Recruitment and Selection in Organizations

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Abstract
This paper studies employer recruitment and selection of job applicants when job-seekers have private, noisy assessments of their firm-specific productivity and the firm performs imperfect (i.e. noisy) evaluations of applicants ("interviews"). If applicants find it costly to undergo the firm’s interview, their willingness to be evaluated will depend both on the wage paid and on the likelihood of being hired. Also, a noisy interview leads the firm to consider the quality of the applicant pool to reach hiring decisions. We characterize the equilibrium application and hiring decisions as well as the firm’s optimal wage. We show that improving the informativeness of the interview has a non-monotone effect on applications, where it dissuades applications for high and low interview costs, but encourages applications for intermediate costs, while improving the informativeness of job-seeker’s assessment has a monotone effect on applications. We explore this interdependence of recruitment and selection on the returns to improving different facets of the firm’s hiring process.

Keywords: hiring, recruitment, selection, employer search.

JEL classifications: D82, L23
1 Introduction

Attracting and selecting the most suitable workers is arguably one of the main challenges that organizations face. This challenge has become more prominent in recent times following a shift towards more knowledge-intensive and team-oriented work practices that place a stronger emphasis on hiring the "right" worker for the organization.\textsuperscript{1,2} Firms meet this challenge by engaging in a variety of recruitment and selection activities, where the former aim to create an applicant pool with the most promising prospects, and the latter intend to detect those applicants that are the best fit for the organization. There is, however, substantial heterogeneity in how firms select among their applicants\textsuperscript{3} and a stark variation in their propensity to adopt new, innovative selection techniques both across firms and jobs.\textsuperscript{4} Do firm’s with idiosyncratic cultures or specific work practices engage in more careful selection of applicants? What are the factors that determine the propensity of firms to adopt alternative selection processes to find the "right" workers?

The lack of adoption by firms of new selection methods, e.g. personality tests and situational judgment tests, has been especially noted in the Personnel Psychology literature (see, for instance, Rynes et al. 2007). Lack of adoption is more problematic as many studies advocate the use of testing on the basis of the decrease in its implementation costs. One leading explanation is that applicant’s perceptions of the selection process dictates their willingness to be evaluated (see Breaugh and Starke 2000 and Ryan and Ployhart 2000 for a general discussion), and these selection methods may have an adverse effect on such perceptions. That is the way firms evaluate applicants impacts job-seekers propensity to apply for those jobs.

This paper presents a model where applicant’s perceptions of the evaluation process will dictate

\textsuperscript{1}While the practical importance of hiring is underscored by the amount of resources that firms allocate to them, there is some evidence of its effect on firm performance. For instance, the importance of hiring practices, among a larger set of complementary HR practices, in workplaces dominated by team structures can be traced back to Ichniowski, Shaw and Prennushi (1997). See also Bloom and Van Reenen (2010) for an analysis of HR practices in empirical studies of productivity effects of management practices.

\textsuperscript{2}The importance of worker-firm or worker-job matching has been recently documented in the literature (for an overview, see Oyer and Schaefer 2010). For instance, Lazear (2003) argues that worker’s human capital is general, multidimensional but firms differ in the value they attach to each dimension, implying that firms are horizontally differentiated in their preferences over workers. Hayes, Oyer and Schaefer (2006) find strong evidence of co-worker complementarity, supporting the claim that the "right" worker for a firm may depend on the firm’s current workforce. Oyer and Schaefer (2012) provide further evidence of match specific productivity derived from co-worker complementarity.

\textsuperscript{3}Typical selection techniques involve direct evaluation of applicants through a series of interviews (structured or unstructured), testing (e.g. psychometric, personality, intelligence), background and resume checks, "trial" periods aimed at measuring on-the-job performance, or situational judgment tests (SJT’s) that study the subjects reaction to hypothetical business situations (see e.g. Gatewood, Feild and Barrick 2010).

\textsuperscript{4}The findings regarding a wide variance in adoption of selection methods come primarily form the Industrial and Personnel Psychology literature, e.g. in Terpstra and Rozell (1997), Van der Zee, Bakker and Bakker (2002) and Wilk and Capelli (2003).
the profitability of improving different facets of the hiring process. The basic force underlying
the analysis is the interdependence between recruitment and selection activities. First, the firm’s
ability to recognize talent, as embodied by the series of interviews and tests used in selecting workers,
affects the likelihood that an applicant gains employment at that firm and thus his willingness to
apply. In turn, if applicants differ in their perceived productivity, the composition of a self-selected
applicant pool provides additional information to the firm in the selection process. This equilibrium
interdependence leads firms to evaluate improvements in one area, say selection, by considering also
their effects on other areas, in this case in their recruitment ability.

To study the interdependence between recruitment and selection I propose a stylized matching
model with the following ingredients: (i) Match specificity: job-seekers differ in their productivity
when employed by different firms. To simplify the model, we assume that there is no uncertainty
regarding their match-specific productivity when matched with a group of firms, while there is
one firm where the match-specific productivity is initially unknown to both job-seekers and the
firm. (ii) Bilateral asymmetric information: each job-seeker receives a noisy, private signal of their
productivity when matched with the firm (her "type"), while the firm can evaluate any applicant (by
subjecting her to an "interview") and generate a private signal that may be (partially) informative
of match value. (iii) Costly evaluations: both applicant and firm find it costly to produce a succesful
evaluation, in the sense that they both need to devote resources to generate a valid signal of match
value. The firm costs derive from the resources needed to evaluate applicants. We don’t consider
"application" costs in our setup while we associate an applicant’s evaluation costs to her "effort"
choice necessary to produce an informative interview. (iv) Directed Search: The firm cannot based
contracts on the results of the interview, but can commit to a "posted-wage" schedule that specifies
payments based on whether the applicant is evaluated and whether she is ultimately hired. This
posted wage schedule not only compensates an applicant’s for her outside option but is the means
available to the firm to elicit effort during an interview. Finally, the firm will hire any applicant

5 The terms "recruitment" and "selection" in this follow their usage in the Human Resource and Industrial Psy-
ology literature. Following Barber (1998, pp5-6), "recruitment includes those practices and activities carried on by
the organization with the primary purpose of identifying and attracting potential employees". Selection is typically
defined as the practices aimed at separating from a pool of applicants those who have the appropriate knowledge,
skills and abilities to perform well on the job (Gatewood et al 2010).

