Inefficiency in Academia Publishing and Why It Was Not Improved: A Dynamic Equilibrium Model

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ABSTRACT

This paper develops a dynamic equilibrium model to identify the inefficiency of the sequential submission process that the current publishing industry in academia adopts. This model improves such inefficiency by releasing assumptions to allow multi-submission. This study first identifies the major variables which mainly determine the benefits of three agents: the author, the editor, and the reviewer. Then utility functions are defined for the agents to compare the academia welfare and the social welfare under different submission arrangements. Results indicate that the difference of the two welfares is greater in sequential submission, and multi-submission generates improvement of inefficiency at a dynamic game regime. Finally, this paper discusses the reasons of the agent’s self-unwillingness for such improvement as an explanation of why the improvement of academic welfare is not welcomed.

Keywords: academic publish, reviewing procedure, inefficiency, welfare analysis

AN INTRODUCTION TO SUBMISSION INEFFICIENCY AND WELFARE

The supply short of the authors’ works seems to be a less important issue in the publishing industry recently than the shortage of publishing opportunities supplied by publishing houses. As a subset of the publishing industry, journals in academia always have a long waiting list of papers need to be reviewed. Inevitably, a growing number of newly minted doctoral degree holders and an increasing size of academic institutions will only lead to keen publishing competition, especially in the battlefield of highly ranked peer-viewed journals. The gap between the demand and supply is one of the main reasons that lead to difficulties in publishing, whereas the inefficient submission mechanism artificially aggravates such difficulties.

This paper develops a dynamic equilibrium model to address the inefficiency in the current sequential submission procedure in academia. Submission inefficiency is the friction and the academic welfare loss caused by the inconsistent utility functions of the editors, authors, and reviewers. Such inefficiency is another major reason that leads to difficulty in publishing. Later, by releasing some of the model assumptions and parameter regimes, this paper suggests the journals to switch to multi-submission arrangement to ease the inefficiency. In addition, the obstacle of such switch is also revealed by a welfare analysis in the dynamic game framework.

Submission inefficiencies include three types of errors: (1) incorrectly reject the papers that should be accepted; (2) incorrectly accept the papers that should be rejected; and (3): spend prolonged time to avoid making the first two types of error. These three errors greatly contribute to the gap of the limited publish opportunities and large quantities of writer outputs. On the other hand, the maximization of academic welfare is defined as the submission process that does not have the three error types. Academic welfare is maximized when the quality of a research paper perfectly matches with the rank of the journal.
Submission inefficiency is common in two environments. On one hand, the fitness issue exists in the context of all the journals in a discipline. A good paper might end up with a lower ranked journal, because of the self-interest of the journal editor, the author’s motivation to guarantee a quick publish due to the immediate tenure or annual review pressure, or the unreasonably long revision process with high costs, to name a few. On the other hand, the second environment, which is the single journal scenario, generates inefficiency. Three parties in this scenario, the writer, the editor, and the reviewer, have different interests and therefore heterogeneous utility functions. The asymmetric information flow among the three benefit-related parties leads to the mismatch of demand and supply. Editors’ best interests are to increase the impact factor (IF) of the journals, while writers’ goals are to publish quickly in a highly ranked journal. The authors therefore polish the paper submitted to meet the editors’ tastes, signaling the editors about the high quality, whereas the reviewer might not reveal the real quality of the paper.

Specifically, four major sources of submission inefficiency are: first, an unreasonably long review process is inefficient. The review process can sometimes be years long, as Dr. Fabio Rojas, editor of The American Journal of Sociology and Sociological Methodology mentioned in 2011. This reduces the authors’ motivation to submit their masterpieces to an appropriate journal, especially when such publication record is in urgent need. Furthermore, for the studies that include time sensitive topics, a delay of the submission process will greatly decrease the necessity of publishing the study. In addition, for papers that involves perishable time series data, a long review process might bring a high dataset updating cost. However, this extra cost does not increase the quality of the paper, per se.

