CHAPTER 4

Asymmetric reply submission model

In chapter 3, we have the same discount rate to the expected value gained in lagged stage and the symmetric arrival in the multi-submission choice which implies the "symmetric submit-accept delay" of both journals. To have a clear picture of the effect of submit-accept delay of journals, we would introduce the asymmetric refereeing delay of journals in the following discussion. Following the analysis above, we can see the Journal 1 often exclude Journal 2 from screening the papers with higher quality due to the reputation difference. Thereby, the purpose of this chapter is trying to figure out whether less prestigious journal could have a welfare improvement with a faster reviewing process than the more prestigious one.

4.1. Specific assumptions

According to the asymmetric refereeing delays of journals we can have the decision process of the authors as follows,

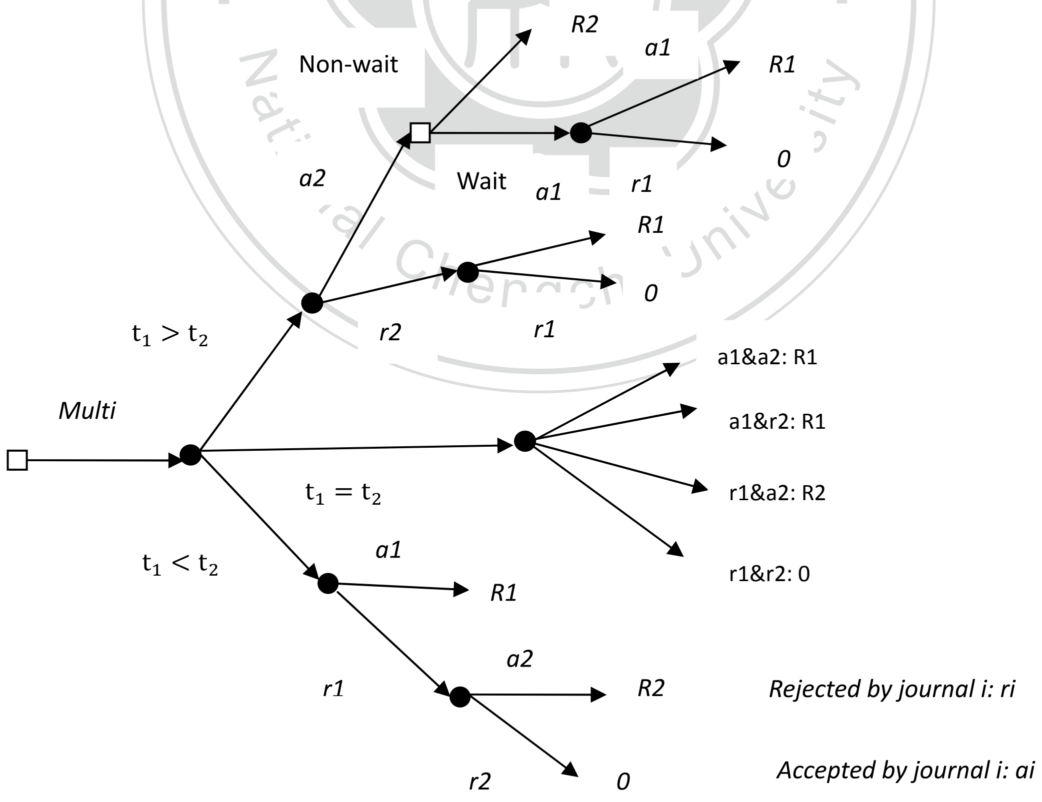

Figure4.1. Author's decision tree with asymmetric reply time (multiple-submission)

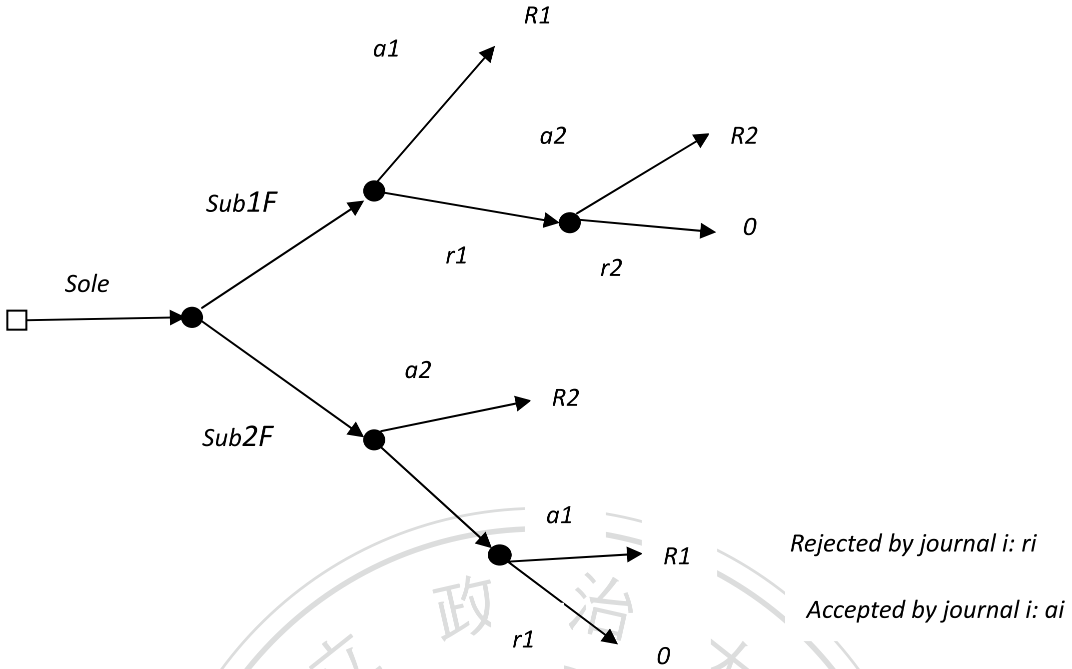

Figure4.2. Author's decision tree with asymmetric reply time (sole-submission)

We assume the average referring delay of each publisher i be t_i, and $t_i > 1$. Since each referring delay of journals counts, we have the following expected utilities:

(4-1) $$V(J_1, J_2) = \delta(t_1)P_1R_1 + \delta(t_1 + t_2)(1 - P_1)P_2R_2$$

(4-2) $$V(J_2, J_1) = \delta(t_2)P_2R_2 + \delta(t_1 + t_2)(1 - P_2)P_1R_1$$

(4-3) $$V(J_1 \& J_2) = \delta(t_1)P_1R_1 + \delta(t_2)(1 - P_1)P_2R_2 \quad \text{if } t_1 \leq t_2$$

(4-4) $$V(J_1 \& J_2) = \delta(t_2)P_2R_2 + \delta(t_1)(1 - P_2)P_1R_1 \quad \text{if } t_1 > t_2$$

δ : The time factor of the submit-accept delay is a function of t and $\delta' < 0, \delta'' > 0$

