Academic copyright in the publishing game: A contest perspective

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Abstract

As scientists are motivated by readership rather than by royalties, one might doubt that academic copyright is required for protecting the authors' property rights and for stimulating research. Consequently, the possibility of moving to an open access regime by abolishing academic copyright is currently intensively being discussed. We contribute to this discussion by focusing on the contest component of the publishing game. In our model, differently talented researchers compete for the limited space in top journals. We assume that publication fees when moving from a readers'-pay to an authors'-pay principle will fully be covered only by top universities. This yields an additional asymmetry in the Tullock-contest which reduces the quality effort incentives even for researchers whose fees are fully paid. We find that private research incentives may be either too high or too low. In the first case, open access is always superior. In the latter case, the welfare ranking of the two regimes depends on the model's parameters.

Keywords. Open Access, Copyright, Economics of Science, Publishing Game, Tullock Contest

JEL-classification: D72, K11, K29, L17, O34

1   Introduction

It was Sir Isaac Newton himself to acknowledge that if he had seen far it was by standing on the shoulders of giants, clearly making a point for the relevance of access to academic knowledge and information.[1] This access is generally provided by journal publishing, reverting to copyright privileges as a lever for the emergence of commercial publishers and printers. Academic copyright has not only motivated publishers to provide the infrastructure for disseminating the results of scientific research, but seems also appropriate for enhancing research incentives.

Nevertheless, academic copyright is currently intensively being debated for at least two reasons.[2] First, recent price discriminating practices of commercial publishers in the digital world may already have become too expensive to bear.[3] Second, it has long been recognized that scientists are mainly motivated by the reputation gains from publishing, and not by royalties which are, in most cases, negligible anyway.[4] But then, academic copyright may reduce readership, and thereby also the incentives for scientific research. We contribute to this current discussion by focussing on the contest perspective of research: Scientists are clearly intrinsically motivated, but they also compete for the scarce positions at top universities.

In an intriguing paper, Steven Shavell (2010) recently made a case for legal action towards the abolition of academic copyright. His main argument is as follows: Scientists are motivated by readership, and readership will be higher with open access, that is, when publishing houses move from a readers' pay- to an authors' pay-principle. This higher readership will encourage additional research activities. Furthermore, authors will not have to pay the publication fees themselves as universities will cover these due to the reputation benefits of research. Hence, the impact on the authors' incentive is clear-cut. Finally, Shavell (2010) provides several arguments why a smooth movement from closed to open access is not feasible without legal action.[5]

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[1]See Scotchmer (1991).

[2]See e.g. Hansen (2005), Hilty (2007), Gienas (2008) and Bernius et al. (2009).

[3]See e.g. Litman (2006), European Commission (2006), Hilty (2007), Conley and Wooders (2009) and Ramello (2010).

[4]See already Merton (1973) besides Stephan (1996) as well as Dasgupta and David (1994) on the economics of science. As such, peer recognition for career advancement and intellectual satisfaction are the driving motives to contribute to the advancement of science (See Tenopir and King (2000)). The open access movement can be seen as a response to the growing dissatisfaction with the traditional (copyright) regime, referring to the preference of scientists to "publish the fruits of their research in scholarly journals without payment." (Budapest Open Access Initiative (2002)).

[5]See Nabilou (2010) for a legal discussion of Shavell's arguments.

We share the opinion that readership will be higher with open access and that readership matters for scientists, but we emphasize the contest aspect of the "publishing game" (Braod (1981)). To this end, we consider an asymmetric Tullock-contest in which differently talented scientists compete for the limited space in top journals.[6] Focusing on the career concern aspects of research adds a different perspective by pointing to fundamental differences in the social and private benefits of providing high quality articles. In the contest, authors will not internalize the impact their own quality effort has on the quality provision of their colleagues, and which journal an article is published in may matter more from the private than from the social point of view. Taking the rent-seeking aspect of publishing seriously yields the result that encouraging research is only beneficial if the positive externalities are sufficiently large.

Another important assumption of our model is that the publication fees in case of open access will only be covered by top universities while scientists in average departments need to bear part of these costs by themselves.[7] This view is supported by the fact that even the current submission fees, which will incline significantly when moving from a readers'-pay to an authors'-pay principle, are not covered by all university departments. In Germany, for instance, most professors have fixed budgets they can use for paying student assistants, conference fees, submission fees or the like. As these budgets are rather small, opportunity costs of submitting articles are high. And as the best researchers will, on average, work in the best universities, this asymmetry tends to go in the same direction as the asymmetry in capabilities.

