An Efficiency Argument For Balanced Transaction Costs

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Abstract
Transaction costs are usually thought to be a major source of inefficiency because they do not allow efficient trades to take place. One might think that lowering transaction costs is always welfare-improving. This paper argues that, in contrast to conventional wisdom, it may be beneficial to increase transaction costs on one side of the market to balance them with the costs on the other side. In the model, transaction costs imposed on applicants serve as a screening device that substantially reduces evaluation costs. Even when application costs are totally wasteful, they arise endogenously in the equilibrium and can result in a welfare improvement.

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1. Introduction

When I see a large stack of job application folders in my mailbox I wonder whether it is efficient for faculty to go through hundreds of application packages each year to find a set of best candidates. After many hours of searching and several rounds of interviews, a hiring institution is lucky to fill a limited number of positions. The fact is, the marginal cost of applying for an academic position at a university is nearly zero for a recent Ph.D. whereas the marginal cost of evaluating an application can be substantial. This paper questions whether it is best for the hiring department and/or socially optimal to have negligible application costs.

Transaction costs, broadly defined as costs incurred in making an economic exchange, are viewed by economists as a source of inefficiency. Transaction cost economics, starting with the seminal work by Coase (1937), explains the existence of institutions and behaviors as means of minimizing transaction costs. The claim of this paper is that, when chosen endogenously by market participants, transaction costs are not minimized in a matching market. Agents on one side of the market choose to impose costs on agents on the other side of the market. And, in contrast to the traditional thinking, transaction costs can improve efficiency of exchange by serving as a screening mechanism.

Advisors often argue to their advisees (Ph.D. candidates) that they should apply everywhere since the cost of sending an additional application package is negligible. However, when applicants have private information about the likelihood of a good match between their skills and the needs of the institution to which they apply, a hiring institution would prefer applicants to be more selective in their application process. Even if application costs are completely wasteful, they arise in equilibrium, and can be welfare-improving as they...
pre-select better-matching individuals.

The rest of the paper is organized as follows. Section 2 presents a simple model that formalizes the argument for non-trivial transaction costs in the context of a job market, and Section 3 concludes.

2. The Model

In this section, I will set up and analyze a stylized model that describes the application and hiring processes. Although the model can describe a number of environments, including application for grants, mortgages, jobs, colleges, childcare and clubs, I will mostly refer to a job market.

There are \( n \geq 2 \) individuals who can apply for a job at two institutions, \( I_1 \) and \( I_2 \). Each institution has one position to fill and extends the same offer to all applicants. Applicants value obtaining a job at \( I_1 \) and \( I_2 \) as \( v_1 \) and \( v_2 \); \( v_1 \geq v_2 \). The difference in valuations could reflect differences in the rank of institutions, compensation packages, working environment, etc. Institutions and applicants are heterogeneous along some dimension, for example, a primary field of specialization. This heterogeneity is captured in a simple model of differentiation resembling a Hotelling line. It is assumed that institutions are located at the ends of a unit segment, while \( n \) potential applicants are independently and randomly located along the segment. Location \( x \in [0, 1] \) of an individual corresponds to the distance from institution \( I_1 \). It is distributed according to a continuously differentiable cumulative distribution function \( F \) with density \( f \).

A person decides whether to apply to institution \( I_1 \), institution \( I_2 \), none or both institutions, given her location. Application costs are institution-specific. Denote by \( c_i \geq 0 \) the cost of applying to \( I_i \), which could include an application fee and a cost of effort. In the benchmark model, I will assume that application costs come in the form of numerous institution-specific requirements on the form and contents of an application package, and are fully wasteful. The imposition of an application fee – a monetary transfer from an applicant to an institution – is discussed at the end of Section 2.3. The selection process by which positions are allocated to candidates is assumed to be perfectly discriminating: each institution selects the best-matching applicant – the applicant who is located the closest to the insti-
tution. Due to the perfectly discriminating selection process, an applicant is always chosen by only one institution, and he or she accepts any forthcoming offer. An institution derives a zero payoff when its job position is not filled. Otherwise, the institution’s payoff equals the value, $v$, from a filled position net of the cost of mismatch and evaluation costs. Assume that the mismatch cost is equal to the distance, $x$, between the applicant’s and institution’s locations, and the cost of evaluating an applicant is $c$ for each institution, $0 < c < v$.