6 The fact that recruitment outcomes are driven by applicants believes of their likelihood of being hired traced back
to expectancy theory as applied to HR (Vroom 1964).

7 We do not restrict the sources of match productivity, which can arise both from the characteristics of workers
and the attributes of the firm/job that jointly shape the productivity of the worker in that firm. While one could
further differentiate between worker-firm productivity and worker-job productivity, we will not make this difference
here.

8 In particular, an applicant could undergo the hiring process at zero cost if she doesn’t exert effort during the
interview.
whose expected productivity exceeds the hiring cost.

Underlying the equilibrium is a simultaneous Bayesian inference problem that the firm and applicants must solve. On the one hand, the applicant’s willingness to apply to the firm is based on her estimate of the probability of being hired given the firm’s evaluation process and her type. In other words, her perceptions over the results of the interview will dictate her willingness to actively engage in it. On the other hand, the firm will use all available information to assess match value. As the interview is imperfect, the firm will also use the fact that job-seekers self-selected into applying. In fact, as type and interview score are correlated, the firm will use the latter to "filter" the type of applicant it is evaluating. Therefore both hiring rules and application decisions are jointly determined in equilibrium.

The only uncertainty in our model regards the productivity of a worker when matched with the firm. This implies that equilibrium exhibits positive assortative matching and positive selection: all job-seekers with a high estimate of match value apply to the firm, and reductions in the wage improves the average quality of the applicant pool. In other words, the firm does not experience any adverse selection in recruiting. In fact, any change in applicant’s perceptions of the hiring process that make them less likely to apply would, ceteris paribus, reduce the firm profits.

Matching frictions in our setup stem from the need to motivate an applicant to incur the costs of yielding a valid interview. Indeed, if evaluation costs were contractible in our model, then the effect of applicant’s perceptions on the hiring outcomes would disappear: the firm would simply compensate the applicant for exerting effort in the interview and would pay her a wage that matches her outside option. As we show in Section 5, this leads to constrained-efficient matching with the firm.

A key insight of our analysis is that improving selection, by adopting a less "noisy" interview, has a non-monotone effect on applications, where it dissuades applications when the interview imposes high and low costs on applicants, but it encourages applications for intermediate costs. In contrast, improving recruitment, in the form of informative advertising to job-seekers, that increases the precisions of their private assessments of match value, does have a monotone effect, encouraging applications when interview costs are high and dissuading applicants when interview costs are low. These comparative statics derived from the way firms update hiring rules and applicants revise their prediction of their interview score as a result of improvements in the information available. As an example, when evaluation costs are high the firm has very few applicants that believe are

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9 As we show in Section 4, this is true for the range of wages that are undominated in equilibrium.
10 Alonso (2012) investigates a model where match value is correlated with the applicant’s outside option. This leads to the possibility of both positive and adverse selection in equilibrium.
likely to be hired. On the one hand, a better interview implies that the firm will put less weight on the fact that the applicant pool is rather selective and demand a higher interview score to be hired. On the other hand, a better interview can reduce the uncertainty faced by applicants and increase their chances of beating a given hiring standard. We show that, in our model, the first effect dominates implying that improving selection when the applicant’s evaluation costs are high will dissuade applications.

This insight provides some intuition regarding the returns to adopting innovative selection processes and the returns to recruitment based on advertising firm/job characteristics. Indeed, the equilibrium marginal value to the firm of improved selection can be decomposed into: (i) a direct effect, whereby hiring mistakes are reduced, and (ii) an indirect effect, driven by the change in the size and quality of the applicant pool. The direct effect is always positive while the indirect effect is negative iff a more informative interview dissuades applications. Therefore, the need to induce applicants to actively engage in the evaluation process, reduces the incentives to adopt innovative selection practices when the costs imposed on the applicant are sufficiently high or low.

The firm can alternatively engage in recruiting through informative advertising that increases the information available to prospective applicants about match value. Although the firm cannot use this information directly, it can benefit from recruiting in two ways. First, better information may increase the effectiveness of recruitment by inducing applicants to engage in the hiring process at a lower wage, thus reducing hiring costs. Second, it may improve selection as, holding constant the expected match value of applicants, better informed applicants implies that self-selecting into the applicant pool is a less noisy estimate of match value. These two effects shape the incentives of a firm to engage in informative advertising of job/firm characteristics.

The rest of the paper is structured as follows. The next section provides a brief overview of the relevant literature and we describe the model in Section 3 we describe the model. Section 4 and 5 analyzes the equilibrium application and hiring decisions. Section 6 provides the main comparative statics on applicant behavior and Section 7 studies the firm returns from improving its recruitment and selection practices. We extend our analysis in Section 8 to include other sources of heterogeneity in the applicant’s perception of the hiring process and Section 9 provides a set of empirical implications. Finally, we conclude in Section 10. All proofs are in the appendix.

