An Application Game with Fees and Time Costs

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October 30, 2008

Abstract

In an application game, agents decide whether to apply for the prize, and reviewing applications allows the decision maker to learn agent qualifications and award prizes to qualified agents. The decision maker finds reviewing applications costly, and prefers not to review applications from agents with sufficiently low probability of being qualified. Positive application fees and time delays can assure that only those with a high-enough probability of being qualified apply for prizes. Applied to the journal submission process, in which tenured and untenured academic authors are affected differently by time delays, the model shows that using time delays instead of higher submission fees benefits tenured authors at the expense of both untenured authors and journal quality. Applied to the process of applying for a permit when there are both rich and poor potential applicants, the model shows that the decision maker should impose both application fees and time delays (e.g., red tape). In this case, eliminating fees benefits poor agents, while it harms rich agents and the decision maker; eliminating red tape benefits rich agents, while it harms poor agents and the decision maker.

Keywords: journal submission, red tape, application fees

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1 Introduction

Application processes are used to award numerous items every day, from building permits and travel visas, to college admissions and jobs, to credit cards and country club memberships. Even the journal submission process may be seen as an application process in which submitting a paper is equivalent to applying for publication. In each of these situations, the decision maker charged with screening applicants wants to identify qualified agents. The decision maker might want to award credit cards to applicants with good credit, grant travel visas to applicants who are not on terrorist watch lists, grant building permits for projects that are consistent with zoning regulations, or accept quality articles for publication in a journal.

This paper develops a simple game theoretic model of an application process in which potential applicants receive a noisy signal about their own quality, and must decide whether to apply for a prize. If a potential applicant applies, the decision maker reviews his application, fully learning the applicant's quality, and awards him a prize only if he is high-enough quality. The decision maker benefits from awarding prizes to qualified applicants, but finds reviewing applications costly. To limit the number (and expected qualifications) of applicants, the decision maker may impose monetary fees or time costs (e.g., delays in processing, waiting in line, or unnecessary paperwork) on applicants. If the decision maker find reviewing applications costly, then it is always optimal for her to impose positive costs on applicants. The magnitude of these costs, and whether its optimal to use monetary fees, time costs, or both depends on the characteristics of the pool of potential applicants.

After developing the model, the paper applies it to the journal submission process, and the application process for a permit. The journal submission game assumes that potential applicants are either tenured or untenured faculty, where untenured faculty experience greater disutility from time delays during the review process. In this case, the use of time delays benefits tenured faculty, but hurts both untenured faculty and overall journal quality. Increasing submission fees while decreasing time delays increases journal quality.

The permit application game assumes that potential applicants are either rich or poor. For any fee and time cost, a rich applicant experiences greater disutility from the time requirements and less disutility from the monetary fee compared to poor applicants. In this case, imposing both positive fees and time costs is optimal for the agency awarding the permits. Eliminating time costs (i.e., eliminating red tape) benefits rich agents, while harming both poor agents and the decision maker. Eliminating fees, on the other hand, benefits poor agents, while harming both rich agents and the decision maker.

Section 2 briefly reviews the closest related literature, including papers that deal with journal submission fees and time delays. Section 3 models the application process, building the framework that is used throughout the remainder of the paper. The paper solves for the equilibrium of the application game in section 4. Section 5 uses the framework to consider the journal submission process, and determines the impact that time delays have on author utility and journal quality. Section 6 uses the framework to consider an application process when there is wealth inequality among potential applicants. The paper concludes with a discussion of limitations and promising extensions in section 7.

2 Literature

The framework developed here is distinct from pervious models of applications. First, here the decision maker wants to award prizes to high-quality agents, as opposed to high-valuation agents (as is the standard assumption in the rationing literature). The model assumes that agents share a common valuation for the prize, and differ in terms of their qualifications (and potentially in terms of how much they care about monetary fees or time delays). Second, the game is one of verifiable information in which a decision maker becomes fully informed about agent quality by reviewing an application. In other papers such as Banerjee (1997), the decision maker may learn about an applicant through his ability or willingness to undertake the cost involved with submitting an application; however, the decision maker learns nothing about an agent by processing his application. This paper makes the opposite assumption: that the decision maker becomes fully informed about an agent's qualifications if she reviews the agent's application. This seams the more appropriate of the two assumptions when the decision maker cares about awarding prizes based on agent qualifications rather than valuations.[1]

[1] Although a social welfare maximizing decision maker may want to award some items (such as a subsidy or wealth transfer) to the agents who value the award the most, in most cases a decision maker likely prefers to award qualified agents: colleges want intelligent, motivated students; firms want competent employees; governments want tourists who are not terrorists; credit card companies want card holders who pay bills; editors want interesting and informative

This is not the first paper to identify positive effects of time costs. In Guriev (2004), applicants deal with red tape, which they find costly but which provides information to the decision maker. The current paper ignores this benefit of red tape, instead assuming that time delays do not provide additional information to the decision maker. Here, the benefit from time delays is that it prevents agents with low probability of being qualified from applying.