Specifically, we consider a Tullock-contest with two differently productive researchers. Their incentives for quality provision depend on readership and on the reputation difference between journals. A first result is that, while the more productive scientist should provide higher effort for quality from a social point of view, private incentives in asymmetric contests yield identical efforts. We model the advantage of open access simply by assuming larger readership,[8] but this advantage comes at the expense of higher submission costs for the low type. As efforts in a Tullock-contest are strategic complements, this asymmetry in submission costs does not only reduce the low type's, but less obviously also the high type's effort provision. It follows that

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[6]See Konrad (2009) for a comprehensive overview on contest theory.

[7]Costs for a single publication, for example in a Public Library of Science (PLoS) journal, currently ranges from $ 1,350 (PLoS ONE) to $ 2,900 (PLoS Biology or PLoS Medicine). See http://www.plos.org/journals/pubfees.html. Besides, King (2007) estimates that the average fixed costs for publishing a single article is $ 3,000.

[8]In Shavell (2010), larger readership is derived endogenously. As the underlying assumptions are entirely convincing, we see no point in re-doing that.

the incentives for providing high quality research may be higher under closed access.

An important implication of the contest perspective is that it cannot be taken for granted that higher quality increases social welfare. In fact, if the rent-seeking motive dominates, private research incentives may well be above the socially optimal ones. In our view, the possibility of excessive research incentives is not dubious. Given that even mediocre universities condition their hiring policy mainly on the publication record, the "publish or perish"-environment may well have led to a situation where, for many of us, the marginal social utility of higher research is already below the marginal social opportunity costs of reading, teaching and administrative work.

A clear-cut result in our analysis is that open access is superior whenever private incentives are excessively high. Then, all effects are in favor of open access: Larger readership is always socially beneficial and, for any audience given, open access reduces effort provision due to the asymmetry in cost functions. In the more natural case of inefficiently low effort incentives, however, either of the two regimes may be superior.

In our model, the quality of papers depends exclusively on the incentives of authors. The same holds in Shavell (2010) who focuses on the number of papers published. One might also think of models where the incentives of publishing houses for accepting articles may depend on the payment mode. McCabe and Snyder (2005) argue that, under open access, publishers might have an incentive to accept too many papers for collecting the fees paid by the authors. This could potentially lead to a quality degradation of open access journals.[9] With respect to the editing process itself, we assume throughout that the services provided by the publishing houses are the same under both regimes.

The remainder of the paper is organized as follows: Section 2 presents the model. In section 3, we derive the privately optimal quality efforts for the two regimes. Section 4 relates to the social welfare perspective. We conclude in section 5.

2　The model

The game of scientists.　There are two differently talented scientists $i = H, L$ competing for publishing an article in a top journal by exerting quality effort e_i. Effort costs are $E_i = \frac{1}{2}e_i^2$. The asymmetry in capabilities is modelled

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[9]Accordingly, Watt (2010) emphasizes that considering the quality of academic works as a second dimension is crucial for a comprehensive approach on the social desirability of an open versus closed access regime. See also Mueller-Langer and Watt (2010).

by assuming that the papers' quality is $q_i = \theta_i e_i$ where θ_i expresses author i's talent. Without loss of generality, we normalize $\theta_L = 1$ and set $\theta_H \equiv \theta > 1$ to capture the high type's predominance.

The probability of getting a paper in the top journal depends on quality, but only in a stochastic way to account for the unpredictability of the publishing game. We capture these features by an asymmetric Tullock-contest where the respective winning probabilities are $p_H = \frac{\theta e_H}{\theta e_H + e_L}$ and $p_L = \frac{e_L}{\theta e_H + e_L}$. The contest loser will then publish the paper in a lower-ranked journal.

The authors' benefit from publishing depend on the reputation of the journal and on the readership which we denote as $r \in (n, m)$ where n and m denote readerships under open and closed access, respectively. Realistically, we assume that the readership is (weakly) higher with open access, that is $n \geq m$. Next, the reputation gain of publishing in the top journal (the "price" of the contest) is normalized to one, and the reputation gain in the lower-ranked journal is denoted $\mu < 1$.[10]

To keep the contest tractable, we add two simplifications: first, we assume that the readership is the same for both journal types, and differs only for the two regimes.[11] Second, the players' utility is assumed to be multiplicative in readership and reputation, so that the utility from publishing in the two journals is just r and μr, respectively. This implies realistically that the authors' marginal benefit from additional readership is higher when publishing in the top journal.