The equation (4-1) shows the expected utility of sole-submitting to Journal 1 first. The expected utility of getting accepted by the first journal discounts by $\delta(t_1)$ and negatively related to the referring delay of Journal 1. However, the expected value of the second journal discounts by $\delta(t_1 + t_2)$ which considers the *aggregate* delay time since authors will submit to Journal 2 after being rejected by Journal 1. Equation (4-2) shows the utility of sole-submitting to Journal 2 first. The utility of multi-submission is displayed as (4-3) and (4-4). The former one shows the expected value of multiple-submitting if the Journal 1 has a faster or similar referring process as Journal

2. In equation (4-3), the expected value is similar as sole-submission to Journal 1 first but the "”time-saving" effect is performed at the 2nd stage which considers "separated" referring delay t_2 only. Equation (4-4) demonstrates the expected utility of multiple-submission when Journal 1 has a slower reviewing process than Journal 2. In such case, Journal 2 would always reply faster than Journal 1 under the multiple-submission. For analytical convenience, we assume $\delta_i(t)$to be a specific form $1/t$.[7]

4.2 **Equilibrium with Asymmetric reply time**

The following analysis will begin with an asymmetric assumption of the refereeing delay that $t_1 > t_2$ which present Journal 2 performs a faster review process than Journal 1.[8]

4.2.1. The decisions of authors

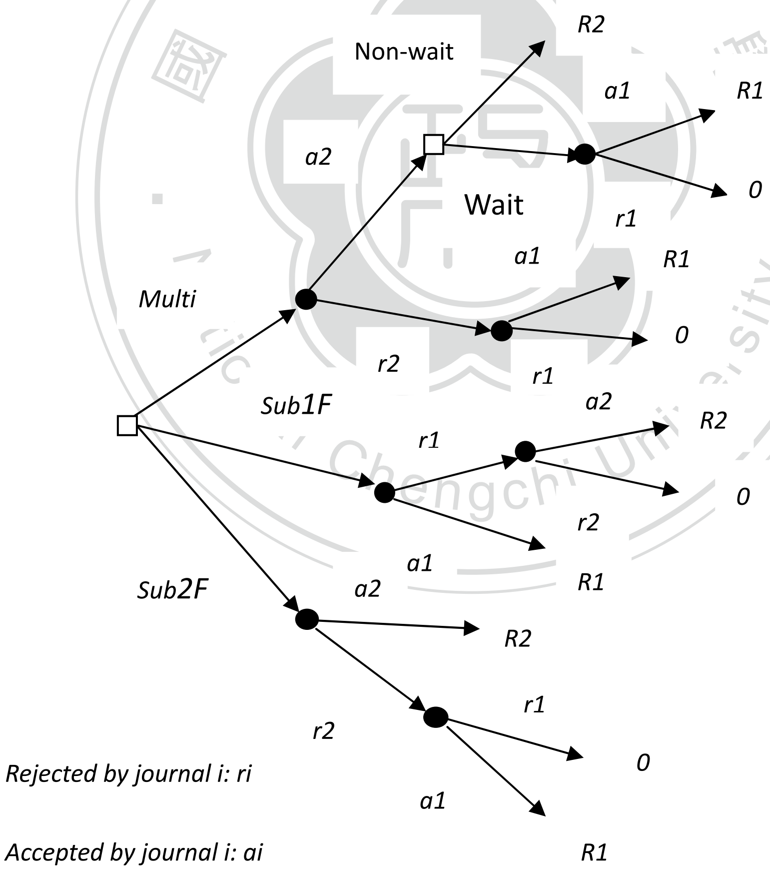

Figure4.3. Author's decision tree with asymmetric reply time of publishers with $t_1 > t_2$

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7 The time discount factor function $\delta_i(t) = 1/t$ which has the characteristics $\delta_i' < 0, \delta_i'' > 0$.

8 We had constructed the symmetric case with $t_1 = t_2$ and reduce to the similar result with chapter 3.

With the authors' decision process above, we can have the expected value of the submission choices as follows:[9]

(4-5) $$V(J_1, J_2) = \frac{1}{t_1} P_1 R_1 + \frac{1}{t_1+t_2}(1 - P_1) P_2 R_2$$

(4-6) $$V(J_2, J_1) = \frac{1}{t_2} P_2 R_2 + \frac{1}{t_1+t_2}(1 - P_2) P_1 R_1$$

(4-7) $$V(J_1 \& J_2) = \begin{cases} \frac{1}{t_1} P_1 P_2 R_1 + \frac{1}{t_1}(1 - P_2) P_1 R_1, \text{if } q > \hat{q} (4-7') \\ \frac{1}{t_2} P_2 R_2 + \frac{1}{t_1}(1 - P_2) P_1 R_1, \ \text{if } q \le \hat{q} (4-7'') \end{cases}$$

We first discuss the expected utility of multi-submission which is significantly different from the former discussion. Since the Journal 2 always has a faster response than Journal 1, the authors who multi-submit would face the dilemma to accept the acceptance of R_2 immediately or just wait (giving up the chance to be published in Journal 2) for the reply of more prestigious Journal 1 if the Journal 2's answer is positive. The authors will wait for the reply of Journal 1 if the following inequality holds.

$$\frac{1}{t_1} P_1 R_1 > \frac{1}{t_2} R_2$$

The left term of the inequality shows that the expected value to wait for the reply of Journal 1 and the right one is the expected value to accept the acceptance of Journal 2 immediately. For our convenience, we let $\hat{q}$ solve following equation.

(4-8) $$\frac{1}{t_2} R_2 = \frac{1}{t_1} P_1 R_1$$

We can express $\hat{q}$ as,

$$\hat{q}(R_1, R_2, t_1, t_2)$$

With a partial derivative of both sides with respect to q, we have the following characteristics. The authors with quality higher than $\hat{q}$ would always wait the reply of Journal 1 if multi-submit and the expected value is shown as equation (4-7').The others accepted the acceptance of the Journal 2 if the submission got positive answer from Journal 2 when multiple-submitting and the payoffs is shown at equation (4-7'').

9 We don't discuss the waiting case when sole-submitting journal 2 first here. But it would not affect the result since the expected value of the waiting case is dominated by the $V(J_1, J_2)$ strategy which saves the waiting cost in early stage.

Sole-submission rule

In the sole-submission case, the available choices of authors would be $V(J_1, J_2)$ and $V(J_2, J_1)$ and the authors would sole-submit to Journal 1 first if the following equation holds.

$$V(J_1, J_2) > V(J_2, J_1)$$

$$\frac{1}{t_2} P_2 R_2 + \frac{1}{t_1+t_2}(1 - P_2) P_1 R_1 > \frac{1}{t_2} P_2 R_2 + \frac{1}{t_1+t_2}(1 - P_2) P_1 R_1$$

$$\frac{R_1 t_2}{R_2 t_1} > \frac{P_2}{P_1} \frac{(t_1+t_2P_1)}{(t_2+t_1P_2)}$$

To conjecture the submission decisions of authors, we let $\bar{\bar{q}}_a$ solves the following equation,

(4-9) $$\frac{R_1 t_2}{R_2 t_1} = \frac{P_2}{P_1} \frac{(t_1+t_2P_1)}{(t_2+t_1P_2)}$$

And we can express it as

$$\bar{\bar{q}}_a(R_1, R_2, t_1, t_2)$$

Let $\omega = \frac{P_2}{P_1} \frac{(t_1+t_2P_1)}{(t_2+t_1P_2)}$

We have the partial derivative of ω respect of q:

$$\frac{\partial \omega}{\partial q} = \frac{1}{P_1^2(t_2+t_1P_2)^2} \{P_1(t_2 + t_1P_2)[P_{2q}(t_1 + t_2P_1) + t_2P_{1q}P_2] - P_2(t_1 + t_2P_1)[P_{1q}(t_2 + t_1P_2) + t_1P_{2q}P_1]\}$$

Following the assumption of previous chapter, we let $P_{1q} = P_{2q}$, $\frac{\partial \omega}{\partial q} < 0$.