Concerning the journal submission process, Azar (2005, 2007) shows that time delays limit the number of low-quality articles submitted to a journal. The logic is the same as in the present paper. The present paper, however, also considers the tradeoff between time delays and imposing monetary fees. Although Azar (2005) suggests that positive time delays are better than no costs, the paper does not consider whether using time delays to limit low-quality submission is better than using submission fees. In this paper, the analysis suggests that fees are superior to time delays. McCabe and Snyder (2005) develop a model of open access journals in which editors may charge author fees rather than subscription fees. In their model, fees cannot limit low quality submissions since authors have no information about their own article quality. Ellison (2002b) finds evidence that a significant amount of the slowdown in the publication process at top economics journals may be attributed to increased competition for publication at the top journals. In the current paper, if authors experience an increase in the benefit from publishing in a journal, then the editor must increase either the submission fees or the time delays in order to maintain the same journal quality. Although such a story is not mentioned in Ellison (2002b), it is consistent with his evidence.[2]

3 Model

There are many candidates, indexed by i, who may apply for a valuable prize. The continuum of candidates is of total mass 1. All candidates share a common value for the prize, which is normalized to 1 without loss of generality.[3] To be awarded the prize, a candidate must first submit a (costly) application, and then be selected by the decision maker who reviews the applications. The prize may be a variety of things including membership in an organization, admission to a college, a travel

articles.

[2]Ellison (2002a) develops a model of leaning and social norms to explain the increase in time to publication.

[3]Other models of application processes assume that candidates have different valuations for the object; see for example Banerjee (1997). This paper focuses on differences in qualifications and fee and time delay costs, rather than differences in valuations.

visa or green card, a government permit or contract, or even an employment opportunity. Section 5 applies the game to the journal submission process, where the prize is publication. Section 6 considers the application for a permit when there is wealth inequality between candidates.

A single decision maker (*the principal*) must determine which applicants receive a prize. Each prize awarded by the decision maker costs her (or her institution) $\kappa > 0$. Candidates differ in terms of their qualifications, where highly-qualified candidates result in a higher benefit to the principal (or her institution) compared with less-qualified candidates. Let $q_i \geq 0$ denote the benefit the principal earns from awarding a prize to candidate i. When $q_i \geq \kappa$, the principal earns a net benefit from awarding candidate i a prize, and candidate i is *qualified*. When $q_i < \kappa$, candidate i is *unqualified*.

All qualified candidates share the same qualifications $q_H > \kappa$, and all unqualified candidates share the same qualifications $q_L < \kappa$. The value v represents the net benefit to the principal from awarding a prize to a qualified candidate, where $v = q_H - \kappa$. Candidate i is qualified with probability θ_i, and unqualified with probability $1 - \theta_i$. Each candidate knows his own θ; although he does not know whether he is qualified or unqualified. Each candidate's θ is the independent realization of random variable uniformly distributed on $[0, 1]$. The principal knows the distribution of θ, but does not observe the draws. Let a_i indicate the application decision of candidate i, where $a_i = 1$ if i applies, and $a_i = 0$ if i does not apply.

The principal learns the qualifications of all applicants. However, reviewing applications requires effort. Each application costs to principal c to review, where $0 < c < v$. When the principal receives applicants from portion λ of the candidates, she faces average (and total given that the total candidate mass equals 1) costs of $c\lambda$ from reviewing applications. The value c is independent of the number of prizes the principal awards. Let $p_i(q_i, a_i)$ indicate whether the principal awards a prize to candidate i, where $p_i = 1$ if she awards i a prize, and $p_i = 0$ otherwise.

Although the principal must review all applications, she can potentially limit the number of applications by charging an application fee or requiring applicants to deal with time costs. Time costs may be interpreted as unnecessary red tape faced by applicants for a government permit, or the time to first response after submitting an article to a journal.[4] The principal chooses fee

[4] A minimum amount of time costs will be required to communicate information about one's qualifications. Think of a positive amount of time costs in the model as exceeding this minimum requirement.