The cumulative distribution of an individual’s location, values, and costs are common knowledge. At the beginning of the game, each individual learns her location. The game unfolds as follows. In the first stage, institutions simultaneously set application costs. In the second stage, individuals observe application costs and decide where to apply; institutions select the best candidate among its applicants. I look for a subgame perfect equilibrium, described by each institution’s choice of an application cost, $c^*_i$, and an application set for an individual located at $x \in [0, 1]$, given the application costs; $i = 1, 2$.

2.1. Application Decision

Next I describe the optimal application decision by individuals, given application costs $c_1$ and $c_2$. To which institutions would an individual located at $x$ apply? The expected benefit to the individual located at $x$ from applying to $I_1$ is

$$Eb(x)_{\{I_1\}} = v_1 (1 - F(x))^{n-1} - c_1. \quad (1)$$

The expression $(1 - F(x))^{n-1}$ is the probability of being selected by institution $I_1$, which is the probability that all other applicants are located further than $x$ from $I_1$. Ties in the locations are zero probability events since the distribution function $F$ is continuous.

Similarly, the expected benefit to the individual located at $x$ from applying to $I_2$ is

$$Eb(x)_{\{I_2\}} = v_2 (F(x))^{n-1} - c_2. \quad (2)$$

The decision to apply to $I_i$ is made whenever $Eb(x)_{\{I_i\}} \geq 0$; $i = 1, 2$.\footnote{Even when fixed application costs are present, the decision to apply to $I_1$ is independent of the decision to apply elsewhere, provided all individuals engage in job search.} This implies that individuals located at $x \leq \hat{x}_1$ will apply to $I_1$, where
\[ \hat{x}_1 = F^{-1} \left( 1 - (c_1/v_1)^{\frac{1}{n-1}} \right). \]  

Similarly, applicants located at \( x \geq \hat{x}_2 \) will apply to \( I_2 \), where

\[ \hat{x}_2 = F^{-1} \left( (c_2/v_2)^{\frac{1}{n-1}} \right). \]

If \( \hat{x}_1 > \hat{x}_2 \), then individuals located on the interval \([\hat{x}_2, \hat{x}_1]\) will apply to both institutions.

Figure 1 illustrates application decisions of job seekers when \( c_i/v_i = 0.01 \) for \( i = 1, 2 \) and \( n = 6 \).

Figure 1: Application Decisions

Notes: Individuals located within the distance \( \hat{x}_i \) from \( I_i \) apply to \( I_i \). Individuals located at \( x \in [\hat{x}_2, \hat{x}_1] \) apply “everywhere.”

The assumption that all individuals participate in the job market (\( \hat{x}_1 \geq \hat{x}_2 \)) holds whenever \( (c_1/v_1)^{\frac{1}{n-1}} + (c_2/v_2)^{\frac{1}{n-1}} \leq 1 \). The left-hand side of the inequality is increasing with \( n \).

Assuming \( c_1/v_1 + c_2/v_2 < 1 \), there exists a unique critical value \( \hat{n} \geq 2 \) such that every person applies to at least one institution provided \( n \leq \hat{n} \). For example, when institutions are symmetric \( (c_1/v_1 = c_2/v_2) \), all individuals are actively searching when \( n \leq \hat{n} = \ln (2v_i/c_i) / \ln 2 \).

Intuitively, participation in the job market is worthwhile when competition is not too intense. As \( n \) increases, \( \hat{x}_1 \) decreases and \( \hat{x}_2 \) increases; the regions where individuals apply to \( I_i \) \((i = 1, 2)\) and where individuals “apply everywhere” contract because the probability of being the best candidate decreases with \( n \). Similarly, an increase in the ratio of the application cost to the value of employment, \( c_i/v_i \), reduces the area where individuals apply to \( I_i \), which stochastically reduces the pool of \( I_i \)’s applicants. Increases in application costs encourage individuals to be more selective in their application decisions. When \( I_i \)’s application cost is
zero, all individuals apply to $I_i$; $I_i$ is not pre-selecting job seekers. At the other extreme, when $c_i \to v_i$, the size of $I_i$’s pool of applicants converges to zero. In what follows, I will focus on the effect of the application cost on the cutoff location, treating it as a function of $c_i$: $\hat{x}_i = \hat{x}_i(c_i)$.