Besides different readerships, the second difference between the regimes is that publishing costs need to be borne by authors in the open access world. As discussed in the introduction, top universities are likely to fully cover their employees' publishing costs, but this will not (always) be the case for lower ranked universities and for institutions outside of the U.S.[12] As the best researchers will, on average, work in the best universities, this asymmetry will usually go in the same direction as the asymmetry in capabilities. We account for this in the following stylized way: Since the high type has no submission costs, his *total* costs of publishing C_H consist only of his effort costs $C_H = \frac{1}{2}e_H^2$. The low type, however, needs to pay part of the publication

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[10]Since the privately optimal efforts depend only on the difference of the reputation gains, one might wonder why we assume two journals. This will prove useful for comparing private to social incentives.

[11]In the concluding section, we will argue that adding different readerships for the two journal types - which is realistic but drives the contest extremely cumbersome - even reinforces our main insights.

[12]This adds an international perspective to our discussion. The desirability of open access and hence the willingsness to promote open access publishing may eventually be different among states. As such. this aspect may particularly gain recognition in the light of developing countries.

costs by himself, and we capture this by assuming that his total costs are $C_L = g\frac{1}{2}e_L^2$ where $g > 1$.[13]

The two types' objective functions can now be summarized as follows:

$$V_L = r\left[\left(\frac{e_L}{\theta e_H + e_L}\right) + \mu\left(1 - \frac{e_L}{\theta e_H + e_L}\right)\right] - \frac{1}{2}I\left(e_L\right)^2. \qquad (1)$$

$$V_H = r\left[\left(\frac{\theta e_H}{\theta e_H + e_L}\right) + \mu\left(1 - \frac{\theta e_H}{\theta e_H + e_L}\right)\right] - \frac{1}{2}\left(e_H\right)^2. \qquad (2)$$

Consider the low type's objective function V_L. $r \in (n, m)$ is the readership under the respective system. $p_L = \frac{e_L}{\theta e_H + e_L}$ is his probability of winning the contest which then yields a reputation gain of one per reader. With probability $1 - p_L$, the reputation gain is only μ. I is an index variable that takes the value 1 for closed access (the publishing costs are paid by readers) and $g > 1$ for open access.

Social welfare   The idea of our necessarily stylized social welfare function is that the benefit from scientific research depends on quality and on readership. Thereby, the quality depends on the scientists' effort incentives, while the readership depends on the regime (closed vs. open access). Our social welfare function takes the simple form

$$SW = \beta r\left(\theta e_H + e_L\right) - \frac{1}{2}\left(e_H\right)^2 - \frac{1}{2}\left(e_L\right)^2. \qquad (3)$$

The higher the quality of papers (that is, the higher are θe_H and e_L) and the higher the readership r, the higher the social benefit from research. $\beta > 0$ is a parameter that expresses the average utility of readers from articles of a given quality. Adding such a parameter is important as there is no reason for assuming that the utility functions of authors and readers are fully aligned, i.e. that the reputation gain per reader equilibrates the average reader's utility.

The authors' effort costs also enter social welfare, but this does not extend to the low type's submission costs under open access as this part is purely redistributive - someone needs to bear the costs of publication anyway. For similar reasons, the benefit of authors is not part of the social welfare function. This captures precisely the contest perspective of our approach as competing for university positions is also a zero-sum game. The

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[13]The multiplicative treatment of the publication and effort costs implies that the expected marginal costs of publication are increasing in effort ($\frac{\partial^2 C_L}{\partial g \partial e} = e_L > 0$). This is reasonable as publication costs occur only for finished papers, and the probability for this is increasing in effort.

same holds for the happiness when getting a paper nicely published, which is, due to the contest structure, again a zero-sum game.

Straightforwardly, the socially efficient effort levels are given by $e_H^f = r\beta\theta$ and $e_L^f = r\beta$. This implies that, in the first best, the quality provided by the high type is higher for two reasons: due to a direct effect (higher quality for identical efforts), but also due to an indirect effect (higher optimal effort). This will become important when comparing the two regimes. Substituting for the optimal efforts yields a maximum social welfare of $SW^f = \frac{r^2\beta^2(1+\theta^2)}{2}$.

