left[\frac{C^a(n_R) - c(n_R)}{n_R c'(n_R)} - 1\right]. \tag{25}$$

Let $\left(n_A^{RP}, n_R^{RP}\right)$ denote the association's optimal choice under the reader-pays model. It is characterized by (RP) and (25). Since $c'(n_R) > 0$ and $C^a(n_R) < c(n_R)$, (25) implies that $C^a(n_R) < q(n_A)$. Similarly, (RP) implies that $Q^a(n_A) > c(n_R)$.

Proposition 3 *(not-for-profit and reader-pays) Consider a not-for-profit journal run by an association maximizing the total utility of its readers. Under reader-pays, the allocation chosen by the association* $\left(n_A^{RP}, n_R^{RP}\right)$ *is characterized by* (RP) *and (25). In particular:*

- *the average quality of published articles is higher than the reading cost of the marginal reader, and*
- *the average reading cost is lower than the quality of the marginal article.*

5.3 Open access

Before studying open access, we note first that in our model, the association maximizing readers' utilities prefers open access to reader-pays as long as the marginal author's benefit from publication is larger than γ.[21] The association can at least choose the same quality

[21] In footnote 29, we give the condition that makes the marginal author's benefit under open access larger than γ, in the case of the iso-elastic distribution functions.

standard that is chosen under reader-pays: then the move to open access increases the number of readers and hence increases the sum of readers' utilities.[22] This argument also shows that the association prefers open access to any hybrid model in which the journal combines author fees with a positive subscription price.

We now consider open-access ($p_R = 0$). This, together with $U_R(n_R : n_A) = 0$ implies:

$$c(n_R)n_A = \int_0^{n_A} q(x)dx. \tag{OA}$$

The association maximizes $TUR\,(n_A, n_R)$ with respect to (n_A, n_R, p_A) subject to (OA), the budget breaking (BB) constraint:

$$(p_A - \gamma)n_A \geq 0, \tag{BB}$$

and the authors' participation constraint:

$$U_A(n_A : n_R) = \alpha_A q(n_A)n_R + u - p_A \geq 0. \tag{PC_A}$$

Note that p_A does not appear in the objective of the association. Without loss of generality, we assume that the association selects the lowest price that is compatible with (BB), namely $p_A = \gamma$. In what follows, we study the association's choice of (n_A, n_R) assuming that (PC_A) is slack at $p_A = \gamma$.

Define $L^{OA} = TUR - \lambda_3 \left[c(n_R)n_A - \int_0^{n_A} q(x)dx\right]$ where λ_3 represents the Lagrangian multiplier associated with (OA). Then, the first-order conditions with respect to n_A and n_R are given by:

$$\int_0^{n_R} \left[c(n_R) - c(y)\right] dy = \lambda_3 \left[c(n_R) - q(n_A)\right]; \tag{26}$$

$$n_A n_R c'(n_R) = \lambda_3 n_A c'(n_R). \tag{27}$$

From (26) and (27), we obtain:

$$q(n_A) = \frac{\int_0^{n_R} c(y)dy}{n_R} (\equiv C^a(n_R)). \tag{28}$$

Let $\left(n_A^{OA}, n_R^{OA}\right)$ denote the association's optimal choice under open access. It is characterized by (OA) and (28). (OA) means that the average quality is equal to the reading cost of the marginal reader. In a somewhat symmetric fashion, condition (28) means that the average reading cost $C^a(n_R)$ is equal to the quality of the marginal author's article.

[22]However, we do not expect all incumbent journals to switch to the open access model in the real world because of the budget constraint of authors (which we did not model for simplicity). As Dewatripont et al. (2006) argue, unless a level-playing field is created for open access journals (in comparison with reader-pay journals), which requires policy makers to provide funding for publication costs, it seems infeasible that a large number of existing journals simultaneously move to open access.

Proposition 4 *(not-for-profit and open-access) Consider a not-for-profit journal run by an academic association maximizing the total utility of its readers. Under open-access the allocation* $\left(n_A^{OA}, n_R^{OA}\right)$ *optimally chosen by the association is characterized by two conditions:*

- *the average quality of published articles is equal to the reading cost of the marginal reader, and*
- *the average reading cost is equal to the quality of the marginal article.*

6 Comparison of all four cases

In this section, we compare four scenarios (first-best, second-best, not-for-profit journal with open-access, not-for-profit journal with reader-pays) in terms of average quality of the articles published in the journal and number of readers. To facilitate the comparison, we choose a particular specification, that we call "iso-elastic":[23]

$$q(n_A) = q_{\max}\left[1 - (n_A)^{\varepsilon_q}\right] \quad \text{and} \quad c(n_R) = c_{\max}\,(n_R)^{\varepsilon_c}\,.$$

In our iso-elastic specification we have:

$$Q^a(n_A) = \frac{\varepsilon_q q_{\max} + q(n_A)}{1 + \varepsilon_q}$$

and

$$C^a(n_R) = \frac{c(n_R)}{1 + \varepsilon_c}.$$

6.1 Average quality

Proposition 5 *(average quality): Consider a not-for-profit journal run by an academic association maximizing the total utility of its readers. In the case of iso-elastic distributions, we have:*

$$Q^a(n_A^{RP}) > Q^a(n_A^{SB}) > Q^a(n_A^{FB}) > Q^a(n_A^{OA}).$$

The association chooses too high a quality standard under the reader-pays model and too low a quality standard under open-access.

[23] The specification $q(n_A) = K n_A^{-\varepsilon q}$ would not work, since it would imply $q(0) = +\infty$, and hence unbounded article qualities.

Proof. See the appendix. ■

Note that Q^{aOA} and Q^{aRP} depend neither on the externality parameter α nor on authors' fixed benefit u since the association does not internalize them. Furthermore, under open access, γ has no impact on the quality choice of the association since there are (by assumption) sufficiently many authors who are willing to pay $p_A = \gamma$ to publish their articles: the participation constraint of authors is not binding. But the social planner internalizes the net publication cost $\gamma - u$. Therefore, as long as $\gamma - u$ is positive, because of the lack of budgetary discipline, the association publishes too many articles under open-access: $Q^{aOA} < Q^{aSB}$.

