Online supplement for
“On submission fees and response times in academic publishing”

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An information structure with continuous article quality

In this online section, we consider an information structure in which both article quality and author signals are continuously distributed. The structure is identical to the one presented in Leslie (2005). This section, therefore, illustrates how the main result in the paper—that journal quality is maximized through a combination of both fees and delays when authors have heterogeneous cost preferences—carries over to the more general information structure.

There is a continuum of authors of total mass 1. Each author has one article of ex ante unknown quality. An article's quality is denoted z, where $z \sim N(\bar{z}, \sigma_z^2)$. Before deciding whether to submit their article, authors observe a private signal (i.e., form their own opinion) about their article's quality. Denote this signal by $q = z + v$, where $v \sim N(0, \sigma_v^2)$. Therefore, $q \sim N(\mu, \sigma_z^2 + \sigma_v^2)$.

Denote by $F_q(\cdot)$ and $f_q(\cdot)$ the density and distribution of q. Denote by $F_z(\cdot|q)$ and $f_z(\cdot|q)$ the conditional density and distribution of z given q. One may explicitly calculate $F_z(\cdot|q)$; for our purposes, however, it is sufficient to recognize that $F_z(\cdot|q)$ is a normal distribution and that $1 - F_z(z|q) < 1 - F_z(z|\hat{q})$ for all z when $\hat{q} > q$.

The journal editor maximizes the average quality of accepted articles while maintaining both an acceptable refereeing burden, τ, and a target publication size, n. To satisfy these constraints, the editor can impose submission fee $M \geq 0$ and time delay $T \geq 0$ on authors who submit their articles, and choose the minimum-quality cutoff for accepted articles z_{min}. After the editor chooses M, T and z_{min}, authors decide whether to submit their article. The editor perfectly observes the true quality z of submitted articles, and publishes any article with $z \geq z_{min}$. An author who's article is published, receives benefit V.

As in the main body of the paper, there are four categories of authors, which differ in their disutility from fees and delays. Denote these categories by $t \in \{MT, M, T, \emptyset\}$, where group-$MT$ authors face costs $C_{MT} = M + T$, group-M authors face costs $C_M = M$, and group-T authors face costs $C_T = T$ when they submit their article for review. A type $\emptyset$ author faces no submission costs. An author is type-t with probability ρ_t. To focus on the case where the acceptable refereeing burden is greater than the minimum number of submissions, we assume $\tau > \rho_\emptyset$.[1]

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[1] In the main body of the paper, $\rho_{MT} = \pi_M \pi_T$, $\rho_M = \pi_M(1 - \pi_T)$, $\rho_T = \pi_T(1 - \pi_M)$ and $\rho_\emptyset = (1 - \pi_M)(1 - \pi_T)$.

An author of group t with quality signal q submits his articles to the journal for review if the expected benefit of submission is greater than the costs:

$$(1 - F_z(z_{min}|q))V \geq C_t.$$

If a group-t author with signal q prefers to submit his article, then any group-t author with $\hat{q} \geq q$ also prefers to submit his article. This implies a group-t signal cut value $\bar{q}_t$ such that any author with $q \geq \bar{q}_t$ submits. When $C_t \leq V$, the cut value $\bar{q}_t$ solves

$$1 - F_z(z_{min}|\bar{q}_t) = \frac{C_t}{V}.$$

If $C_t > V$, then $\bar{q}_t \to \infty$, and no author from group-t submits.

We can now formalize the refereeing burden and journal size constraints. The journal must maintain an acceptable refereeing burden, meaning that the total mass of submitted articles cannot exceed τ. Therefore,

$$\sum_t \rho_t \int_{\bar{q}_t}^{\infty} f_q(q)dq \leq \tau.$$

The editor must also maintain a fixed journal size, n. Since the journal editor always prefers to accept the n highest-quality submissions, she chooses z_{min} such that

$$\sum_t \rho_t \int_{\bar{q}_t}^{\infty} f_q(q) \int_{z_{min}}^{\infty} f_z(z|q)dzdq = n.$$

The editor's objective is to maximize the average quality of published articles subject to these constraints. Average quality of published articles is given by

$$\frac{1}{n} \sum_t \rho_t \int_{\bar{q}_t}^{\infty} f_q(q) \int_{z_{min}}^{\infty} f_z(z|q)zdzdq.$$

Let M^* and T^* define the editor's equilibrium choice of fee and delay. That is, M^* and T^* maximize journal quality. Proposition 1 shows that the result from the main body of the paper continues to hold.