3   Privately optimal effort levels

Under both systems, the authors maximize their objective functions as given in Eqn. (1) and Eqn. (2), respectively. The first order conditions are

$$\frac{\partial V_L}{\partial e_L} = r\frac{e_H\theta(1-\mu)}{(e_L+\theta e_H)^2} - Ie_L = 0. \tag{4}$$

$$\frac{\partial V_H}{\partial e_H} = r\frac{e_L\theta(1-\mu)}{(e_L+\theta e_H)^2} - e_H = 0. \tag{5}$$

Solving the equation system and recalling that $r = n$ and $I = g > 1$ for open access, while $r = m$ and $I = 1$ for closed access, we get the following privately optimal effort levels:

$$e_L^O = \frac{\sqrt{n\sqrt{g}\theta(1-\mu)}}{g\theta+\sqrt{g}}; \ e_H^O = \frac{\sqrt{n\sqrt{g}\theta(1-\mu)}}{\sqrt{g}\theta+1}.$$

$$e_L^C = e_H^C = \frac{\sqrt{m\theta(1-\mu)}}{1+\theta}.$$

The following Lemma summarizes the insights from inspecting the effort levels for the two systems separately (where $S \in (O, C)$ is the system index):

Lemma 1 *(i) All privately optimal quality effort levels are increasing in the difference in the utilities from winning and losing the contest, $\frac{\partial e_i^S}{\partial(1-\mu)} > 0$ $\forall i, \forall S$. (ii) With closed access, effort levels of the two types are identical, $e_H^C = e_L^C$. Both efforts are decreasing in the degree of asymmetry, i.e. $\frac{\partial e_i^C}{\partial\theta} < 0$ $\forall i$. (iii) With open access, the high type's effort is higher than the low type's effort.. Both effort levels are decreasing in the degree of asymmetry and in the low type's submission cost, $\frac{\partial e_i^O}{\partial\theta} < 0$ $\forall i$ and $\frac{\partial e_i^O}{\partial g} < 0$ $\forall i$.*

All proofs are provided in the Appendix.

All parts of the Lemma follow from the properties of the Tullock-contest. As to *part (i)*, just note that incentives depend on the *marginal* benefit from effort, and this marginal benefit is decreasing in the utility when losing the contest. Hence, the objective functions of the researchers are quite different from social incentives: while socially optimal efforts are *increasing* when papers in the lower ranked journal gain higher readership, private incentives are *decreasing* as the marginal gain from winning the contest is diminished.

Part (ii) reflects the important insight from contest theory that asymmetric contestants exert identical efforts, and that these efforts are decreasing in the degree of asymmetry.[14] Again, this differs from the social welfare perspective since more talented researchers should exert higher effort.

With open access (*part (iii)* of Lemma 1), effort levels *are* different. The reason is that, by contrast to asymmetry in capabilities, asymmetry in cost functions does yield different equilibrium efforts. The interesting part is that the low type's submission costs do not only reduce his effort, but also the high type's effort. The intuition is that effort levels in Tullock-contests are strategic complements, so that, everything else equal, the high type's effort is decreasing in the low type's effort (and hence in his costs).

Whereas Lemma 1 captures the effort levels under the two regimes separately, Proposition 1 extends to comparing the two systems.

Proposition 1 *(i) The low type's effort is higher with open access if and only if $\frac{n}{m} > \frac{\sqrt{g}\left(\sqrt{g}\theta+1\right)^2}{(1+\theta)^2}$. (ii) The high type's effort is higher with open access if and only if $\frac{n}{m} > \frac{\left(\sqrt{g}\theta+1\right)^2}{\sqrt{g}(1+\theta)^2}$. (iii). The ratio between the high and the low type's effort is higher for open access.*

Part (i) of the Proposition expresses the trade-off of the two regimes for the low type's effort incentives: On the one hand, open access leads to a higher readership and thereby to a higher incentive for effort. The strength of this effect depends on the readership-ratio n/m. On the other hand, the effort incentive is lower since part of the publishing costs must be borne privately by the low type. The strength of this effect depends on g. More interestingly, the high type's effort may also be lower with open access even though the readership is larger, and even though the high type pays no submission fees by assumption (*part (ii)*). As mentioned after Lemma 1, this follows from

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[14]Both properties also hold for the more general case where $p_H = \frac{\theta(e_H)^t}{\theta(e_H)^t+(e_L)^t}$ and $p_L = \frac{(e_L)^t}{\theta(e_H)^t+(e_L)^t}$. In this more general version, t captures the degree of discrimination, that is the sensitivity of winning the contest to the efforts taken by the players.

the fact that efforts are strategic complements. *Part (iii)* is a straightforward implication as the two types' efforts are identical with closed access, while the high type exerts relatively higher effort under open access.

