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## Conference Paper

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# AN AUCTION MARKET FOR JOURNAL ARTICLES

JENS PRÜFER AND DAVID ZETLAND

**ABSTRACT.** We recommend that an auction market replace the current system for submitting academic papers and show a strict Pareto-improvement of equilibrium. Besides the benefits of speed, this mechanism increases the average quality of articles and journals and rewards editors and referees for their effort. In addition, the “academic dollars” for papers sold at auction go to the authors, editors and referees of *cited* articles. This nonpecuniary income indicates academic impact—facilitating decisions on tenure and promotion. We discuss practical issues and demonstrate that the auction market is implementable without relaxing editors’ current pecuniary or time constraints.

The Manuscript Clearing House . . . would reduce the social cost of information to editors, authors and the subscribing public thereby generating considerable efficiency in the production and consumption of scholarly output. By promoting competitive bidding for manuscripts, it would equalize returns to scholarly output across ranks, improve the efficiency of the academic job market and tend to reduce alleged discrimination by journals. [. . .] Editors would have far more information about the papers available on the market, reducing duplication in publication, double reviewing and delay in collating related papers. —Havrilesky (1975)

Many academics wish the Current Publishing System (CPS) worked better (Ellison, 2002b,a; Colander and Plum, 2004). The need to reform is growing more urgent as pressure from different sources increases: Publications are more important for junior academics seeking validation of their academic production but losing their value to senior academics annoyed with problems in the system (Oswald, 2006; Ellison, 2007).

Some reforms address speed: The Berkeley Electronic Press urges reviewers to work faster (“median decision time in 2006 was 27 days”). The Social Science Research Network sidesteps

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the problem of reviewers, allowing authors to upload preprints for instant distribution. Others change the reviewer's role: Open-source peer-review allows anyone to comment (Zamiska, 2006); Tsang and Frey (2006) suggest an "As-Is Review", i.e., editors accept or reject based on referee comments, but authors choose which revisions to make. Each of these ideas fails to address the main problem: Giving adequate incentives to referees who must expend effort to understand a paper well-enough to comment on and/or improve a paper.

We propose auctions—with revenue sharing—to fix incentives. Although we worked out "our" auction idea before discovering Havrilesky's undeservedly-forgotten article, we are honored to resurrect his idea.

The Auction Market for Journal Articles (AMJA) works as follows: In period zero, the author writes, markets and submits his paper to the AMJA auction server. In period one, editors screen and value papers. In period two, editors bid for papers. Winning bids—in "academic dollars" or A\$—go to the authors, editors and referees of articles *cited* in auctioned papers. In period three, referees review papers, and editors decide to accept or reject papers in period four.

Since papers do not generate A\$ income unless they are cited, authors have an additional incentive to write in an accessible yet convincing way. Since referees and editors share of these revenues, they have incentives to improve papers—rather than reject them—and to speed up the review process.

After a paper is published as an article, citation revenue is an accurate measure of its value: A\$ revenue rises in the number of citations it receives, the "quality" of the citing papers (as reflected in their auction prices), and the uniqueness of the article—if similar papers are also cited, all papers receive lower citation revenue. It is a simple step to sum A\$ income (from work as author, referee, and/or editor) to get an accurate signal of academic output. This signal could facilitate decisions on tenure, promotion, grant-awards, etc. It is thus that A\$ income can map to cash income, prestige, etc. and therefore improve overall

outcomes. For example, experienced referees could work full time on improving others' work (a useful division of labor that raises overall productivity) in exchange for A\$ income that can be used to gain career benefits; see Sections 5.1 and 5.2 for further discussion of A\$.

In the next section, we describe the pros and cons of the CPS. In Section 2, we put the CPS and AMJA in the same model framework. We analyze the AMJA game in Section 3 and compare its equilibrium with the CPS equilibrium in Section 4, showing how the AMJA equilibrium is a strict Pareto-improvement on the CPS equilibrium. In Section 5, we discuss some aspects of the AMJA not explicitly in the model (push vs. pull, valuing academic output, bidding errors, citation gaming, AMJA implementation and comparison to the law review system) and demonstrate how editors need not spend more time or money under the AMJA.

## 1. PROBLEMS IN THE CURRENT PUBLISHING SYSTEM

Science demands recognition of the fact that exclusive review procedures promulgated by editors work to their and to the referees' decided advantage, not to that of potential authors. The basis for this policy is more one of convenience, power, and control than ethics. —Szenberg (1994)

An editor's job is triage, but he is unpopular since he rejects 75 percent of the submissions, sends papers for review to people who are too busy and then badgers those reviewers. —Pressman (2005)

... an active discussion among economists could reveal a lot about whether the current system maximizes the utility of those involved or whether an alternate system might make economists' lives more enjoyable and research more productive. —Ellison (2002b, p. 990)

In the CPS, an author chooses and submits his paper to one journal. This choice matters: Shoot too high and suffer delay before rejection;<sup>1</sup> shoot too low and waste an opportunity to publish well (Oster, 1980). According to Judge et al. (2007), the single most important factor determining an article's popularity is not how well it is written, who the author is, or the originality of the idea—it is the prestige of the journal publishing it. If true, authors

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<sup>1</sup>The average wait for rejection is eight months; thirty percent of articles accepted for publication had been previously rejected by another journal (Hamermesh, 1994).

are right to worry about appropriate placement. Unfortunately, bias in favor of their own brilliance ensures they shoot too high more often than too low, wasting everyone's time.

The editor receives papers pushed by authors. If the editor does not “desk-reject” the paper, he chooses one or more referees to review it. Their reviews help the editor decide to accept or reject the paper. Although all parties to the process are trying to do the right thing, editors and referees make mistakes in rejection (or acceptance).<sup>2</sup> These mistakes arise from the characteristics and incentives of the CPS: Authors push papers at editors, who have a temporary monopoly on review by referees who receive little credit for their work.

Let us look at the CPS from the perspectives of each actor, concentrating on the main problem each faces.<sup>3</sup>

**Authors** are unhappy because **slow publishing delays decisions on tenure & precedence and the debate, use & dispersion of their ideas**: Submitting to the wrong journal increases the problems of delay. On the other hand, authors like the control and choice they have in the CPS: They push their papers to the journals they want. They also like getting “free” review services, although this is an obvious, negative externality for referees and editors.<sup>4</sup>

**Editors** are unhappy because **authors push papers at them**: They choose neither the quality nor volume of incoming papers, regularly reject authors, have the burden of affecting others' careers, struggle to get effort from referees, are paid little, and sometimes doubt the sincerity of those who claim to be friends. On the other hand, power and prestige benefit editors' own research and careers.

**Referees** are unhappy because **they work for “free”**: Their reputation does not improve because their work is anonymous to most; editors push them; and they are constantly finding

<sup>2</sup>Gans and Shepherd (1994) reported how (now) famous economists could not get their seminal articles published. (Interestingly, Gans' article was “accepted before it was researched and published about a year later” (Gans, 2004).)

<sup>3</sup>We ignore other parties (e.g., publishers and university administrators) to concentrate on the central players in academic publishing.

<sup>4</sup>Submission is not always free. Some journals have submission charges and/or require future referee reports.

problems—not solutions—in papers they review. On the other hand, referees are happy because they receive “credits” from editors for future, favorable treatment of their own work; they give back as a member of the academic community; and they have power from insider information.

**Readers** are unhappy because **the CPS is too slow**—recent publications do not reflect state-of-the-art research<sup>5</sup>—and **the CPS system of matching papers to journals by quality is too inaccurate**: Although all articles in a given journal are good, not all good articles will be in that journal, either because they are published in another journal (increasing search costs) or because they are still in-press (increasing waiting costs) (Starbuck, 2005; Chow et al., 2006; Oswald, 2007). On the other hand, readers are happy because journals filter and rank articles from a much larger pool of papers—improving them (presumably) before publication.

Broadly speaking, authors and readers want a slow process to speed up but be more accurate; editors want control over the papers they consider; and referees want rewards for good work.

Weak incentives for referees have perhaps the greatest adverse impact. Their rational reaction—choosing minimal effort—leads to bad outcomes.<sup>6</sup> Referees delay and/or avoid work, argue with each other and fail to understand value (Szenberg, 1994; Starbuck, 2003; Seidl et al., 2005).<sup>7</sup> They reject original, significant works that conflict with current beliefs and favor papers that echo their own results (Armstrong, 1997, 2002). Referees’ reviews have a low or negative correlation with subsequent citations; referees often miss the big picture, and over three-quarters of their requested changes were based on “whim, bias or personal

<sup>5</sup>The proliferation of conferences and/or rise in registration fees may be partially-explained by publication delay: As delay increases, the value of attending conferences rises.