Proposition 1 *In equilibrium of the continuous-quality game, $M^* > 0$ and $T^* > 0$.*

Journal quality is maximized through a combination of positive fee and positive delay. Relying only on a fee or only on a delay to discourage low-probability submissions does not maximize journal quality.

To establish this result, we rule out the possibility that $M^* > 0 = T^*$ in equilibrium. A symmetric analysis rules out the case where $M^* = 0 < T^*$. The case where $M^* = T^* = 0$ does not satisfy the refereeing burden constraint. Thereby, we conclude that both $M^* > 0$ and $T^* > 0$ in equilibrium.

If $\tau < \rho_\emptyset + \rho_T$, then the editor cannot maintain an acceptable refereeing burden through the use of fees alone. Setting very high fees to discourage all submissions from group MT and M authors will still result in submissions from mass $\rho_\emptyset + \rho_T$ of the author population. In this case, the editor cannot rely only on fees and it must be that $T^* > 0$ in equilibrium. If, on the other hand, $\tau > \rho_\emptyset + \rho_T$, then the editor can maintain an acceptable referee burden through the use of fees alone. For this case, we establish that the editor prefers positive delay in equilibrium.

Consider two equations for M as a function of T. One equation, M_{RB}, represents the acceptable refereeing burden constraint; for any value of T, it gives the corresponding minimum value of M that maintains an acceptable refereeing burden. The second equation, M_{IC}, represents the indifference curve that goes through the point where the editor maintains an acceptable refereeing burden through the use of fee alone (no time delay); for any value T, it gives the corresponding value of M that maintains the same journal quality. Graphically, these functions are depicted in Figure 1.

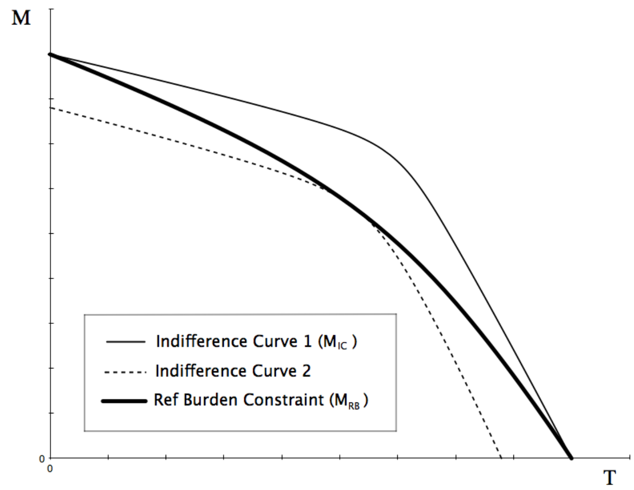

Figure 1: Indifference Curves and Refereeing Burden Constraint

The figure is drawn under the implicit assumption that $\rho_M = \rho_T$; in the symmetric problem, the editor is indifferent between only relying on fees or only relying on delays to maintain the acceptable refereeing burden. If $\rho_M \neq \rho_T$, this will not be the case, and a single indifference curve will not intercept both axes at the same points as the refereeing burden constraint. This symmetry is not required for the analysis, as we will compare the slope of M_{IC} and M_{RB} at the point where $M_{IC} = M_{RB} > 0$ and $T = 0$. The analysis will rule out the possibility that $M^* > 0 = T^*$ in equilibrium. A symmetric analysis may be conducted to rule out $M^* = 0 < T^*$ using whichever indifference curve intercepts the T axis at the same point as the acceptable refereeing burden constraint.

Notice that journal quality is higher the closer an indifference curve is to the origin on the graph. That is, in the absence of the acceptable refereeing burden constraint, journal quality is strictly higher when the costs of submission are lower. This is because lower submission costs result in lower $\bar{q}_t$ for the groups affected by the costs, and therefore result in more submissions. Even though the average quality of total submissions decreases as $\bar{q}_t$ decreases, the average quality of the n best submissions increases. Therefore, journal quality increases as either M or T decrease.