4   Social welfare under the two regimes

Comparing the private incentives under the two regimes has led to the following main insights: First, the efforts, and hence the quality provided by both types may be higher under either regime. The trade-off is obvious for the low type who, with open access, benefits from higher readership but suffers from higher submission fees. Less obvious though, this also holds for the high type who reduces his effort due to the higher submission costs borne by the low type. Second, submission fees increase the contest's asymmetry as they are only paid by the low type. This kind of asymmetry tends to increase social welfare: in optimum, the high type should exert higher effort, but this will not be the case with closed access. The low type's higher publication cost hence mitigates the inefficiency that privately optimal efforts of differently productive players are otherwise identical.

In Shavell's seminal analysis, the private quality incentives can never be too high. The reason is that the social welfare function consists of the benefits for authors and readers and, crucially, the benefits of authors are additively separable. Hence, each author causes positive, but no negative, externalities. By contrast, our contest structure points to a fundamental difference in the objective functions captured by the parameter μ. The higher μ, the lower is the authors' effort incentive as the difference between publishing in the two outlets decreases. By contrast, μ has no impact in the social welfare function. This yields the result that it can no longer be taken for granted that social welfare is increasing in the researchers' efforts: Due to the rent-seeking element, private incentives may be distorted from socially optimal behavior in either direction.

Substituting the efforts chosen by the authors into the social welfare functions for the two systems yields, after simplifying, the following results:

$$SW^C = \beta m \left(\sqrt{m\theta\left(1-\mu\right)} \right) - \frac{m\theta\left(1-\mu\right)}{\left(\theta+1\right)^2}. \tag{6}$$

$$SW^O = \frac{\beta n \sqrt{\sqrt{g}n\theta\left(1-\mu\right)}}{\sqrt{g}} - \frac{n\theta\left(1-\mu\right)\left(1+g\right)}{2\sqrt{g}\left(\sqrt{g}\theta+1\right)^2}. \tag{7}$$

Closed access. Comparing the socially and the privately optimal quality efforts for closed access yields the following insights:

Lemma 2 *(i) The high type's effort is too low if and only if $\beta > \frac{\sqrt{m\theta(1-\mu)}}{m\theta(1+\theta)} \equiv K_H^C$. (ii) The low type's effort is too low if and only if $\beta > \frac{\sqrt{m\theta(1-\mu)}}{m(1+\theta)} \equiv K_L^C$. (iii) Whenever the low type's effort is too low, this will also be the case for the high type. (iv) That private efforts are too low is the more likely the higher β, m, θ and μ.*

The expressions in the Lemma show that $\beta = 1$ is a sufficient condition for all efforts being too low. This also holds for $\mu = 0$, i.e. when the incentive for winning the contest is maximum as publishing in the lower ranked journal has no reputation gain. The reason for insufficient effort provision is that, from a social point of view, the quality-effect θe_H and e_L counts in any case, whereas it counts for the authors only by increasing the probability of publishing in the high ranked journal. Hence, if the average reader's utility from having access to research is identical to the authors' marginal benefit per reader ($\beta = 1$), then encouraging research is desirable from a social welfare perspective.

For $\beta < 1$, however, the rent-seeking motive may exceed the social benefit from research, and the comparative statics stated in Lemma 2 then follows from the detrimental impact of the asymmetry on effort incentives. Since the two types' efforts are identical, there are no parameter constellations for which social and private incentives are aligned - with closed access, the *relative* distortion in the efforts always exists.

Open access. For open access, we get

Lemma 3 *(i) The high type's effort is too low if and only if $\beta > \frac{\sqrt{\sqrt{g}n\theta(1-\mu)}}{n\theta(\sqrt{g}\theta+1)} \equiv K_H^O$. (ii) The low type's effort is too low if and only if $\beta > \frac{\sqrt{\sqrt{g}n\theta(1-\mu)}}{\sqrt{g}n(\sqrt{g}\theta+1)} \equiv K_L^O$. (iii) The "relative" distortion of the two efforts depends on g and θ, that is $\frac{K_H^O}{K_L^O} = \frac{\sqrt{g}}{\theta}$. (iv) That private efforts are too low is the more likely the higher β, n, θ, μ and g.*

The Lemma follows closely along the lines for the closed access case.[15] The main difference is that the relative distortion of the two types' efforts now

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[15]See the comparative statics expressed in *part (iv)* and note that $\beta = 1$ is still a sufficient condition for insufficiently high efforts.