$m \geq 0$, and time requirement $t \geq 0$ to impose on applicants. Applicant i faces costs $-\alpha_i m - \beta_i t$ from paying fee m and dealing with t units of time costs, where $\alpha_i > 0$ and $\beta_i > 0$. Candidates know their own α and β. For each of the applications considered in this paper, one may think of two groups of candidates where the same α and β apply to each member of a group, and where both groups share the same distribution of θ. A randomly selected candidate (candidate, not applicant) is type x with probability π and type y with probability $1 - \pi$. All type x candidates share α_x and β_x; all type y candidates share α_y and β_y. Although π is common knowledge, it is not necessary that the principal be able to distinguish whether a given applicant is type x or y.

The equilibrium payoff the principal receives from her interaction with candidate i is written $w_i(p_i, q_i, a_i)$. If candidate i applies and is awarded a prize, then the principal receives payoff $w_i = q_i - \kappa - c$. If i applies and does not receive a prize, then $w_i = -c$. If i does not apply, then $w_i = 0$. The principal receives total utility $W(p, q, a) = \int_i w_i(p_i, q_i, a_i)di$. The payoff function assumes that the principal does not directly benefit from collecting fees or imposing time delays. Although such an assumption is less than realistic, it serves to focus the analysis on the case when application costs are used solely to discourage low-quality applications.

The equilibrium payoff to candidate i is written $u_i(p_i, q_i, a_i)$. If candidate i applies and receives a prize, his payoff is $u_i = 1 - \alpha_i m - \beta_i t$. If he applies and does not receive a prize, his payoff is $u_i = -\alpha_i m - \beta_i t$. If he does not apply, $u_i = 0$.

4 Analysis

The game takes place as follows:

1. The principal chooses m and t.

2. Each candidate chooses whether to apply. If one applies, he pays fee m and time t.

3. The principal reviews applications, and awards prizes.

The analysis focuses on the subgame perfect Nash equilibrium of the game. A description of the equilibrium must define the principal choice of m and t, and each candidate's application decision given m, t, α_i, β_i, and θ_i.

Because the principal awards prizes after she reviews all applications and learns all applicant qualifications, she will award prizes to all qualified applicants, and will not award a prize to any unqualified applicant. Therefore, if candidate i applies the principal expected payoff $\theta_i v - c$ from her interaction with i, and applicant i expects payoff $\theta_i - \alpha_i m - \beta_i t$.

Candidate i applies when $\theta_i - \alpha_i m - \beta_i t \geq 0$.

The following subsections solve the game for various relationships between type x and type y utility parameters. Remember, a candidate's α describes how costly he finds paying monetary fees, and β describes how costly he finds dealing with time costs. First, the analysis considers the most simple case when there is no difference between the two types of candidates. Second, it considers the case when the groups differ in terms of either α or β, but not both. Finally, it considers the case when type x and type y candidates differ in terms of both α and β.

4.1 No differences between types x and y

Here, all candidates share the same money and time preferences, or $\alpha_i = \alpha$ and $\beta_i = \beta$ for all players. Define $\bar{\theta}(m,t) = \alpha m + \beta t$. Candidate i applies when $\theta_i \geq \bar{\theta}(m,t)$.

The principal chooses m and t knowing that her choice determines $\bar{\theta}$. Her expected per-candidate payoff from (m,t) is

$$\int_{\bar{\theta}(m,t)}^{1} (\theta v - c)\, d\theta$$

Substituting $\alpha m + \beta t$ for $\bar{\theta}(m,t)$, and taking first order conditions for m or t gives the equilibrium requirement

$$\bar{\theta}(m,t) = \alpha m + \beta t = \frac{c}{v}. \tag{1}$$

The principal expects a negative payoff from reviewing applications from any candidate with $\theta_i < \frac{c}{v}$, and she is better off when such candidates do not apply. The principal expects a positive payoff from any candidate with $\theta_i > \frac{c}{v}$, and prefers all candidates that meet this requirement to apply. She therefore chooses m and t such that $\bar{\theta}(m,t) = \frac{c}{v}$. In equilibrium, the principal chooses (m,t) such that the expected benefit from processing the application of a candidate with $\theta_i = \bar{\theta}(m,t)$ equals the cost of processing the application, or $\bar{\theta}(m,t) = \frac{c}{v}$.

The equilibrium choice of (m,t) is not unique; for any $m \leq \frac{c}{v\alpha}$, there exists a $t \geq 0$ that satisfies equation 1. The principal is indifferent between any (m,t) that meet this requirement. By choosing m and t such that $\bar{\theta}(m,t) = \frac{c}{v}$, the referee ensures that she receives an application from all candidates from which she expects a positive payoff.

4.2 Differences between types x and y

When type x and y candidates differ in terms of α or β, the values $\bar{\theta}_x(m,t)$ and $\bar{\theta}_y(m,t)$ define the respective equilibrium cutoff values of θ for the two types. Any type x candidate with $\theta_i \geq \bar{\theta}_x$ and any type y candidate with $\theta_i \geq \bar{\theta}_x$ applies. Therefore, $\bar{\theta}_x(m,t) = \min\{(\alpha_x m + \beta_x t), 1\}$ and $\bar{\theta}_y(m,t) = \min\{(\alpha_y m + \beta_y t), 1\}$.