This means that the editor will always set costs such that the acceptable refereeing burden holds with equality. That is, the equilibrium choice of M^* and T^* will be such that $M^* = M_{RB}(T^*)$.

To rule out an equilibrium in which $M^* > 0$ and $T^* = 0$, it is sufficient to show that

$$\left.\frac{\partial M_{RB}(T)}{\partial T}\right|_{T=0} < \left.\frac{\partial M_{IC}(T)}{\partial T}\right|_{T=0} < 0. \tag{1}$$

Because both M_{RB} and M_{IC} are strictly decreasing in T, this condition means that at $T = 0$, the slope of the indifference curve is nearer 0 (i.e., flatter) than the slope of the refereeing burden constraint. When this condition is met, starting from $T = 0$ and $M = M_{RB}(0)$, if the editor marginally increases T and decreases M while maintaining the same acceptable refereeing burden, then the new cost combination falls inside of the M_{IC} curve. That is, the new M, T combination lies on a higher-payoff indifference curve, and results in higher journal quality than the original $M > 0 = T$ combination.

We rewrite the acceptable refereeing burden constraint to hold with equality as a function of $M_{RB}(T)$ and T:

$$\sum_t \rho_t \int_{\bar{q}_t(M_{RB}(T),T)}^{\infty} f_q(q)dq = \tau.$$

The derivative with respect to T is

$$-\sum_t \rho_t f_q(\bar{q}_t(M_{RB}(T),T)) \left(\frac{\partial \bar{q}_t(M_{RB}(T),T)}{\partial M} \frac{\partial M_{RB}(T)}{\partial T} + \frac{\partial \bar{q}_t(M_{RB}(T),T)}{\partial T} \right) = 0. \tag{2}$$

Solving Eq. 2 for $\frac{\partial M_{RB}(T)}{\partial T}$ gives

$$\frac{\partial M_{RB}(T)}{\partial T} = -\frac{\sum_t \rho_t f_q(\bar{q}_t(M_{RB}(T),T)) \frac{\partial \bar{q}_t(M_{RB}(T),T)}{\partial T}}{\sum_t \rho_t f_q(\bar{q}_t(M_{RB}(T),T)) \frac{\partial \bar{q}_t(M_{RB}(T),T)}{\partial M}}.$$

Note that $\frac{\partial \bar{q}_T}{\partial M} = \frac{\partial \bar{q}_M}{\partial T} = \frac{\partial \bar{q}_\emptyset}{\partial M} = \frac{\partial \bar{q}_\emptyset}{\partial T} = 0$, $\frac{\partial \bar{q}_M}{\partial M} > 0$, $\frac{\partial \bar{q}_T}{\partial T} > 0$, and $\frac{\partial \bar{q}_{MT}}{\partial M} = \frac{\partial \bar{q}_{MT}}{\partial T}$. Thus,

$$\frac{\partial M_{RB}(T)}{\partial T} = -\frac{\rho_{MT} f_q(\bar{q}_{MT}(M_{RB}(T),T)) \frac{\partial \bar{q}_{MT}(M_{RB}(T),T)}{\partial T} + \rho_T f_q(\bar{q}_T(M_{RB}(T),T)) \frac{\partial \bar{q}_T(M_{RB}(T),T)}{\partial T}}{\rho_{MT} f_q(\bar{q}_{MT}(M_{RB}(T),T)) \frac{\partial \bar{q}_{MT}(M_{RB}(T),T)}{\partial M} + \rho_M f_q(\bar{q}_M(M_{RB}(T),T)) \frac{\partial \bar{q}_M(M_{RB}(T),T)}{\partial M}}.$$

Evaluated at $M > 0$ and $T = 0$, this equation simplifies further. As $T = 0$, cut value $\bar{q}_T \to -\infty$ and thus $f_q(\bar{q}_T) \to 0$. Furthermore, $T = 0$ means $\bar{q}_{MT} = \bar{q}_M$ and $\frac{\partial \bar{q}_{MT}}{\partial M} = \frac{\partial \bar{q}_M}{\partial M}$.