With the result above, the authors with ability higher than $\bar{\bar{q}}_a$ would choose to sole-submit to Journal 1 first and the ones under $\bar{\bar{q}}_a$ would submit to Journal 2 first under sole-submission rule.

Multi-submission rule

If the multi-submission is allowable, the third choice to submit simultaneously $V(J_1 \& J_2)$ would be added. We can have the decision segments as the following graph to begin our analysis.[10]

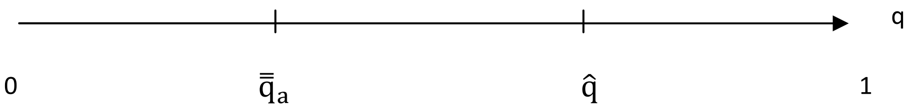

Figure4.4. Segments of authors ‘decisions with asymmetric reply time $t_1 > t_2$.

According to the discussion of authors’ decisions above, we have known,

$$V(J_1, J_2) \gtreqless V(J_2, J_1) \text{ if } q \gtreqless \bar{\bar{q}}_a$$

$$V(J_1 \& J_2) = \begin{cases} \dfrac{1}{t_1} P_1 R_1, & \text{if } q > \hat{q} \\ \dfrac{1}{t_2} P_2 R_2 + \dfrac{1}{t_1}(1 - P_2) P_1 R_1, & \text{if } q \le \hat{q} \end{cases}$$

With several comparisons, we can have following results.

$$V(J_2, J_1 | q < \bar{\bar{q}}_a) > V(J_1, J_2 | q < \bar{\bar{q}}_a)$$

$$V(J_1, \& J_2 | q < \hat{q}) > V(J_2, J_1 q < \bar{\bar{q}}_a)$$

$$V(J_1, \& J_2 | q < \hat{q}) > V(J_2, J_1 q < \bar{\bar{q}}_a) > V(J_1, J_2 | q < \bar{\bar{q}}_a)$$

It shows that the authors with quality lower than $\bar{\bar{q}}_a$ will always multiple-submit if the multiple-submission is allowable.

$$V(J_1, J_2 | q > \bar{\bar{q}}_a) > V(J_2, J_1 | q > \bar{\bar{q}}_a)$$

$$V(J_1, J_2 | q > \bar{\bar{q}}_a) > V(J_1, \& J_2 | q > \hat{q})$$

[10] The relative locations of $\bar{\bar{q}}_a$ and $\hat{q}$ could be proved in Appendix.

The people with writing ability between $\hat{q}$ and 1 would choose to sole-submit to Journal 1 first even though the multiple-submission is allowable.

$$V(J_1, J_2 | q > \bar{\bar{q}}_a) > V(J_2, J_1 | q > \bar{\bar{q}}_a)$$

$$V(J_1, \&J_2 | q < \hat{q}) > V(J_2, J_1 | q > \bar{\bar{q}}_a)$$

$$V(J_1, J_2 | q > \bar{\bar{q}}_a) \gtreqless V(J_1, \&J_2 | q < \hat{q}) \text{ iff } (t_1 + t_2)\frac{t_2}{t_1}\frac{R_1}{R_2} \gtreqless \frac{t_1 + t_2 P_1}{P_1}$$

To analyze the submission decision of authors, we have another parameter $\tilde{q}$ solves the following equation,

(4-10) $$(t_1 + t_2)\frac{t_2}{t_1}\frac{R_1}{R_2} = \frac{t_1 + t_2 P_1}{P_1}$$

And it can be expressed as

$$\tilde{q}(R_1, R_2, t_1, t_2)$$

For the convenience of analysis, we let $\lambda = \frac{t_1 + t_2 P_1}{P_1}$ and have the following partial derivative with respect to q:

$$\frac{\partial \lambda}{\partial q} = \frac{t_2 P_1 P_{1q} - P_{1q}(t_1 + t_2 P_1)}{p_1^2} < 0$$

With the result above, we can conclude that the authors with q that higher than $\tilde{q}$ will choose to sole-submit to Journal 1 first. However, the authors with q lower than $\tilde{q}$ will choose to multi-submit to both journals if the multi-submission is allowable. Therefore, we can again have following graph of the submission behaviors of authors under the multi-submission rule.[11]

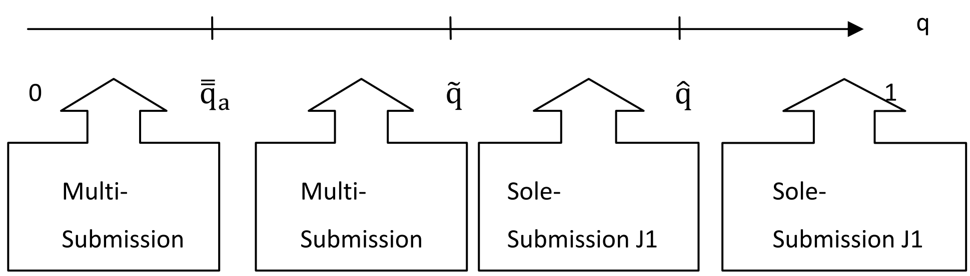

Figure4.5. the reaction of authors in sole-convention with time-delay (asymmetric reply time)

[11] The relative positions of the three parameters of q are proved in Appendix 5.

4.2.2. The decisions of journals

Knowing the submission reactions of authors under both submission rules, we can form the expected payoffs of both journals.