<sup>6</sup>Frey (2003) argues that referees have little incentive to make articles better; he proposes that editors accept/reject article and referees only be allowed to suggest ways to improve the article. The AMJA is one, explicit way to implement such a suggestion.

<sup>7</sup>Garcia-Berthou and Alcaraz (2004) sample articles in *Nature* and the *British Medical journal*, identifying one or more statistical errors in 38 percent of the articles. In four percent of the cases, “the conclusion would change from significant to nonsignificant” [p. 3]

preference” (Armstrong, 2002; Starbuck, 2005). If there is one thing to fix, it is referee incentives. In the next section, we suggest how.

## 2. AUCTIONS AS A SOLUTION—A SIMPLE MODEL

We define variables and parameters with all subscripts; in later use, we drop subscripts whenever possible to reduce clutter.

**2.1. Induced Utility and Cost Functions.** We characterize the induced utility functions of the four parties involved in the publication process by quantifying the main arguments mentioned in Section 1. The reader/consumer  $C$  values article quality and publication speed, i.e.,

$$v_C = u_C(Q_j, T_j), \tag{1}$$

where the utility of reading articles ( $u_C$ ) is increasing in the average quality of articles in journal  $j$  ( $Q_j$ ) and decreasing in time-to-publication of journal  $j$  ( $T_j$ ).

We assume that any competitive publication system—in equilibrium—publishes high-quality papers in high-reputation journals; this condition solves the reader’s asymmetric information problem, i.e., judging the quality of an article before he spends a reasonable amount of time reading it.<sup>8</sup> We also assume that the career prospects of author  $i$  positively depend on the reputation of a journal publishing article  $i$ ; see Judge et al. (2007).<sup>9</sup> Hence, author  $i$  prefers to produce a paper with high quality.<sup>10</sup> He also prefers speedy publication, i.e., low  $T_j$ . For production of a paper with quality  $q_i$  and marketing the paper with effort

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<sup>8</sup>If the reputation ranking of a journal is a rough indicator of the quality of its articles, journals provide a public good to the academic community, i.e., paper preselection and vertical classification. (This is a public good because the journal publishers cannot charge every consumer of the good, i.e. all readers know the table of contents at little or no cost.)

<sup>9</sup>We assume that author and paper are paired only with each other; thus we refer to both with the same subscript  $i$ .

<sup>10</sup>Many authors produce high quality for other, extrinsic or intrinsic reasons. Since these reasons complement career goals, we ignore them.

$m_i$ , the author bears costs of  $a_i(q_i, m_i)$ , which are convex in both arguments.<sup>11</sup> The author's induced utility is:<sup>12</sup>

$$\nu_i = u_i(q_i, T_j) - a_i(q_i, m_i). \quad (2)$$

Editor  $j$  values the power and prestige of his journal, which is a function of average article quality ( $Q_j$ ).<sup>13</sup> The editor incurs costs in his job: the cost of preliminary review for submitted papers ( $s_j$ ), the cost of choosing a referee for papers that survive preliminary review ( $r_j$ ), and the cost of finalizing papers for publication ( $f_j$ ). We assume cost functions  $s_j(\cdot)$ ,  $r_j(\cdot)$  and  $f_j(\cdot)$  are convex in the number of papers at each stage to reflect increasing opportunity costs. Thus, the editor's induced utility function is:

$$\nu_j = u_j(Q_j) - [s_j(\cdot) + r_j(\cdot) + f_j(\cdot)]. \quad (3)$$

Referee  $R$  of journal  $j$  obtains utility  $u_R$  from expected preferential treatment for his next submission to that journal. A referee can invest effort  $e \geq \underline{e} > 0$  in judging and improving a paper for a cost represented by the convex function  $c_R(e)$ .  $\underline{e}$  is the minimum effort necessary to deliver a referee report that satisfies the editor; i.e., we assume the editor and referee both know when a report is unsatisfactory. Since one characteristic of report quality is speed, we assume that higher  $e$  speeds publication, i.e.,  $\frac{dT}{de} < 0$ .  $u_R$  is positively dependent and concave in  $e$ . The induced utility of a referee is:

$$\nu_R = u_R(e) - c_R(e). \quad (4)$$

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<sup>11</sup>Marketing refers to presenting at conferences or seminars, sending emails, posting to preprint servers and listservs, soliciting reviews from colleagues, etc. (Armstrong, 2002, p. 78).

<sup>12</sup>Costs of quality production and marketing are convex because of increasing opportunity costs, e.g., time away from other work.

<sup>13</sup>We assume that editor and journal are paired only with each other; thus we refer to both with the same subscript  $j$ .



**2.2. The Auction Market for Journal Articles (AMJA) Game.** Authors write papers, market them to editors, and post them for auction. Editors bid Academic Dollars (A\$) for papers and assign “purchases” to referees.<sup>14</sup> Referees put in effort to review and improve papers. After publication, readers read and cite articles (published papers) in their own work. When those reader-authors’ papers are subsequently auctioned for A\$, the redistribution of A\$ to the authors, editors and referees of articles *cited* in subsequently-auctioned papers rewards quality.<sup>15</sup> Note that A\$ are not compensation but a non-pecuniary measure of productivity. Figure 1 displays the flow of a paper and A\$; see Section 5.1 for a detailed discussion of A\$ circulation. The detailed timing of auctions is as follows:

*Period  $t_0$ —Author Writes/Markets Paper:* Author  $i$  writes paper  $i$  with quality  $q_i \equiv q$  for a cost of  $a(q)$  and makes the exogenous decision to post it on the auction server, for an exogenous submission fee of  $\phi$  (in US\$, not A\$). The author specifies:

- (1) a reserve price,
- (2) positive/negative “handicaps” on bids from particular journals in A\$, which allow the author to signal specific journals they find (in)appropriate for paper  $i$ ,<sup>16</sup>
- (3) the maximum time he will wait for a final acceptance/rejection decision from the editor who wins the paper at auction,
- (4) a minimum share of future revenues from the article, and
- (5) whether to remain anonymous.<sup>17</sup>

<sup>14</sup>Throughout this paper, we say that papers are purchased, optioned, and/or won at auction. Strictly speaking, bidders in the AMJA option the exclusive right to consider a paper for publication. Publication is not required, and ownership still resides with the author.

<sup>15</sup>Say, for example, Paper 1 is auctioned for 100A\$. Since it cites 10 older articles, the authors, editors and referees of each cited article divide 10A\$. When Paper 2—citing Paper (now Article) 1 and 19 others—sells for 120A\$, Article 1’s author, editor and referee split 6A\$ according to their prior agreements.

<sup>16</sup>Hence the signalling provided by author self-selection to journal  $j$  in the CPS could be imitated—but without the restrictive quality of the CPS signal preventing consideration of paper  $i$  at journal  $k \neq j$ . Unique handicaps would prevent ties among journals.

<sup>17</sup>Acceptance rates and referee ratings are lower and more critical when the reviewer is unaware of the author’s identity, which is only 55 percent of the time (Blank, 1991, pp 1041-2).