### 2.2. Admissions: A Case for Non-Trivial Application Costs

When institutions simultaneously and independently select application costs, they have to take into account the effect that application costs have on the job seekers’ application decisions. One may think of an institution as choosing the optimal cut-off level, $x$, which is the location of the marginal applicant. There is a chance that the position will not be filled because no applicant chooses to apply to the institution, given the application cost. This happens when no person is located within distance $x$ from the institution, and the institution derives a zero payoff in this case. When at least one person applies for the position, the best-matching candidate is selected by the institution. The location of the closest candidate, denoted by $x_{(1)}$, is the first order statistics for the minimum among $n$ independent draws from distribution $F$. Hence, the institution derives the benefit $(v - x_{(1)})$ when $x_{(1)} \leq x$ and zero otherwise.

Consider $I_1$’s problem of selecting the optimal cut-off level $x = \hat{x}_1 = \hat{x}_1(c_1)$. The expected benefit of choosing a cut-off level at a distance $x$ from $I_1$ is

$$EB(x) = \Pr(x_{(1)} \leq x) (v - E_F(x_{(1)} | x_{(1)} \leq x)).$$

(5)

Denote the distribution function for the order statistics by $G$ and the corresponding density by $g$: $G(x) = 1 - (1 - F(x))^n$ and $g(x) = n (1 - F(x))^{n-1} f(x)$. The expected benefit can be written in terms of this distribution as $EB(x) = G(x) (v - E_G(y | y \leq x))$, or

$$EB(x) = G(x)v - \int_0^x yg(y)dy.$$ 

(6)

Using Leibnitz rule,

$$MB(x) = \frac{\partial EB(x)}{\partial x} = g(x) (v - x).$$

(7)

The expected cost of choosing the cut-off level at a distance $x$ from $I_1$ is equal to the expected number of applicants considered times the cost of evaluating one applicant. Since
locations of applicants are the outcomes of independent Bernoulli trials, the expected number of applicants for a given choice of $x$ by $I_1$ is $nF(x)$. Hence, the expected cost is

$$EC(x) = cnF(x). \tag{8}$$

The marginal cost is then

$$MC(x) = \frac{\partial EC(x)}{\partial x} = cnf(x). \tag{9}$$

In choosing the optimal cut-off level, $I_1$ faces a trade-off between increasing its chances of filling the position and higher evaluation costs. The interior solution, when it exists, is characterized by the equality of the marginal cost and the marginal benefit of conducting a slightly broader search, $MB(x) = MC(x)$. Define the normalized (per-person) marginal cost and benefit as $mb(x) = MB(x)/nf(x) = (v - x)(1 - F(x))^{n-1}$ and $mc(x) = MC(x)/nf(x) = c$. The optimality condition can then be written as an equality of the normalized marginal benefit and cost:

$$(v - x)(1 - F(x))^{n-1} = c, \tag{10}$$

where $x = \hat{x}_1(c_1)$ is defined by (3). The marginal cost of one additional applicant equals the marginal benefit that the additional applicant offers, which is the value of the marginal applicant times the probability that all other applicants are located further away from $I_1$.

Let $c^*_1$ and $x^*_1$ denote the solution to (10) in terms of the best application cost and location of the marginal applicant. Similarly, $c^*_2$ and $x^*_2$ are determined from $(v - x)F(x)^{n-1} = c$, where $x = \hat{x}_2(c_2)$ is defined by (4). As stated in Proposition 1, the best application costs are positive.

**Proposition 1.** For each institution, there exists a unique best application cost, which is positive even though it is totally wasteful.