(i) Sole-submission (SS)

The Sole-submission rule will be adopted if one of the publishers refuses to accept multiple-submission. We have known best reaction of the authors is:

$$\begin{cases} \mathrm{V}(\mathrm{J}_1,\mathrm{J}_2) > V(\mathrm{J}_2,\mathrm{J}_1)\text{submit Journal 1, if } \mathrm{q} > \bar{\bar{\mathrm{q}}}_\mathrm{a} \\ \mathrm{V}(\mathrm{J}_1,\mathrm{J}_2) \le \mathrm{V}(\mathrm{J}_2,\mathrm{J}_1)\text{submit Journal 2, if } \mathrm{q} \le \bar{\bar{\mathrm{q}}}_\mathrm{a} \end{cases}$$

We can observe that authors submit with a similar manner under sole-submission rule which we had discussed in Chapter 3(but with different value of $\bar{\bar{\mathrm{q}}}_\mathrm{a}$). We can simply adopt the submission reactions of authors under sole-submission rule in the former chapter. Given the criterion of each journal, we again have the following possible cases of the accepting situation due to the relative positions of the criterions and the $\bar{\bar{\mathrm{q}}}_\mathrm{a}$:

Case (4.a) $\bar{\bar{\mathrm{q}}}_\mathrm{a} < z_2 < z_1$

(4-11) $$\pi_{\mathrm{ss}}^1|_{\bar{\bar{\mathrm{q}}}_\mathrm{a}<z_2<z_1} = \frac{\beta}{2}(1-\mathrm{z}_1^2) - \mathrm{c}$$

(4-12) $$\pi_{\mathrm{ss}}^2|_{\bar{\bar{\mathrm{q}}}_\mathrm{a}<z_2<z_1} = \frac{\beta}{2}(\mathrm{z}_1^2-\mathrm{z}_2^2) - \mathrm{cz}_1$$

Case (4.b) $z_2 < \bar{\bar{\mathrm{q}}}_\mathrm{a} < z_1$

(4-13) $$\pi_{\mathrm{ss}}^1|_{z_2<\bar{\bar{\mathrm{q}}}_\mathrm{a}<z_1} = \frac{\beta}{2}(1-\mathrm{z}_1^2) - \mathrm{c}(1-\bar{\bar{\mathrm{q}}}_\mathrm{a}+\mathrm{z}_2)$$

(4-14) $$\pi_{\mathrm{ss}}^2|_{z_2<\bar{\bar{\mathrm{q}}}_\mathrm{a}<z_1} = \frac{\beta}{2}(\mathrm{z}_1^2-\mathrm{z}_2^2) - \mathrm{cz}_1$$

Case (4.c) $z_2 < z_1 < \bar{\bar{\mathrm{q}}}_\mathrm{a}$

(4-15) $$\pi_{\mathrm{ss}}^1|_{z_2<z_1<\bar{\bar{\mathrm{q}}}_\mathrm{a}} = \frac{\beta}{2}(1-\bar{\bar{\mathrm{q}}}_\mathrm{a}^2) - \mathrm{c}(1-\bar{\bar{\mathrm{q}}}_\mathrm{a}+\mathrm{z}_2)$$

(4-16) $$\pi_{\mathrm{ss}}^1|_{z_2<z_1<\bar{\bar{\mathrm{q}}}_\mathrm{a}} = \frac{\beta}{2}(\bar{\bar{\mathrm{q}}}_\mathrm{a}^2-\mathrm{z}_2^2) - \mathrm{c}\bar{\bar{\mathrm{q}}}_\mathrm{a}$$

(ii) Multi-submission (MS)

The Multi-submission rule will be formed if both journals agree with the multiple-submission. With the analysis above, we have the best reaction of authors as follows:

$$\begin{cases} \mathrm{V}[\mathrm{J}_1, \mathrm{J}_2]\text{submit Journal 1, if } \mathrm{q} > \tilde{\mathrm{q}} \\ \mathrm{V}[\mathrm{J}_1\&\mathrm{J}_2]\text{multiple submit, if } \mathrm{q} \leq \tilde{\mathrm{q}} \end{cases}$$

The multi-submission here enables Journal 2 to first screen since the Journal 2 performs a faster referring process and the authors will always accept the offers once the reply is positive what we had show in the previous analysis. Different from the symmetric case, the payoffs of both journals changes with the possible relative locations of the criterions of them and the parameter $\tilde{q}$.

Case (4.d) $\tilde{q} < z_1 (\tilde{q} < z_2 < z_1$ or $z_2 < \tilde{q} < z_1)$

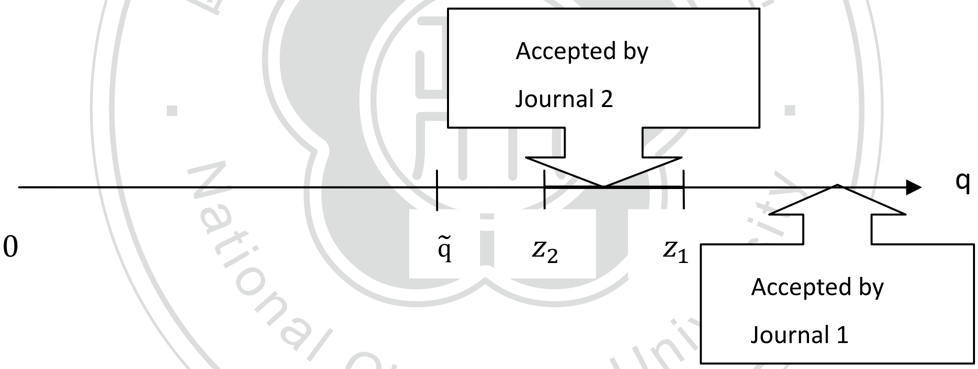

Figure4.6. the papers selected by each journal (4.d.1)

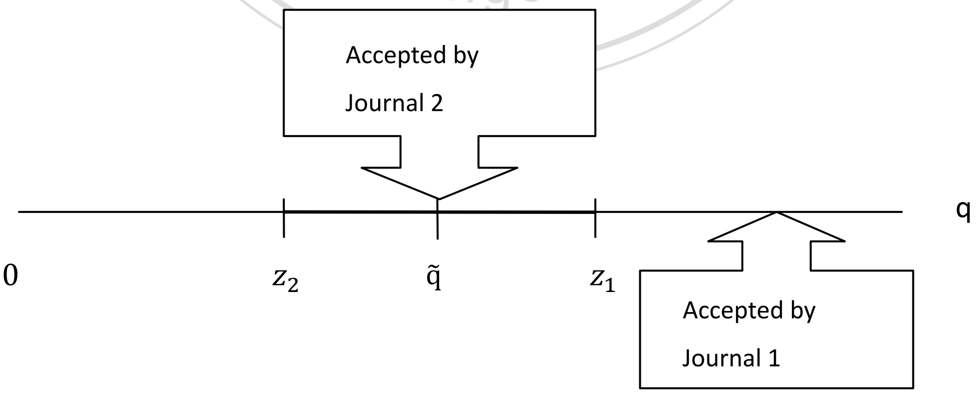

Figure4.7. the papers selected by each journal (4.d.2)

For Journal 1, he should review all the submissions including sole-submissions and multi-submissions under multiple-submission rule. The papers with $\mathrm{q} \in [z_1, 1]$

would be accepted by Journal 1 and those with quality between $\tilde{q}$ and z_1 will be rejected and resubmitted to Journal 2. Since he should review all the papers, the total quantity refereed is unity which cost him c to referee. On the other hand, the ones with $q \in [z_2, z_1]$ in the papers submitted to Journal 2 would be accepted. The quantity of papers Journal 2 reviewed would be the multiple-submission ones $\tilde{q}$ plus the resubmitted papers which cost her cz_1 to referee. The expected payoffs of both journals would be:

(4-17) $$\pi^1_{ms}|_{\tilde{q}\le z_1} = \frac{\beta}{2}(1 - z_1^2) - c$$

(4-18) $$\pi^2_{ms}|_{\tilde{q}\le z_1} = \frac{\beta}{2}(z_1^2 - z_2^2) - cz_1$$

Case (4.e) $\tilde{q} > z_1$

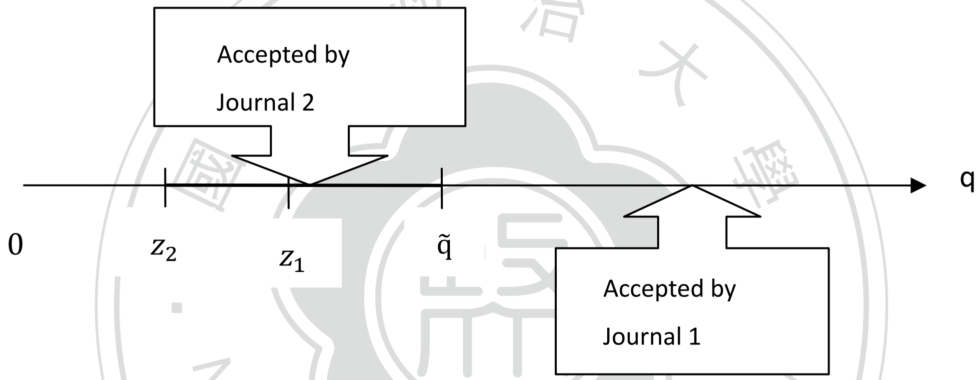

Figure4.8. the papers selected by each journal (4.e)

Once the criterion of Journal 1 is lower than the parameter $\tilde{q}$, Journal 1 will fail to screen all the qualified papers under the multiple-submission rule since the authors with ability between z_1 and $\tilde{q}$ will choose to multi-submit and will be accepted by Journal 2 due to the faster referring process. Thereby, Journal 1 can collect only the papers with quality higher than $\tilde{q}$. Similarly, he should review all the submissions including sole-submissions and multi-submissions which cost him c to referee. On the other hand, Journal 2 can first screen the papers with quality lower than $\tilde{q}$ and papers with quality between z_2 and $\tilde{q}$ will be accepted. Since no one resubmit, it costs her $c\tilde{q}$ to referee the papers.Again the expected payoffs could be illustrated as follows:

(4-19) $$\pi^1_{ms}|_{\tilde{q}>z_1} = \frac{\beta}{2}(1 - \tilde{q}^2) - c$$

(4-20) $$\pi^2_{ms}|_{\tilde{q}>z_1} = \frac{\beta}{2}(\tilde{q}^2 - z_2^2) - c\tilde{q}$$

Proposition 9.The pillage effect

Faster reviewing process may give the less prestigious journal ability to "steal" high quality papers from the more prestigious one under multiple-submission.

From the Figure 4.5, we see that the change of submission rule may force some authors who solely submit to more prestigious journal first in sole-submit rule to multiple-submit. Since the Journal 2 has a shorter submit-accept delay and authors with quality lower than $\hat{q}$ will accept the acceptance of Journal 2 if the reply is qualified. Journal 2 has actually extended the range to firstly screen these papers. Thus, the journal with lower reputation may be able to collect papers with higher quality under multiple-submission rule if z_1 is lower than $\tilde{q}$ which is shown at the case (4.e)

The expected payoffs of journals would be more complex here than the previous case since there're two parameters $\tilde{q}$ and $\bar{\bar{q}}$ we should take into consideration. With simple comparison, we have $\tilde{q}$ is greater than $\bar{\bar{q}}_a$ which we prove it in appendix. In the following discussions of the payoffs matrix of both journals, we should analyze five possible situations of the relative positions among z_1, $\tilde{q}$, and $\bar{\bar{q}}_a$ which are $z_2 < z_1 < \bar{\bar{q}}_a < \tilde{q}$, $z_2 < \bar{\bar{q}}_a < z_1 < \tilde{q}$, $\bar{\bar{q}}_a < z_2 < z_1 < \tilde{q}$, $z_2 < \bar{\bar{q}}_a < \tilde{q} < z_1$, and $\bar{\bar{q}}_a < z_2 < \tilde{q} < z_1$ or $\bar{\bar{q}}_a < \tilde{q} < z_2 < z_1$

(i) $z_2 < z_1 < \bar{\bar{q}}_a < \tilde{q}$

Strategy	S	M
S	$\begin{pmatrix} \frac{\beta}{2}(1-\bar{\bar{q}}_a^2) - c(1-\bar{\bar{q}}_a + z_2), \\ \frac{\beta}{2}(\bar{\bar{q}}_a^2 - z_2^2) - c\bar{\bar{q}}_a \end{pmatrix}$	$\begin{pmatrix} \frac{\beta}{2}(1-\bar{\bar{q}}_a^2) - c(1-\bar{\bar{q}}_a + z_2), \\ \frac{\beta}{2}(\bar{\bar{q}}_a^2 - z_2^2) - c\bar{\bar{q}}_a \end{pmatrix}$
M	$\begin{pmatrix} \frac{\beta}{2}(1-\bar{\bar{q}}_a^2) - c(1-\bar{\bar{q}}_a + z_2), \\ \frac{\beta}{2}(\bar{\bar{q}}_a^2 - z_2^2) - c\bar{\bar{q}}_a \end{pmatrix}$	$\begin{pmatrix} \frac{\beta}{2}(1-\tilde{q}^2) - c, \\ \frac{\beta}{2}(\tilde{q}^2 - z_2^2) - c\tilde{q} \end{pmatrix}$

Table4.1. the expected payoffs matrix of the strategy combination (4.i)

In such situation, the journal with higher reputation has no incentive to agree with the multi-convention since it loss more qualified papers and cost more with the enhanced refereeing loads of submissions if the multiple-submission rule is formed. On the other hand, with the following calculation, the Journal 2 would tend to support multi-submission attending to grip more qualified papers even with higher refereeing cost.

$$\frac{\beta}{2}(\tilde{q}^2 - z_2^2) - c\tilde{q} > \frac{\beta}{2}(\bar{\bar{q}}^2 - z_2^2) - c\bar{\bar{q}}_a$$

$$\frac{\beta}{2}\tilde{q}^2 - c\tilde{q} > \frac{\beta}{2}\bar{\bar{q}}_a^2 - c\bar{\bar{q}}_a$$

$$\left(\frac{\beta}{2}\tilde{q} - c\right)\tilde{q} > \left(\frac{\beta}{2}\bar{\bar{q}}_a - c\right)\bar{\bar{q}}_a \ \ \text{(Holds since } \tilde{q} > \bar{\bar{q}}\text{)}$$

The pure N.E. here would be **(s, m)** which leads to a sole-submission rule.