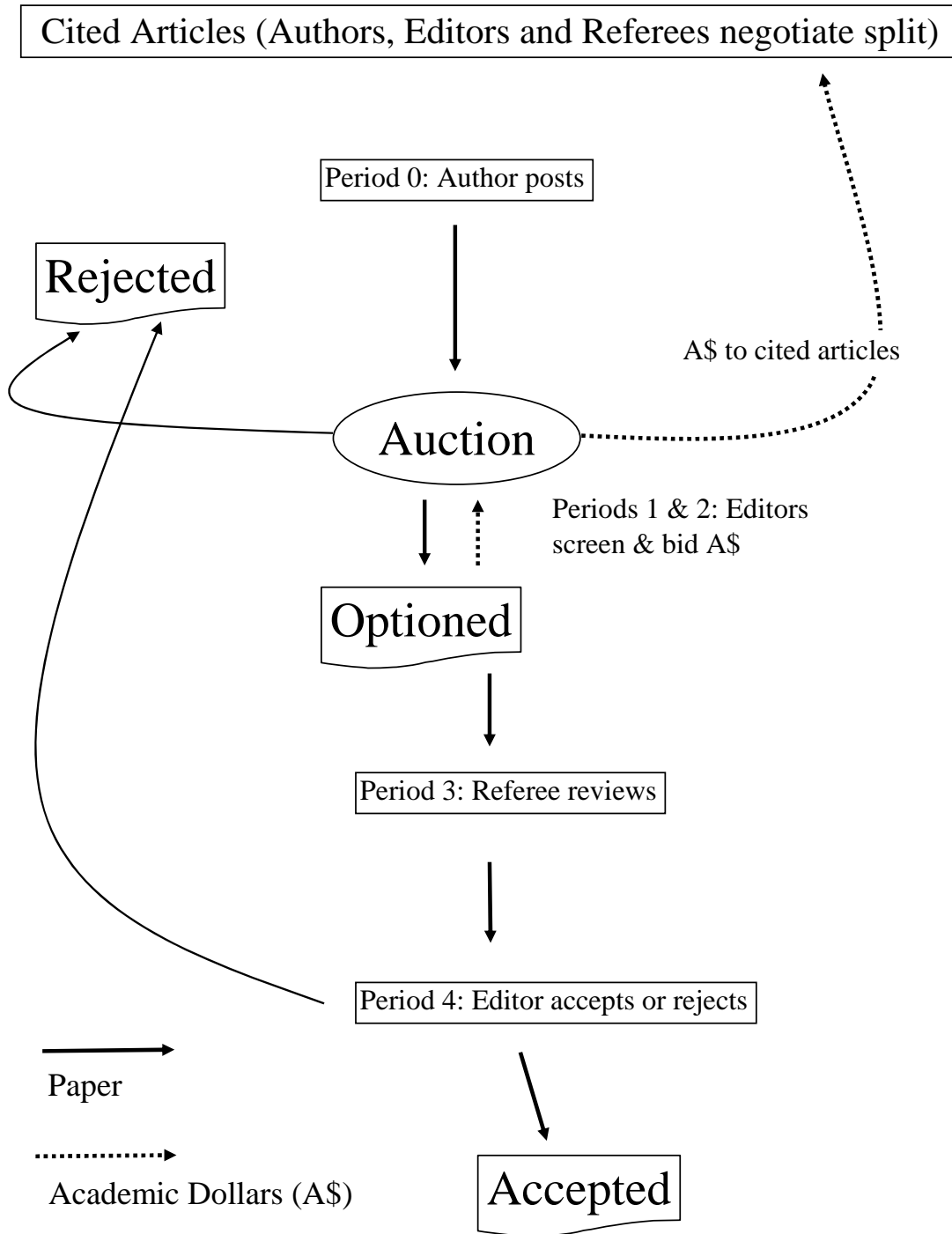


FIGURE 1. Market Structure from Auction to Publication. In Period 2, auction proceeds go to prior *cited* articles. The auctioned paper receives revenue after publication, when papers citing it (as an article) are themselves auctioned. Rejected papers go back to the author.

Since authors specify these five criteria outside of the game, we treat the author’s share of future revenues from the article  $(1 - \alpha)$  and total time from submission of a paper to the auction server to final acceptance/rejection decision  $(T)$  as exogenous variables that can be set by the non-strategic organizer of the auction platform.<sup>18</sup> The author decides marketing effort  $(m)$ , which has a cost of  $a(m)$ .

*Period  $t_1$ —Editor Screens Papers:* Editor  $j$  of journal  $j$  already knows about the set  $K_j \equiv K$  papers, where  $K$  is a random draw from the much larger set  $(\infty)$  available on the auction market; see Figure 2. He decides  $|L|$ , the number of papers in set  $L \subseteq K$ , at a cost of  $s(|L|)$ . In doing so, he learns his willingness to pay  $(v_{ij} \equiv v)$  for each of the  $|L|$  papers.  $v$  depends on the expected revenue of an article  $(\hat{\pi})$ , which differs among editors and is drawn from an arbitrary distribution.<sup>19</sup> Let  $\mu$  denote the probability that the editor’s valuation is positive, i.e.,  $\text{Prob}\{v > 0\} \equiv \mu$ .<sup>20</sup> We normalize valuations such that editor  $j$  only has a valuation  $v > 0$  for a paper if his prior after spending  $s(\cdot)$  on it is that he is willing (in principle) to publish that paper. Publication will not occur if the editor wins a “better” paper at auction, and both papers compete for the same space in journal  $j$ .

*Period  $t_2$ —Editor Bids on Papers:* Editor  $j$  submits a single bid of  $b_{ij} \equiv b$  for each paper in  $L$ . A\$ bids are not published. This sealed-bid, second-price (Vickrey) auction ends at the pre-specified time after which the highest and the second-highest bids are known. The

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<sup>18</sup>Diversity in these variables can correct for author and editor/journal heterogeneity. Duration  $T$  could be split into a standard duration  $(T_1)$  for the auction and a standard duration  $(T_2)$  for the editors acceptance/rejection decision. Standardization at the auction server could minimize transaction costs, but flexible  $T$ s allow for various heterogeneities. Auctions should be frequent enough to allow editors several chances to fill each issue of the journal. Although  $T_2$  might easily exceed the lapse between auctions, we do not consider inter-auction dependencies here.

<sup>19</sup>To avoid combinatorial issues we assume that editor  $j$ ’s valuation for paper  $i$  does not depend on his valuation for paper  $l \neq i$ . If an editor wants to bid on related papers (e.g. to publish a one-topic issue), he could increase his valuation for paper  $i$  by adding a value component to  $\hat{\pi}$  that depends on his expected probability of winning the other papers. Alternatively, papers could be bundled at auction.

<sup>20</sup>The probability for positive valuations varies among editors: An editor of a high-quality journal might not want to publish the same paper an editor of a lower-quality journal would; see more about private values on page 15.

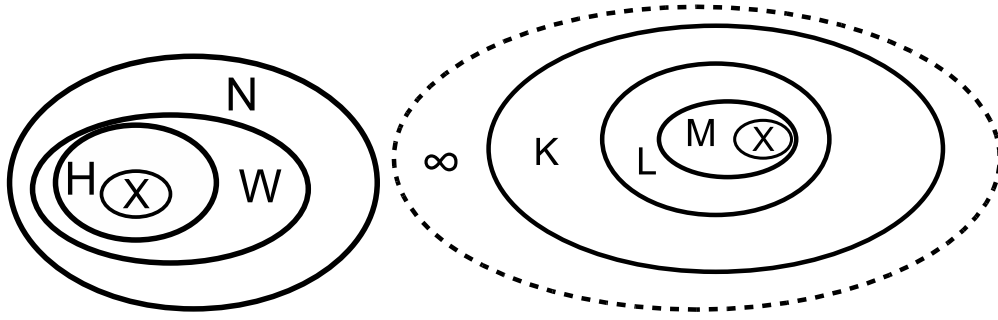


FIGURE 2. In the CPS [left], editor  $j$  makes a preliminary review of subset  $W$  in the set of submitted papers  $N$ . He sends a subset  $H \subseteq W$  to referees for review and accepts  $X \subseteq H$ . In the AMJA [right], each editor has a set  $K$  of “known” papers in the much larger set  $(\infty)$  available on the auction market. He “learns” about (and sets a value on) an endogenous subset  $L$ . He wins a subset  $(M \subseteq L)$  at auctions and sends them to referees and accepts  $X \subseteq M$ .

highest bidder wins and pays the price  $p = \hat{b}$ , where  $\hat{b}$  is the second-highest bid.<sup>21</sup>  $p$  is distributed equally among the editors of the articles cited by  $i$  (who then split their shares with referees and authors of those articles). Editor  $j$  wins a set of papers  $M \subseteq L$ . He has the right to accept or reject those papers before  $T$  ends.<sup>22</sup>

*Period  $t_3$ —Referee Reviews Paper:* The editor incurs costs  $r(|M|)$  to find a referee willing to review the papers he has optioned for a share  $(\beta)$  of future revenues  $(\pi_{ij} \equiv \pi)$ —should the editor publish the paper.<sup>23</sup> The referee chooses effort  $e$  to judge/improve the paper and recommend its acceptance or rejection.

*Period  $t_4$ —Editor Accepts/Rejects Paper:* We define  $X$  as the set of papers finally accepted for publication in a given issue of journal  $j$  and  $|X|$  as the exogenously-given number of slots available for articles.<sup>24</sup> Given  $|X|$ , we define  $\gamma$  as the share of papers the editor can

<sup>21</sup>These auction rules guarantee maximum anonymity of bidders and bids—and thereby solve the typical problems of auctions with common or affiliated values and sniping; see Section 3 for more details. Without loss of generality we also use  $\hat{b}$  to denote the *expected* bid of the second-highest bidder.

<sup>22</sup>Authors pre-specify the bidders they would refuse via Period 0 handicaps.

<sup>23</sup>We assume  $\beta$ , like  $\alpha$ , is exogenous. In practice,  $\beta$  may result from a bargaining process that integrates referees’ heterogeneous quality and standing.

<sup>24</sup>We ignore the fact that papers differ in length.

accept out of the  $|M|$  won at auction, i.e.,  $|X| \equiv \gamma|M|$ .<sup>25</sup> The editor accepts and finalizes for publication the best  $\gamma|M|$  papers at a cost of  $f(\gamma|M|)$ ; he rejects  $(1 - \gamma)|M|$ , which go back to authors who may improve and resubmit them to the auction server. This decision involves no additional effort and therefore no optimization trade-off.