The principal chooses m and t to maximize her expected utility,

$$\pi \int_{\bar{\theta}_x(m,t)}^{1} (\theta v - c)\, d\theta + (1-\pi) \int_{\bar{\theta}_y(m,t)}^{1} (\theta v - c)\, d\theta$$

The first integral represents the expected payoff from type x candidates; the second integral represents the expected payoff from type y candidates.

First, the analysis considers the case when *either* $\alpha_x \neq \alpha_y$ or $\beta_x \neq \beta_y$. It then considers the case when the groups of agents differ in terms or *both* α and β.

4.2.1 Differ in either α or β

Reviewing an application from any candidate with $\theta_i > \frac{c}{v}$ results in a positive expected payoff for the principal; reviewing an application from a candidate with $\theta_i < \frac{c}{v}$ results in a negative expected payoff. The principal's payoff is therefore maximized when $\bar{\theta}_x = \bar{\theta}_y = \frac{c}{v}$. When the two groups of candidates only differ on one dimension (either α or β), the principal can achieve the common cutoff value $\bar{\theta} = \frac{c}{v}$ by only imposing costs on the symmetric dimension. This means that when the two groups only differ in terms of β, the principal can achieve $\bar{\theta} = \frac{c}{v}$ for all candidates by setting $t = 0$ and $m > 0$.

When $\beta_x \neq \beta_y$ and $\alpha_x = \alpha_y = \alpha$, the equilibrium application costs are

$$t = 0 \quad \text{and} \quad m = \tfrac{c}{v\alpha}.$$

Similarly, if $\beta_x = \beta_y = \beta$ and $\alpha_x \neq \alpha_y$, the equilibrium application costs are

$$t = \tfrac{c}{v\beta} \quad \text{and} \quad m = 0.$$

4.2.2 Differ in both α and β

Suppose the two groups of candidates differ in terms of both α and β. For now, the analysis assumes that one group has a higher α and the other group a higher β. This is consistent with a story of wealth differences, where rich applicants are impacted less by monetary costs and more by time costs compared with poor applicants. Let $\alpha_x < \alpha_y$ and $\beta_x > \beta_y$.

As in the earlier analysis, the principal prefers to choose m and t such that $\bar{\theta}_x = \bar{\theta}_y = \frac{c}{v}$. She is able to achieve such $\bar{\theta}$. If $\alpha_x < \alpha_y$ and $\beta_x > \beta_y$, the equilibrium application costs are

$$t = \tfrac{c(\alpha_y - \alpha_x)}{v(\alpha_y \beta_x - \alpha_x \beta_y)} \quad \text{and} \quad m = \tfrac{c(\beta_x - \beta_y)}{v(\alpha_y \beta_x - \alpha_x \beta_y)}.$$

If either $\alpha_x = \alpha_y$ or $\beta_x = \beta_y$, these conditions simplify to the conditions in section 4.2.1.

When one group of candidates have both higher α and higher β, the results are not as straightforward. Let $\alpha_x > \alpha_y$ and $\beta_x > \beta_y$, so type y candidates are less affected by both money and time costs. In this case, it is not possible to set m and t such that $\bar{\theta}_x = \bar{\theta}_y$. So long as $m > 0$ or $t > 0$ or both, it will follow that $\bar{\theta}_x > \bar{\theta}_y$. In this case, a larger portion of type y candidates will apply, resulting in lower probability that type y applicants are qualified. For the purpose of this paper, when candidates differ in both α and β, it will be assumed that one group has larger α and the other group has larger β.

5 Journal Submission

This section applies the application framework to the journal submission process. Here, the candidates are authors who must decide whether to submit papers to a journal for review. Each author observes his θ_i, which is the probability that his article is of high-enough quality to be published in the journal. If he submits his paper to the journal editor for review, the editor publishes the paper with probability θ_i. To limit the number (and quality) of submissions, the editor can charge submission fees m and impose time costs t. The time costs may be interpreted as the expected time between submission and first response. Journal quality is strictly increasing in the number of high-quality articles published.

There are two types of author: tenured authors (group T) and untenured authors (group U). To keep the analysis focused on the primary difference between tenured and untenured authors, the paper assumes both types of authors receive the same benefit from publishing in the journal, and both types find paying submission fees equally as costly. Untenured authors, however, find any time delay more costly than a tenured author. Therefore, $\alpha_T = \alpha_U = \alpha$ and $\beta_T < \beta_U$.