Under the reader-pays model, the association has to recover γ by charging the sole readers. By contrast, what matters for the social planner is $\gamma - u$. This, together with the fact that the association does not internalize the authors' benefit, makes the reader-pays association publish too few articles compared with the second-best: $Q^{aRP} > Q^{aSB}$.

The intuition for why the change from reader-pays to open access induces a quality degradation can be given in two steps. First, given the quality standard chosen under the reader-pays model $q_{\min} = q(n_A^{RP})$, the move to open access increases the number of readers to n_R' determined by $c(n_R') = Q^a(n_A^{RP})$. Second, in the case of iso-elastic distributions, the condition $q(n_A^{RP}) > C^a(n_R')$ holds, which implies that the association finds it optimal to lower the standard to publish more articles. Basically, the reader-pays model imposes too much discipline on quality because of the need to recover γ while the open access model imposes too little discipline since γ is financed with author fees.

6.2 Readership size

We now compare readership size in the four regimes. First, comparing the first-best outcome with the second-best, we find:

$$c^{SB} < c^{FB},$$

which implies $n_R^{FB} > n_R^{SB}$. Furthermore, under open-access the marginal reader is determined by the average quality of articles (i.e. $Q^a = c(n_R)$). Since, by Proposition 5, the average quality is higher under the second-best than with an open-access association, readership size is larger in the former than in the latter. Therefore, we have:

$$n_R^{FB} > n_R^{SB} > n_R^{OA}.$$

We now compare the policy of an open-access association with that of a reader-pays association in terms of readership size. The comparison gives

$$n_R^{OA} \gtreqless n_R^{RP} \text{ if and only if } \varepsilon_q \gtreqless \frac{1}{1+\varepsilon_c}.$$

If $\varepsilon_q > \frac{1}{1+\varepsilon_c}$, the change from the reader-pays model to the open-access increases the readership size of the journal run by the association, as could have been expected. But a rather surprising result holds if $\varepsilon_q < \frac{1}{1+\varepsilon_c}$: in this case open-access reduces readership size. This occurs because even though readers do not pay for subscription, the average quality of the journal becomes very low under open access. Basically, there is a conflict between low cost readers and high cost readers over the choice of quality standard: the former prefers a low standard while the latter prefers a high standard. When $\varepsilon_q < \frac{1}{1+\varepsilon_c}$, the conflict is severe[24] and hence resolving the conflict in favor of low cost readers by lowering quality standard induces many high cost readers to stop reading the journal.

Summarizing, we have:

Proposition 6 *(readership size): Consider a not-for-profit journal run by an academic association maximizing the total utility of its readers. In the case of iso-elastic distributions, we have:*

$$n_R^{FB} > n_R^{SB} > n_R^{OA}.$$

The journal attracts too few readers under the open-access model. Moreover:

$$n_R^{OA} \gtreqless n_R^{RP} \text{ if and only if } \varepsilon_q \gtreqless \frac{1}{1+\varepsilon_c}.$$

The change from the reader-pays model to the open-access model increases the readership of the journal if $\varepsilon_q > \frac{1}{1+\varepsilon_c}$ and reduces it if $\varepsilon_q < \frac{1}{1+\varepsilon_c}$.

Figures 4 and 5 illustrate the allocations chosen by the association under open access and under reader-pays together with the second-best allocation.

[24] For instance, a small ε_c means that a small change in c creates a large change in n_R. Therefore, as ε_c decreases, a given quality degradation, that induces a decrease in the marginal c through $Q^a = c$, induces a larger reduction in n_R.

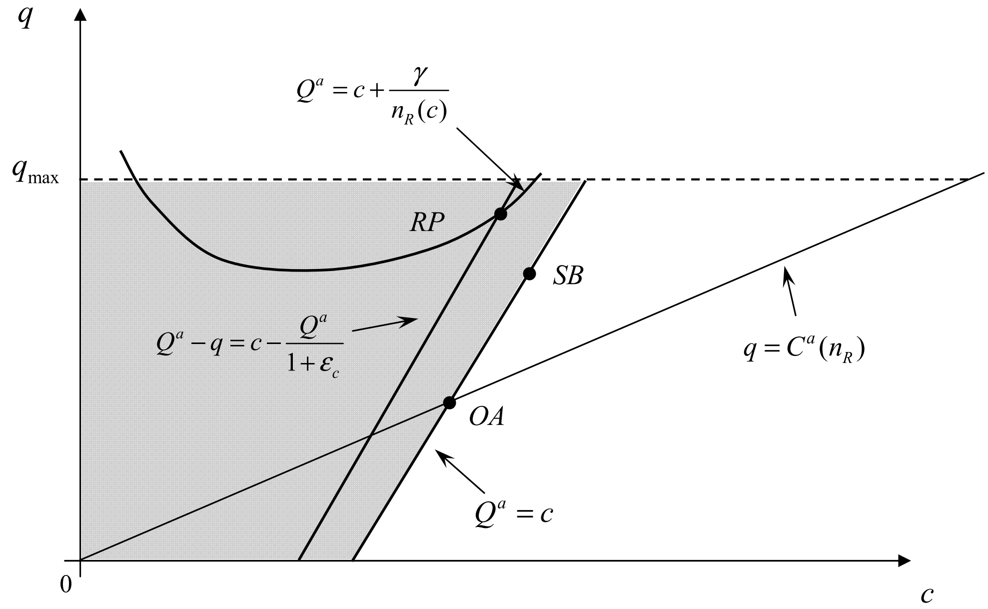

Figure 4: The allocations chosen by a not-for-profit journal when $\varepsilon_q < \frac{1}{1+\varepsilon_c}$ (OA: open-access, RP: reader-pays).