$$\left. \frac{\partial M_{RB}(T)}{\partial T} \right|_{T=0} = -\frac{\rho_{MT} f_q(\bar{q}_{MT}(M_{RB}(0),0)) \frac{\partial \bar{q}_{MT}(M_{RB}(0),0)}{\partial T}}{(\rho_{MT} + \rho_M) f_q(\bar{q}_{MT}(M_{RB}(0),0)) \frac{\partial \bar{q}_{MT}(M_{RB}(0),0)}{\partial M}} = -\frac{\rho_{MT}}{\rho_{MT} + \rho_M}.$$

Next, consider the indifference curve which goes through $T = 0$ and $M = M_{RB}(0)$. Suppose that average quality of published articles through this point is Z. Therefore, $M_{IC}(T)$ solves

$$\frac{1}{n} \sum_t \rho_t \int_{\bar{q}_t(M_{IC}(T),T)}^{\infty} f_q(q) \int_{z_{min}(M_{IC}(T),T)}^{\infty} f_z(z|q) z dz dq = Z.$$

The derivative with respect to T is

$$-\tfrac{1}{n} \textstyle\sum_t \rho_t \Bigg(\left(\frac{\partial \bar{q}_t(M_{IC}(T),T)}{\partial M} \frac{\partial M_{IC}(T)}{\partial T} + \frac{\partial \bar{q}_t(M_{IC}(T),T)}{\partial T} \right) f_q(\bar{q}_t(M_{IC}(T),T)) \int_{z_{min}(M_{IC}(T),T)}^{\infty} f_z(z|\bar{q}_t(M_{IC}(T),T)) z dz$$

$$+ \left(\frac{\partial z_{min}(M_{IC}(T),T)}{\partial M} \frac{\partial M_{IC}(T)}{\partial T} + \frac{\partial z_{min}(M_{IC}(T),T)}{\partial T} \right) \int_{\bar{q}_t(M_{IC}(T),T)}^{\infty} f_q(q) f_z(z_{min}(M_{IC}(T),T)|q) z_{min}(M_{IC}(T),T) dq \Bigg)$$

$$= 0.$$

Solving for $\frac{\partial M_{IC}(T)}{\partial T}$ gives

$$\begin{aligned}\frac{\partial M_{IC}(T)}{\partial T} = \; & -\sum_t \rho_t \Bigg(\frac{\partial \bar{q}_t(M_{IC}(T),T)}{\partial T} f_q(\bar{q}_t(M_{IC}(T),T)) \int_{z_{min}(M_{IC}(T),T)}^{\infty} f_z(z|\bar{q}_t(M_{IC}(T),T)) z dz \\ & + \frac{\partial z_{min}(M_{IC}(T),T)}{\partial T} \int_{\bar{q}_t(M_{IC}(T),T)}^{\infty} f_q(q) f_z(z_{min}(M_{IC}(T),T)|q) z_{min}(M_{IC}(T),T) dq \Bigg) \Bigg/ \\ & \sum_t \rho_t \Bigg(\frac{\partial \bar{q}_t(M_{IC}(T),T)}{\partial M} f_q(\bar{q}_t(M_{IC}(T),T)) \int_{z_{min}(M_{IC}(T),T)}^{\infty} f_z(z|\bar{q}_t(M_{IC}(T),T)) z dz \\ & + \frac{\partial z_{min}(M_{IC}(T),T)}{\partial M} \int_{\bar{q}_t(M_{IC}(T),T)}^{\infty} f_q(q) f_z(z_{min}(M_{IC}(T),T)|q) z_{min}(M_{IC}(T),T) dq \Bigg).\end{aligned}$$