**2.3. Quality Production and Article Revenues.** Before we solve the AMJA Game, let us specify  $Q_j \equiv Q$ , the average quality of *accepted* papers in journal  $j$ .<sup>26</sup>  $Q$  is a function of the quality of papers authors submit to the auction ( $q$ ), referee effort ( $e$ ), and the journal's acceptance rate ( $\gamma$ ). As  $Q$  is the average quality of papers in  $X$ , a subset of  $\infty$ , in expectation it positively depends on  $q_i$ , a single paper's quality, where  $i \in \infty$ . As the increased quality of an individual paper translates monotonically into increased average journal quality, we assume that  $q$  has a non-convex impact on  $Q$ . As a referee's work can increase a paper's final quality and partly substitute for its original quality,  $e$  has a similar effect on  $Q$  as  $q$ .

The editor can rank the  $|M|$  papers he has optioned for publication after spending  $s(\cdot)$ ,  $r(\cdot)$  and reading referee reports. As long as he chooses to publish the best of those papers, which is in his interest, a lower acceptance rate ( $\gamma$ ) results in higher average journal quality, *ceteris paribus*. For simplicity, we assume a linear relation such that  $\gamma$  positively depends on the exogenous number of slots in a given journal issue ( $|X|$ ) and negatively on the number of papers the editor options in the auction market ( $|M|$ ). We assume  $|M|$  increases monotonically in  $|L|$ , the number of papers an editor bids on, because each non-zero bid increases the probability of placing the highest bid for a paper and winning its auction.<sup>27</sup> Formally,

<sup>25</sup>We will refer to  $\gamma$  also as the "acceptance rate". Note that this rate is different from the CPS acceptance rate, which equals  $\frac{|X|}{|N|}$ .

<sup>26</sup>This definition allows us to use  $Q$  as the "quality of journal  $j$ " as well.

<sup>27</sup>If editor  $j$  spends  $s'$  on paper  $i$  and learns that his valuation  $v = 0$ , he has a dominant strategy of bidding  $b = 0$ . As the editor's prior on his expected valuation for a given paper in  $K$  must be positive (otherwise he would be a useless editor), a marginal increase in  $|L|$ —while assuming that the quality standards of the editor, expressed by  $\mu$ , are constant in  $|L|$ —increases the probability of finding a paper on the auction market for which  $v > 0$ . For each such paper, as we will see below, his optimal bidding strategy is  $b^* = v > 0$ . Combine this with our assumption that the sets of known papers of editors  $j$  and  $k$  ( $K_j$  and  $K_{k \neq j}$ ) are random draws from  $\infty$ . (Thus  $\text{prob}\{K_j \equiv K_{k \neq j}\} = 0$ .) We conclude that an increase in  $|L|$  increases the probability that editor  $j$  places the highest bid for a paper and thereby increases  $|M|$ .

we operate with the following Equations:

$$Q = Q(q, e, \gamma(|M|(|L|))) \quad (5)$$

$$\frac{dQ}{dq} > 0 \quad ; \quad \frac{d^2Q}{dq^2} \leq 0 \quad (6)$$

$$\frac{dQ}{de} > 0 \quad ; \quad \frac{d^2Q}{de^2} \leq 0 \quad (7)$$

$$\frac{dQ}{d\gamma} < 0 \quad ; \quad \frac{d^2Q}{d\gamma^2} = 0 \quad (8)$$

$$\frac{dQ}{d|L|} = \frac{dQ}{d\gamma} \frac{d\gamma}{d|M|} \frac{d|M|}{d|L|} > 0 \quad ; \quad \frac{d^2Q}{d|L|^2} = 0 \quad (9)$$

Equation (5) characterizes the production function of journal quality. Equations (6), (7) and (9) capture the marginal effects of the efforts of authors, referees and editors on the production of journal quality. Equation (8) is necessary to understand (9).

We make the crucial assumption—following Judge et al. (2007)—that an article’s citation revenues monotonically increase in the quality of the journal in which it appears. Formally, let  $i$  be one of  $G$  papers that cites article  $ij$ , let  $p_i$  be the price of  $i$  in a future auction, and let  $n_i$  be the number of articles cited in  $i$ . Then, abstracting from time discounting, article  $ij$  generates future revenues of:

$$\pi_{ij} = \sum_{i=1}^G \frac{p_i}{n_i}. \quad (10)$$

As revenues will be made in the uncertain future, we denote the *expected* revenues of article  $ij$  by  $\hat{\pi} \equiv \hat{\pi}_{ij}(\cdot)$ . By the above argumentation and Equation (10), we have:

$$\frac{d\hat{\pi}}{dQ} = \frac{d\hat{\pi}}{dG} \frac{dG}{dQ} > 0. \quad (11)$$

We assume that  $\hat{\pi}$  is non-convex in  $Q_j$ , i.e.,<sup>28</sup>

$$\frac{d^2\hat{\pi}}{dQ^2} \leq 0. \quad (12)$$

Summarizing Equations (6), (7), (9) and (11), we get:

**Lemma 1** (Expected revenues of an accepted paper).

*The expected revenue of an article ( $\hat{\pi}$ ) is increasing in the quality of the paper an author submits to the auction ( $q$ ), the effort of a referee to improve the paper ( $e$ ), and the number of papers an editor chooses to learn about ( $|L|$ ).<sup>29</sup>*

### 3. ANALYSIS OF THE AMJA GAME

We ignore the possibility of zero strategies and look for a subgame-perfect equilibrium that provides positive outcomes.<sup>30</sup> Since there is no optimization in  $t_4$ , we start with the referee's optimization problem in  $t_3$  where the referee faces a moral hazard problem concerning acceptance or rejection of the paper he is to review: Since he will only get a payoff if the paper is published (and cited), he is unlikely to recommend rejection.<sup>31</sup> If so, the editor making acceptance decisions in  $t_4$  could use his own ranking of papers within  $|M|$  that he got from spending  $s'(\cdot)$  in  $t_1$  and could compare the arguments the referee provides with the

<sup>28</sup>We assume non-convexity to reflect the fact that journals do not have increasing returns to scale. This is evident in the emergence of more, not bigger, journals in response to the multiplication of fields and demand for publication space. The most recent manifestation is the AER's spawning of four field journals.

<sup>29</sup>We call papers "accepted" or "articles" after they are published.

<sup>30</sup>One obvious subgame-perfect equilibrium of the AMJA game is a strategy combination in which no party exerts any effort, i.e., a *zero equilibrium* where authors invest  $q = m = 0$ ; editors learn about  $|L| = 0$  papers and bid  $b = 0$  for each paper in an empty set  $L$ ; referees pick  $e = \underline{e}$  but suffer no refereeing disutility because editors send them no papers. No papers are published, and all four parties enjoy induced utility of zero. Nobody has an incentive to deviate as publishing papers is only feasible cooperatively.

<sup>31</sup>In a repeated version of the game such a proposed pooling equilibrium, where all referees recommend acceptance, is not necessarily stable; referees could build a reputation for honesty and seriousness by rejecting a higher share of papers without effort; see Mailath and Samuelson (2006) for modeling possibilities that we ignore here.

arguments of another referee in favor of another paper. We conclude that the recommendation of the referee in a one-shot game does not contain useful information for the editor. This does not imply that the referee is useless: He improves the quality of the paper.

Recall that  $\alpha$  is the journal's share of future revenue  $\hat{\pi}$  for an article published with the expected probability  $\hat{\gamma}$ , of which the editor gives the share  $\beta$  to the referee. This share extends the objective function of the referee in Equation (4). Therefore, the referee chooses effort  $e^*$  to solve the optimization problem:

$$\max_e \hat{\gamma}\alpha\beta\hat{\pi}(e, \cdot) - c_R(e) + u_R(e), \text{ subject to } e \geq \underline{e}. \quad (13)$$

We know that referees work (choose positive effort) without explicit remuneration in the CPS. Consequently we must have  $u_R(\underline{e}) \geq c_R(\underline{e})$ .<sup>32</sup> As the AMJA only adds utility to existing CPS utility—from the same work, we have:

$$\hat{\gamma}\alpha\beta\hat{\pi}(\underline{e}, \cdot) + u_R(\underline{e}) > c_R(\underline{e}). \quad (14)$$

We know from Lemma 1 that  $\hat{\pi}$  is increasing in  $e$ . From Equations (7) and (12), we know the LHS of (14) is concave in  $e$ ; the RHS, by assumption, is convex. This yields:

**Lemma 2** (Effort of the referee).

*The optimization problem of the referee, Equation (13), has a unique and well-defined solution,  $e^* > \underline{e}$ .*

In period  $t_2$  the editor bids for papers. The value of a paper comes from two properties: a *private value* for editors of certain journals and a *common value* for all editors. Without knowing the mix of private and common values, a bidder has no information to rationally guess the common value component.<sup>33</sup> Thus, we treat the value of a paper as a random

<sup>32</sup>This is a corollary to maximizing (13) when  $\hat{\pi} = 0$ .