2 Literature Review

TBD
3 The Model

Players: There is a continuum of job-seekers of unit mass. Job-seeker’s are risk neutral, protected by limited liability, and can seek employment in firm $A$ or in any firm of a group of alternative, identical firms. There is no uncertainty regarding the productivity of a job-seeker if employed by a firm other than firm $A$, where I further assume that this productivity is the same across matches and equal to $w$. Competition for workers implies that a job-seeker can find employment at any time in any of those firms at a wage $w$.11

Firm $A$ (henceforth "the firm") can create a continuum of vacancies of mass one at no cost. To study the impact of match-specificity in the returns to recruiting and screening applicants we assume that job-seekers differ in their productivity $J(\theta)$ if employed by the firm, where the match specific value $\theta$ is a random variable that is i.i.d. across job-seekers and is normally distributed, $\theta \sim N(0,1/h_0)$. In our main analysis we will focus on the case that the match-specific productivity $J(\theta)$ is simply $J(\theta) = \theta$. It follows that if $\theta$ is costlessly observed by all market participants, the surplus generated by a $\theta$-worker when employed by the firm would be $\theta - w$ and efficient matching would entail all job-seekers with $\theta \geq w$ being employed by the firm.

Hiring Process: The hiring process is divided into three stages: application, evaluation, and hiring decision. At the application stage job-seekers decide whether to apply to the firm. Prior to submitting their application, a job-seeker receives a private signal $s_A$ that is informative of $\theta$. More specifically, we assume that $s_A/\theta \sim N(\theta,1/h_A)$ where $h_A$ is the precision of a job-seeker’s private assessment of its productivity when employed by the firm.

The evaluation stage ("interview") can be thought as a statistical experiment in which the firm may obtain information about the applicant’s match-specific productivity through a series of tests. An important aspect of our model is that both applicants and the firm find it costly to engage in the hiring process. While there are several ways in which applicants and firms bear costs in the hiring process,12 we model the evaluation stage as a moral hazard in teams problem: the interview yields a valid signal (i.e. a signal directly correlated with the value of the match $\theta$) if, and only if, both the applicant and the firm exert effort. To simplify the exposition we assume that the firms’ costs of evaluation are sunk at the time it decides to evaluate an applicant. In particular, if the

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11 XXXAlso, the value of leisure is strictly lower than $w$ for all job-seekers so that all job-seekers strictly prefer employment. This simplification is without loss of generality as the role of the group of alternative firms is to provide a homogenous outside option to all job-seekers when applying to firm $A$. XXX

12 In particular firms must commit resources to identify job openings and requirements, as well to advertising and evaluation of workers. Applicants, on the other hand, typically incur application costs, as well as evaluation costs during the interview phase, ranging from psychic costs associated with intense scrutiny, opportunity cost of time or effort costs necessary to perform during the interview.
firm decides to evaluate a measure $K$ of applicants ("interview capacity") it incurs cost $C(K)^{13}$. The timing assumption on the firm’s costs matches the observation that in practice firms need to
determine ahead of time the number of recruiters available to interview the applicants, design the
tests to which applicants will be subject, etc...given their expectations of the size and quality of
the applicant pool.

The result of the interview is summarized in a signal $(val, s_F)$ which is privately observed by
the firm. Once the firm decides to evaluate a candidate, the interview will be "valid" if and only if
the candidate exerts effort at a personal cost $c_A$, which we assumed to be independent of the job-
seeker’s private assessment of the value of the match. $^{14}$ In particular, if the applicant exerted effort
then $val = 1$ and $s_F$ is correlated with $\theta$ according to $s_F/\theta \sim N(\theta, 1/h_F)$, while if the applicant
does not exert effort, however, then $val = 0$ and $s_F$ is independent of $\theta$. $^{15}$ Thus $h_F$ captures the
precision with which the firm can evaluate the match-specific productivity of a given applicant.

Finally, at the last stage of the hiring process the firm decides whether to extend an employment
offer to the applicant, which will depend on whether it chose to evaluate the applicant and, if so,
on the result of the interview.

This model of the hiring process can be cast in terms of the literature on employer search
where employers have two dimensions on which to scale their search efforts (see e.g. Rees 1966 and
Barron, Bishop and Dunkelberg 1985 ): employers can decide the number of applicants to evaluate
/extensive margin) and the extent to which each applicant is evaluated (intensive margin). In our
framework, the extensive margin is given by the interview capacity $K$ while the intensive margin
is given by the precision of the firm’s assessment $h_F$. In our analysis, however, we will assume that
the firm is endowed with an evaluation technology characterized by $(C(K), c_A, h_F)$. It follows that
in our analysis the extensive margin will be determined in equilibrium given applicant’s attitudes
towards the test and the firms hiring policy, while our main results concern the firm’s marginal
returns to improving the intensive margin.

*Informational content of assessments:* As most of our results involve comparative statics on
the precisions $h_A$ and $h_F$ it is convenient to normalize the signals $s_A$ and $(val, s_F)$ in terms of the
posterior means that they induce. Therefore, letting $I\{val = 1\}$ be the indicator function of the

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13 To avoid corner solutions in the firm’s equilibrium choice of interview capacity we posit the standard Inada
conditions in the sense that $C(K)$ satisfies $C'(K) > 0$ and $C''(K) > 0$ if $K > 0$, while $\lim_{K \to 0} C(K) = 0$,
$\lim_{K \to 1} C(K) = \infty$.

14 In many cases, firms’ hiring processes encompass a set of staggered interviews and tests in which a subset of
applicants that performed poorly are discarded. We study this possibility in Section XXX where we augment the
model by assuming that the cost of producing a valid signal by an applicant is increasing in his type.

15 This specification greatly simplifies the inference problem by the firm. One could have alternative specifications
XXX
event $val = 1$, we define

$$
\begin{align*}
v_F &= E[\theta|val, s_F] = \frac{h_F}{h_0 + h_F} s_F I\{val = 1\}, \\
v_A &= E[\theta|s_A] = \frac{h_A}{h_0 + h_A} s_A.
\end{align*}
$$

with ex-ante distribution $v_i \sim N(0, \sigma^2_{v_i})$ where $\sigma^2_{v_i} = \frac{h_i}{h_0(h_0+h_i)}, \ i \in \{A,F\}$. We will informally refer to the signal $v_A$ as the applicant’s "type" and $v_F$ as the interview "score".