In equilibrium, the editor sets $t = 0$ and $m = \frac{c}{v\alpha}$. This result follows directly from section 4.2.1.[5] When the editor sets m and t at the equilibrium levels, $\bar{\theta}_T = \bar{\theta}_U = \frac{c}{v}$. Therefore, the editor expects non-negative payoffs from reviewing any submission, be it from a tenured or untenured author. This result suggests that if authors differ primarily in the costs of time delays, as is a reasonable assumption in the academic publishing process, then a journal benefits from imposing monetary costs instead of time costs to limit the number of submissions.

As Ellison (2002b) shows, however, the economics publishing process has slowed down significantly over the last three and a half decades. He finds that "the slowdown does not seem to have been intentional" and "it is hard to attribute the majority of the slowdown to observable changes in the profession" (p 950). He goes on the suggest that the slowdown may be due to changing social norms, which he formally models in Ellison (2002a). In the present model, the slowdown in the publishing process represents an increase in t. The following analysis considers the implications of this slowdown on journal quality.

The time delay t cannot be less than $t' > 0$. To simplify this segment, the analysis imposes the following assumption.

A 1 *Assume* $t' < \frac{c}{v\beta_T} \leq \frac{1}{\beta_U}$.

Any $t' > \frac{c}{v\beta_T}$ necessarily decreases journal quality and the expected payoffs of all players. Assumption A 1 limits the analysis to the interesting case where $t' < \frac{c}{v\beta_T}$. Assuming $\frac{c}{v\beta_T} \leq \frac{1}{\beta_U}$ implies that the editor's optimal m and t for tenured authors do not rule out participation from untenured

[5] The result assumes that $t = 0$ is possible. Obviously, the editor requires a positive amount of time to review submissions. Therefore, think of $t = 0$ as the minimum amount of review time, and any $t > 0$ as excess time delays that could be avoided.

authors. The assumption holds whenever the cost of reviewing a submission is sufficiently small compared to the benefit to an author from publication. Without A 1, there are ranges of parameters over which t' results in *no* participation from one or both groups of authors. Weakening the assumption leads to a more complicated analysis, without significantly changing the results.

It should be clear from the earlier analysis that the editor prefers to set as low a t as possible, and therefore sets $t = t'$. The editor may also impose a positive monetary cost on submissions. If t' is small enough, the editor also chooses $m > 0$ in order to further increase the costs of submitting a paper and limit the number of submissions. If t' is sufficiently large, however, then the editor prefers to impose no additional costs on submissions, and sets $m = 0$. More formally, for any $t' \geq \frac{c}{v}\frac{1}{(1-\pi)\beta_U+\pi\beta_T}$ the editor sets

$$m = 0 \quad \text{and} \quad t = t',$$

and for any smaller t', the editor sets

$$m = \frac{c}{v\alpha} - t'\frac{(1-\pi)\beta_U+\pi\beta_T}{\alpha} \quad \text{and} \quad t = t'.$$

When $\bar{\theta} < \frac{c}{v}$, more authors submit papers than preferred by the editor, since reviewing any article with $\theta_i < \frac{c}{v}$ results in a negative expected payoff. Similarly, when $\bar{\theta} > \frac{c}{v}$, fewer authors submit papers than preferred by the editor.

Lemma 1 *Assuming A 1, in equilibrium $\bar{\theta}_T < \frac{c}{v} < \bar{\theta}_U$ for any $t' > 0$.*

Since $\bar{\theta}_T < \frac{c}{v}$ when $t' > 0$, the editor receives submissions from a greater number of tenured authors than she would otherwise prefer. Since $\bar{\theta}_U > \frac{c}{v}$ when t', the editor receives submissions from fewer untenured authors than she would prefer.[6]

Proposition 1 and corollary 1 provide the main results from the analysis of journal submissions. It establishes that positive time costs benefit tenured authors, while they harm untenured authors and drive down journal quality. Decreasing the minimum time costs t' increases journal quality

[6] As t' increases, the number of submissions from untenured authors decreases. The effects of a change in t' on tenured author submission is non monotonic. $\bar{\theta}_T$ is decreasing in $t' < \frac{c}{v}\frac{\beta_T}{(1-\pi)\beta_U+\pi\beta_T}$ and increasing in $t' > \frac{c}{v}\frac{\beta_T}{(1-\pi)\beta_U+\pi\beta_T}$. $\bar{\theta}_T$ achieves its minimum, thus maximizing expected payoffs to tenured authors, when $t' = \frac{c}{v}\frac{\beta_T}{(1-\pi)\beta_U+\pi\beta_T}$.

and the payoffs of untenured authors at the expense of tenured authors.