<sup>33</sup> A sealed-bid auction does not rule out the existence of common values: all editors want good papers. Milgrom (1981) has shown that sealed-bid auctions prevent bidders from learning common values through



variable whose realizations are i.i.d. Editor  $j$ 's realization of the random variable is his private information. For simplicity, we specify that editors bid in a sealed-bid second-price auction.<sup>34</sup>

Given that editors may bid for several papers at once and that they face A\$ budget constraints, our setting is a private-value, sealed-bid, second-price auction with budget constraints and multiple-objects. Che and Gale (1998) have analyzed such a setting for a single object. They find that it is optimal for a bidder to bid the lower of his valuation for the object and his budget. In other words, if the budget constraint is not binding, a bidder bids his private value  $v$ . If the budget constraint is binding, he bids his entire budget.<sup>35</sup> This implies that, if the editor runs out of A\$, he simply has to stop bidding for further papers.

With respect to multiple objects (papers), we make use of each editor's uncertain knowledge of other editors' budgets.<sup>36</sup> Because no editor knows the number or financial strength of other bidding editors, he has no reason to deviate from the single-object equilibrium strategy. Finally, sealed bids also prevent shill bidding and sniping.<sup>37</sup>

Private value  $v$  depends on the expected revenues of an article ( $\hat{\pi}$ ), the editor's share of those revenues ( $\alpha(1 - \beta)$ ), the probability that a purchased paper will be published ( $\gamma$ ), and the cost of finding a referee ( $r'(\cdot)$ ). As  $r(|M|)$  is convex, the editor estimates the number of papers he will win as a function of the number of positive bids,  $\mu|L|$ .

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others' bids, resulting in lower bids (to avoid winner's curse) and sub-maximal revenue. Since this characteristic affects all papers equally, and *relative* incomes do not change, we can ignore it. (Recall that our goal is to allocate papers and value articles—not maximize revenues.)

<sup>34</sup>We could specify that bids be published ex post so bidders and authors can monitor the manager of the auction platform but gain no useful information on bidding strategies. Anonymizing bids would prevent others from strategically using this information ex post.

<sup>35</sup>Benoît and Krishna (2001) show that this result changes if objects have common values and information is complete. Che and Gale (1998) also show that binding budget constraints do indeed affect the revenue equivalence between first-price and second-price auctions. As mentioned in footnote 33, this is not of our concern here.

<sup>36</sup>See Section 5.1 for the idea that authors and referees may reassign their A\$ to editors after some time. If this happens in anonymity, nobody can guess a certain editor's budget precisely.

<sup>37</sup>*Shill bidding* occurs when someone bids for the author to drive prices up. *Sniping* occurs when someone bids just before the auction ends—and before others have a chance to react—and wins (Roth and Ockenfels, 2002).

Let  $|\hat{M}|$  denote the *expected* number of papers the editor wins using his equilibrium strategy. Since auctions for all papers run simultaneously within one period, the editor in equilibrium will attribute the average cost of refereeing ( $\frac{r(|\hat{M}|)}{|\hat{M}|}$ ) to each paper. We assume that the editor can bid his budget  $w$  this period. We also assume that he cannot go bankrupt, i.e., bid more than  $w$  for all papers. The editor decides one bid at a time and compares his valuation for that paper  $v$  with  $w$ , his budget remaining after earlier bids have been subtracted. We establish:

**Lemma 3** (Editor bidding).

*The optimal bid of editor  $j$  on each paper in  $L$  is*

- (i)  $b^* = 0$  if  $v \leq 0$  and
- (ii)  $b^* = v = \gamma\alpha(1 - \beta)\hat{\pi} - \frac{r(|\hat{M}|)}{|\hat{M}|}$  if  $w > v > 0$  and
- (iii)  $b^* = w$  if  $w \leq v$ .

Before the editor bids in period  $t_1$ , he decides to give a preliminary review to  $|L|$  papers. He learns his valuation ( $v$ ) for all  $|L|$  at a total cost of  $s(|L|)$ . His decision on  $|L|$  directly affects the expected number of purchased papers ( $|\hat{M}|$ ) and hence the cost of choosing suitable referees,  $r(|\hat{M}|)$ .<sup>38</sup> Thus, we rewrite Equation (3) to get the editor's maximization problem:

$$\max_{|L|} \sum_{|X|} [\alpha(1 - \beta)\hat{\pi}(|L|)] - \sum_{|\hat{M}|} p + u_j(Q(|L|)) - [s(|L|) + r(|\hat{M}|(|L|)) + f(|X|)], \quad (15)$$

where  $\alpha(1 - \beta)\hat{\pi}$  is the editor's share of expected total revenues of one of  $|X|$  papers published as articles and  $\sum_{|\hat{M}|} p = |\hat{M}|\hat{b}$  denotes the expected price the editor has to pay at auctions for the right to publish  $|\hat{M}|$  papers. Note that  $f(|X|)$  is independent of  $|L|$ . The first-order condition of (15) is:

$$|X|\alpha(1 - \beta)\frac{d\hat{\pi}}{d|L|} + \frac{du_j}{dQ}\frac{dQ}{d|L|} = \frac{d|\hat{M}|}{d|L|}\hat{b} + \frac{ds(|L|)}{d|L|} + \frac{dr(|\hat{M}|)}{d|L|}. \quad (16)$$

<sup>38</sup>See footnote 27 for more on the relation between  $|L|$  and  $|M|$ .

Since Equations (9), (11) and (12) imply non-convex growth of  $\hat{\pi}$  and linear growth of  $u_j$  and  $|\hat{M}|$  in  $|L|$ , and  $s(|L|)$  and  $r(|\hat{M}|)$  are convex, we can state:

**Lemma 4** (Editor's optimal set of pulled papers).

*The optimization problem of the editor, Equation (15), has a unique and well-defined solution,  $|L|^* > 0$ .*

In period  $t_0$  authors decide their effort in marketing papers to editors. Let  $\kappa_i = \frac{m_i}{|K'_j| + m_i} \equiv \kappa$ , the probability that paper  $i$  is among the papers known to editor  $j$ , where  $|K'_j|$  is the number of papers known to editor  $j$  before author  $i$ 's marketing decision. It follows that  $\kappa(m = 0) = 0$ , and  $\kappa$  is concave in  $m$ . Given paper  $i \in K$ , the probability that it is also an element of  $L$  is  $\frac{|L|}{|K|}$ , and the probability that  $j$  makes a positive bid for a paper in  $L$  is  $\mu$ . Finally, only  $\gamma$  of the papers purchased by editor  $j$  will be published and have a positive expected revenue.

Let us define the *expected publication probability* of paper  $i$  (i.e.,  $i$ 's aggregate probability over all journals  $j$  of receiving a bid  $b > 0$ , multiplied by the expected probability of publication in journal  $k$  ( $\hat{\gamma}_k$ ) that placed the highest bid for  $i$  in  $t_0$ ) as:<sup>39</sup>

$$\rho_i = \sum_j \left( \kappa(m, |K'_j|) \cdot \frac{|L_j|}{|K_j|} \cdot \mu_j \right) \hat{\gamma}_k \equiv \rho. \quad (17)$$

Author  $i$  considers all these factors in solving the maximization problem:

$$\max_{m,q} \rho[1 - \alpha]\hat{\pi}(q, \cdot) + u_i(q, T) - a(m, q) - \phi, \quad (18)$$

<sup>39</sup>One could claim that  $\mu_j$  positively depends on  $q_i$  or negatively on  $Q_j$  of the last round. Since we already included effects of higher paper quality in  $\hat{\pi}$ , we assume  $\mu_j$  is a fixed parameter.

which has first-order conditions of:

$$\sum_j \left( \frac{|K'_j|}{(|K'_j| + m)^2} \cdot \frac{|L_j|}{|K_j|} \cdot \mu_j \right) \hat{\gamma}_k [1 - \alpha] \hat{\pi} = \frac{da(m, \cdot)}{dm} \quad (19)$$

$$\rho [1 - \alpha] \frac{d\hat{\pi}}{dQ} \frac{dQ}{dq} + \frac{du_i(q, \cdot)}{dq} = \frac{da(q, \cdot)}{dq}. \quad (20)$$

$\hat{\pi}$  is independent of  $m$ ; hence the LHS of Equation (19) is decreasing in  $m_i$ , while its RHS is increasing by the convexity assumption. Due to (6) and (12), the LHS of Equation (20) is not increasing in  $q$ , while its RHS is increasing by assumption. Thus we establish:

**Lemma 5** (Author's optimal efforts to produce quality and marketing).

*The optimization problem of the author, Equation (18), has one unique and well-defined solution,  $q^* > 0$  and  $m^* > 0$ .*

Notice that the LHS of Equation (19) depends on  $\hat{\pi}$ , which depends on  $q$ . Increased paper quality  $q$  has a positive effect on optimal marketing effort  $m^*$ . Similarly, according to the LHS of (20), the author's marginal expected revenue from increasing quality  $q$  increases in marketing effort  $m$  (because  $\frac{d\rho}{dm} > 0$ ), i.e., optimal quality  $q^*$  grows in  $m$ . Put another way, quality and marketing are complements in the AMJA author's objective function—something that is not necessarily true in the CPS. We summarize our results as:

**Proposition 1** (Equilibrium of the AMJA publishing system).

*Consider Lemmas 2 through 5. The unique, non-zero, subgame-perfect equilibrium of the AMJA game is characterized by the strategies  $e^*$ ,  $b^*$ ,  $|L|^*$ ,  $q^*$  and  $m^*$ .*

#### 4. COMPARING THE CPS AND AMJA

**4.1. The Equilibrium of the CPS.** First, we characterize the equilibrium of the current publishing system (CPS). Consider the induced utility functions from Section 2.1: Equation (4) denotes the objective function of a CPS referee. If we assume  $u_R(e)$  is concave and  $c_R(e)$

is convex in  $e$ , the equilibrium strategy of a referee in a functioning CPS (i.e.,  $u_R(\underline{e}) \geq c_R(\underline{e})$ ) is to choose effort of:<sup>40</sup>

$$\tilde{e} \geq \underline{e}. \quad (21)$$

A CPS editor's objective function is Equation (3). He chooses a set of papers ( $W$ ) from the exogenous set of papers pushed at him ( $N$ ) and gives them preliminary reviews—at a cost  $s(|W|)$ —within period  $T$ . Naturally, we assume the effects of  $|W|$  on  $|H|$  (the number of papers being sent to referees—and hence on  $\gamma$  and  $Q$ )—to be the same as those effects of  $|L|$  on  $|M|$ ; see Equation (9). If we assume  $u_j$  is linear in  $|W|$  and  $s(\cdot) + r(\cdot)$  is convex in  $|W|$ , a unique solution to his maximization is:

$$|\tilde{W}| > 0. \quad (22)$$

In the CPS, an author's marketing effort does not improve the quality of his paper, the only measure relevant when perfectly-rational editors consider papers pushed at them. This is why  $u_i$  is independent of  $m$  in a CPS author's objective function, Equation (2). Consequently, equilibrium marketing effort is:<sup>41</sup>

$$\tilde{m} = 0. \quad (23)$$

In contrast,  $q$  has a positive, non-convex impact on  $Q$ , which the editor values positively; see Equation (6).  $u_i(q, T)$  is therefore non-convex in  $q$ . Since the costs of quality ( $a(q)$ ) are convex in  $q$ , the unique equilibrium strategy is:

$$\tilde{q} > 0. \quad (24)$$

<sup>40</sup>We will denote equilibrium CPS values with a tilde, e.g.,  $\tilde{e}$ .

<sup>41</sup>Alternatively, one could claim that (as in reality) CPS authors also spend effort on marketing papers, i.e.,  $\tilde{m} > 0$ . This marketing would increase the normalized marketing level and thus  $m^*$ ; since the effect influences both systems equally, it is irrelevant.

Since there is no auction in the CPS, there is no bidding strategy. Our benchmark case for the subsequent comparison is thus:

**Proposition 2** (Equilibrium of the Current Publishing System).

*Consider Equations (21) through (24). A unique non-zero, subgame-perfect equilibrium in the CPS is characterized by the strategies  $\tilde{e}$ ,  $|\tilde{W}|$ ,  $\tilde{m}$  and  $\tilde{q}$ .*

**4.2. Comparing Equilibria.** Compare the referee's objective function in the CPS, Equation (4), to his objective function in the AMJA, Equation (13). The only difference is that the referee gets additional utility in the AMJA, i.e.,  $\hat{\gamma}\alpha\beta\hat{\pi}(e, \cdot)$ . Since  $\frac{d\hat{\gamma}\alpha\beta\hat{\pi}(e, \cdot)}{de} > 0$ , the referee's equilibrium strategy in the AMJA is:

$$e^* > \tilde{e}. \quad (25)$$

The comparison for editors is more complicated. To compare  $|\tilde{W}|$  and  $|L|^*$ , rewrite the objective function of the AMJA editor in period  $t_1$ , Equation (15), as:

$$\sum_{|X|} [\alpha(1 - \beta)\hat{\pi}(|L|)] - |M|\hat{b} + u_j(Q(|L|)) - [s(|L|) + r(|\hat{M}|(|L_j|)) + f(|X|)]. \quad (26)$$

Next, use  $|M| = \frac{|X|}{\gamma}$  and replace  $\hat{b}$  (the maximum price that editor  $j$  could have to pay for each purchased paper) with his valuation  $v = \gamma\alpha(1 - \beta)\hat{\pi} - \frac{r(|\hat{M}|)}{|\hat{M}|}$ ; see Lemma 3.<sup>42</sup> Rewriting Equation (26), we get:

$$\frac{|X|}{\gamma} \frac{r(|\hat{M}|)}{|\hat{M}|} + u_j(Q(|L|)) - (s(|L|) + r(|\hat{M}|(|L|)) + f(X)). \quad (27)$$

Note that the CPS editor's objective function, Equation (3), lacks  $\frac{|X|}{\gamma} \frac{r(|\hat{M}|)}{|\hat{M}|}$ . When calculating the FOC of (27), note that  $\frac{d\gamma}{d|L|} < 0$  (hence  $\frac{|X|}{\gamma}$  increases in  $|L|$ ) and that  $\frac{r(|\hat{M}|)}{|\hat{M}|}$  also increases in  $|L|$  (from the convexity of  $r(\cdot)$ ). Consequently, an editor gains more utility at

<sup>42</sup>For every price  $p < v$  the editor's incentive to increase  $|L|$  is even more pronounced.

the margin from increasing  $|L|$  in AMJA than from  $|\tilde{W}|$  in CPS. This leads to:

$$|L|^* > |\tilde{W}|. \quad (28)$$

For authors, compare the FOCs of the AMJA, Equation (20) with respect to  $q$ , and the CPS, Equation (2). The only difference is that increasing quality gives the author in the AMJA an additional marginal benefit of:

$$\rho[1 - \alpha] \frac{d\hat{\pi}}{dQ} \frac{dQ}{dq}, \quad (29)$$

which is positive for  $m^* > 0$ . This provides us with the insight that:

$$q^* > \tilde{q}. \quad (30)$$

Finally, we state as a corollary to Lemma 5 and Equation (23) that:

$$m^* > \tilde{m}. \quad (31)$$

These insights allow us to state two further results:

- (1) According to Equations (6) to (9), the average quality of articles in a journal ( $Q$ ) increases in  $q$ ,  $e$ , and  $|L|$ . Consequently, by considering the comparative results of Equations (25), (28) and (30), we have:<sup>43</sup>

$$Q^* > \tilde{Q}. \quad (32)$$

- (2) With  $e^* > \tilde{e}$  and, by assumption,  $\frac{dT}{de} < 0$ , we have:

$$T^* < \tilde{T}. \quad (33)$$

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<sup>43</sup>For clarity reasons we denote the AMJA (CPS) equilibrium value of  $Q$  by  $Q^*$  ( $\tilde{Q}$ ) and will do the same for other variables below. We are aware that those are not strategic variables in the strict sense.

These results complete our equilibrium analysis.

**4.3. Pareto-optimality.** What claims can we make from our results about the well-being of authors, editors, referees and readers? Ignoring the transition from one system to another (see Section 5.8 on page 31), we compare the expected, induced utility of each party in both systems.

Readers are better off in the AMJA. Reader utility rises with journal quality ( $Q$ ) and falls with time-to publication ( $T$ ). Since both equilibrium values improve in the AMJA system (according to Equations (32) and (33)), we get:

$$\nu_C^* > \tilde{\nu}_C. \quad (34)$$

Why do referees, editors, and authors choose higher values for  $e$ ,  $|L_j|$ ,  $q_i$  and  $m_i$  in the AMJA system? If players increase their inputs *voluntarily*—based on a comparison of expected marginal utility and marginal costs of such an increase, it must be because they expect higher induced utility in the AMJA system.