Secondly, reviewers generate inappropriate acceptances or rejections. Dr. Richard Horton (2000), an editor of the British medical journal, The Lancet, points out that “…we know that the system of peer review is biased, unjust, unaccountable, incomplete, easily fixed, often insulting, usually ignorant, occasionally foolish, and frequently wrong.” This might be caused by the moral hazard of the reviewer. For example, reviewers might copy the creative theoretical model under review and publish it as their own work. Another potential problem is brought up by the writer’s comments in the paper related to the reviewer. In fact, the reviewer might be assigned the work because of the previous work is cited in the literature review part of the paper. Comments in the literature review on the reviewer’s previous work might bring biasness to the reviewer’s neutrality. Academic school difference might also lead to unreasonable negative review opinions.

The third source of submission inefficiency is from the editor’s biasness and moral hazard. Being motivated to increase the impact factor of the journal, editors might be less interested in a well-developed paper if it has a narrow or non-popular focus. Instead, editors might accept more review or survey articles or increase the citable fraction to increase the numerator of the IF but not the denominator (PLoS Medicine Editors 2006). Furthermore, editors might tend to accept papers that are co-authored with or recommended by famous scholars, or to accept papers that cite the editor’s journal frequently. Agrawal (2005) reports that “At or before the time of acceptance, several journals’ editors are requesting that authors cite additional papers published in that same journal.” Meanwhile, the conflicting fundamental academic view stated above in the reviewer’s problem might also apply to the editor.

The last but not least source of submission inefficiency is from the author. The authors always understand the quality of their papers better than the editors and sometimes the reviewers. However, in the sequential submission framework, an author could have the incentive to submit relatively low quality work to a higher ranked journal first as long as the timeline allows. This leads to additional unnecessary
work for the editors and reviewers. Learning from such game of “bad money drives out good”, the editors and reviewers may hold the presumption of guilt in mind and this might lead to a systematic undervaluation of a potentially high quality paper. Another inefficiency authors generate is that they might help the editors and themselves to increase the citation by adding some directional statements in the paper (Grant 2010). For example, in 2008, a single article "A short history of SHELX" included a sentence that essentially instructs readers to cite the paper: "This paper could serve as a general literature citation when …" and therefore received more than 6,600 citations. As a consequence, the impact factor of the journal Acta Crystallographica Section A rose from 2.051 in 2008 to 49.926 in 2009, more than Nature (31.434) and Science (28.103).

Submission inefficiency can be greatly reduced if journals in academia switch from sequential submission to a multi-submission mechanism. The latter is highly competitive in the supply side of the publishing opportunity. The waiting period will be significantly reduced and more reviewers will help match the quality of papers and the rankings of journals more precisely. In fact, the sequential submission regime protects the monopoly role of a single journal as the publish opportunity supplier. Such temporary monopoly power will only be broken down after the journal rejects the paper and the writer moves on to the next journal, from which monopoly is formed again. Monopoly adds extra cost on the marginal cost of paper production from the writers, and this extra cost does not exist in a perfectly competitive market of the journals.

Submission inefficiency will decrease the academic welfare, but might increase the social welfare. The social welfare maximization is the optimal allocation of the writer, the editor, and the reviewer’s personal interests, assuming they are economic men. For instance, a medium-quality review paper might be accepted by a top-tier journal, as a review paper will be cited more often than other regular research papers. The reviewer who is appointed by the editor might give the green light to this review paper, because it cites the reviewer’s previous work a lot with positive comments. In this case, academic welfare is not maximized as the quality of paper does not match the rank of the journal. Nevertheless, social welfare is improved, as the utilities of the writer, the editor, and the reviewer are all increased.

Such controversial welfare effects answers the following question: If people have long realized the inefficiency of the sequential submission process, why it is still adopted? As economic men, writers, editors and reviewers pursue the maximization of social welfare more than the maximization of academic welfare. In addition, the lack of leadership and organization of academic journals within a discipline prevents the establishment of a unified and well-governed multi-submission process. A popular concern about the disadvantage of the multi-submission regimes is that the cost to practice is overwhelmingly high, and this huge cost makes the sequential submission process a suboptimal one. However, the following chapters prove that this argument is in fact less important.