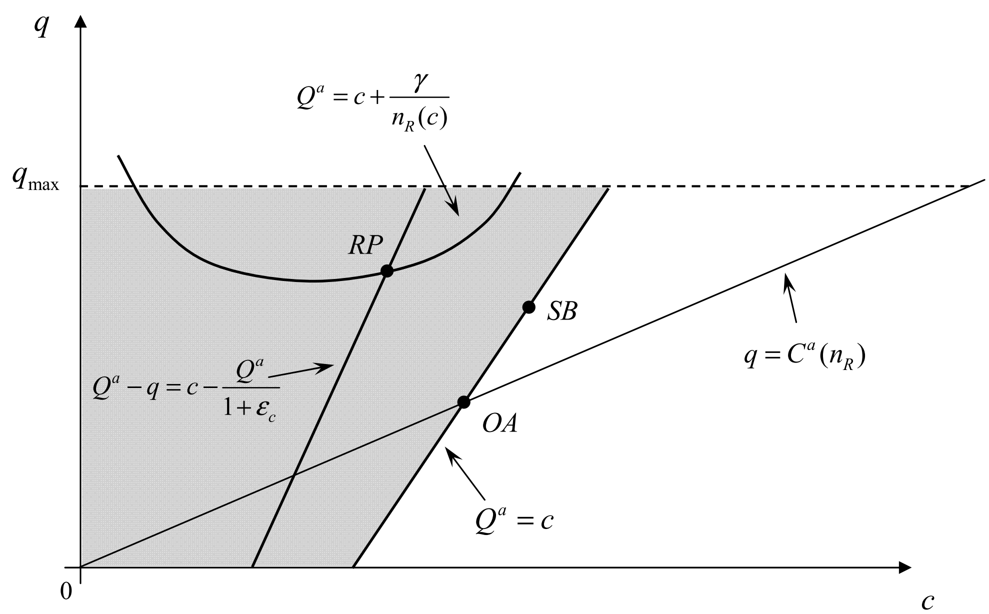

Figure 5: The allocations chosen by a not-for-profit journal when $\varepsilon_q > \frac{1}{1+\varepsilon_c}$ (OA: open-access, RP: reader-pays).

6.3 Social welfare

In this subsection, we compare the reader-pays model with the open access model in terms of social welfare, when the journal's objective is to maximize the sum of readers' utilities. Consider the special case $\varepsilon_q = \frac{1}{1+\varepsilon_c}$ in which, as seen from Proposition 6, the number of readers remains the same (i.e. $n_R^{RP} = n_R^{OA} = n_R$). Then, from section 3, we have:

$$\frac{\partial W}{\partial n_A} = (1+\alpha)n_R q(n_A) - (\gamma - u) - n_R C^a(n_R).$$

Under open access, $C^a(n_R) = q(n_A^{OA})$ holds. Then, from the participation constraint of the marginal author, we have $u + \alpha_A n_R q(n_A^{OA}) \geq \gamma$. Plugging these two conditions into the above first-order derivative shows that increasing the number of accepted papers increases social welfare (i.e. $\frac{\partial W}{\partial n_A} > 0$ for $n_A = n_A^{OR}$). This in turn implies that the open access model dominates the reader-pays model in terms of social welfare.

Consider now the case in which the number of readers is larger under open access than under the reader-pays model (i.e., $\varepsilon_q > \frac{1}{1+\varepsilon_c}$ holds). Then, we can also prove that the open access model dominates the reader-pays model. We proceed in two steps. First, suppose that the move from open access to reader-pays does not change the number of readers. Then, we know from the previous argument that $W(n_A^{OA}, n_R^{OA}) > W(n_A^{RP}, n_R^{OA})$. Second, when we keep the quality standard (hence the number of papers accepted) constant at $q(n_A^{RP})$, $W(n_A^{RP}, n_R^{OA}) > W(n_A^{RP}, n_R^{RP})$ must hold: since open access is second-best optimal for any given quality standard and the number of readers under open access is smaller when the quality standard is $q(n_A^{OA})$ than when it is $q(n_A^{RP})$, the reduction in number of readers from n_R^{OA} to $n_R^{RP}$when the standard is fixed at $q(n_A^{RP})$ reduces social welfare.

Finally, when $\varepsilon_q < \frac{1}{1+\varepsilon_c}$, the change from reader-pays to open access reduces the number of readers. In this case, we cannot obtain a general result. However, we have performed analytical computations[25] and simulations[26] suggesting that open access is likely to dominate the reader-pays model in terms of social welfare as long as the marginal author's participation constraint is slack under open access.

Summarizing, we have:

Proposition 7 *Consider a not-for-profit journal maximizing the sum of readers' payoffs. In the case of iso-elastic distributions, as long as open access does not lead to a significant*

[25]For instance, the Taylor expansion of W around $\gamma = 0$ shows that open access dominates the reader-pays model in terms of social welfare. Computations are available from the authors.

[26]In fact, simulations show that as ε_q decreases, the relative performance of reader-pays over open access in terms of social welfare improves.

reduction in terms of readership, the open access model leads to a higher social welfare than the reader-pays model.

7 Robustness

In this section, we show that our main result (open access can lead to quality degradation) is robust in the case of the two-sided pricing model where both authors and readers pay and when the journal maximizes impact: the analysis of the for-profit journal is relegated to the Appendix.

7.1 The two-sided pricing model

In this section, we consider the case in which the journal cannot recover the entire publication cost through author fees because of the authors' budget constraint and hence study the transition from the reader-pays model to the two-sided pricing model in which the journal complements author fees with a positive subscription price. Let $B(< \gamma)$ be the maximum amount authors can pay. Under the two-sided pricing model, the journal charges an author fee equal to B and recovers $(\gamma - B)n_A$ through a subscription price:

$$p_R n_R = (\gamma - B)n_A.$$

Let $\gamma' \equiv \gamma - B$. Then, the two-sided pricing model is equivalent to a reader-pays model in which γ is replaced by γ'. Hence, we need to know how the quality standard under the reader-pays model changes as γ decreases. In the appendix, we show that this quality standard decreases as γ decreases in the case of iso-elastic distribution functions. Summarizing we have:

Proposition 8 *Consider a not-for-profit journal maximizing the sum of readers' utilities in the case of iso-elastic distribution functions. When each author is budget constrained and can afford to pay at most a fee $B(< \gamma)$, the move from the reader-pays model to the two-sided pricing model:*

(i) always induces a quality degradation.