(ii) $z_2 < \bar{\bar{q}}_a < z_1 < \tilde{q}$

Strategy	S	M
S	$\begin{pmatrix} \frac{\beta}{2}(1 - z_1^2) - c(1 - \bar{\bar{q}}_a + z_2), \\ \frac{\beta}{2}(z_1^2 - z_2^2) - cz_1 \end{pmatrix}$	$\begin{pmatrix} \frac{\beta}{2}(1 - z_1^2) - c(1 - \bar{\bar{q}}_a + z_2), \\ \frac{\beta}{2}(z_1^2 - z_2^2) - cz_1 \end{pmatrix}$
M	$\begin{pmatrix} \frac{\beta}{2}(1 - z_1^2) - c(1 - \bar{\bar{q}}_a + z_2), \\ \frac{\beta}{2}(z_1^2 - z_2^2) - cz_1 \end{pmatrix}$	$\begin{pmatrix} \frac{\beta}{2}(1 - \tilde{q}^2) - c, \\ \frac{\beta}{2}(\tilde{q}^2 - z_2^2) - c\tilde{q} \end{pmatrix}$

Table4.2. the expected payoffs matrix of the strategy combination (4.ii)

In such situation, Journal 1 would never agree to accept the multi-submissions due to losing more qualified papers they want and generating more cost under multiple-submission rule. However, the Journal 2 may also prefer the multi-submission rule with the similar reason as case (a) above:

$$\frac{\beta}{2}(\tilde{q}^2 - z_2^2) - c\tilde{q} > \frac{\beta}{2}(z_1^2 - z_2^2) - cz_1$$

$$\frac{\beta}{2}\tilde{q}^2 - c\tilde{q} > \frac{\beta}{2}z_1^2 - cz_1$$

$$\left(\frac{\beta}{2}\tilde{q} - c\right)\tilde{q} > \left(\frac{\beta}{2}z_1 - c\right)z_1 \ \ \text{(Holds since } \tilde{q} > z_1 \text{ here)}$$

The equilibrium result would be again **(s, m)** for the similar reasons that Journal 1 would stick to sole-submission to avoid of losing qualified papers.

(iii) $\bar{\bar{q}}_a < z_2 < z_1 < \tilde{q}$

Strategy	S	M
S	$\begin{pmatrix} \frac{\beta}{2}(1-z_1^2)-c, \\ \frac{\beta}{2}(z_1^2-z_2^2)-cz_1 \end{pmatrix}$	$\begin{pmatrix} \frac{\beta}{2}(1-z_1^2)-c, \\ \frac{\beta}{2}(z_1^2-z_2^2)-cz_1 \end{pmatrix}$
M	$\begin{pmatrix} \frac{\beta}{2}(1-z_1^2)-c, \\ \frac{\beta}{2}(z_1^2-z_2^2)-cz_1 \end{pmatrix}$	$\begin{pmatrix} \frac{\beta}{2}(1-\tilde{q}^2)-c, \\ \frac{\beta}{2}(\tilde{q}^2-z_2^2)-c\tilde{q} \end{pmatrix}$

Table4.3. the expected payoffs matrix of the strategy combination (4.iii)

For Journal 1, he would not agree with multiple-submission rule for losing a certain volume of the qualified papers. But Journal 2 would always prefer the multiple-submission rule as we had proved above. Therefore, the equilibrium result would be also **(s, m)** which leads to sole-submission rule of the industry.

(iv) $z_2 < \bar{\bar{q}}_a < \tilde{q} < z_1$

Strategy	S	M
S	$\begin{pmatrix} \frac{\beta}{2}(1-z_1^2)-c(1-\bar{\bar{q}}_a+z_2), \\ \frac{\beta}{2}(z_1^2-z_2^2)-cz_1 \end{pmatrix}$	$\begin{pmatrix} \frac{\beta}{2}(1-z_1^2)-c(1-\bar{\bar{q}}_a+z_2), \\ \frac{\beta}{2}(z_1^2-z_2^2)-cz_1 \end{pmatrix}$
M	$\begin{pmatrix} \frac{\beta}{2}(1-z_1^2)-c(1-\bar{\bar{q}}_a+z_2), \\ \frac{\beta}{2}(z_1^2-z_2^2)-cz_1 \end{pmatrix}$	$\begin{pmatrix} \frac{\beta}{2}(1-z_1^2)-c, \\ \frac{\beta}{2}(z_1^2-z_2^2)-cz_1 \end{pmatrix}$

Table4.4. the expected payoffs matrix of the strategy combination (iv)

If z_1 is higher than the parameter $\tilde{q}$, the expected payoffs seems indifferent to Journal 2 no matter what the submission rule is. But Journal 1 would never accept the multi-submission rule since it cost much on reviewing the enhanced submissions without the gross in qualified papers published in its journal. Therefore, the possible equilibriums will be the **(s, s)** and **(s, m)** only which also lead to sole-submission.

(v) $\bar{\bar{q}}_a < z_2 < \tilde{q} < z_1$ or $\bar{\bar{q}}_a < \tilde{q} < z_2 < z_1$

Strategy	S	M
S	$\begin{pmatrix} \frac{\beta}{2}(1-z_1^2)-c, \\ \frac{\beta}{2}(z_1^2-z_2^2)-cz_1 \end{pmatrix}$	$\begin{pmatrix} \frac{\beta}{2}(1-z_1^2)-c, \\ \frac{\beta}{2}(z_1^2-z_2^2)-cz_1 \end{pmatrix}$
M	$\begin{pmatrix} \frac{\beta}{2}(1-z_1^2)-c, \\ \frac{\beta}{2}(z_1^2-z_2^2)-cz_1 \end{pmatrix}$	$\begin{pmatrix} \frac{\beta}{2}(1-z_1^2)-c, \\ \frac{\beta}{2}(z_1^2-z_2^2)-cz_1 \end{pmatrix}$

Table4.5. the expected payoffs matrix of the strategy combination (v)

From the result of table 4.5, both submission rules generate indifferent expected payoffs for both Journal 1 and Journal 2. Therefore, all the strategy combinations would be the possible equilibriums.

Proposition 10. Conflicting interests between publishers

Even though the faster reviewing process improved the welfare of less prestigious journal under multiple-submission rule, the equilibrium rule would always be sole-submission due to the veto power of more prestigious journal.

With the discussions above, we can see that the faster reviewing process enable Journal 2 to have pillage effect on papers with higher quality under multiple-submission rule in cases where z_1 is lower than $\tilde{q}$. While that hurt Journal 1's benefit to agree with multiple-submission rule, he would not await his doom and stick to the sole-submission policy which leads to the equilibrium of sole-submission. Since there is *competing* interests between the two journals, the welfare improvement of one of them may imply welfare inferior to the other journal.

4.3 Welfare Analysis

With the expected payoffs of authors and publishers in the previous section, we can have the aggregate welfare as follows.