The rest of this study is organized as follows: section 2 defines the agent’s problem for the three parties, and defines the social planner’s and academia planner’s problem; section 3 addresses the model assumptions and compares social and academia welfare under the framework of sequential submission and multi-submission; section 4 discusses the obstacles of the multi-submission arrangement; and section 5 concludes.
THE MODEL

There are three related parties in the submission and publishing process, which are the author ($AUT$), the editor ($EDI$), and the reviewer ($REV$). The authors maximize their utility at time $t$ defined in Equation (1):

$$U_{AUT}^t: \mathbb{X} \rightarrow \mathbb{R}, \mathbb{X} \in \mathbb{R}^4; U_{AUT}^t = U_{AUT}^t(P_t, \Omega, T, I) (1)$$

$P_t, \Omega, T,$ and $I$ refer to the weighted journal ranking, waiting period, revision time, and revision cost, respectively. $P$ as the ranking of journals in a given discipline is assumed to be public information among the three agents: the author, the editor, and the reviewer. Such rankings are widely accepted in academia based on the impact factor and journal reputation. The quality of the journal decreases as $P$ increases. $t$ is the time of submission and $i$ is the submission to journal $i$. The variable $\Omega$ refers to the time period from the author’s first submission to the moment that they receive the editor’s rejection decision or revision request for the first time. In many cases such revision will occur back and forth several times and all the following revision after the first time is not covered in this variable $\Omega$ at time $t$, but $t+i$ where $i \in \mathbb{R}^+$. The variable $T$ is the potential time input after the author receives the reviewer’s comment and advice. At time $t$, this revision time is simply an expected value. The variable $I$ is the expected economic cost, excluding time and opportunity cost, of revision other than the time input.

There are tradeoffs among the four dimensions of the utility function. A journal’s rank might be correlated with the review time bidirectionally. A top tier journal might be more efficient as a richer reviewer source is available; yet it can be less efficient as the target of all the researchers. Therefore, different types of authors with different needs have to balance the tradeoffs and attach heterogeneous weights on the four dimensions to maximize utility. This increases the difficulty of the model in this study as non-identical agents exist.

To avoid regime multiple author agents, this study defines a $4 \times 1$ vector $\vec{w}_{AUT}$ as the weights of the $4 \times 1$ vector of variables ($\rho, \omega, \tau, I$) that affects author utility:

$$\vec{w}_{AUT} = \left( \frac{\alpha_1}{\rho}, \frac{\alpha_2}{\omega}, \frac{\alpha_3}{\tau}, \frac{\alpha_4}{I} \right), \text{ where } \alpha_i \in \mathbb{R}^+ \text{ and } \sum_{i=1}^{4} \alpha_i = 4.$$

This paper assumes that there is an agent who acts as the representative for all types of authors who maximize their utility by considering four variables: $\rho, \omega, \tau,$ and $I$. Under various objective circumstances the agent might weigh the importance of rank, waiting period, revision time, and revision cost differently. The realized choices of these parameters are the weight-adjusted nominal choices from the agent’s stereotype:

$$U_{AUT}^t: \mathbb{X} \rightarrow \mathbb{R}, \mathbb{X} \in \mathbb{R}^4; U_{AUT}^t = U_{AUT}^t(\rho, \omega, \tau, I) (2)$$

Intuitively, the four independent variables affect $U_{AUT}^t$ in different ways:

$$\frac{\partial U_{AUT}^t}{\partial \rho} > 0, \frac{\partial U_{AUT}^t}{\partial \omega} < 0, \frac{\partial U_{AUT}^t}{\partial \tau} < 0, \text{ and } \frac{\partial U_{AUT}^t}{\partial I} < 0$$

The definitions of the four independent variables exclude the endogenous and multicollinearity problem, though there are concerns about the positive correlation between the review and revision time, and the journal quality. Regressions are performed on the rankings of journals against review time, revision time, and publish time, and the coefficients are insignificant at $p<10\%$ level. The data is obtained
from Hutter’s survey (1996). Cullison (2009) surveys top journals in Philosophy, and consistent with the regression results in this study, hersurvey data also proves the zero correlation.