(ii) also reduces the number of readers if $\varepsilon_q < \frac{1}{1+\varepsilon_c}$.

Proof. See the appendix. ■

7.2 Impact-maximizing journal

Maximizing the utility of readers is a reasonable objective for a reader-pays (not-for-profit) journal, since readers are also the members of the association that controls the journal. However this objective may seem less natural for an open-access journal. Thus the move from reader-pays to open-access may be accompanied by a change in objective. To account for this possibility, and as a robustness check, we consider now an alternative objective for the journal. We assume that it endeavors to maximize its impact, measured by the sum of all readers' benefit from reading the journal:

$$IM(n_A, n_R) \equiv n_R \int_0^{n_A} q(y)dy.$$

IM is proportional to the number of citations of the article, or to the number of patents derived from it.

The association maximizes $IM(n_A, n_R)$ with respect to (n_A, n_R, p_A) subject to (OA), the budget breaking constraint (BB) and the authors' participation constraint (PC_A):

$$c(n_R)n_A = \int_0^{n_A} q(x)dx; \tag{OA}$$

$$(p_A - \gamma)n_A \geq 0 \tag{BB}$$

$$U_A(n_A : n_R) = \alpha_A q(n_A)n_R + u - p_A \geq 0. \tag{PC_A}$$

As before, p_A does not appear in the objective of the association. Without loss of generality, we assume that the association selects the lowest price that is compatible with (BB), namely $p_A = \gamma$. In what follows, we study the association's choice of (n_A, n_R) assuming that (PC_A) is slack at $p_A = \gamma$.

Define $L^{IM,OA} = IM(n_A, n_R) - \lambda_4 \left[c(n_R)n_A - \int_0^{n_A} q(x)dx\right]$ where λ_4 represents the Lagrangian multiplier associated with (OA). Appendix shows that the allocation chosen by the impact-maximizing organization under open access, denoted by $\left(n_A^{IM,OA}, n_R^{IM,OA}\right)$, is characterized by (29) and (OA).

$$q(n_A) = \frac{c(n_R)}{1 + \frac{n_R c'(n_R)}{c(n_R)}}. \tag{29}$$

Furthermore, in the iso-elastic case, this allocation coincides with the allocation chosen by an open-access journal maximizing the utility of its readers. Indeed condition (28) (marginal quality equals average readers cost) coincides in this case with condition (29), since:

$$C^a(n_R) = \frac{1}{n_R} \int_0^{n_R} c(y)dy = \frac{c(n_R)}{1 + \varepsilon_c} = \frac{c(n_R)}{1 + \frac{n_R c'(n_R)}{c(n_R)}}.$$

Proposition 9 *(i) Under open access, the allocation chosen by an impact-maximizing journal* $\left(n_A^{IM,OA}, n_R^{IM,OA}\right)$ *is characterized by* (OA) *and (29).*

(ii) In the case of iso-elastic distributions, this allocation coincides with the allocation chosen by a journal who maximizes the utility of its readers.

Proof. See the appendix. ■

Proposition 9 shows the robustness of our main conclusion, at least in the iso-elastic case. Independently of whether the journal maximizes its impact or the utility of its readers, it chooses the same quality standard, which is below the socially efficient level.

8 Concluding remarks

We showed that for an electronic academic journal, social welfare maximization implies open access given that subscription prices cannot be negative. This is because the marginal cost of distribution is zero, while readers exert positive externalities on the rest of society. We also examined the consequences of a move from the reader-pays model to the open-access model by considering journals run by not-for-profit associations or by for-profit publishers. The reader-pays model imposes too much discipline on quality since the journal has to recover publication costs from subscription fees and the journal does not internalize the positive externalities on authors and society. Under open access, a for-profit journal does not internalize reading costs and hence can have an incentive to publish low quality articles to increase its profit from author fees. What is rather surprising is that the move to open access may generate quality degradation even for a not-for-profit journal maximizing readers' payoffs (and hence internalizing reading costs). The basic intuition is simple: under open access, the association does not internalize the cost of publication (which is covered by author fees) while a social-welfare maximizing journal internalizes this (net of authors' fixed benefit from publication). Furthermore, quality degradation can even make the number of readers smaller under open access than with the reader-pays model. This happens when publishing too many articles induces a large number of high cost readers to stop reading the journal. However, as long as open access does not reduce readership, we find that the open access model unambiguously gives higher social welfare than the reader-pays model, in the case of a not-for profit journal maximizing readers' utilities.

Even though we did not model library subscriptions under the reader-pays model, our main results seem to be robust to the introduction of this feature, as long as we maintain the assumption that the journal charges a uniform subscription price. Note first that library subscription plays no role under open access. Under reader-pays model, as a first approximation, we can reinterpret a reader in our model as a group of readers for which a library makes the subscription decision. Then, a library will subscribe only if the total benefit of its group is larger than the sum of the subscription price and the total reading cost of its group. Hence, library subscription decisions would also impose some discipline on the quality standard of the reader-pays model.

It would be interesting to extend our analysis to the case in which the journal can signal the quality of an accepted article by giving it one among several ratings. For instance, some B.E. journals in economics give one among three quality ratings (Advances, Contributions, Topics).[27]

There are other interesting issues to study regarding open access journals. One of them is to know how the change in the pricing model affects competition among journals. There is a "bottleneck argument"[28] according to which the change from reader-pays to open access would promote competition. Indeed, once articles are published in journals, each journal is a bottleneck and has a monopoly power on its content; however, at the submission stage (i.e. prior to publication) journals are substitutes and compete for attracting authors. A formal modeling of the consequence of open access on authors' submission policies, together with readers' choices, could provide interesting insights into this "bottleneck argument".