This specification has two advantages. First, changes in $h_i, i \in \{A,F\}$ have no effect on how a given $v_i$ is interpreted as a predictor of the applicant’s productivity since $E[\theta|v_i] = v_i$. For instance, if the firm had no additional information, hiring decisions will depend solely on $v_F$, regardless of the precision of the interview. Second, increases in the precisions $h_i, i \in \{A,F\}$, lead to a higher variance of the signals $v_i, i \in \{A,F\}$, which is consistent with the fact that more informative signals lead ex-post to a higher dispersion of beliefs about $\theta$.

A key feature of our model is that evaluations $v_A$ and $v_F$ are correlated (iff the interview is valid) which allows both the estimation of the applicant’s type from the interview score and the applicant’s prediction of the result of the interview. As the (linear) correlation coefficient $\rho$ between $v_A$ and $v_F$ is given by

$$
\rho^2 = \frac{h_F}{h_0 + h_F} \frac{h_A}{h_0 + h_A}, \tag{1}
$$

we have that the mean and variance of estimating $v_i$ from $v_j, i, j \in \{A,F\}, i \neq j$, are

$$
\begin{align*}
E[v_i|v_j] &= \frac{h_i}{h_0 + h_i} v_j, \\
\sigma^2_{v_i|v_j} &= Var[v_i|v_j] = (1 - \rho^2) \sigma^2_{v_i} = \left(\frac{h_i}{h_0 + h_i}\right)^2 \left(\frac{1}{h_0 + h_j} + \frac{1}{h_i}\right).
\end{align*}
$$

Contracts: We take the view that both the applicant’s type and the interview score observed by the firm are private information (i.e. they are "soft" information) and contracts cannot be written directly on these values. This implies, for instance, that the firm cannot contractually commit to reject a candidate after an uninformative interview or, more generally, to base hiring decisions on the interview score. Therefore, in our set-up, the only contractible actions are whether the firm subjects the applicant to the interview and whether the latter is extended an employment offer.

As job-applicants find it costly to be evaluated, the firm will need to compensate them in order to attract applications and elicit a valid measure of their productivity. To do so, we assume that the firm can ex-ante commit to a "posted-wage" schedule $(w_E, w_N, t_E)$, where $w_E$ is the wage to be paid to a hired applicant that has been evaluated, $w_N$ is the wage to be paid to a hired applicant that has not been evaluated, and finally $t_E$ is a transfer paid to each applicant that is evaluated,
regardless of whether she is ultimately hired. Our limited liability assumption translates in this case to \( t_E \geq 0 \).

**Timing and Equilibrium:** The model is static and considers matching in a single period. The firm is endowed initially sets the parameters of the hiring process: (i) the wage schedule \((w_E, w_N, t_E)\), and (ii) the interview capacity \(K\). Job-seekers learn their type \(v_A\) and, after observing \((w_E, w_N, t_E)\) and \(K\), decide to apply to the firm. After observing the mass of applicants, the firm decides whether to submit an applicant to an interview. If the applicant is not evaluated the firm decides whether to extend an employment offer that pays the posted wage \(w_N\). If evaluated, the firm decides whether to extend an employment offer based on the result of the interview, paying \(w_E + t_E\) to a hired applicant and \(t_E\) if it does not extend an employment offer. Independent of whether they are evaluated or not, applicants that do not receive an employment offer, or reject an employment offer, can costlessly find employment at any of the identical firms that pay \(w\). Finally, payoffs are realized and the game ends.

The notion of equilibrium is Perfect Bayesian Equilibrium. Given our assumptions on the job-market we can directly establish the equilibrium \(w_N\) and \(t_E\). First, as there are no costs of application borne by applicants and any applicant can guarantee herself a payoff of \(t_E + w\) when evaluated (i.e. by not exerting effort and obtaining outside employment at a wage \(w\)), it follows that if \(w_N > w\) or \(t_E > 0\) all job-seekers would strictly prefer to apply to the firm. As a result, in equilibrium, we must have \(w_N = w\) and \(t_E = 0\). Therefore, equilibrium contracts will take the form \((w_E, w, 0)\).

**Discussion of Assumptions:** TBD

### 4 Equilibrium Hiring and Application Decisions

We now characterize the equilibrium application and hiring choices in a subgame where the firm posts a wage schedule \(w_E\) and sets an interview capacity \(K\). For simplicity, our results in Sections 4-7 are derived for the case where \(C(K) = 0\) for all \(K\). We complete our analysis by considering a costly extensive margin, \(C(K) > 0\) if \(K > 0\), in Section 8.

We solve for an equilibrium by backward induction. First, we characterize the firm’s hiring rule based on whether it evaluates an applicant and the result of the interview. The firm optimally sets a "hiring standard", that depends on the composition of the applicant pool, and hires any applicant whose interview score exceeds it. Anticipating the firm’s hiring standard, we then determine the job-seeker’s willingness to apply and exert effort as a function of her type.
4.1 Firm’s Hiring Decision

Suppose that all job-seekers with types $v_A$ in the set $A$ apply to the firm and let $A' \subseteq A$ be the (measurable) subset of types that are willing to exert effort if evaluated. As $v_A$ is correlated with $\theta$, the firm has available two informative signals to infer the match productivity: the interview score $v_F$ and the fact that the applicant is willing to exert effort during the interview, i.e. $v_A \in A'$. More precisely, the firm solves a Bayesian filtering problem as the interview score provides an estimate of the candidates actual type $v_A$, which can be used to refine the firm’s estimate of $\theta$. That is, the firm can use $v_F$ to infer which applicant type from a pool $v_A \in A'$ it is actually evaluating. The following lemma shows that this filtering problem leads to a threshold hiring rule and characterizes hiring decisions based on whenever the applicant is evaluated.