This conclusion is simple for editors and referees because they only gain—and do not lose—utility in the AMJA system, i.e.,

$$\nu_j^* > \tilde{\nu}_j \quad (35)$$

$$\nu_R^* > \tilde{\nu}_R \quad (36)$$

For authors, the AMJA is better *only if* additional induced utility exceeds additional disutility, i.e.,

$$\rho(m^*)[1 - \alpha]\hat{\pi}(q^*) + (u_i(T^*) - u_i(\tilde{T})) > \phi. \quad (37)$$

Thus, if the costs of posting a paper to the auction server ( $\phi$ ) are too high, authors will not contribute. If authors differ (e.g., through heterogenous abilities), they have different



cost functions ( $a(q, m)$ ) for increasing paper quality and marketing, which results in different levels of  $q^*$  and  $m^*$ . To maximize participation,  $\phi$  must be low enough to attract higher cost authors.<sup>44</sup>

Finally, since author  $i$  voluntarily spends  $a(m^* > 0) > 0$ , the author trades loss for gain while Equation (37) holds.<sup>45</sup> We conclude:

$$\nu_i^* > \tilde{\nu}_i, \tag{38}$$

which allows us to state our main result:

**Proposition 3** (Pareto-optimality).

*Consider Equations (34) through (38). As long as the submission fee to the auction server ( $\phi$ ) is sufficiently low, the equilibrium of the AMJA is strictly Pareto-superior to the equilibrium of the CPS.*

In the AMJA system, additional, explicit incentives induce referees to put more effort into improving papers, editors to pull more papers for preliminary review (which frees other papers from the idleness common in the CPS), and authors to put more effort into papers' quality and marketing (given that submission fees are not prohibitive).<sup>46</sup> As a result, we

<sup>44</sup>This insight opens an entire discussion on the potential goals (and welfare) of the academic community as a whole: Is it better to encourage every author to post papers to the auction server by charging low  $\phi$ —thus allowing unsuccessful papers to subsidize more successful papers—or should a certain threshold for quality of papers (and marketing efforts) be set indirectly by charging high  $\phi$ ?

<sup>45</sup>Notice that there is a *positive* externality of  $m$ . Suppose an author writes a paper with high  $q$ . Increasing  $m$  increases the probability that it is known to editors, who are more likely to give it a preliminary review and bid for it. If this means journal quality ( $Q$ ) rises to directly benefit readers and editors and  $\hat{\pi}$  rises—see Equation(11)—to indirectly benefit editors and referees, then effort spent on marketing a good paper benefits society. The contrary is also true: more marketing for a low-quality paper results in either no bids (wasted marketing effort) or displacement of a better, but less marketed, competitor, which harms society and efficiency.

<sup>46</sup>Will explicit referee incentives in the AMJA crowd out implicit incentives responsible for current levels of referee effort? Not exactly. AMJA-referees are explicitly rewarded in A\$ (on top of the current good feeling from “service to society”), not cash. Since A\$ acts as tokens (or quasi-medals), they merely reinforce the “service” reward. On the other hand, higher A\$ may be positively correlated with higher real income (e.g., a better job), which result in a second order loss of intrinsic motivation. The degree with which A\$ income adds to the existing chances of getting a better job as a referee under the CPS (potentially lowering implicit

expect the quality of journals to rise and publication delay to decrease. These developments directly improve the well-being of readers, authors, and editors—and indirectly, via remuneration from articles cited by subsequent, auctioned papers, the utility of referees.

## 5. DISCUSSION

Our model compares the actions of players in the CPS to players in the AMJA, but it is difficult to specify every difference and dimension within a model. We discuss hard-to-quantify, but important, issues in this section.

**5.1. A\$ Circulation.** The AMJA uses nonpecuniary Academic Dollars (A\$)—not a liquid currency.<sup>47</sup> After each auction, A\$ are allocated to the authors, editors and referees of *cited* articles in proportion to their prior agreements.

Since editors need A\$ to bid for new papers, and authors and referees do not “need” A\$, they reassign their A\$ to *any editor(s) they choose* within, say, one year. These insider votes strengthen good editors/journals and support competition to serve the needs of authors and referees—in direct proportion to realized author/referees success. (Minority and heterodox editors could benefit from a *relatively* loyal constituency.)

A\$ reallocation gives journals the incentive to increase their differentiation and quality, which lowers search costs. If the journal’s subscription price was “too high” relative to its A\$ revenue, it would lose readers and citations. Journals that charged “too little” could choose between increasing price or building even higher readership.

The use of A\$ limits the current problem of entry by publishers with “hot” money who fragment the location of articles with small benefits for readers, dubious benefits to authors, and great detriment to research libraries’ budgets (Bergstrom and Bergstrom, 2001, 2004). Entry would instead occur when authors/referees pooled their A\$ to support a new journal.

motivation) compared to its augmentation of explicit incentives is hard to predict but likely to be small enough to ignore.

<sup>47</sup>The initial allocation of A\$ could be in proportion to, for example, subscribers, cumulative citations, impact factor, etc.

Exit would take place when a journal failed to garner A\$ support from authors/referees: Regardless of ownership, the journal would die from “academic unprofitability”. Interestingly, an editor’s limited supply of A\$ might limit the practice of excessive “banking,” i.e., accepting so many papers that “the time lag from acceptance to publication [rises] to 30 months or even three years” (Dunleavy, 2003, pp. 231–2).

The fixed supply of A\$ would limit inflation in bidding and prices. Users’ A\$ accounts, income, redistribution, etc. will be administered through an Internet-based AMJA platform. (Think of a version of SSRN that includes an auction platform, cross-links to existing articles, and A\$ “bank” accounts for AMJA users.)

**5.2. Valuing Academic Output.** The AMJA quantifies academic output through A\$ income, and academics need such a measure now more than ever. Long ago, decisions on professional advancement depended on a number of subjective factors. These were replaced over time by a greater reliance on “objective” factors, such as publication or citation counts. As publication has grown more important, the number of submitted papers has increased, leading—in turn—to a greater supply of journals offering publication spaces.<sup>48</sup> Far from fixing the problem, the multiplication of titles has made measurement (and professional decisions) more difficult. Neither tenure candidates nor committees are happy with current evaluation methods (Varian, 1997); they need a simple indicator.

In the CPS, departments may multiply articles (or pages) by the “rank” of the publishing journal. The department may define rank (inviting provincial bias) or use ISI’s “Impact Factor” (inviting ISI’s bias).<sup>49</sup>

<sup>48</sup>When publishers (both for-profit and non-profit) realized they could issue more journals without lowering prices—since journals are complements and not substitutes—the number of journals exploded from about 120 in 1980 to almost 300 in 2000 (Bergstrom and Bergstrom, 2001; Plasmeijer, 2002). EconLit lists over 1,100 at [http://www.econlit.org/journal\\_list.html](http://www.econlit.org/journal_list.html)—using a more inclusive definition. Bergstrom (2001) claims that many new journals deliver little value.

<sup>49</sup>“The impact factor of a journal is calculated by dividing the number of current year citations to the source items published in that journal during the previous two years. Example: A= total cites in 1992 B= 1992 cites to articles published in 1990-91 (this is a subset of A) C= number of articles published in 1990-91 D= B/C = 1992 impact factor” (Garfield, 1994); see Kalaitzidakis et al. (2003) for another method. Thompson

The most-accurate method multiplies citations of an author’s articles times the impact factor of the journals where citing articles appear, i.e., the value of each article ( $i$ ) depends on the number of citing articles and the impact factor of the journals ( $j$ ) in which those articles appear. Thus, total value of an academic’s work is  $\sum_i \sum_j ImpactFactor_j$ .

The major problem with this metric is the bias within ISI’s impact factor. An additional problem is the assumption that all articles in a journal have the same, average value (the journal’s Impact Factor). For example, a citation from an excellent article in a “bad” journal counts for less than a citation by a terrible article in a “good” journal. This method gives *prima facie* inaccurate measures of value (Chow et al., 2006; Ellison, 2007; Oswald, 2007). Oswald (2006) notes the problem is growing worse as the profession relies more heavily on citations, which increases the incentive for manipulation.

Under the AMJA, an academic’s output is the sum of his earnings (in A\$) as an author, editor and/or referee. The value of a journal is the sum of A\$ earnings to articles that appear in that journal. Since A\$ will vary with an article’s *actual* academic quality, these measures are more accurate. Thus, the impact of an article is determined *endogenously* in the AMJA (via its A\$ revenue), while it is *exogenous* to participants in ISI’s system.

**5.3. How Can Editors Filter Papers?** Editors in the AMJA must sort through “all” papers in  $K$ , but they can use heuristics to find papers on the auction server that they are likely to want.<sup>50</sup> An editor could even replicate the CPS’s push system by only including the submissions that give his journal the highest positive handicap.<sup>51</sup> Consequently, the AMJA is implementable without relaxing current time constraints of editors.

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ISI has a monopoly on citation-tracking, mixes authors with the same first initials, is sloppy about journal inclusion, fails to control for different journal formats, and introduces within-journal citation bias (Klein and Chiang, 2004).