**Proof.** Consider $I_1$’s choice of the application cost, $c_1$. At $x = 0$, the normalized marginal benefit exceeds the cost, $c$, of broadening search because $mb = v > c$. At $x = 1$, the opposite holds: $mb = 0 < c$. Since the normalized marginal benefit is a continuous decreasing function, there exists a unique interior solution to (10), $x = \hat{x}_1 \in (0, 1)$. From (3), the cutoff level $\hat{x}_1 = \hat{x}_1(c_1)$ is a monotonically decreasing function of the application cost; $\lim(\hat{x}_1(c_1)) = 1$
as $c_1 \to 0$ and $\lim (\hat{x}_1(c_1)) = 0$ as $c_1 \to v_1$. Hence, for each $\hat{x}_1 = (0, 1)$ there exists a unique application cost, and it is positive, $c_1^* > 0$. The argument for $I_2$ is the same. Q.E.D.

Why would an institution pre-select applicants with an application cost? When $c_1 = 0$, every person applies to $I_1$. Consider a marginal increase in $c_1$. There is a negligible increase in the probability that no person will apply to $I_1$ and, given that at least one person applies to institution $I_1$, the institution obtains the same benefit. At the same time, higher $c_1$ stochastically reduces the cost of evaluation. For a very broad search, the cost saving from narrowing search out-weighs the loss in benefit due to a lower chance of filling the position, while the opposite is true for a very narrow search.

Next I look at how the optimal application cost depends on the parameters of the model. Substituting (3) into (10), I obtain

$$\left( v - F^{-1}\left( 1 - \left( c_1/v_1 \right)^{\frac{1}{1+n}} \right) \right) \left( c_1/v_1 \right) = c. \quad (10^*)$$

The normalized marginal benefit in the left-hand side of the equality increases in $v$, $c_1$ and $n$, and decreases in $v_1$. Therefore, the best application cost $c_1 = c_1^*$ that solves (10*) increases in $c$ and $v_1$ and decreases in $v$ and $n$, $c_1^* = c_1\left( c, v_1, v, n \right)$.

**Proposition 2.** An institution sets a large application cost when the evaluation cost is high, the value of employment is high for applicants and low for the institution, and there are only few job seekers in the market.

Naturally, when it is difficult to evaluate applicants, institutions set higher application costs in attempt to reduce the expected total evaluation costs.\(^5\) The model also predicts that a higher application cost is set by an institution that offers a more valuable employment to applicants. The application cost is lower when filling a position becomes more important for the institution. When the job market is tightening, application costs are lowered to encourage job seekers to apply despite intense competition. The exact relationship between the application and evaluation costs depends on the competitiveness of the job market. In highly competitive markets, application costs and evaluation costs are balanced – the

\(^5\)Note that student-edited law reviews have lower evaluation and application costs (e.g., they do not require sequential submissions of the manuscripts).
application cost is proportional to the evaluation cost since \( c_1/v_1 \to c/v \) as \( n \to \infty \). For \( v = 1 \) and uniformly distributed locations, the best application cost for \( I_i \) is \( c_i^* = v_i e^{1-{1\over n}} \).

### 2.3. Socially Optimal Application Costs

The social welfare from setting an application cost \( c_1 \) with an associated cut-off location, \( \hat{x}_1 = \hat{x}_1(c_1) \), consists of benefits and costs accrued to \( n \) applicants and institution \( I_1 \).

An individual located at \( x \) obtains an expected payoff \( E_b(x)_{\{I_1\}} = v_1 (1 - F(x))^{n-1} - c_1 \) if \( x \leq \hat{x}_1(c_1) \), and zero otherwise. Whatever the location, the applicant prefers to have lower application costs. All applicants jointly derive an ex-ante expected payoff of \( E_b = n v_1 \int_{0}^{\hat{x}_1(c_1)} (1 - F(x))^{n-1} f(x) dx - n c_1 F(\hat{x}_1(c_1)) \) and simplifying yields\(^6\)

\[
E_b = v_1 (1 - (1 - F(\hat{x}_1(c_1)))^n) - c_1 n F(\hat{x}_1(c_1)). \tag{11}
\]