Proposition 1 *Assuming A 1, for any* $t' \in \left(0, \frac{c}{v\beta_T}\right)$

- *expected utility of tenured authors is strictly increasing in* $t' < \frac{c}{v}\frac{1}{(1-\pi)\beta_U+\pi\beta_T}$ *and strictly decreasing in* $t' > \frac{c}{v}\frac{1}{(1-\pi)\beta_U+\pi\beta_T}$*,*
- *expected utility of untenured authors is strictly decreasing in* t'*, and*
- *journal quality is strictly decreasing in* t'*.*

Corollary 1 *Assuming A 1, compared to the case when* $t' = 0$*, imposing any* $t' \in \left(0, \frac{c}{v\beta_T}\right)$

- *increases the expected utility of tenured authors,*
- *decreases the expected utility of untenured authors, and*
- *decreases journal quality.*

Both journal quality and expected payoffs to untenured authors are maximized when $t' = 0$. Both values are strictly decreasing in t'. However, tenured authors benefit from positive time delays, as time delays result in overall costs that are less restrictive for tenured authors who find the delays less costly than untenured authors.[7]

6 Permit Application with Wealth Differences

In the journal submission game, the two groups of potential applicants differ in terms of the costs of time delays, but not in terms of how costly they find paying submission fees. In alternative applications, potential applicants may differ in how costly they find both monetary payments and time requirements. Consider the application process for a government permit or travel visa. Let potential applicants be rich (type R) with probability $1-\pi$ or poor (type P) with probability π. Rich applicants find monetary payments less costly than poor applicants. Poor applicants find time requirements less costly than rich applicants. Therefore, $\alpha_R < \alpha_P$ and $\beta_R > \beta_P$.

[7] The expected payoffs for tenured authors is maximized when $t' = \frac{c}{v}\frac{1}{(1-\pi)\beta_U+\pi\beta_T}$.

The government responsible for awarding the permits can require applicants to an pay application fee m, and deal with red tape, t. As determined in section 4.2.2,

$$t = \frac{c(\alpha_y - \alpha_x)}{v(\alpha_y \beta_x - \alpha_x \beta_y)} \quad \text{and} \quad m = \frac{c(\beta_x - \beta_y)}{v(\alpha_y \beta_x - \alpha_x \beta_y)}. \tag{2}$$

When m and t are at the equilibrium levels, $\bar{\theta}_R = \bar{\theta}_P = \frac{c}{v}$. Therefore, the government expects non-negative payoffs from reviewing any application, be it from a rich or poor candidate. This result suggests that when there is wealth inequality amongst potential applicants, the application process should require both fees and time costs to limit the number of submissions. The lower the costs of reviewing applications, the lower are the equilibrium values m and t, and the greater is the number of applications in equilibrium.[8]

Eliminating either the submission fees or red tape rules out the optimal (m, t) combination from the standpoint of the government. The analysis will consider the impact of both requiring $m = 0$ and requiring $t = 0$.

A 2 *Assume* $\frac{c}{v\alpha_R} < \frac{1}{\alpha_P}$ *and* $\frac{c}{v\beta_P} < \frac{1}{\beta_R}$.

These conditions assure that setting costs to maximize the government's payoff from one group of candidates does not completely eliminate participation from all members of the other group. Removing this assumption complicates the analysis, without significantly changing the results.

Consider first the case when the government cannot use red tape to help screen applicants, or $t = 0$ and $m \geq 0$. In this case, the government sets $m = \frac{c}{v} \frac{(1-\pi)\alpha_R + \pi\alpha_P}{(1-\pi)\alpha_R^2 + \pi\alpha_P^2}$, which is a strictly higher fee than if $t > 0$ is feasible. Alternatively, consider the case when the government cannot use fees to help screen applicant, or $m = 0$ and $t \geq 0$. In this case, the government sets $t = \frac{c}{v} \frac{(1-\pi)\beta_R + \pi\beta_P}{(1-\pi)\beta_R^2 + \pi\beta_P^2}$, which is a strictly higher time requirement than if $m > 0$ is possible. it is straightforward to determine the effect that eliminating either fees or red tape has on the expected payoffs of the different players. These results are presented in proposition 2.

Proposition 2 *Assuming A 2, compared to the case when both $m > 0$ and $t > 0$ are allowed:*

- *Eliminating the application fee (requiring $m = 0$)*

[8] As $c \to 0$, it follows that $m \to 0$, $t \to 0$, $\bar{\theta}_R \to 0$, and $\bar{\theta}_P \to 0$.