[27] The simple model we considered at the end of Appendix to analyze a for-profit journal shows that publishing some low quality articles together with high quality articles can be socially optimal when articles generate large positive externalities on the society. In this case, completely revealing each article's quality reduces social welfare since then readers will read only high quality articles.

[28] For instance, Dewatripont et al. (2006, p.67): "there are two (non conflicting) theoretical possibilities for increasing price competition in the market: shift price competition to a level where journals are viewed as substitute rather than complement or make researchers and users more price sensitive".

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Appendix

Characterization of all four outcomes in the case of iso-elastic distributions

In what follows, we characterize all four outcomes (the first-best, the second-best, the allocations chosen by the association maximizing readers' payoffs under reader-pays and under open access) in the case of iso-elastic distributions.

1. The first-best allocation:

The first-best allocation is characterized by two conditions:

$$(1+\alpha)q(n_A) = \frac{\gamma - u}{n_R} + C^a(n_R), \tag{8}$$

and

$$(1+\alpha)\int_0^{n_A} q(x)dx = n_A c(n_R). \tag{9}$$

Condition (8), expressed in terms of (q, c) leads to:

$$(1+\alpha)q = \frac{(\gamma - u)(c_{\max})^{1/\varepsilon_c}}{c^{1/\varepsilon_c}} + \frac{c}{1+\varepsilon_c}. \tag{30}$$

Condition (9), expressed in terms of the same variables leads to:

$$(1+\alpha)\left[\varepsilon_q q_{\max} + q\right] = (1+\varepsilon_q)c. \tag{31}$$

Substracting (30) from (31) leads to:

$$\left(\varepsilon_q + \frac{\varepsilon_c}{1+\varepsilon_c}\right) c - \frac{(\gamma - u)(c_{\max})^{1/\varepsilon_c}}{c^{1/\varepsilon_c}} = (1+\alpha)\varepsilon_q q_{\max}. \tag{32}$$

Let $\Phi^{FB}(c) \equiv \left(\varepsilon_q + \frac{\varepsilon_c}{1+\varepsilon_c}\right) c - \frac{\gamma - u}{c^{1/\varepsilon_c}}$. Since $\Phi^{FB}(c)$ increases from $\Phi^{FB}(0) = -\infty$ to $\Phi^{FB}(+\infty) = +\infty$, there is a unique solution to (32), denoted $c^{FB} \equiv c(n_R^{FB})$. Replacing c by $(1+\alpha)Q^a$ (this results from (9)) into (32) and dividing (32) by $(1+\alpha)$ gives:

$$\left(\varepsilon_q + \frac{\varepsilon_c}{1+\varepsilon_c}\right) Q^a - \frac{(\gamma - u)(c_{\max})^{1/\varepsilon_c}}{(1+\alpha)^{1+1/\varepsilon_c}(Q^a)^{1/\varepsilon_c}} = \varepsilon_q q_{\max}. \tag{33}$$

$Q^{aFB} \equiv Q^a(n_A^{FB})$ is the unique solution of (33).

2. The second-best allocation:

It is characterized by two conditions:

$$(1+\alpha)q(n_A) = \frac{(\gamma - u)}{n_R} + \frac{\int_0^{n_R} c(y)dy}{n_R} + \frac{\alpha c(n_R)}{n_R c'(n_R)}\left[c(n_R) - q(n_A)\right] \tag{17}$$

and

$$c(n_R) = Q^a(n_A). \tag{18}$$

After replacing $n_R c'(n_R) = \varepsilon_c c(n_R)$ into (17) and expressing everything in terms of (q, c), we obtain:

$$(1 + \alpha + \frac{\alpha}{\varepsilon_c})q = \frac{(\gamma - u)(c_{\max})^{1/\varepsilon_c}}{c^{1/\varepsilon_c}} + \frac{c}{1+\varepsilon_c} + \frac{\alpha c}{\varepsilon_c},$$

from which we get:

$$q = \frac{(\gamma - u)(c_{\max})^{1/\varepsilon_c}}{\left(1 + \alpha + \frac{\alpha}{\varepsilon_c}\right) c^{1/\varepsilon_c}} + \frac{c}{1+\varepsilon_c} \tag{34}$$

Since $q = (1+\varepsilon_q)Q^a - \varepsilon_q q_{\max} = (1+\varepsilon_q)c - \varepsilon_q q_{\max}$ (the latter equality results from (18)), condition (34) becomes:

$$\left(\varepsilon_q + \frac{\varepsilon_c}{1+\varepsilon_c}\right) c - \frac{(\gamma - u)(c_{\max})^{1/\varepsilon_c}}{(1 + \alpha + \frac{\alpha}{\varepsilon_c})c^{1/\varepsilon_c}} = \varepsilon_q q_{\max}. \tag{35}$$

$c^{SB}\left(\equiv c(n_R^{SB})\right)$ is the unique solution of (35). Furthermore, we have $c^{SB} = Q^{aSB} \equiv Q^a(n_A^{SB})$.