Authors' Welfare

$$E[U]^{ss} = \int_0^{\bar{\bar{q}}_a} V(J_2, J_1)\,dq + \int_{\bar{\bar{q}}_a}^1 V(J_1, J_2)\,dq$$

$$E[U]^{ms} = \int_0^{\bar{\bar{q}}_a} V(J_2\&J_1)\,dq + \int_{\bar{\bar{q}}_a}^{\tilde{q}} V(J_2\&J_1)dq + \int_{\tilde{q}}^1 V(J_1, J_2)\,dq$$

With the fact $\bar{\bar{q}}_a < \tilde{q}$ and

$$V(J_1\&J_2) > V(J_2, J_1) \quad \text{for } q \le \bar{\bar{q}}_a$$
$$V(J_1\&J_2) > V(J_1, J_2) \text{ for } q \in (\bar{\bar{q}}_a, \tilde{q})$$

Multiple-submission rule generates higher aggregate expected utility of authors rather than Sole-submission rule.

$$E[U]^{ss} < E[U]^{ms}$$

Publishers' Welfare

Due to the indeterminacy of positions of $\bar{\bar{q}}_a$ and $\tilde{q}$ with respect to z_1 and z_2, we have five possible cases of expected payoffs of publishers.

(i) $z_2 < z_1 < \bar{\bar{q}}_a < \tilde{q}$

$$E[\pi]^{ss}_{z_2<z_1<\bar{\bar{q}}_a<\tilde{q}} = \frac{\beta}{2}(1 - z_2^2) - c(1 + z_2)$$

$$E[\pi]^{ms}_{z_2<z_1<\bar{\bar{q}}_a<\tilde{q}} = \frac{\beta}{2}(1 - z_2^2) - c(1 + \tilde{q})$$

$$E[\pi]^{ss}_{z_2<z_1<\bar{\bar{q}}_a<\tilde{q}} > E[\pi]^{ms}_{z_2<z_1<\bar{\bar{q}}_a<\tilde{q}}$$

(ii) $z_2 < \bar{\bar{q}}_a < z_1 < \tilde{q}$

$$E[\pi]^{ss}_{z_2<\bar{\bar{q}}_a<z_1<\tilde{q}} = \frac{\beta}{2}(1 - z_2^2) - c(1 - \bar{\bar{q}}_a + z_1 + z_2)$$

$$E[\pi]^{ms}_{z_2<\bar{\bar{q}}_a<z_1<\tilde{q}} = \frac{\beta}{2}(1 - z_2^2) - c(1 + \tilde{q})$$

$$E[\pi]^{ss}_{z_2<\bar{\bar{q}}_a<z_1<\tilde{q}} > E[\pi]^{ms}_{z_2<\bar{\bar{q}}_a<z_1<\tilde{q}}$$

(iii) $\bar{\bar{q}}_a < z_2 < z_1 < \tilde{q}$

$$E[\pi]^{ss}_{\bar{\bar{q}}_a<z_2<z_1<\tilde{q}} = \frac{\beta}{2}(1 - z_2^2) - c(1 + z_1)$$

$$E[\pi]^{ms}_{\bar{\bar{q}}_a<z_2<z_1<\tilde{q}} = \frac{\beta}{2}(1 - z_2^2) - c(1 + \tilde{q})$$

$$\mathrm{E}[\pi]^{ss}_{\bar{\bar{q}}_a<z_2<z_1<\tilde{q}} > E[\pi]^{ms}_{\bar{\bar{q}}_a<z_2<z_1<\tilde{q}}$$

(iv) $z_2 < \bar{\bar{q}}_a < \tilde{q} < z_1$

$$\mathrm{E}[\pi]^{ss}_{z_2<\bar{\bar{q}}_a<\tilde{q}<z_1} = \frac{\beta}{2}(1 - z_2^2) - c(1 - \bar{\bar{q}}_a + z_1 + z_2)$$

$$[\pi]^{ms}_{z_2<\bar{\bar{q}}_a<\tilde{q}<z_1} = \frac{\beta}{2}(1 - z_2^2) - c(1 + z_1)$$

$$\mathrm{E}[\pi]^{ss}_{\bar{\bar{q}}_a<z_2<z_1<\tilde{q}} > E[\pi]^{ms}_{\bar{\bar{q}}_a<z_2<z_1<\tilde{q}}$$

(v) $\bar{\bar{q}}_a < z_2 < \tilde{q} < z_1$ or $\bar{\bar{q}}_a < \tilde{q} < z_2 < z_1$

$$\mathrm{E}[\pi]^{ss}_{\bar{\bar{q}}_a<z_2<\tilde{q}<z_1} = \frac{\beta}{2}(1 - z_2^2) - c(1 + z_1)$$

$$\mathrm{E}[\pi]^{ms}_{\bar{\bar{q}}_a<z_2<\tilde{q}<z_1} = \frac{\beta}{2}(1 - z_2^2) - c(1 + z_1)$$

$$\mathrm{E}[\pi]^{ss}_{\bar{\bar{q}}_a<z_2<\tilde{q}<z_1} = E[\pi]^{ms}_{\bar{\bar{q}}_a<z_2<\tilde{q}<z_1}$$

Social Welfare

(i) $z_2 < z_1 < \bar{\bar{q}}_a < \tilde{q}$

$$\mathrm{E}[W]^{ss}_{z_2<z_1<\bar{\bar{q}}_a<\tilde{q}} = \mathrm{E}[U]^{ss} + \frac{\beta}{2}(1 - z_2^2) - c(1 + z_2)$$

$$\mathrm{E}[W]^{ms}_{z_2<z_1<\bar{\bar{q}}_a<\tilde{q}} = \mathrm{E}[U]^{ms} + \frac{\beta}{2}(1 - z_2^2) - c(1 + \tilde{q})$$

Multiple-submission is social-desirable if the following condition holds.

$$\mathrm{E}[W]^{ms}_{z_2<z_1<\bar{\bar{q}}_a<\tilde{q}} > E[W]^{ss}_{z_2<z_1<\bar{\bar{q}}_a<\tilde{q}}$$

(4-21) $$\mathrm{E}[U]^{ms} - \mathrm{E}[U]^{ss} > c(\tilde{q} - z_2)$$

(ii) $z_2 < \bar{\bar{q}}_a < z_1 < \tilde{q}$

$$\mathrm{E}[W]^{ss}_{z_2<\bar{\bar{q}}_a<z_1<\tilde{q}} = \mathrm{E}[U]^{ss} + \frac{\beta}{2}(1 - z_2^2) - c(1 - \bar{\bar{q}}_a + z_1 + z_2)$$

$$\mathrm{E[W]}^{\mathrm{ms}}_{z_2<\bar{\bar{\mathrm{q}}}_\mathrm{a}<z_1<\tilde{\mathrm{q}}} = \mathrm{E[U]^{ms}} + \frac{\beta}{2}(1-\mathrm{z}_2^2) - \mathrm{c}(1+\tilde{\mathrm{q}})$$

Multiple-submission is social-desirable if the following condition holds.

$$\mathrm{E[W]}^{\mathrm{ms}}_{z_2<\bar{\bar{\mathrm{q}}}_\mathrm{a}<z_1<\tilde{\mathrm{q}}} > E[W]^{\mathrm{ss}}_{z_2<\bar{\bar{\mathrm{q}}}_\mathrm{a}<z_1<\tilde{\mathrm{q}}}$$

(4-22) $$\mathrm{E[U]^{ms}} - \mathrm{E[U]^{ss}} > c(\tilde{\mathrm{q}} + \bar{\bar{\mathrm{q}}}_\mathrm{a} - \mathrm{z}_1 - \mathrm{z}_2)$$