- *increases the expected utility of poor candidates, and*
- *decreases the expected utility of rich candidates and the government.*

- *Eliminating red tape (requiring $t = 0$)*
  - *increases the expected utility of rich candidates, and*
  - *decreases the expected utility of poor candidates and the government.*

Applying this paper's application framework to an environment in which potential applicants differ in terms of their wealth suggests that both application fees and red tape play important roles. Both fees and time requirements impose costs on applicants, which decrease the number of applications from unqualified candidates. If applying is costly, then only candidates with high-enough probability of being qualified submit applications. When candidates differ in terms of their wealth, it is optimal for the government to set both positive application fees and positive time costs in order to impose equal utility costs on both rich and poor agents. Eliminating application fees in favor of greater time delays harms poor candidates because they then find submitting an application more costly than rich candidates. Similarly, eliminating red tape in favor of greater application fees harms rich candidates because they then find applications more costly relative to poor candidates.

7 Conclusion

This paper develops a simple application model, in which applying for a prize fully reveals one's qualifications to a decision maker. Both application fees and time requirements impose costs on applicants and help ensure that only those candidates with a sufficiently-high probability of being qualified apply. By defining application costs along two dimensions, the model allows for the distinction between monetary and time costs. When potential applicants differ in terms of how costly they find fees or time requirements, the two types of costs are not equivalent.

Consider the case when potential applicants differ in terms of how costly they find one dimension of cost, but not the other. In this situation, the decision maker should only impose costs along the symmetric dimension. This is a rough description of the journal submission process, in which untenured authors find time delays more costly than tenured authors. In the journal submission game, the results imply that editors should minimize time delays, while increasing submission fees. Excessive time requirements benefit tenured authors, while they decrease both untenured author payoffs and journal quality.

When there are wealth differences among applicants, rich agents may find monetary payments less costly and time delays more costly than poor agents. In this case, it is optimal for the decision maker to charge both positive application fees and positive time requirements in order to impose the same utility-costs on all applicants, whether rich or poor. In this case, eliminating time delays (interpreted as red tape) benefits rich agents at the expense of poor applicants and the decision maker. Eliminating monetary fees, on the other hand, benefits poor agents at the expense of rich applicants and the decision maker.

The paper presents a simple framework, intended to capture some of the key aspects of the application process. In no way does the framework attempt to completely describe any specific application process. For example, in the journal submission process authors also may differ in terms of their benefit from publication. In such a situation, eliminating all time delays may not be optimal. So long as the differences in β are large enough compared to other differences, the intuition suggested by the main results will continue to hold. Extensions of this model may allow for agents to differ in terms of v as well as α and β, or for more than two groups of applicants. Furthermore, decision makers may often benefit from collecting fees or imposing time delays.

Additionally, the model assumes there is only one decision maker who can award a symmetric prize. Future work may limit the number of prizes available to the decision maker, or allow for multiple decision makers competing for qualified applicants. Allowing for competition amongst decision makers may better represent the journal submission process. Limiting the number of prizes may better represent the college admissions process and other situations involving limited capacity.

8 Appendix

8.1 Proofs

Proof of Lemma 1. From section 4, it should be clear that $\bar{\theta}_i = \alpha_i m + \beta_i t$. Therefore, substituting in for equilibrium m and t, gives

$$\bar{\theta}_T(t') = \begin{cases} \frac{c}{v} - (\beta_U - \beta_T)(1-\pi)t' & \text{for } t' \leq \frac{c}{v}\frac{1}{(1-\pi)\beta_U + \pi\beta_T} \\ \beta_T t' & \text{for } t' \geq \frac{c}{v}\frac{1}{(1-\pi)\beta_U + \pi\beta_T} \end{cases}, \text{ and}$$

$$\bar{\theta}_U(t') = \begin{cases} \frac{c}{v} + (\beta_U - \beta_T)\pi t' & \text{for } t' \leq \frac{c}{v}\frac{1}{(1-\pi)\beta_U + \pi\beta_T} \\ \beta_U t' & \text{for } t' \geq \frac{c}{v}\frac{1}{(1-\pi)\beta_U + \pi\beta_T} \end{cases}.$$

Since $\beta_U > \beta_T$, $0 < \pi < 1$, and $t' > 0$, it is straightforward to see that $\bar{\theta}_T < \frac{c}{v}$ and $\bar{\theta}_U > \frac{c}{v}$ for any $t' \leq \frac{c}{v}\frac{1}{(1-\pi)\beta_U + \pi\beta_T}$. Furthermore $\frac{\beta_U}{(1-\pi)\beta_U + \pi\beta_T} > 1$; therefore, $\bar{\theta}_U > \frac{c}{v}$ for any $t' > \frac{c}{v}\frac{1}{(1-\pi)\beta_U + \pi\beta_T}$ as well. Finally, $\bar{\theta}_T < \frac{c}{v}$ for $t' > \frac{c}{v}\frac{1}{(1-\pi)\beta_U + \pi\beta_T}$ follows because $\beta_T t' = \frac{c}{v}$ when $t' = \frac{c}{v\beta_T}$. The value $\beta_T t'$ is strictly increasing in t', so for all $t' < \frac{c}{v\beta_T}$ (which is required by A 1), $\beta_T t' < \frac{c}{v}$. ■