3. Reader-pays:

The allocation chosen under the reader-pays model is characterized by two conditions:

$$c(n_R) + \frac{\gamma}{n_R} = Q^a(n_A), \tag{RP}$$

and

$$C^a(n_R) = q(n_A) + \frac{\gamma}{n_R}\left[\frac{C^a(n_R) - c(n_R)}{n_R c'(n_R)} - 1\right]. \tag{30}$$

Since $c = c_{\max} n_R^{\varepsilon_c}$, (RP) is equivalent to

$$Q^a = c + \frac{\gamma(c_{\max})^{1/\varepsilon_c}}{c^{1/\varepsilon_c}}. \tag{36}$$

If we express (25) as a function of c, using $C^a = \frac{1}{1+\varepsilon_c}c$, $q = (1+\varepsilon_q)Q^a - \varepsilon_q q_{\max}$ and (36), we get:

$$\frac{c}{1+\varepsilon_c} = (1+\varepsilon_q)\left[c + \frac{\gamma(c_{\max})^{1/\varepsilon_c}}{c^{1/\varepsilon_c}}\right] - \varepsilon_q q_{\max} + \frac{\gamma(c_{\max})^{1/\varepsilon_c}}{c^{1/\varepsilon_c}}\left[\frac{\frac{c}{1+\varepsilon_c} - c}{\varepsilon_c c} - 1\right],$$

and after simplifications:

$$\left(\varepsilon_q + \frac{\varepsilon_c}{1+\varepsilon_c}\right)c - \frac{\gamma(c_{\max})^{1/\varepsilon_c}(\frac{1}{1+\varepsilon_c} - \varepsilon_q)}{c^{1/\varepsilon_c}} = \varepsilon_q q_{\max}. \tag{37}$$

For the comparison with open access in terms of readership, we also write the following equation, which is equivalent to (37):

$$\left(\varepsilon_q + \frac{\varepsilon_c}{1+\varepsilon_c}\right)c + \frac{\gamma}{n_R}(\varepsilon_q - \frac{1}{1+\varepsilon_c}) = \varepsilon_q q_{\max}.$$

4. Open access:[29]

The allocation chosen by a not-for-profit journal under open-access is characterized by two conditions:

$$(OA) \quad c(n_R)n_A = \int_0^{n_A} q(x)dx.$$

[29] In the case of the iso-elastic distribution functions, the marginal author's benefit under open access is larger than γ if the following condition holds:

$$\frac{\alpha_A}{1+\varepsilon_c}\left[\frac{\varepsilon_q}{\varepsilon_q + \frac{\varepsilon_c}{1+\varepsilon_c}}q_{\max}\right]^{\frac{1+\varepsilon_c}{\varepsilon_c}} > (\gamma - u)\,(c_{\max})^{\frac{1}{\varepsilon_c}}.$$

Note that this condition holds if $q_{\max}$ or α_A is large enough or $c_{\max}$ is small enough.

and

$$q(n_A) = \frac{\int_0^{n_R} c(y)dy}{n_R} (\equiv C^a(n_R)). \tag{25}$$

From $q = (1+\varepsilon_q)Q^a - \varepsilon_q q_{\max}$, (28) becomes

$$(1+\varepsilon_q)Q^a - \varepsilon_q q_{\max} = \frac{c}{1+\varepsilon_c} \tag{38}$$

Replacing c with Q^a in (38) gives Q^{aOA}:

$$\left(\varepsilon_q + \frac{\varepsilon_c}{1+\varepsilon_c}\right) Q^{aOA} = \varepsilon_q q_{\max}. \tag{39}$$

Proof of Proposition 5

When we replace c with Q^a in (35), compare it with (33), and use the fact that $(1+\alpha)^{1+1/\varepsilon_c} > (1+\alpha+\frac{\alpha}{\varepsilon_c})$, we find:

$$Q^{aSB} > Q^{aFB}.$$

It is easy to compare the first-best allocation with the allocation chosen by an open-access association in terms of average quality. Indeed, comparing (33) with (39) tells us immediately that:

$$Q^{aFB} > Q^{aOA}.$$

We now compare the second-best allocation with the reader-pays outcome, again in terms of average quality. Replacing c with $Q^a - \frac{\gamma(c_{\max})^{1/\varepsilon_c}}{c^{1/\varepsilon_c}}$ into the first term of (37) gives

$$\begin{aligned} & \left(\varepsilon_q + \frac{\varepsilon_c}{1+\varepsilon_c}\right)\left(Q^a - \frac{\gamma(c_{\max})^{1/\varepsilon_c}}{c^{1/\varepsilon_c}}\right) - \frac{\gamma(c_{\max})^{1/\varepsilon_c}}{c^{1/\varepsilon_c}}\left(\frac{1}{1+\varepsilon_c} - \varepsilon_q\right) \\ = \quad & \left(\varepsilon_q + \frac{\varepsilon_c}{1+\varepsilon_c}\right) Q^a - \frac{\gamma(c_{\max})^{1/\varepsilon_c}}{[\tilde{c}(Q^a)]^{1/\varepsilon_c}} = \varepsilon_q q_{\max}, \end{aligned} \tag{40}$$

where $\tilde{c}(Q^a)$ is the largest c that satisfies (36). This function is defined for

$$Q^a > \min_c \left[c + \frac{\gamma(c_{\max})^{1/\varepsilon_c}}{c^{1/\varepsilon_c}}\right].$$

As already mentioned, we assume that $q_{\max}$ is large enough for this set to be non empty. In this case, Q^{aRP} is determined by (40). $Q^a > \tilde{c}(Q^a)$ implies

$$\left(\varepsilon_q + \frac{\varepsilon_c}{1+\varepsilon_c}\right) Q^a - \frac{\gamma(c_{\max})^{1/\varepsilon_c}}{(Q^a)^{1/\varepsilon_c}} > \left(\varepsilon_q + \frac{\varepsilon_c}{1+\varepsilon_c}\right) Q^a - \frac{\gamma(c_{\max})^{1/\varepsilon_c}}{[\tilde{c}(Q^a)]^{1/\varepsilon_c}}. \tag{41}$$

Let $\widetilde{Q}^a$ denote the solution of

$$\left(\varepsilon_q + \frac{\varepsilon_c}{1+\varepsilon_c}\right) Q^a - \frac{\gamma(c_{\max})^{1/\varepsilon_c}}{(Q^a)^{1/\varepsilon_c}} = \varepsilon_q q_{\max}. \tag{42}$$