**Lemma 1.** Given measurable sets $A, A', A' \subseteq A$, (i) if the applicant is subjected to an interview and exerts effort then there exists a hiring standard $v_F(A')$ such that the firm extends employment offers to an applicant if and only if $v_F \geq v_F(A')$. The hiring standard satisfies

$$E[\theta | v_F(A'), v_A \in A'] = w_E.$$  \hspace{2cm} (3)

(ii) If the applicant is evaluated and does not exert effort, the firm extends an employment offer if and only if

$$E[\theta | v_A \in A'/A] \geq w_E.$$  \hspace{2cm} (4)

(iii) The firm will extend an employment offer absent an interview if and only if

$$E[\theta | v_A \in A] \geq w.$$  \hspace{2cm} (5)

To explain Lemma 1, consider first the case where the applicant is evaluated. Following an uninformative interview the only information available to the firm is that $v_A \in A'/A'$. The inability to commit to rejecting the applicant upon an invalid interview implies that the firm will hire the applicant if (4) is satisfied. If the candidate exerted effort, however, the firm will rationally infer the applicant’s productivity from the interview score $v_F$ and the fact that the applicant is willing to exert effort, i.e. $v_A \in A'$. In our framework, with joint normality of match value and signals, if the applicant’s type could be credibly disclosed (i.e. $v_A$ is "hard" information) then the firm would just weigh each signal to arrive to an estimate of $\theta$

$$E[\theta | v_F, v_A] = \frac{h_0 + h_F}{h_0 + h_F + h_A} v_F + \frac{h_0 + h_A}{h_0 + h_F + h_A} v_A.$$

When the applicant’s type is soft, the firm will try to estimate $v_A$ by using both the interview score and the fact that $v_A \in A'$. Overall, the firm’s posterior expectation over match value is

$$E[\theta | v_F, v_A] = \frac{h_0 + h_F}{h_0 + h_F + h_A} v_F + \frac{h_0 + h_A}{h_0 + h_F + h_A} [E[v_A | v_F, v_A \in A']$$

\hspace{2cm} (7)
Expression (7) clarifies the role of the firm’s filtering of the applicant’s type when estimating the underlying match-value: the firm still weighs each piece of information where it now uses its estimate of the applicant’s type $E[v_A | v_F, v_A \in A']$. The fact that hiring decisions satisfy a cut-off rule then follows from the observation that, as $v_F$ and $v_A$ satisfy the monotone likelihood ratio property (MLRP) with $\theta$, they also satisfy the same property among them (Karlin and Rubin XXX). This implies that for any measurable set $A'$ the filtering term $E[v_A | v_F, v_A \in A']$ is (weakly) increasing in the interview score $v_F$. Finally, non-commitment to hiring rules and sequential rationality implies that the firm will reject any applicant whose expected productivity falls short of the cost of hiring, as giving by the wage $w_E$, while it will offer employment to any applicant whose expected productivity exceeds $w_E$.

The firm needs to decide also whether to extend employment offers to those applicants that it does not evaluate. As the expected productivity of a randomly selected applicant is $E[\theta | v_A \in A]$, the firm will offer employment without evaluation, matching the outside wage $w$, as long as (5) is satisfied.

4.2 Applicant’s Interview Behavior

Given the firm’s sequentially rational hiring decision, which applicants would be willing to incur the costs $c_A$ during the interview and provide a valid assessment of their productivity? If (4) holds, an applicant will have no incentive to exert effort as the firm is willing to hire her at a wage $w_E$ following an invalid interview. Thus, to induce applicants to provide a valid interview, the firm must rationally reject applicants that don’t exert effort if evaluated, i.e. we must have $E[\theta | v_A \in A/A'] < w_E$.

Suppose therefore that (4) does not hold. As $v_F$ and $v_A$ are correlated, the applicant faces a prediction problem, namely, to estimate the likelihood of meeting the firm’s hiring criteria given her type. In general, arbitrary hiring rules may deter applicants with a high estimate of $\theta$ from exerting effort but induce effort from applicants with lower estimates. However, as the firm follows a cut-off rule with hiring standard (3), the applicant’s effort decision will also be monotone in type.

**Lemma 2.** For any threshold hiring standard $v_F$ there exists a marginal type $v_A(v_F)$ such that a job-applicant of type $v_A$ exerts effort if evaluated iff $v_A \geq v_A(v_F)$ where $v_A(v_F)$ satisfies

$$(w_E - w) \Pr [v_F \geq v_A(v_F)] = c_A$$

(8)

The left hand side of (8) provides the expected incremental benefit from employment if the applicant exerts effort. An applicant of type $v_A$ needs to predict her likelihood of meeting the hiring standard, i.e. estimate $\Pr [v_F \geq v_A(v_A)]$. As $v_A$ and $v_F$ are conditionally independent, the applicants prediction
problem can be seen as a two step process. First she estimates the value of the match directly given her type and then proceeds to add an independent noise component which captures the imperfect nature of the interview. Under the assumption of joint normality, this prediction problem translates to

\[
\Pr \left[ v_F \geq v_F | v_A \right] = 1 - \Phi \left( \frac{v_F - E[v_F | v_A]}{\sigma_{v_F | v_A}} \right). \tag{9}
\]

As mentioned before, \( v_F \) and \( v_A \) satisfy the MLRP, implying that \( \Pr \left[ v_F \geq v_F | v_A \right] \) is increasing in the applicant’s type.\(^{16}\) Therefore, a threshold hiring rule induces a monotone equilibrium by applicants, where all types \( v_A > v_A(v_F) \) exert effort if evaluated.