When $M > 0$ and $T = 0$, this simplifies to

$$\begin{aligned}\left.\frac{\partial M_{IC}(T)}{\partial T}\right|_{T=0} = \; & -\Bigg(\rho_{MT} \left(\frac{\partial \bar{q}_{MT}}{\partial T} f_q(\bar{q}_{MT}) \int_{z_{min}}^{\infty} f_z(z|\bar{q}_t) z dz + \frac{\partial z_{min}}{\partial T} \int_{\bar{q}_{MT}}^{\infty} f_q(q) f_z(z_{min}|q) z_{min} dq \right) \\ & + \rho_T \frac{\partial z_{min}}{\partial T} \int_{-\infty}^{\infty} f_q(q) f_z(z_{min}|q) z_{min} dq \Bigg) \Bigg/ \\ & (\rho_{MT} + \rho_M) \Bigg(\frac{\partial \bar{q}_{MT}}{\partial M} f_q(\bar{q}_{MT}) \int_{z_{min}}^{\infty} f_z(z|\bar{q}_{MT}) z dz + \frac{\partial z_{min}}{\partial M} \int_{\bar{q}_{MT}}^{\infty} f_q(q) f_z(z_{min}|q) z_{min} dq \Bigg) \\ = \; & -\frac{\rho_{MT}}{\rho_{MT} + \rho M} - \frac{\rho_{MT} \left(\frac{\partial z_{min}}{\partial T} - \frac{\partial z_{min}}{\partial M} \right) \int_{\bar{q}_{MT}}^{\infty} f_q(q) f_z(z_{min}|q) z_{min} dq + \rho_T \frac{\partial z_{min}}{\partial T} \int_{-\infty}^{\infty} f_q(q) f_z(z_{min}|q) z_{min} dq}{(\rho_{MT} + \rho_M) \left(\frac{\partial \bar{q}_{MT}}{\partial M} f_q(\bar{q}_{MT}) \int_{z_{min}}^{\infty} f_z(z|\bar{q}_{MT}) z dz + \frac{\partial z_{min}}{\partial M} \int_{\bar{q}_{MT}}^{\infty} f_q(q) f_z(z_{min}|q) z_{min} dq \right)}.\end{aligned}$$

Therefore, the condition given in Eq. 1 is satisfied if and only if the above expression for $\left.\frac{\partial M_{IC}(T)}{\partial T}\right|_{T=0}$ is greater than $\left.\frac{\partial M_{RB}(T)}{\partial T}\right|_{T=0} = -\frac{\rho_{MT}}{\rho_{MT} + \rho_M}$. This will be the case when

$$\frac{\rho_{MT} \left(\frac{\partial z_{min}}{\partial T} - \frac{\partial z_{min}}{\partial M} \right) \int_{\bar{q}_{MT}}^{\infty} f_q(q) f_z(z_{min}|q) z_{min} dq + \rho_T \frac{\partial z_{min}}{\partial T} \int_{-\infty}^{\infty} f_q(q) f_z(z_{min}|q) z_{min} dq}{(\rho_{MT} + \rho_M) \left(\frac{\partial \bar{q}_{MT}}{\partial M} f_q(\bar{q}_{MT}) \int_{z_{min}}^{\infty} f_z(z|\bar{q}_{MT}) z dz + \frac{\partial z_{min}}{\partial M} \int_{\bar{q}_{MT}}^{\infty} f_q(q) f_z(z_{min}|q) z_{min} dq \right)} < 0, \tag{3}$$

which we return to in a moment.

Changing the cost parameters M and T affect the minimum accepted article quality z_{min}. Taking the derivative of the journal size constraint with respect to M gives

$$-\sum_t \rho_t \left(\frac{\partial \bar{q}_t}{\partial M} f_q(\bar{q}_t) \int_{z_{min}}^{\infty} f_z(z|\bar{q}_t) dz + \frac{\partial z_{min}}{\partial M} \int_{\bar{q}_t}^{\infty} f_q(q) f_z(z_{min}|q) dq \right) = 0.$$

Solving for $\frac{\partial z_{min}}{\partial M}$ evaluated at $T = 0$ gives

$$\left.\frac{\partial z_{min}}{\partial M}\right|_{T=0} = -\frac{(\rho_{MT} + \rho_M) \frac{\partial \bar{q}_{MT}}{\partial M} f_q(\bar{q}_{MT}) \int_{z_{min}}^{\infty} f_z(z|\bar{q}_{MT}) dz}{\sum_t \rho_t \int_{\bar{q}_t}^{\infty} f_q(q) f_z(z_{min}|q) dq}.$$

Similarly, one may calculate

$$\left.\frac{\partial z_{min}}{\partial T}\right|_{T=0} = -\frac{\rho_{MT} \frac{\partial \bar{q}_{MT}}{\partial M} f_q(\bar{q}_{MT}) \int_{z_{min}}^{\infty} f_z(z|\bar{q}_{MT}) dz}{\sum_t \rho_t \int_{\bar{q}_t}^{\infty} f_q(q) f_z(z_{min}|q) dq},$$

as well as

$$\left[\frac{\partial z_{min}}{\partial T} - \frac{\partial z_{min}}{\partial M}\right]_{T=0} = \frac{\rho_M \frac{\partial \bar{q}_{MT}}{\partial M} f_q(\bar{q}_{MT}) \int_{z_{min}}^{\infty} f_z(z|\bar{q}_{MT})dz}{\sum_t \rho_t \int_{\bar{q}_t}^{\infty} f_q(q) f_z(z_{min}|q)dq}.$$