Furthermore, the editor maximizes the utility at time $t$ defined in Equation (3):

$$U_{t}^{ED}: x \rightarrow \mathbb{R}, x \in \mathbb{R}^{2}; U_{t}^{ED} = U_{t}^{EDI}(\Delta \rho; \phi; \psi)$$ \hspace{0.2cm} (3)

$\Delta \rho, \phi, \text{ and } \psi$ refer to the increase inthe ranking of a journal brought by the publishing of a paper, review input, and author input, respectively. The primary reason why a paper is adopted is the potential citation and impact factor increase it can bring to the journal. $\Delta \rho = \rho_{t} - \rho_{t-1}$. The review input mainly refers to the quality of review cooperation between the editor and the reviewer, including the easiness to find a competent and available reviewer, the quick response from the reviewer, the constructive and feasible revise suggestion, and the satisfaction of communication. The review input mainly refers to the external welfare that the author brings to the editor and the journal, including the author’s reputation, the author’s considerable amount of citation from the editor’s journal, etc. However, the empirical change of $\rho$ for journal $i$ might not be observed immediately after a poor-quality paper is accepted. In the long term, the impacts of the independent variables are:

$$\frac{\partial U_{t}^{EDI}}{\partial \Delta \rho} > 0, \frac{\partial U_{t}^{EDI}}{\partial \phi} > 0, \text{ and } \frac{\partial U_{t}^{EDI}}{\partial \psi} > 0$$

The independent variables $\phi_{t}$ and $\psi_{t}$ are the inefficient component in the author-editor-reviewer framework. If academic welfare is maximized, $\phi_{t}$ and $\psi_{t}$ should not affect $U_{t}^{EDI}$. The variable $\Delta \rho$ also serves as the quality of the paper submitted.

Finally, the reviewer maximizes the utility at time $t$ defined in Equation (4) and (5):

$$U_{t}^{REV}: x \rightarrow \mathbb{R}, x \in \mathbb{R}^{2}; U_{t}^{REV} = U_{t}^{REVID}(\Delta \rho; \rho)$$ \hspace{0.2cm} (4)

As $\Delta \rho = \rho - \rho_{t-1}$,

$$U_{t}^{REV} = U_{t}^{REV}(\rho_{t-1}, \rho)$$ \hspace{0.2cm} (5)

The reviewer’s utility is related to the quality of the paper, as well as the quality of the journal $i$ that assigns the review request at time $t$. The quality of paper is positively related with the utility of the reviewer, as it can be a good inspiration source of the reviewers’ own study. The quality of the journal is partially endogenous with the quality of the paper, as there should be fundamental match between both of them. If the journal that assigns paper is a high-quality one, it can help increase the reputation of the reviewers and benefit their academic experience. The time series $\rho_{t}$ does not follow a sub-martingale, as the rankings of journals are relatively stable. Therefore $\rho_{t-1}$ and $\rho_{t}$ are correlated.

Empirically,

$$\rho_{t} = \beta \rho_{t-1} + e_{t}; E(e_{t}) = 0, Var(e_{t}) = \text{Constant}$$

And hence Equation (5) updates to

$$U_{t}^{REV} = U_{t}^{REV}(\rho_{t-1}, \beta)$$ \hspace{0.2cm} (6)

As $\Delta \rho_{t}$ is the proxy of the paper quality, it is reasonable to assume that $U_{t}^{REV}$ is positively linked with $\Delta \rho_{t}$. The impacts of the independent variables are therefore:

$$\frac{\partial U_{t}^{REV}}{\partial \rho_{t-1}} < 0, \text{ and } \frac{\partial U_{t}^{REV}}{\partial \beta} > 0$$