### 4.3 Equilibrium Application and Evaluation

We now turn to the firm’s decision to evaluate an applicant and the job-seekers’ decision to which firm to apply. Before doing so we first show that both low and high wages are dominated and will never be chosen by the firm in equilibrium. This allows us to restrict the set of subgames needed to characterize equilibrium hiring outcomes.

#### 4.3.1 Limits to the wage as a recruitment tool.

When valid evaluations are costly to the applicant, the wage \( w_E \) plays a dual role as it both motivates effort from applicants if evaluated and induces ex-ante sorting of applicants, attracting those that believe are a good match.\(^{17}\) However, the firm’s inability to commit to arbitrary hiring rules based on the interview score limits the efficacy of the wage as a recruitment tool: low wages are ineffective in inducing valid interviews while high wages may actually act as deterrent in eliciting effort from applicants and will never be used by the firm.

To see this, define \( v_A(w_E) \) and \( v_F(w_E) \) as the solution to the system of equations

\[
\begin{align*}
E[\theta | v_F, v_A \geq v_A] &= w_E, \\
(w_E - w) \Pr [v_F \geq v_F | v_A] &= c_A.
\end{align*}
\]

Following Lemmas 1 and 2, \( v_A(w_E) \) represents the marginal applicant that is willing to exert effort when the firm hires only if the interview is valid and \( v_F \geq v_F \), while \( v_F(w_E) \) is the firm’s hiring standard after a valid interview by an applicant from a pool \( \{v_A : v_A \geq v_A\} \).

\(^{16}\) One can also establish monotonicity of the likelihood of meeting the hiring standard as a function of the applicant’s type by simple inspection of (9).

\(^{17}\) More precisely, with homogenous evaluation costs, the firm will attract applicants that believe have a high probability of exceeding the hiring standard. However, in our model with unbiased assessments by both firms and applicants, applicants with a high type will also believe it to be more likely to exceed any hiring threshold. This is not true, however, when we consider the role of overconfidence in Section XXX.
First, if $v_A(w_E) \geq w_E$ the firm would be willing to hire an applicant after an uninformative interview. This in turn destroys the incentives of an applicant to exert effort when evaluated. Letting $w_{\min}$ be the minimum solution to $v_A(w_E) = w_E$, it then follows that the firm will not evaluate applicants if $w_E \leq w_{\min}$. Second, high wages are dominated in equilibrium. Indeed, increasing $w_E$ actually has two countervailing effects on an applicant’s behavior in an interview. To be sure, a higher wage makes employment more desirable. However, a higher wage also increases the hiring cost for the firm, increasing the hiring standard and reducing the probability that the marginal applicant passes the interview test. As we show below, the first effect dominates for low wages while the second effect dominates for high wages. In other words, increasing the wage $w_E$ may actually increase the marginal type and reduce the number of applications. This implies that there is a lower wage that attracts the same applicant pool.\footnote{To be precise, this is true as $v_A(w_E)$ is continuous and unbounded as $w_E \to w_E^\text{max}$ for any wage above $w_E > w_E^{\text{max}}$.} As the behavior of applicants is unchanged with this lower wage, $w_E > w_E^{\text{max}}$ would never be chosen by the firm in equilibrium. These results are summarized in the following lemma.

**Lemma 3.** Let $v_A(w_E)$ and $v_F(w_E)$ be defined by (10) and define $w_{\min}$ as the minimum $w_E$ that satisfies the equation $v_A(w_E) = w_E$, and $w_{\max}$ the unique solution to $dv_A/dw_E|_{w_E=w_{\text{max}}} = 0$. If the firm evaluates applicants, then the equilibrium posted wage $w_E$ satisfies

$$w_{\min} < w_E < w_{\max}.$$  

### 4.3.2 Equilibrium Evaluation and Hiring

Lemma 3 captures the implications of the firm’s inability to commit to arbitrary hiring rules on the effective equilibrium wage $w_E$. The next proposition completes the analysis of the firm’s behavior by describing the equilibrium evaluation and applicant pool.

**Proposition 1 (Equilibrium Hiring and Evaluation).** For each $w < w_E < w_{\max}$ and $K > 0$ there is an equilibrium where applications are positively assortative in the sense that there exists $v_A$ such that all types $v_A \geq v_A$ apply to the firm while types $v_A < v_A$ gain employment in other firms at a wage $w$. Moreover, there exist at most two wage levels $w_E'$ and $w_E''$ with $w < w_E' < w_E''$ such that (i) If $w_E < w_E'$ the firm does not evaluate any applicant and $v_A = w$. (ii) If $w_E' < w_E$ the firm evaluates all applicants and all applicants exert effort if evaluated. Moreover, the marginal applicant $v_A$ and the hiring standard $v_F$ are given by the (unique) solution to (10).

The proof of the proposition characterizes the threshold wages $w_E'$ and $w_E''$ as a function of the parameters of the model. Part (i) of the proposition establishes that the firm will only evaluate applicants if the wage exceeds the threshold $w_E'$. This threshold is obtained from two separate
effects. First, applicants will not exert effort if they expect the firm to hire after an invalid interview. That is raising the costs of hiring makes it credible for the firm to reject applicants after an invalid interview. Thus we must have $w'_E \geq w_{\min}$. Second, even if the applicants exert effort, positively assortative applications imply that only job-seekers that believe to be a good match will apply when wages are low. This reduces the incentive of the firm to further evaluate an applicant as evaluation would impose a wage premium $w_E - w$ over hiring without an interview. The firm ultimately compares the benefits from evaluating a candidate from a pool $\{v_A \geq v_A\}$

$$E[\theta - w_E|v_F \geq v_F(w_E), v_A \geq v_A(w_E)] \Pr[v_F \geq v_F(w_E)|v_A \geq v_A(w_E)]$$