Note that the left hand side of (41) increases with Q^a, while the right hand side equals $\varepsilon_q q_{\max}$ when $Q^a = Q^{aRP}$, by condition (40). Then, (40) and (41) imply that $\widetilde{Q}^a < Q^{aRP}$. Comparing (42) with (35) (and in the latter condition, replacing c with Q^a) leads to $\widetilde{Q}^a > Q^{aSB}$, which in turn implies $Q^{aRP} > Q^{aSB}$. Since we know that $Q^{aSB} > Q^{aFB}$, we have finally:

$$Q^{aRP} > Q^{aSB} > Q^{aFB} > Q^{aOA}.$$

Proof of Proposition 8

Since the two-sided pricing model is equivalent to a reader-pays model in which γ is replaced by $\gamma'(<\gamma)$, we examine below how the quality standard under the reader-pays model changes as γ decreases. Consider first the case with $\varepsilon_q \geq \frac{1}{1+\varepsilon_c}$. We suppose that γ strictly decreases and that Q^a weakly increases and find a contradiction. Note first that these two conditions imply that c strictly increases. This is because c is the maximum value satisfying

$$\text{(RP)} \quad Q^a = c + \frac{\gamma(c_{\max})^{1/\varepsilon_c}}{c^{1/\varepsilon_c}}.$$

After substituting $\frac{\gamma(c_{\max})^{1/\varepsilon_c}}{c^{1/\varepsilon_c}}$ with $Q^a - c$ into the following equation, which characterizes the optimal Q^a:

$$\left(\varepsilon_q + \frac{\varepsilon_c}{1+\varepsilon_c}\right) Q^a - \frac{\gamma(c_{\max})^{1/\varepsilon_c}}{c^{1/\varepsilon_c}} = \varepsilon_q q_{\max},$$

we find:

$$\left(\varepsilon_q - \frac{1}{1+\varepsilon_c}\right) Q^a + c = \varepsilon_q q_{\max}.$$

Since the L.H.S. of the above equation strictly increases but the R.H.S. remains unchanged, we have a contradiction. Therefore, the move to the two-sided pricing case generates quality degradation as long as $\varepsilon_q > \frac{1}{1+\varepsilon_c}$.

Consider now $\varepsilon_q < \frac{1}{1+\varepsilon_c}$. From the following equation that characterizes the optimal n_R,

$$\left(\varepsilon_q + \frac{\varepsilon_c}{1+\varepsilon_c}\right) c_{\max} n_R^{\varepsilon_c} + \frac{\gamma}{n_R}\left(\varepsilon_q - \frac{1}{1+\varepsilon_c}\right) = \varepsilon_q q_{\max}$$

we find

$$\frac{dn_R}{d\gamma} = \frac{-\left(\varepsilon_q - \frac{1}{1+\varepsilon_c}\right)}{\left[\left(\varepsilon_q + \frac{\varepsilon_c}{1+\varepsilon_c}\right)\varepsilon_c c_{\max} n_R^{\varepsilon_c} - \frac{\gamma}{n_R}\left(\varepsilon_q - \frac{1}{1+\varepsilon_c}\right)\right]} > 0.$$

This implies that as γ decreases, the number of readers n_R (and hence $c(n_R)$) strictly decreases. However, from (RP), c cannot decrease if γ decreases and Q^a weakly increases. Therefore, Q^a must strictly decrease.

Proof of Proposition 9

The first-order conditions with respect to n_A and n_R are given by:

$$n_R q(n_A) = \lambda_4 \left[c(n_R) - q(n_A)\right]; \tag{43}$$

$$\int_0^{n_A} q(y)dy = \lambda_4 n_A c'(n_R). \tag{44}$$

(44) is equivalent to

$$\lambda_4 = \frac{\int_0^{n_A} q(y)dy}{n_A c'(n_R)} > 0. \tag{45}$$

Replacing λ_4 in (43) with the expression in (45) gives:

$$n_R q(n_A) c'(n_R) = Q^a(n_A)\left[c(n_R) - q(n_A)\right]. \tag{46}$$

Since (OA) is binding, we have that $Q^a(n_A) = c(n_R)$. Rearranging (46) gives (29).

Analysis of a For-profit Journal

As another robustness check, we consider here the case of a for-profit journal. Since this case is more complex, we use a simpler version of our model in which all readers are homogenous and have the same reading cost per article $c > 0$. As before, authors differ in terms of the quality of their article, but the distribution of qualities is now Bernoulli: a fraction ν of authors have articles of high quality, denoted by q_H, and a fraction $1-\nu$ of authors have articles of low quality, denoted by $q_L \in (0, q_H)$. We introduce two assumptions:

A1: $\nu q_H + (1-\nu)q_L < c$.

A2: $(q_H - c) > \gamma$ and $u + \alpha_A q_H > \gamma$

A1 says that if all articles are accepted, the average quality is lower than the reading cost, which implies that no reader reads the journal. In other words, A1 means that the certification service provided by the journal is essential. A2 says that if the journal publishes only high-quality articles, the journal is viable both under the reader-pays model and under the open-access model. More precisely, if all readers read a high quality article, under reader-pays, the sum of readers' net benefits from reading it is larger than the publication cost and, under open access, the author's benefit is larger than the publication cost.

The journal's editorial policy consists of the probability of accepting a high-quality article, denoted by β_H, and the probability of accepting a low-quality article, denoted by β_L, where a low-quality article can be published (i.e. $\beta_L > 0$) only if $\beta_H = 1$. Equivalently, this editorial policy can be interpreted in terms of the minimum quality standard q_{min} and the number of articles to publish n_A with prioritization of high quality articles. To simplify our analysis, we assume that the refereeing cost is zero and hence the submission fee is zero.