The social welfare of the three parties can be identified in Equation (7):

$$U_{t}^{REV}: x \rightarrow \mathbb{R}, x \in \mathbb{R}^{2}; W_{t}^{S,i} = W_{t}^{S,i}(U_{t}^{DIV}, U_{t}^{EDI}, U_{t}^{REV}) = W_{t}^{S,i}(\rho_{t}, \phi_{t}, \rho_{t-1}, \psi_{t})$$ \hspace{0.2cm} (7)

As $\Delta \rho_{t} = \rho_{t} - \rho_{t-1}$ is the proxy of the quality of paper and $\rho_{t}$ refers to the quality of journal, the independent variable $\Delta \rho_{t}$ can be substituted with $\rho_{t-1}$. Social welfare is the combination of the utilities of the three parties. There is no conflict of interest among the three parties; hence the impacts of independent variables are consistent with the utility functions:
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\[
\frac{\partial \mathcal{W}_{t}^{i}}{\partial t_{i}} > 0, \frac{\partial \mathcal{W}_{t}^{i}}{\partial \phi_{i}} < 0, \frac{\partial \mathcal{W}_{t}^{i}}{\partial \rho_{i}^{t-1}} < 0, \frac{\partial \mathcal{W}_{t}^{i}}{\partial \psi_{i}^{t}} > 0 \text{, and } \frac{\partial \mathcal{W}_{t}^{i}}{\partial \phi_{i}} > 0.
\]

On the other hand, the academic welfare maximization does not consider the cost of revision by the author, excluding time input. The author input, \(\phi_{i}^{t}\), and reviewer input, \(\psi_{i}^{t}\), as the submission inefficiency components, are excluded from the academic welfare. Only time related factors and quality related factors should be included to maximize academic welfare.

The academic welfare of the three parties can be identified in Equation (8):

\[
\mathcal{U}_{t}^{AV}: \mathbf{X} \rightarrow \mathbb{R}, \mathbf{X} \in \mathbb{R}^{3}; \mathcal{W}_{t}^{A} = \mathcal{W}_{t}^{A}(\rho_{i}, \omega_{i}, t_{i}, \rho_{i-1})(8)
\]

This paper assumes that \(\mathcal{W}_{t}^{i}\) as the expected economic cost of revision is not related to the academic welfare issue. The impacts of independent variables are consistent with the social welfare:

\[
\frac{\partial \mathcal{W}_{t}^{A}}{\partial t_{i}} > 0, \frac{\partial \mathcal{W}_{t}^{A}}{\partial \omega_{i}} < 0, \frac{\partial \mathcal{W}_{t}^{A}}{\partial t_{i}} < 0, \frac{\partial \mathcal{W}_{t}^{A}}{\partial \rho_{i-1}} < 0
\]

Though the first order conditions have deterministic signs, intuitively, the signs of second order conditions are undetermined. In order to identify submission inefficiency, which is the difference of social welfare and academic welfare, a general function form is created for Equation (9) and (10):

\[
y = x + \sin(x), x \in \mathbb{R}^{+} \frac{dy}{dx} = 1 + \cos(x), \text{ and } \frac{d^2y}{dx^2} = -\sin(x).
\]

This is a specially designed function that has the feature of \(\frac{dy}{dx} \geq 0\), but \(\frac{d^2y}{dx^2}\) has random sign.

\[
\mathcal{W}_{t}^{S,i} = \rho_{i}^{t} + \phi_{i}^{t} + \psi_{i}^{t} - (t_{i}^{+} + \rho_{i}^{t-1}) + \sin \phi_{i}^{t} + \sin \psi_{i}^{t} - (\sin \phi_{i}^{t} + \sin \psi_{i}^{t})(9)
\]

\[
\mathcal{W}_{t}^{A} = \rho_{i}^{t} - (t_{i}^{+} + \rho_{i}^{t-1}) + \sin \phi_{i}^{t} - (\sin \phi_{i}^{t} + \sin \psi_{i}^{t})(10)
\]