Higher application costs reduce the expected number of applicants and increase the chances that no one applies to \( I_1 \). At the same time, higher \( c_1 \) increases the cost of applying for each of the applicants. Taking the derivative of (11) and simplifying, I obtain\(^7\)

\[
{dE_b \over dc_1} = -n F(\hat{x}_1) \leq 0. \tag{12}
\]

According to (12), a change in the application cost reduces the payoff to the applicants due to the direct effect on the application cost. This can be written in terms of the cut-off location level as

\[
{dE_b \over d\hat{x}_1} = -n F(\hat{x}_1) (\partial c_1 / \partial \hat{x}_1) > 0 \tag{13}
\]

where

\[
\partial c_1 / \partial \hat{x}_1 = -v_1 (n - 1) (1 - F(\hat{x}_1))^{n-2} f(\hat{x}_1). \tag{14}
\]

Not only do applicants individually prefer lower application costs, but they also jointly favor costless applications. The best outcome for the applicants, achieved when \( c_1 = 0 \) and

\(^6\)Note that \( E_b \) can be viewed either as a function of the application cost or the cut-off location: \( E_b = E_b(\hat{x}_1(c_1), c_1) \) or \( E_b = E_b(\hat{x}_1, c_1(\hat{x}_1)) \).

\(^7\)The terms corresponding to the change in the probability that no individual chooses to apply and the effect of the application cost on the number of applicants cancel out since \( v_1 (d ((1 - F(\hat{x}_1))^n) / dc_1) = v_1 n (1 - F(\hat{x}_1))^{n-1} f(\hat{x}_1) \hat{x}_1' = c_1 n f(\hat{x}_1) \hat{x}_1', \) where \( \hat{x}_1 = \hat{x}_1(c_1) \) and \( \hat{x}_1' = \partial \hat{x}_1 / \partial c_1 \).
\( \hat{x}_1 = 1 \), yields \( E_b = v_1 \).

Institution \( I_1 \) obtains the expected payoff \( EB(x) - EC(x) \) from setting an application cost consistent with the cut-off level \( x \), where the expected cost and benefit are defined in (6) and (8). The social welfare is then

\[
W(\hat{x}_1) = E_b(\hat{x}_1, c_1(\hat{x}_1)) + (EB(\hat{x}_1) - EC(\hat{x}_1))
\]  

(15)

What is the socially optimal cut-off location \( \hat{x}_1 \)? From \( dW/d\hat{x}_1 = d(E_b)/d\hat{x}_1 + MB(\hat{x}_1) - MC(\hat{x}_1) \), it follows that the condition

\[
(dW/d\hat{x}_1) / (nf(\hat{x}_1)) = -(F(\hat{x}_1)/f(\hat{x}_1)) (\partial c_1/\partial \hat{x}_1) + (1 - F(\hat{x}_1))^{n-1} (v - \hat{x}_1) - c = 0,
\]

(16)

with \( \partial c_1/\partial \hat{x}_1 \) as in (14), implicitly defines the socially optimal cut-off location for \( I_1 \), \( \hat{x}_1^* \). The first term corresponds to the benefit each applicant obtains from lower application costs while the last two terms are the normalized benefit and cost to \( I_1 \). Condition \( v > v_1 + 1 \) guarantees the existence and uniqueness of an interior socially optimal solution.

It is not socially optimal to set the application cost to zero and encourage everyone to apply because \( (dW/d\hat{x}_1) / (nf(\hat{x}_1)) |_{\hat{x}_1=1} = -c < 0. \) At the best application cost for \( I_1 \), \( (dW/d\hat{x}_1) / (nf(\hat{x}_1)) |_{\hat{x}_1=\hat{x}_1^*} = -(F(\hat{x}_1)/f(\hat{x}_1)) (\partial c_1/\partial \hat{x}_1) |_{\hat{x}_1=\hat{x}_1^*} > 0. \) Therefore, institutions choose application costs that are larger than the socially optimal. Using notations, \( \hat{x}_1^* < \hat{x}_1^o < 1 \) and \( 0 < c_1^o < c_1^*. \) Proposition 3 summarizes these findings.

**Proposition 3.** The socially optimal application costs are positive and lower than the application costs chosen by institutions.