1. Benchmark: Second best:

We study the social optimum under the constraint that the social planner cannot force a reader to read the journal when the average quality of the journal is below the reading cost. From A2, all high-quality articles should be published (i.e. $\beta_H = 1$). Regarding β_L, let $\overline{\beta}_L$ be defined by

$$\frac{\nu q_H + (1-\nu)\overline{\beta}_L q_L}{\nu + (1-\nu)\overline{\beta}_L} \equiv c,$$

which is equivalent to:

$$(1-\nu)\bar{\beta}_L(c - q_L) = \nu(q_H - c).$$

According to A1 and A2, such $\overline{\beta}_L$ exists and $\overline{\beta}_L \in (0,1)$. It is not optimal to choose $\beta_L > \overline{\beta}_L$ since in this case the journal will not be read. For $\beta_L \leq \overline{\beta}_L$, social welfare from publishing low quality articles is given by

$$SW_L(\beta_L) = (1-\nu)\beta_L\left[(1+\alpha)q_L - (\gamma - u) - c\right].$$

If a low-quality article is published, the gain to society is $u + (1+\alpha)q_L$ while society incurs the publication cost γ and the reading cost c. Therefore, $\beta_L = \overline{\beta}_L$ is optimal if and only if $u + (1+\alpha)q_L \geq \gamma + c$: otherwise, $\beta_L = 0$ is optimal.

2. Reader-pays:

Consider now a reader-pays for-profit journal. Define the average quality of the journal as follows:

$$Q^a(\beta_H, \beta_L) \equiv \frac{\nu\beta_H q_H + (1-\nu)\beta_L q_L}{\nu\beta_H + (1-\nu)\beta_L}$$

The profit is zero if the average quality is lower than the reading cost. Otherwise, the maximum price that the journal can charge a reader for subscription is $[\nu\beta_H + (1-\nu)\beta_L]\,(Q^a - c)$.

Therefore, the profit is given by

$$\begin{aligned}\Pi^{RP}(\beta_H,\beta_L) &= [\nu\beta_H + (1-\nu)\beta_L]\,[Q^a(\beta_H,\beta_L) - c - \gamma] \\ &= [\nu\beta_H q_H + (1-\nu)\beta_L q_L] - [\nu\beta_H + (1-\nu)\beta_L]\,(c+\gamma)\end{aligned}$$

Profit maximization leads to $\beta_H = 1$ from A2 and $\beta_L = 0$ from A1.

3. Open Access:

Consider now an open access for-profit journal. As before, the profit is zero if the average quality is lower than the reading cost. Otherwise, the maximum price that the journal can charge for publication is $u + \alpha_A q_H$ if $\beta_L = 0$ or $u + \alpha_A q_L$ if $\beta_L > 0$. Hence, if $u + \alpha_A q_L \leq \gamma$, the journal will not publish any low quality articles (i.e. $\beta_L = 0$) and will choose $\beta_H = 1$ from A2; this outcome is equivalent to the one under the reader-pays for-profit journal. When $u + \alpha_A q_L > \gamma$, conditional on $\beta_L > 0$, profit maximization leads to $\beta_L = \overline{\beta}_L$ (and $\beta_H = 1$). In this case, we need to compare the profit obtained when $(\beta_H, \beta_L) = (1,0)$ with the one obtained when $(\beta_H,\beta_L) = (1,\overline{\beta}_L)$. The difference between the two is

$$\begin{aligned} & \nu\,(u + \alpha_A q_H - \gamma) - \left[\nu + (1-\nu)\overline{\beta}_L\right](u + \alpha_A q_L - \gamma) \\ = \;& \nu\alpha_A\,(q_H - q_L) - (1-\nu)\overline{\beta}_L\,(u + \alpha_A q_L - \gamma)\end{aligned}$$

Therefore, the journal chooses $(\beta_H,\beta_L) = (1,\overline{\beta}_L)$ if and only if

$$u - \gamma + \alpha_A q_L \geq \frac{\nu\alpha_A\,(q_H - q_L)}{(1-\nu)\overline{\beta}_L} = \frac{\alpha_A\,(q_H - q_L)\,(c - q_L)}{(q_H - c)}.$$

Otherwise, the journal chooses $(\beta_H,\beta_L) = (1,0)$.

Summarizing, we have:

Proposition 10 *Under A1-A2, (i) high quality articles are always published under any of the three cases: second-best, reader-pays for-profit, open access for-profit.*

(ii) As for low quality articles:

a. In the second best outcome, $\beta_L = \overline{\beta}_L$ is optimal if and only if $u - \gamma + (1+\alpha)q_L \geq c$: otherwise, $\beta_L = 0$ is optimal.

b. A reader-pays for-profit journal always chooses $\beta_L = 0$.

c. An open access for-profit journal chooses $\beta_L = \overline{\beta}_L$ if and only if

$$u - \gamma + \alpha_A q_L \geq \frac{\alpha_A\,(q_H - q_L)\,(c - q_L)}{(q_H - c)}.$$

Otherwise, it chooses $\beta_L = 0$.

Corollary 1 *(i) The quality standard chosen by a reader-pays for-profit journal is (weakly) higher than both the one chosen by an open-access for-profit journal and the second best quality standard. Therefore, the change from the reader-pays model to open access (weakly) creates quality degradation.*

(ii) If c is larger than $u - \gamma + (1 + \alpha)q_L$, the quality standard chosen by an open access for-profit journal is (weakly) lower than the second best standard.

A reader-pays for-profit journal has no interest in publishing low quality articles since including any low quality article only reduces readers' willingness to pay for the subscription. However, publishing a low quality article may be socially desirable when the positive externalities on the society are large enough. Therefore, a reader-pays for profit journal tends to have too high a standard since it does not internalize these externalities. On the contrary, an open access for-profit journal does not internalize readers' reading costs as long as the average quality of the journal is larger than the reading cost per article c. Therefore, it may have an incentive to degrade the quality by publishing low quality articles until the average quality of the journal becomes equal to c. This quality degradation is profitable as long as the positive effect from publishing more articles dominates the negative effect from reducing the author fee (since an author's benefit is larger when publishing a high-quality article than when publishing a low quality article). Therefore, if publishing low quality articles is not socially desirable because of a high c, the change from the reader-pays model to open access weakly creates quality degradation.