In a single paper submission to a single journal \(i\) at time \(t\), the social planner’s problem is to locally minimize submission inefficiency indicated in Equation (11):

\[
\min_{\phi_{i}^{t}, \psi_{i}^{t}, \omega_{i}^{t}, t_{i}^{+}} (\mathcal{W}_{t}^{S,i} - \mathcal{W}_{t}^{A}) = \phi_{i}^{t} + \psi_{i}^{t} + \omega_{i}^{t} + t_{i}^{+} + \sin \phi_{i}^{t} + \sin \psi_{i}^{t} + \sin \omega_{i}^{t} + \sin t_{i}^{+} + \bar{g}(t_{i}^{+})(11)
\]

\(\bar{g}(t_{i}^{+})\) as the expected economic cost of revision is set as the fixed effect of the welfare difference. The first order conditions are:

\[
\frac{\partial (\mathcal{W}_{t}^{S,i} - \mathcal{W}_{t}^{A})}{\partial \phi_{i}^{t}} = 0, \frac{\partial (\mathcal{W}_{t}^{S,i} - \mathcal{W}_{t}^{A})}{\partial \psi_{i}^{t}} = 0, \frac{\partial (\mathcal{W}_{t}^{S,i} - \mathcal{W}_{t}^{A})}{\partial \omega_{i}^{t}} = 0, \text{ or } \frac{\partial (\mathcal{W}_{t}^{S,i} - \mathcal{W}_{t}^{A})}{\partial t_{i}^{+}} = 0, \text{ or } \phi_{i}^{t} = 0, \psi_{i}^{t} = 0, \omega_{i}^{t} = 0, t_{i}^{+} = 0 (12)
\]

This implies that minimizing submission inefficiency is equivalent to eliminating the author and editor input, and eliminating the waiting period and excess revision period.

Nevertheless, in the dynamic sequential submission process, if at time \(t\), the author’s paper is rejected by a journal \(i\), the author will continue submit to journal \(i+1\) at time \(t+1\) until it is accepted at \(t+N-1\) after a total number of \(N\) submissions, the social planner’s problem will be then updated to locally minimize submission inefficiency indicated in Equation (13).

\[
\min_{\phi_{i+1}^{t+1}, \psi_{i+1}^{t+1}, \omega_{i+1}^{t+1}, t_{i+1}^{+}} \left(\mathcal{W}_{t+1}^{S,i+1} - \mathcal{W}_{t+1}^{A;i+1}\right) = \sum_{\xi=0}^{N} \left(\mathcal{W}_{t+1}^{S,i+1} - \mathcal{W}_{t+1}^{A;i+1}\right)
\]

\(s.t. \phi_{i+1}^{t+1} \geq 0, \psi_{i+1}^{t+1} \geq 0, \omega_{i+1}^{t+1} \geq 0, t_{i+1}^{+} \geq 0, \text{ and } \xi \in \mathbb{Z}^{+}
\]

As indicated in Equation (13), the dynamic sequential submission process significantly accumulates submission inefficiency, which cannot be cancelled out across different periods. The previous inefficiency converts into sunk cost, so does the opportunity cost caused by the inefficiency.
MULTI-SUBMISSION PROCESS

To treat the inefficiency generated in the dynamic sequential submission process, this paper proposes a multi-submission process in academic journals by changing and releasing some assumptions in the above welfare model. The new regimes are described in the following five assumptions.

First, if the author needs to submit ŋ times to ŋ journals to get their papers accepted under the sequential submission regime, now the author can simultaneously submit to ŋ journals. The variable ŋ is bounded to the author’s submission fee budget and is determined by the author.

Second, the author informs the editor that the paper has also been submitted to other journal(s) simultaneously, without revealing the number or the name of journals. The cases that the author indeed only submits to one journal but claims that she has submitted to multiple journals are included. However, this rarely benefits the author, assuming that the submission fees are not overwhelming. To reduce \( \eta_t(x) \), the author hides her name during the submission process and the paper is only assigned an identification code. The author’s identification is only disclosed after the paper is accepted. If the paper is rejected, the author needs not to disclose her identity.