depends on the low type's publication costs g: If g increases, then both types provide lower quality, but the low type's effort is decreasing faster. This explains *part (iii)* of Lemma 3, and implies that there are now parameter constellations where both efforts are socially efficient.[16]

Comparison. Regardless of whether qualities provided are above or below the socially optimal ones, there are two advantages of open access: The readership is larger and efforts of the two types are different. Still, for analyzing the welfare ranking of the two systems, we need to distinguish between the situations where efforts are below or above the socially optimal ones. We start with the first case:

Proposition 2 *Suppose $e_i^S < e_i^f$ $\forall S, i$. Then, (i) A sufficient condition for open access to be superior is that efforts are the same under both regimes. (ii) A sufficient condition for closed access to be superior is that the readership is the same. (iii) In all other cases, closed access is more likely to be welfare superior if n is low and if m, θ and g are high.*

If private efforts are below the socially optimal ones, the ranking depends on whether the higher readership with open access overcompensates the lower effort incentives caused by the asymmetry in publication costs. To see that identical efforts are sufficient for the superiority of open access, just recall that open access always has the advantage of higher audience (*part (i)*). By contrast, when the readership is identical, then both efforts are lower under open access due to the negative incentives caused by the low type's publication costs. This explains *part (ii)* of the Proposition.

In all other cases, the ranking depends on the parameters (*part (iii)*). The impacts of n and m are straightforward as higher audience increases social welfare. The reason why higher θ is more beneficial under closed access is that, with open access, even the high type's effort is decreasing in the low type's publication costs. And the higher θ, the higher is the optimal effort that should be provided. For similar reasons, open access becomes less favorable when submission costs g are high.

We next turn to the case where quality efforts are above the socially optimal ones. Then, the welfare ranking of the two regimes is clear-cut:

Proposition 3 *Suppose $e_i^S \geq e_i^f$ $\forall S, i$. Then, open access is superior to closed access.*

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[16]This is the case if $g = \theta^2$ and $\beta = \frac{\sqrt{(1-\mu)}}{\sqrt{n}(\theta^2+1)}$.

The reason for Proposition 3 is as follows: Again, open access has the advantage of higher audience. This advantage holds regardless of whether efforts are too high or too low. Now consider the limit case where the readership is identical under both regimes, that is $n = m$. Even then, open access is superior since both efforts are lower which, in the case considered in Proposition 3, increases social welfare.

5   Conclusion

As scientists are motivated by readership rather than by royalties which are negligible in most cases anyway, a shift towards an open access to science seems straightforward. We have shown that there are countervailing effects when considering publication as a contest for reputation, and thereby for scarce positions at top universities. To see why the contest perspective reveals a fundamental difference in the objective functions of readers and researchers, assume an extended version of our model where readership for the lower ranked journal decreases while readership for the top journal remains constant (for whatever, exogenously given reasons). Then, socially optimal efforts are also *decreasing* due to a lower audience. Private incentives, however, are determined by the difference of the utility when publishing in the high compared to the low ranked journal, and efforts in the Tullock-contest will hence *increase*.

Our model yields the result that private research incentives are, from a social perspective, either too high or too low. If they are too high, then open access is always superior for two reasons: readership is larger and quality effort incentives are lower due to the asymmetry in publication costs. If quality effort incentives are too low, the welfare ranking of the two regimes depends on whether the higher readership under open access outweighs the detrimental impacts of asymmetric costs on effort provision.

Straightforwardly, subsequent research questions are whether a coexistence of the two systems outperforms each standing alone system, and whether uncoordinated market behavior would induce such a coexistence. Accordingly, if a unique open access is superior, one might ask if markets will enforce such a system anyway or if the lock-in effect of the established closed access system will prevent such an evolutionary process. The current developments with E-journals suggest that a - most likely inefficiently slow - move towards a mixed system is on its way, but there may also be need for legal action. The literature provides basically two arguments for a coordination failure:[17] First and foremost, open access journals are re-

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[17]See Bjoerk (2004), Cavaleri et al. (2009), and Shavell (2010).

stricted in accumulating reputation and hence in creating a certain level of demand. Especially young researchers will have few incentives to publish their prestigious research results in yet rarely known open access journals. Second, authors might tend to avoid the payment of publication fees and transfer their copyright to the journal publisher in order to impose charges on readers.[18] Questions on the existence and the policy implications of such a coordination failure leaves us with a promising avenue for further research. In our contest perspective, the interesting question will then be how different researchers self-select to different contracts, and how those who "architecture" the contest would try to attract the best publications. In the current paper, however, our purpose was enriching the perspective by pointing to the contest structure of the publishing game in a world with either only open or closed access.