(11)

to the payoff obtained by eschewing the interview and hiring the applicant directly

$$E[\theta - w|v_A \geq v_A(w_E)].$$

(12)

The threshold $w'_E$ is defined as the maximum between the wage level that equates (11) and (12) and $w_{\min}$. Finally, if $w_E < w'_E$ the firm does not evaluate the worker and is willing to hire her at a wage $w$. Job-seekers are then indifferent between applying to the firm or obtaining the outside wage $w$, and apply to the firm as long as $v_A \geq w$. The equilibrium $v_A = w$ corresponds to the equilibrium with the highest profit for the firm, conditional on no evaluation occurring.$^{19}$

Part (ii) of the Proposition shows that, for any wage $w_E > w'_E$ the firm will be willing to evaluate all applicants and all applicants are willing to exert effort in the interview. The fact that the firm evaluates all applicants, so that in equilibrium the firm does not hire without evaluation, derives in part from our assumption that the firm incurs no costs in expanding its extensive margin, i.e. $C(K) = 0$. In Section 8 we expand the analysis to the case of increasing and convex costs $C(K)$ and show that a mix mode is possible in equilibrium, where the firm hires some applicants after an interview while it hires others without interview them.

### 4.3.3 Hiring Standard and Marginal Applicant

When the firm evaluates applicants, both the composition of the applicant pool, as given by the marginal applicant, and the hiring standard of the firm are jointly established in equilibrium as the solution to (10). We now describe in more detail this simultaneous inference problem by looking separately at the firm’s filtering and applicant’s prediction problems. We differ the analysis of comparative statics with respect to the precision of the applicant’s type and the firm’s interview to Section 6.

$^{19}$Proposition 4 shows that this equilibrium can be obtained as the limit of equilibria corresponding to a model with positive applications costs, when these costs tend to zero.
We first turn to the firm’s filtering problem. If the applicant’s type were credibly disclosed, say in the form of credible credentials, then the firm optimally weighs the informative credentials with the interview score according to reach an assessment of the applicant’s productivity. As the applicant’s type is not observable, however, the firm uses the interview to "filter" which applicant it is actually facing. In our jointly normal framework we have that \( v_A | v_F \sim N \left( E[v_A | v_F], \sigma^2_{v_A | v_F} \right) \), where both \( E[v_A | v_F] \) and \( \sigma^2_{v_A | v_F} \) are given in (2). Therefore, an applicant randomly drawn from a pool \( \{ v_A : v_A \geq \underline{v}_A \} \) whose test result is \( v_F \) is expected to be of type\(^2^0\)

\[
E[v_A | v_F, v_A \geq \underline{v}_A] = \frac{h_A}{h_0 + h_A} v_F + \sigma_{v_A | v_F} h \left( \frac{v_A - E[v_A | v_F]}{\sigma_{v_A | v_F}} \right),
\]

where \( h(\cdot) \) is the hazard rate of a standard Normal distribution. Combining this filtering by the firm with (7), the firm’s ex-post evaluation of an applicant is given by

\[
E[\theta | v_F, v_A \geq \underline{v}_A] = v_F + \frac{h_0 + h_A}{h_0 + h_F + h_A} \sigma_{v_A | v_F} h \left( \frac{v_A - E[v_A | v_F]}{\sigma_{v_A | v_F}} \right). \tag{13}
\]

That is, the firm will correct its initial assessment of the candidate \( v_F \) by an amount that depends on the difference between the marginal applicant and the firm’s expectation of the applicant’s type \( v_A - E[v_A | v_F] \). It is instructive to compare (13) to (6) which is the firm’s inference when the applicant’s type is observable. In this case, the sensitivity of the firm’s updating with respect to applicant’s credentials is independent of the interview score. This is no longer true when the applicant’s type is unobservable as the firm tries to infer the applicant’s type from the interview score. In fact, twice differentiating (13) establishes that both pieces of information act as substitutes since

\[
\frac{\partial^2 E[\theta | v_F, v_A \geq \underline{v}_A]}{\partial v_F \partial v_A} \leq 0.
\]

Thus the firm’s posterior expectation becomes less responsive to the interview score as the applicant pool becomes less selective. Finally, (10) implies that the hiring standard will be given by

\[
v_F + \frac{h_0 + h_A}{h_0 + h_F + h_A} \sigma_{v_A | v_F} h \left( \frac{v_A - E[v_A | v_F]}{\sigma_{v_A | v_F}} \right) = w_E. \tag{14}
\]

We now turn to the applicant’s prediction problem. The conditional distribution of \( v_F \) given \( v_A \) is \( v_F | v_A \sim N \left( E[v_F | v_A], \sigma^2_{v_F | v_A} \right) \) where both \( E[v_F | v_A] \) and \( \sigma^2_{v_F | v_A} \) are given in (2). Therefore condition (10) translates in our setting to\(^2^1\)

\[
\frac{v_F - E[v_F | v_A]}{\sigma_{v_F | v_A}} = -\Phi^{-1} \left( \frac{c_A}{w_E - w} \right). \tag{15}
\]

---

\(^{2^0}\)This expression follows from the fact that a normal distribution of mean \( \mu \) and variance \( \sigma \) we have \( E[x | x \geq a] = \mu + \sigma h \left( \frac{a - \mu}{\sigma} \right) \) where \( h(\cdot) \) is the hazard rate of the standard Normal distribution.