Third, after the reviewer and the editor have made the acceptance decision, they should offer the author a grace period to refuse such acceptance. After the grace period, the editor will proceed to publish the paper and the author cannot accept publish acceptance from other journals.

Fourth, reviewers will be reimbursed if the review opinion is returned to the editor promptly and the author’s feedback, in terms of the quality of the review opinion, is positive.

Fifth, reviewers should issue the acceptance opinion only once to the most appropriate journal, if occasionally they receive the review requests for the same paper from multiple journals.

These five assumptions set up a tri-lateral blind submission and revision system, as an improvement to the double blind sequential submission system. The social planner’s problem in the multi-submission process is to minimize the submission inefficiency defined in Equation (14):

\[
\min_{\psi_t^{i+\xi}, \phi_t^{i+\xi}, \omega_t^{i+\xi}} \sum_{i=0}^{N-1} (\psi_t^{i+\xi} - \omega_t^{i+\xi}) = \sum_{i=0}^{N-1} (\phi_t^{i+\xi} + \psi_t^{i+\xi} + \omega_t^{i+\xi} + \tau_t^{i+\xi} + \sin\phi_t^{i+\xi} + \sin\psi_t^{i+\xi} + \sin\omega_t^{i+\xi} + \sin\tau_t^{i+\xi} + \eta_t(x))
\]

s.t. \( \phi_t^{i} \geq 0, \psi_t^{i} \geq 0, \omega_t^{i} \geq 0, \tau_t^{i} \geq 0, \text{and } \xi \in \mathbb{Z}^+ \) (14)

The difference of Equation (14) and (13) is the efficiency improvement generated by switching from the sequential submission to multi-submission. The improvements are concluded as follows:

**Lemma 1:** \( \sum_{i=0}^{N-1} (\phi_t^{i+\xi} + \omega_t^{i+\xi} + \sin\omega_t^{i+\xi} + \sin\tau_t^{i+\xi}) < \sum_{i=0}^{N-1} (\phi_t^{i+\xi} + \omega_t^{i+\xi} + \sin\omega_t^{i+\xi} + \sin\tau_t^{i+\xi})\). Multi-submission process greatly shortens the waiting period of review and processing. Meanwhile, the competitiveness imported into the journal editors can also decrease the processing time. In addition, the reimbursement incentive mechanism will also speed up the reviewers’ response.

**Lemma 2:** \( \sum_{i=0}^{N-1} (\phi_t^{i+\xi}) < \sum_{i=0}^{N-1} (\phi_t^{i+\xi})\). The reviewer’s inefficient input to the editor is reduced. The inappropriate acceptance or rejection opinion issued by one of the reviewers in the multi-submission process will be corrected by other reviewers. The likelihood of reviewer academic misconduct is limited by the speeded publishing process.

**Lemma 3:** \( \sum_{i=0}^{N-1} (\psi_t^{i+\xi}) < \sum_{i=0}^{N-1} (\psi_t^{i+\xi})\). The author’s inefficient input to the editor is decreased. Authors always signal editors and reviewers that their papers are high quality ones. In the sequential submission framework, the author will have the incentive to submit a relatively low quality work to a higher ranked journal first, hoping that the reviewer and editor will mistakenly accept it. Defining the reflection function of the editors and reviewers for a journal \( i \) at current submission period \( t \) is \( \eta_t(x) \), if the
probability of recognizing the quality of paper is \( p_i \), then the quality of the paper decided by the editor and reviewer is:

\[
\begin{align*}
\text{Actual Paper Quality} = \text{Good} \quad \eta_i(Good) &= \begin{cases} 
\text{Paper quality = good} & (p_i) \\
\text{Paper quality = poor} & (1 - p_i)
\end{cases} \\
\text{Actual Paper Quality} = \text{Poor} \quad \eta_i(Poor) &= \begin{cases} 
\text{Paper quality = good} & (1 - p_i) \\
\text{Paper quality = poor} & (p_i)
\end{cases}
\end{align*}
\]