Appendix

Proof of Lemma 1. *Part (i)*. $\frac{\partial e_H^C}{\partial(1-\mu)} = \frac{\partial e_L^C}{\partial(1-\mu)} = \frac{m\theta}{2(\theta+1)\sqrt{m(1-\mu)\theta}} > 0$; $\frac{\partial e_H^O}{\partial(1-\mu)} = \frac{\sqrt{g}n\theta}{2(1+\sqrt{g}\theta)\sqrt{\sqrt{g}n(1-\mu)\theta}} > 0$; $\frac{\partial e_L^O}{\partial(1-\mu)} = \frac{\sqrt{g}n\theta}{2(g\theta+\sqrt{g})\sqrt{\sqrt{g}n(1-\mu)\theta}} > 0$.

Part (ii). $e_H^C = e_L^C$ follows from inspection. Furthermore, $\frac{\partial e_H^C}{\partial\theta} = \frac{\partial e_L^C}{\partial\theta} = \frac{1}{2\theta}\frac{1-\theta}{(\theta+1)^2}\sqrt{m\theta(1-\mu)} < 0$ since $\theta > 1$. *Part (iii)*. $\frac{e_H^O}{e_L^O} = \sqrt{g} > 1$. Next, $\frac{\partial e_H^O}{\partial\theta} = -\frac{\sqrt{g}n(\sqrt{g}\theta-1)(1-\mu)}{2(\sqrt{g}\theta+1)^2\sqrt{\sqrt{g}n\theta(1-\mu)}} < 0$ as both G and θ are bounded below by one. $\frac{\partial e_L^O}{\partial\theta} = \frac{n(\sqrt{g}\theta-1)(1-\mu)}{2(\sqrt{g}\theta+1)^2\sqrt{\sqrt{g}n\theta(1-\mu)}} < 0$; $\frac{\partial e_H^O}{\partial g} = -\frac{n\theta(\sqrt{g}\theta-1)(1-\mu)}{(\sqrt{g}\theta+1)^2\sqrt{\sqrt{g}n\theta(1-\mu)}} < 0$; $\frac{\partial e_L^O}{\partial g} = -\frac{n\theta(3\sqrt{g}\theta+1)(1-\mu)}{4g(\sqrt{g}\theta+1)^2\sqrt{\sqrt{g}n\theta(1-\mu)}} < 0$. ∎

Proof of Proposition 1. *Part (i)*. Solving $e_L^O = e_L^C$ gives $\frac{n}{m} = \frac{\sqrt{g}(\sqrt{g}\theta+1)^2}{(1+\theta)^2}$. To see that the threshold is unique, note that for the minimum $g = 1$, we have $\Delta e_L \equiv (e_L^O - e_L^C) = \frac{\sqrt{n(1-\mu)}-\sqrt{m(1-\mu)}}{\theta+1} \geq 0$. Furthermore, $\frac{\partial(\Delta e_L)}{\partial g} = -\frac{n\theta(3\sqrt{g}\theta+1)(1-\mu)}{4g(\sqrt{g}\theta+1)^2\sqrt{\sqrt{g}n\theta(1-\mu)}} < 0$. For the minimum $n = m$, however, we have $\Delta e_L = 0$ for $g = 1$, and hence $\Delta e_L < 0 \ \forall g > 1$ as $\frac{\partial(\Delta e_L)}{\partial g} < 0$. *Part (ii)*. Solving $e_H^O = e_H^C$ gives $\frac{n}{m} = \frac{(\sqrt{g}\theta+1)^2}{\sqrt{g}(\theta+1)^2}$. The proof for the threshold's uniqueness proceeds analogously. *Part (iii)*. $\frac{e_H^O/e_L^O}{e_H^C/e_L^C} = \frac{\sqrt{g}}{1} > 1 \ \forall g > 1$. ∎

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Proof of Lemma 2. *Part (i)*. Solving $\frac{e_H^f}{e_H^C} = \frac{m\beta\theta}{\sqrt{\frac{m\theta(1-\mu)}{1+\theta}}} = 1$ for β yields the

threshold given in Lemma 2. and $e_L^f = r\beta$. *Part (ii)*. Proceeds analogously.
Part (iii). $\frac{K_H^C}{K_L^C} = \frac{1}{\theta} < 1$ which shows that the high type's effort is always too

low if this holds for the low type. *Part (iv)*. $\frac{\partial K_H^C}{\partial m} = -\frac{1-\mu}{2m(1+\theta)\sqrt{m\theta(1-\mu)}} < 0,$