Proof of Proposition 1. Total expected payoffs for either group of authors equals

$$\pi \int_{\bar{\theta}_i}^{1} (\theta - \alpha m - \beta_i t)\, d\theta = \pi \int_{\bar{\theta}_i}^{1} \theta d\theta - \pi\bar{\theta}_i,$$

which is strictly decreasing in $\bar{\theta}_i = \alpha m + \beta_i t$. The proof to lemma 1 establishes that $\bar{\theta}_T$ is strictly decreasing in $t' < \frac{c}{v}\frac{1}{(1-\pi)\beta_U + \pi\beta_T}$ and strictly increasing in $t' > \frac{c}{v}\frac{1}{(1-\pi)\beta_U + \pi\beta_T}$. It therefore follows that total expected payoffs for tenured authors is strictly increasing in $t' < \frac{c}{v}\frac{1}{(1-\pi)\beta_U + \pi\beta_T}$ and strictly decreasing in $t' > \frac{c}{v}\frac{1}{(1-\pi)\beta_U + \pi\beta_T}$. The proof to lemma 1 establishes that $\bar{\theta}_U$ is strictly increasing for all t'; therefore total expected payoffs to untenured authors is strictly decreasing for all t'.

Journal quality is given by

$$Q = \pi \int_{\bar{\theta}_T}^{1} \theta d\theta + (1-\pi) \int_{\bar{\theta}_U}^{1} \theta d\theta.$$

Q is strictly decreasing in both $\bar{\theta}_T$ and $\bar{\theta}_U$. For $t' \geq \frac{c}{v}\frac{1}{(1-\pi)\beta_U + \pi\beta_T}$, both $\bar{\theta}_T$ and $\bar{\theta}_U$ are strictly increasing in t', and, therefore, Q is strictly decreasing in t'. Consider now the case when $t' <$

$\frac{c}{v}\frac{1}{(1-\pi)\beta_U+\pi\beta_T}$. Substituting $m = \frac{c}{v\alpha} - t'\frac{(1-\pi)\beta_U+\pi\beta_T}{\alpha}$ into the equation for Q, and then taking a derivative with respect to t' gives

$$\frac{\partial Q}{\partial t'} = -(\beta_U - \beta_T)^2(1-\pi)\pi t' < 0.$$

Therefore, journal quality is strictly decreasing in t' for all $t' > 0$. ■

Proof of Corollary 1. Follows directly from lemma 1 and proposition 1. ■

Proof of Proposition 2. The proof is straightforward, and purely arithmatic. Total expected utility of poor candidates equal $\pi\int_{\alpha_P m+\beta_P t}^{1}(\theta-\alpha_P m+\beta_P t)\,d\theta$, total expected utility of rich candidates equal $(1-\pi)\int_{\alpha_R m+\beta_R t}^{1}(\theta-\alpha_R m+\beta_R t)\,d\theta$, and the utility of the government equals $\pi\int_{\alpha_P m+\beta_P t}^{1}(\theta-c)d\theta+(1-\pi)\int_{\alpha_R m+\beta_R t}^{1}(\theta-c)d\theta$. In the baseline case, $m > 0$ and $t > 0$ are given by Eq. 2. In this case, total expected utility of poor candidates simplifies to $\pi\frac{(v-c)^2}{2v^2}$, total expected utility of rich candidates simplifies to $(1-\pi)\frac{(v-c)^2}{2v^2}$, and government utility simplifies to $\frac{(v-c)(v+c-2vc)}{2v^2}$. It is equally straightforward to calculate these values for the cases when $t = 0$ and $m = \frac{c}{v}\frac{(1-\pi)\alpha_R+\pi\alpha_P}{(1-\pi)\alpha_R^2+\pi\alpha_P^2} > 0$, or $t = \frac{c}{v}\frac{(1-\pi)\beta_R+\pi\beta_P}{(1-\pi)\beta_R^2+\pi\beta_P^2} > 0$ and $m = 0$. Comparing the values, given the required conditions that $0 < \pi < 1$, $\frac{c}{v\alpha_R} < \frac{1}{\alpha_P}$, and $\frac{c}{v\beta_P} < \frac{1}{\beta_R}$, concludes the proof. ■

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