The denominator of Eq. 3 is always positive. To see this,

$$(\rho_{MT} + \rho_M)\left(\frac{\partial \bar{q}_{MT}}{\partial M} f_q(\bar{q}_{MT}) \int_{z_{min}}^{\infty} f_z(z|\bar{q}_{MT})zdz + \frac{\partial z_{min}}{\partial M} \int_{\bar{q}_{MT}}^{\infty} f_q(q) f_z(z_{min}|q) z_{min} dq\right) > 0 \iff$$

$$\frac{\partial \bar{q}_{MT}}{\partial M} f_q(\bar{q}_{MT}) \int_{z_{min}}^{\infty} f_z(z|\bar{q}_{MT})zdz > \frac{(\rho_{MT} + \rho_M)\frac{\partial \bar{q}_{MT}}{\partial M} f_q(\bar{q}_{MT}) \int_{z_{min}}^{\infty} f_z(z|\bar{q}_{MT})dz}{\sum_t \rho_t \int_{\bar{q}_t}^{\infty} f_q(q) f_z(z_{min}|q)dq} \int_{\bar{q}_{MT}}^{\infty} f_q(q) f_z(z_{min}|q) z_{min} dq.$$

$$\iff \frac{(\rho_{MT} + \rho_M)\int_{\bar{q}_{MT}}^{\infty} f_q(q) f_z(z_{min}|q)dq}{\sum_t \rho_t \int_{\bar{q}_t}^{\infty} f_q(q) f_z(z_{min}|q)dq} \times \frac{\int_{z_{min}}^{\infty} f_z(z|\bar{q}_{MT}) z_{min} dz}{\int_{z_{min}}^{\infty} f_z(z|\bar{q}_{MT})zdz} < 1.$$

Both fractions on the left hand side of this expression are less than 1. Therefore, the expression holds and the denominator of Eq. 3 is positive. For Eq. 3 to be satisfied, its numerator must therefore be negative; that is,

$$\rho_{MT}\left(\frac{\partial z_{min}}{\partial T} - \frac{\partial z_{min}}{\partial M}\right) \int_{\bar{q}_{MT}}^{\infty} f_q(q) f_z(z_{min}|q) z_{min} dq + \rho_T \frac{\partial z_{min}}{\partial T} \int_{-\infty}^{\infty} f_q(q) f_z(z_{min}|q) z_{min} dq < 0. \quad (4)$$

From above, we see that

$$\rho_{MT}\left[\frac{\partial z_{min}}{\partial T} - \frac{\partial z_{min}}{\partial M}\right]_{T=0} = \rho_M \left[\frac{\partial z_{min}}{\partial T}\right]_{T=0},$$

and therefore Eq. 4 simplifies to

$$\int_{\bar{q}_{MT}}^{\infty} f_q(q) f_z(z_{min}|q) z_{min} dq < \int_{-\infty}^{\infty} f_q(q) f_z(z_{min}|q) z_{min} dq,$$

which is always satisfied since $\bar{q}_{MT} > -\infty$.

This concludes the proof that Eq. 1 is satisfied. Because both M_{RB} and M_{IC} are strictly decreasing in T, this means that at $T = 0$, the slope of the indifference curve is more-flat than the slope of the refereeing burden constraint. When this condition is met, starting from $T = 0$ and $M = M_{RB}(0)$, if the editor marginally increases T and decreases M while maintaining the refereeing burden constraint, the new cost combination falls inside of the M_{IC} curve. That is, the new M, T combination lies on a higher-payoff indifference curve, and results in higher journal quality than the original $M > 0 = T$ combination. This rules out the possibility that $M^* > 0 = T^*$. A symmetric analysis can rule out the alternative possibility that $M^* = 0 < T^*$. Therefore, we can conclude that both $T^* > 0$ and $M^* > 0$ in equilibrium.

References

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