$\frac{\partial K_H^C}{\partial \theta} = -\frac{(1-\mu)(3\theta+1)}{2\theta(\theta+1)^2 \sqrt{m\theta(1-\mu)}} < 0, \frac{\partial K_H^C}{\partial \mu} = -\frac{1}{2(1+\theta)\sqrt{m\theta(1-\mu)}} < 0.$ ∎

Proof of Lemma 3. All calculations proceed along the lines for the
proof of Lemma 2.

Proof of Proposition 2. *Part (i)*. Suppose $e_i^O = e_i^C \ \forall i$. Then, the
quality is the same under both systems, and $SW^O > SW^C$ follows from
$n > m$. *Part (ii)*. Define

$$\widehat{e}_L \equiv \frac{e_L^O}{e_L^C} = \frac{\frac{\sqrt{n\sqrt{g}\theta(1-\mu)}}{g\theta+\sqrt{g}}}{\frac{\sqrt{m\theta(1-\mu)}}{1+\theta}} = \frac{(1+\theta)\sqrt{\sqrt{g}n}}{\sqrt{g}\left(\sqrt{g}\theta+1\right)\sqrt{m}} \tag{8}$$

$$\widehat{e}_H \equiv \frac{e_H^O}{e_H^C} = \frac{\frac{\sqrt{n\sqrt{g}\theta(1-\mu)}}{\sqrt{g}\theta+1}}{\frac{\sqrt{m\theta(1-\mu)}}{1+\theta}} = \frac{(1+\theta)\sqrt{\sqrt{g}n}}{\left(\sqrt{g}\theta+1\right)\sqrt{m}} \tag{9}$$

If $n = m$, then both efforts are higher under closed access as $\frac{e_L^O}{e_L^C} =$

$\frac{1+\theta}{\sqrt[4]{g}\left(\sqrt{g}\theta+1\right)} < 1 \ \forall g > 1$ and $\frac{e_H^O}{e_H^C} = \frac{\sqrt[4]{g}(1+\theta)}{\sqrt{g}\theta+1} < 1$ where the last inequality follows

from $\frac{\partial\left(\frac{e_H^O}{e_H^C}\right)}{\partial \theta} = -\frac{\sqrt[4]{g}\left(\sqrt{g}-1\right)}{\left(\sqrt{g}\theta+1\right)^2} < 0$ and $\frac{\partial\left(\frac{e_H^O}{e_H^C}\right)}{\partial g} = -\frac{\left(\sqrt{g}\theta-1\right)((\theta+1))}{4g^{\frac{3}{4}}\left(\sqrt{g}\theta+1\right)^2} < 0$ together

with $\frac{e_H^O}{e_H^C} = 1$ for the minimum values $\theta = g = 1$. *Part (iii)*. From $\widehat{e}_L$ and $\widehat{e}_H$,
we get

$$\frac{\partial \widehat{e}_L}{\partial \theta} = -\frac{\sqrt{\sqrt{g}n}\left(\sqrt{g}-1\right)}{\sqrt{g}\sqrt{m}\left(\sqrt{g}\theta+1\right)^2} < 0, \tag{10}$$

$$\frac{\partial \widehat{e}_H}{\partial \theta} = -\frac{\sqrt{\sqrt{g}n}\left(\sqrt{g}-1\right)}{\sqrt{m}\left(\sqrt{g}\theta+1\right)^2} < 0, \tag{11}$$

$$\frac{\partial \widehat{e}_L}{\partial g} = -\frac{\left(3\sqrt{g}\theta+1\right)n\left(1+\theta\right)}{4g\sqrt{m}\left(\sqrt{g}\theta+1\right)^2\sqrt{\sqrt{g}n}} < 0, \tag{12}$$

$$\frac{\partial \widehat{e}_H}{\partial g} = \frac{n\left(1-\sqrt{g}\theta\right)\left(1+\theta\right)}{4\sqrt{g}\sqrt{m}\left(\sqrt{g}\theta+1\right)^2\sqrt{\sqrt{g}n}} < 0. \text{∎} \tag{13}$$

Proof of Proposition 3. Follows from the proof of *part (ii)* in Proposition 2. ∎

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