Application costs discourage applications and reduce the costs of hiring for institutions. They are similar to taxes on production that generates a negative externality. Institutions choose higher than the socially optimal application cost because they do not fully account for the costs to applicants. Depending on the parameter values, the welfare can be higher or lower at \( \hat{x}_1^* \) than when application costs are absent (at \( \hat{x} = 1 \)). Figure 2 illustrates the point by depicting the social welfare and the expected net benefits to institution and applicants as dependent on the application costs for \( v_1 = 1, \ v = 3, \ c = 0.4, \) and \( n = 6. \) The welfare rises sharply at low application costs due to the strong effect on the expected total evaluation
costs. The socially optimal level is achieved at $c_1^o \approx 0.06$, but $I_1$ would select a higher application cost, $c_1^* \approx 0.15$. Although a marginal reduction in application costs increases the welfare, a ban on application costs is welfare-reducing.

Figure 2: Social Welfare and Net Benefits to the Institution and Applicants

Notes: The expected net benefits to $I_1$ and applicants are labeled $(EB - EC)$ and $Eb$, respectively. The social welfare is labeled $W$; $W (c_1 = 0) \approx 1.46$, $W (c_1^o \approx 0.06) \approx 2.55$, and $W (c_1^* \approx 0.15) \approx 2.45$. The welfare comparison reveals that $W (c_1 = 0) < W (c_1^*) < W (c_1^o)$.

The result that institutions would set higher than the optimal application costs continues to hold when the institutions can impose monetary application fees on applicants. Let $\lambda \in (0,1]$ be the portion of the application cost recovered by institutions. The expected benefit to $I_1$ is as before while the expected cost is lower than in (8) because evaluation costs are partly reimbursed, $EC(x) = (c - \lambda c_1) nF(x)$. Both $c_1^*$ and $c_1^o$ would be higher when they include application fees, provided institutions attract more than $(1/n) th$ of population. Even when applications costs are just monetary transfers ($\lambda = 1$), institutions set sub-optimally high application fees because they do not fully internalize the costs they impose on applicants.
3. Conclusion

In a number of environments, non-trivial transaction costs may be welfare improving. In the context of an application decision, transaction costs eliminate applicants who are not a good match for an institution. With trivial application costs, one may choose to apply to a school to have a fallback option. Clearly, application fees are preferred to other non-monetary transaction costs because they are not wasteful.\(^8\) The paper argues that even when application costs are totally wasteful they may arise endogenously and be welfare improving. Increasing the pool of applicants adds marginal applicants who are not likely to be the best choice for the institution.\(^9\)

The rationale for higher transaction costs can be found in a number of other areas. It has been argued that the search engines, which require advertising firms to pay for consumer traffic, provide a better service to consumers because they are less likely to engage in bait-and-switch practices and are more responsive to consumer inquiries. The pay-for-click technology selects serious merchants. Spam mails are another example of low transaction costs resulting in an inefficient outcome. A dating service that charges a large subscription fee and promises a better matching technology, may indeed deliver on the promise if the fee itself pre-selects more desirable subscribers. Similarly, co-payments and longer waiting periods can lower healthcare expenses. In the area of law, nuisance suits can be discouraged by high costs of filing a suit. The United States Patent and Trademark Office explicitly states that patent and trademark fees will “reduce the incentives for applicant’s to pursue wasteful examination.”\(^10\)

Paradoxically, bureaucracy and inefficiency may be good if the cost imposed on agents pre-selects only serious cases. The paper suggests that applications will not and should not be costless even if technological advances in the submission and evaluation processes would allow for this to happen.

\(^8\)Institutions may be averse to charging application fees because the fees discriminate against the applicants with lower income. Applicants could also be reluctant to pay fees because of the hold-up problem – institutions might just want to collect fees and hire no one.

\(^9\)Transaction costs could, in fact, improve the quality of the successful applicant if there is randomness in the evaluation process. When the selection process is not perfect, institutions may mistakenly select an inferior applicant over the best one. Institutions would have an additional reason to pre-select better matching individuals with application costs.

References