In the sequential submission process, the probability of making a misrecognition error is:

\[1 - \prod_{i=0}^{\bar{q}} (1 - p_i (^{\text{seq}})) (17)\]

In the multi-submission process, the probability of making \( q \) misrecognition error is reduced because:

\[\prod_{i=0}^{\bar{q} - q} (1 - p_i (^{\text{seq}})) < 1 - p_i (18)\]

Such improvement of making less misrecognition error in fact reduces the submission inefficiency by increasing the academic welfare and matches the quality of paper with the quality of journal. Another inefficiency authors generate in the sequential submission process is that they tend to cite papers published on the journal that they are submitting to. In multi-submission regime, this is eliminated as the author cannot ingratiate themselves with too many editors in a single paper.

**SWITCHING FROM SEQUENTIAL TO MULTI-SUBMISSION: OBSTACLES**

Three major obstacles prevent academic journals from switching to multi-submission from the current sequential submission process: editors’ own utility maximization incentive, cost, and lack of organization.

Cost seems to be a major concern that makes multi-submission less popular. Sinha (2005) thinks that making many reviewers and editors’ work on the same paper is “wasting the time of the whole scientific community apart from journal resources”. However, such argument ignores the fact that such multi-reviewer cost also exists in the sequential submission regime. In fact, the greatest extra cost generated by the multi-submission process is the sunk cost that an editor incurs related to each paper. If an author rejects a publishing invitation from an editor and turns to a higher-ranked journal, the effort paid by the editor is then valueless. Such cost can be significant, yet it is less important than the opportunity cost incurred in sequential submission and loss of academic welfare. In addition, given the time restriction in the multi-submission process, the sunk cost is limited.

The lack of organization to switch to the multi-submission process prevents editors who are willing to switch to do so unilaterally. Multi-submission arrangements cannot be achieved until multiple journals accept such a regime. However, this is not an overwhelming barrier, as almost every discipline in Academia has its own association and annual conference. These institutes, as the organizers, can set up and regulate the submission process.

The real barrier of switching from sequential to multi-submission process is from the editors, who maximize their utility indicated in Equation (3) by three dimensions: First, they might accept papers that can improve the ranking of the journal, regardless the fact that the paper is over-qualified for their journals. Second, they might accept papers that bring high author inputs, for example, a second-class paper written by a famous researcher. Third, she might accept papers that may lead to high reviewer inputs, for example, a paper that can assign a reviewer easily and the reviewer is a comfortable co-worker with the editor. These independent variables in the editor’s utility function imply incentives for the editor to maintain the sequential submission regime and avoid competing with other journals directly.
CONCLUDING REMARKS

This paper develops a dynamic equilibrium model to identify the inefficiency of the sequential submission process in journal publishing in Academia. In the three-party submission process, this study first defines the utility functions and the social welfare as well as the academic welfare. Then the academia welfare and the social welfare under different submission arrangements are compared to identify the inefficiency improvement at a dynamic game regime. Finally, this research discusses the reasons of the agent’s self-unwillingness for such improvement.

Submission inefficiency is the friction caused by the inconsistent utility functions of the editors, authors, and reviewers. In other words, submission inefficiency is the difference between the social welfare and the academic welfare. The maximization of academic welfare is defined as the submission process that matches the quality of paper with the quality of journal rapidly. However, the social welfare maximization is the optimal allocation of the writer, the editor, and the reviewer’s personal interests, assuming they are economic men.

This study proves that by switching from the sequential submission regime to the multi-submission regime, submission inefficiency will be greatly reduced, as the reviewers and authors input are eliminated, and the submission period is curtailed. Yet as economic men, writers, editors and reviewers pursue the maximization of the social welfare more than the maximization of academic welfare, the establishment of a unified and well-governed multi-submission process may not be a quick and easy process. The further study of this issue might be to set up the detailed structure of multi-submission regime, or to compare this regime with a centralized paper database, such as SSRN or RePEc.

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