<sup>50</sup>In practice, this could mean that an editor receives a daily, customized email featuring papers with the JEL-codes, keywords, and other characteristics he specifies.

<sup>51</sup>Thus, editor  $j$  would only give his preliminary attention to the  $|L|$  papers that favored his journal  $j$  over all other journals  $k \neq j$ .

Since all editors see all papers simultaneously and bid for those they value, the AMJA places papers more quickly and accurately. Although editors now have to fight for papers they previously got for “free”, they also have a chance to get others’ papers. Moreover, editors could assemble special-topic issues by purchasing all the papers on a particular topic.

**5.4. What about Bidding Errors?** An editor’s desk review assigns values to  $|L|$  papers from the set  $K$ . Errors in establishing these values—due to mistakes in the editor’s judgement and/or stochastic elements in eventual, realized demand—means that they vary from the true quality (value) of the papers. An editor is more likely to win a paper when his positive error leads him to overestimate a paper’s published value as an article and thus to over bid; he is less likely to win papers when negative errors lead him to underestimate the paper’s value.

In the CPS, editors benefit from referee comments when considering value.<sup>52</sup> AMJA editors only have this benefit when and if they actually win the paper at auction. Holding all else constant, an editor in the AMJA looking at the same set of papers as the editor in the CPS is more likely to miss a few good ones and accept a few bad ones.

The cost of these mistakes in the AMJA is trivial: The auction price is slightly lower (higher) for papers where the second price bid is under (over) biased. Since the real value of the paper comes from future citations, the bid only affects revenue to cited articles.<sup>53</sup> (If the average article is cited a number of times, these errors cancel out.) For editors, mistakes in over and underbidding will, similarly, balance out if other editors make mistakes at the same rate. (An editor who makes too many mistakes exits in the long run.) For the author, a mistake means placement in one journal and not another, but this effect will be small when

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<sup>52</sup>The CPS advantage comes at a cost, since referees spend time (a negative externality) to grade all papers in the CPS set  $H$ . CPS editor errors matter on the margin, when they desk-reject papers that should have gone to referees.

<sup>53</sup>It is for this reason that we do not have to worry about editors who win “bad” articles. Even if the article is published—no sure thing—its value depends on the A\$ price of subsequent papers that cite it. If these papers point out how bad the article is but are not good themselves, then they will sell for low A\$ values, which means that the cited, “bad” article will earn little A\$ revenue.

displacement is only a few ranks up/down the journal ladder; it disappears completely if the paper ends up in a horizontally-equivalent journal or if readers read it à la carte.

In the CPS, the problem of under-estimated value is greater because the wait for rejection is so long. In the AMJA, more eyeballs means fewer Type-I (mistaken rejection) and Type-II (mistaken acceptance) errors; see, e.g., Gans and Shepherd (1994) and Oswald (2007).

**5.5. What about Citations Gaming?** Although authors face stronger incentives to trade citations (“you cite me, I cite you”) in the AMJA, gaming the AMJA is harder because the value of an article depends on the auction prices of citing papers, not just the number of citing papers.<sup>54</sup>

Self-citations would not count in calculating the division of auction revenue for a paper. Citations of friends/colleagues/co-authors would count, since determining the difference between legitimate and undeserved citations would be difficult.<sup>55</sup> Over-citing would decrease if citing authors want to maximize “rewards” to prior contributions they admire; under-citing [plagiarism] would decrease if overlooked authors have a reason (A\$) to see their contributions acknowledged. Papers without citations are rare; if one were to sell at auction, the revenue could be distributed to all journals on some ex-ante, pro-rata basis.

Works cited that originate outside the auction system (books, unpublished papers and papers from other disciplines, newspapers, etc.) would not receive citation revenue. Authors of these works could track “what if” A\$ revenues to understand the opportunity cost of

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<sup>54</sup>Thus, an AMJA author who trades citations with other authors gains benefits (A\$ income) in direct proportion to the auction prices of those citing papers. Since those prices are exogenous, he is uncertain what is being traded in the shadow market. The likely result is that a researcher capable of writing good/popular papers will only trade citations with researchers whose publication prospects are at least as good as his own, and citation trading will only occur at the same quality level in equilibrium. Such trading may increase absolute A\$ income at each “quality cluster” of researchers, but it is unlikely to distort relative income ranking. Hence, the truthful ranking of researchers—the ultimate goal of our publication system—would be accurate.

<sup>55</sup>Although this allowance makes the practice of quid-pro-quo citations possible, that problem already exists in the CPS.

non-participation; AMJA managers could use “what if” A\$ to indicate areas where could expand with the most benefit.

**5.6. Framing and Feedback.** While the CPS uses a push mechanism to place papers, the AMJA uses a pull mechanism. Pulling, like buying, has a lower psychological cost than pushing, i.e., selling.<sup>56</sup> We expect that a referee, for example, is more likely to favor a paper pulled by an AMJA editor than a paper pushed to a CPS editor.

Unlike the CPS, where rejection leads to resubmission elsewhere and a longer wait, authors in the AMJA only wait until  $T$  to learn of acceptance/rejection. Even if  $T$  lasts as long as the average review period in the CPS, placement under the AMJA is already optimal—at least in terms of expectations. If there are no positive bids on a paper after  $T_1$ , this sends a clear signal to the author that he should invest more in quality and/or marketing—a signal that rejection in the CPS does not produce.

**5.7. AMJA versus Multiple Submissions.** The AMJA superficially resembles the multiple submission system common to law reviews but differs in important ways; see Table 1.<sup>57</sup> Pressman (1994) argues against the multiple submission system, saying it does not reduce publication times (because reviews have limited publication space); leads authors to play reviews against each other (thus reviews delay initial acceptance); and burdens referees, who react to a lower probability of publication by giving less effort.

Pressman’s criticisms do not apply to the AMJA, since editors bid for papers only when they want to fill publication space; authors cannot game editors with a fixed deadline; referees only review papers editors hold exclusively; and referees gain from a paper’s success.

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<sup>56</sup>Hagel and Brown (2005) note the efficiency of pull models in an environment of uncertainty; Blois (2000) states that customer pull is more efficient when suppliers market directly to customers (not via intermediaries). This case exists in the AMJA, where authors “sell” to editors/journals, not readers.

<sup>57</sup>Book publishers and universities handle multiple submissions for books and student applications, respectively. Peters (1976) was the first to propose multiple submissions for academic journals.

TABLE 1. Comparing multiple submission to auctions

|                 | Multiple Submissions | Auctions         |
|-----------------|----------------------|------------------|
| Participation   | Push (Mandatory)     | Pull (Voluntary) |
| Competition     | Secret               | Open             |
| Deadline        | None                 | Predetermined    |
| Allocation      | Author’s Choice      | Highest Bidder   |
| Reviewer Effort | Often Wasted         | Rewarded         |

5.8. **The Transition to the AMJA.** Given that economics journals have the longest publishing delays, the natural place to implement this idea is within economics (Ellison, 2002a, p. 998). How do we know it will work? How can it be better than what we have? These worries, along with the fears that participants would game citation credits and that academics are adverse to being measured—are perhaps over-cautious. Gaming and measurement are already abused (Oswald, 2006).

One or more journals might implement a pilot program by pooling submissions and then allowing assistant editors to bid against each other. If a number of journals wanted to begin an AMJA unilaterally, they could return auction revenue to participating journals only. Other journals would have to agree to pool some or all of their submissions in the auction to receive “their share” of citation revenue. The potential for A\$ income is highest for journals with stronger back-catalogs, providing a useful incentive for them to join the AMJA earlier. Early support is especially valuable, since the AMJA has network effects/increasing returns to scale technology.<sup>58</sup>

## 6. CONCLUSION

We explore an auction market for journal articles (AMJA) that allows editors to bid for the papers they want, increasing the speed and accuracy of matching papers to journals. Because the AMJA results in A\$ revenue to articles cited by papers that are auctioned, it

<sup>58</sup>Although we assume a single auction platform (which might create problems of market power or incompetence), multiple platforms could coexist and compete (cf., competing stock exchanges) if A\$ and information easily flowed between platforms.



rewards (and quantifies the contribution of) prior effort by editors, referees and authors of those articles. Because editors pull papers toward them in the auction (contra the push method inherent to the current publishing system, or CPS) and referees are rewarded when an article they reviewed is cited, the AMJA changes incentives such that referees look for ways to improve—not reject—papers. In the short run, A\$ income to authors, referees and editors quantifies their academic contribution. In the long run, the recirculation of A\$ (from authors and referees to those editors/journals they prefer) rewards journal quality. Although these benefits are appealing, some readers may worry that they are offset by even greater costs. We show in a formal model that readers, editors, referees and authors gain from moving from the CPS to the AMJA.

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