(iii) $\bar{\bar{\mathrm{q}}}_\mathrm{a} < z_2 < z_1 < \tilde{\mathrm{q}}$

$$\mathrm{E[W]}^{\mathrm{ss}}_{\bar{\bar{\mathrm{q}}}_\mathrm{a}<z_2<z_1<\tilde{\mathrm{q}}} = \mathrm{E[U]^{ss}} + \frac{\beta}{2}(1-\mathrm{z}_2^2) - \mathrm{c}(1+\mathrm{z}_1)$$

$$\mathrm{E[W]}^{\mathrm{ms}}_{\bar{\bar{\mathrm{q}}}_\mathrm{a}<z_2<z_1<\tilde{\mathrm{q}}} = \mathrm{E[U]^{ms}} + \frac{\beta}{2}(1-\mathrm{z}_2^2) - \mathrm{c}(1+\tilde{\mathrm{q}})$$

Multiple-submission is social-desirable if the following condition holds.

$$\mathrm{E[W]}^{\mathrm{ms}}_{z_2<\bar{\bar{\mathrm{q}}}_\mathrm{a}<z_1<\tilde{\mathrm{q}}} > E[W]^{\mathrm{ss}}_{z_2<\bar{\bar{\mathrm{q}}}_\mathrm{a}<z_1<\tilde{\mathrm{q}}}$$

(4-23) $$\mathrm{E[U]^{ms}} - \mathrm{E[U]^{ss}} > c(\tilde{\mathrm{q}} - \mathrm{z}_1)$$

(iv) $z_2 < \bar{\bar{\mathrm{q}}}_\mathrm{a} < \tilde{\mathrm{q}} < z_1$

$$\mathrm{E[W]}^{\mathrm{ss}}_{z_2<\bar{\bar{\mathrm{q}}}_\mathrm{a}<\tilde{\mathrm{q}}<z_1} = \mathrm{E[U]^{ss}} + \frac{\beta}{2}(1-\mathrm{z}_2^2) - \mathrm{c}(1-\bar{\bar{\mathrm{q}}}_\mathrm{a}+\mathrm{z}_1+\mathrm{z}_2)$$

$$\mathrm{E[W]}^{\mathrm{ms}}_{z_2<\bar{\bar{\mathrm{q}}}_\mathrm{a}<\tilde{\mathrm{q}}<z_1} = \mathrm{E[U]^{ms}} + \frac{\beta}{2}(1-\mathrm{z}_2^2) - \mathrm{c}(1+\mathrm{z}_1)$$

Multiple-submission is social-desirable, if the following condition holds.

$$\mathrm{E[W]}^{\mathrm{ms}}_{z_2<\bar{\bar{\mathrm{q}}}_\mathrm{a}<z_1<\tilde{\mathrm{q}}} > E[W]^{\mathrm{ss}}_{z_2<\bar{\bar{\mathrm{q}}}_\mathrm{a}<z_1<\tilde{\mathrm{q}}}$$

(4-24) $$\mathrm{E[U]^{ms}} - \mathrm{E[U]^{ss}} > c(\bar{\bar{\mathrm{q}}}_\mathrm{a} - \mathrm{z}_2)$$

(v) $\bar{\bar{\mathrm{q}}}_\mathrm{a} < z_2 < \tilde{\mathrm{q}} < z_1$ or $\bar{\bar{\mathrm{q}}}_\mathrm{a} < \tilde{\mathrm{q}} < z_2 < z_1$

$$\mathrm{E[W]}^{\mathrm{ss}}_{\bar{\bar{\mathrm{q}}}_\mathrm{a}<z_2<\tilde{\mathrm{q}}<z_1} = \mathrm{E[U]^{ss}} += \frac{\beta}{2}(1-\mathrm{z}_2^2) - \mathrm{c}(1+\mathrm{z}_1)$$

$$\mathrm{E[W]}^{\mathrm{ms}}_{\bar{\bar{\mathrm{q}}}_\mathrm{a}<z_2<\tilde{\mathrm{q}}<z_1} = \mathrm{E[U]}^{\mathrm{ms}} + \frac{\beta}{2}(1 - \mathrm{z}_2^2) - \mathrm{c}(1 + \mathrm{z}_1)$$

If the multiple-submission is social-desirable, the following condition should hold.

$$\mathrm{E[W]}^{\mathrm{ms}}_{\bar{\bar{\mathrm{q}}}_\mathrm{a}<z_2<\tilde{\mathrm{q}}<z_1} > E[W]^{\mathrm{ss}}_{\bar{\bar{\mathrm{q}}}_\mathrm{a}<z_2<\tilde{\mathrm{q}}<z_1}$$

$$\mathrm{E[U]}^{\mathrm{ms}} - \mathrm{E[U]}^{\mathrm{ss}} > 0 \tag{4-25}$$

With the results above, we can see that multiple-submission rule always benefits authors but raises extra reviewing burden of publishers in most of the cases. Multiple-submission rule is second best welfare-superior than Sole-submission if the enhanced utility of authors excesses the increased reviewing cost under Multiple-submission rule. While the Multiple-submission would never be the equilibrium submission rule due to the rejection of Journal 1 against the pillage effect we have proposed.

We summarize the equilibrium submission rules with various model settings in the following table.

Model	Setting(cost consideration)	Nash Equilibrium	Equilibrium Regime
Basic Model	N/A	(s, s),(m, s)	Sole-submission
Time Preference Model	$\bar{\bar{\mathrm{q}}} < z_2 < z_1$	(s, s), (m, s)	Sole-submission
	$z_2 < \bar{\bar{\mathrm{q}}} < z_1$	(s, s)	Sole-submission
	$z_2 < z_1 < \bar{\bar{\mathrm{q}}}$	(s, s) /(m, s)	Sole-submission
Asymmetric Reply Model ($\mathrm{t}_1 > \mathrm{t}_2$)	$z_2 < z_1 < \bar{\bar{\mathrm{q}}}_\mathrm{a} < \tilde{\mathrm{q}}$	(s, m)	Sole-submission
	$z_2 < \bar{\bar{\mathrm{q}}}_\mathrm{a} < z_1 < \tilde{\mathrm{q}}$	(s, m)	Sole-submission
	$\bar{\bar{\mathrm{q}}}_\mathrm{a} < z_2 < z_1 < \tilde{\mathrm{q}}$	(s, m)	Sole-submission
	$z_2 < \bar{\bar{\mathrm{q}}}_\mathrm{a} < \tilde{\mathrm{q}} < z_1$	(s, s), (s, m)	Sole-submission
	$\bar{\bar{\mathrm{q}}}_\mathrm{a} < z_2 < \tilde{\mathrm{q}} < z_1$ or $\bar{\bar{\mathrm{q}}}_\mathrm{a} < \tilde{\mathrm{q}} < z_2 < z_1$	All possible	Indifference

Table4.6. Equilibrium results of models

The results above support why journals have declined to adopt Multiple-submission policy even it is social-desirable.