\(^{2^1}\)This follows as a job-seeker of credentials \( v_A \) believes that the test score \( v_F \) is Normally distributed with mean \( \frac{h_A}{\pi_0 + h_F} v_A \) and variance \( \sigma^2_{v_F | v_A} = \left( \frac{h_A}{\pi_0 + h_A} \right)^2 \left( \frac{1}{\pi_0 + h_A} + \frac{1}{h_F} \right) \).
Figure 1 describes the equilibrium hiring standard when the applicant’s type is certifiable and when the applicant’s type is private information. As it is intuitive, unobservability of the applicant’s type by the firm raises the probability that lower types are higher but reduces that of higher types. Moreover, uniqueness of equilibrium follows from the fact that the firm’s hiring standard is decreasing in the quality of the applicant pool (and hence decreasing in the marginal applicant), while an applicant’s willingness to apply decreases in the hiring standard.

5 Equilibrium Wage Determination

In this section we solve for the equilibrium wage \( w^E \) and interview capacity \( K \) given the application and hiring behavior described in Proposition 1. We first start by providing a useful benchmark for our results given by the case where the applicant’s effort is contractible.

5.1 Benchmark: Contractible Applicant’s Costs

Suppose that the firm can contract on the effort exerted by the applicant during the evaluation process and offers a contract \((c, w)\) to each applicant that it evaluates, which pays \( c \) if the applicant exerts effort and, additionally, a wage \( w \) if the candidate is hired. The following proposition summarizes the properties and comparative statics of equilibrium in this case.

**Proposition 2 (Contractible Applicant Costs)** If the costs of evaluation are contractible, then there exists a unique PBE. In equilibrium the firm offers a contract \((c, w) = (c_A, w)\) and all job-seekers of type \( v_A = v^C_A \) apply to the firm. The marginal type \( v^C_A \) satisfies

\[
E[\theta - w|v_F \geq v^C_A, v^F_A] \Pr [v_F \geq v^C_A] = c_A, \tag{16}
\]

where the hiring standard \( v^F_A \) satisfies

\[
E[\theta|v_A \geq v^C_A, v_F] = w.
\]

(ii) Firm profits are increasing both in the precision of the interview and in the precision of the applicants type.

When applicant’s evaluation cost are contractible, the firm will optimally cover that cost and pay a wage equal to the applicant’s outside option \( w \). Applicant’s are thus indifferent between being evaluated, regardless of the hiring outcome, or seeking employment in other firms. Furthermore, there is no ex-post distortion in the hiring decision: firm hires the applicant as long as the expected surplus from matching exceeds the expected surplus when the applicant is employed at other firms.
other words, hiring decisions are ex-post optimal given the information available to the firm. As the firm captures all the surplus derived from matching, evaluation decisions are also ex-ante optimal.

Part (ii) of Proposition 2 shows that improvements in the precision of the applicant’s type or the interview score unambiguously increase firm profits. This follows as, from a joint surplus perspective, better information on both sides of the market improves matching. As the firm is residual claimant to match value, and both evaluation and hiring are constrained efficient, firm profits increase. Finally in our stylized setup, when evaluation costs are contractible candidates are indifferent among their employment options in any firm. This implies that there is an equilibrium where each applicant truthfully communicate their type to the firm. In this equilibrium, hiring outcomes achieve first best given the evaluation technology.

5.2 Equilibrium Wage and Evaluation Capacity

If the applicant’s type cannot be credibly disclosed, then (14) and (??) jointly determined the equilibrium application and hiring choices for a wage \( w_E \). The firm’s expected profit from hiring can be written as the product of the total mass of applicants evaluated and the expected value of a hired applicant. In our case, then, we can write the firm’s expected profit as

\[
\Pi = (1 - F(v_A))E[\theta - w_E|v_F \geq \bar{v}_F, v_F \geq v_A] \\
= \int_{-\infty}^{\infty} \int_{\bar{v}_F}^{\infty} \int_{v_A}^{\infty} (\theta - w_E) \, dF(\theta, v_A, v_F)
\]

As the firm sets \( v_F \) optimally given the marginal applicant \( v_A \), applying the envelope theorem and after rearranging we can express the marginal profit as

\[
\frac{d\Pi}{dw_E} = \text{Pr}[v_F \geq \bar{v}_F, v_A \geq v_A] \left( -1 - \frac{\partial v_A}{\partial w_E} E[\theta - w_E|v_F \geq \bar{v}_F, v_F \geq v_A] \right) \frac{\text{Pr}[v_F \geq \bar{v}_F, v_A \geq v_A]}{\text{Pr}[v_F \geq \bar{v}_F, v_A \geq v_A]}
\]

This expression highlights the recruiting role of the wage in determining the composition of the applicant pool, and, in particular, the marginal applicant. First, Lemma 3 implies that the optimal \( w_E \) satisfies \( w_{\min} < w_E < w_{\max} \). Furthermore, the firm will never set a wage such that the marginal applicant, conditional of being hired, is a bad match to the firm, that is we must have

\[
E[\theta - w_E|v_F \geq \bar{v}_F, v_F \geq v_A] > 0
\]

The following proposition describes the properties of the optimal wage \( w^*(c_A) \) as a function of the costs \( c_A \) borne by the applicant.

**Proposition 3 (Optimal Posted Wage)** If the firm faces no costs of evaluating workers \( C(K) = 0 \), then, given \( h_0, h_A \) and \( h_F \) there exists \( \bar{c}_E \) such that

(i) The firm foregoes the possibility of evaluating applicants if \( c_E > \bar{c}_E \), hires all applicants without evaluation and \( \bar{v}_A = \bar{w} \).
(ii) The firm will optimally offer a wage \( w^*(c_E) > c_E \) whenever \( c_E < \bar{c}_E \). Moreover \( w^*(c_E) \) is (weakly) increasing in \( c_E \).

(iii) The equilibrium probability of the marginal applicant being hired, which is given by \( c_E/w^*(c_E) \) (weakly) increases with \( c_E \).

Part (i) of the Proposition indicates that when the costs of evaluation are high, the firm does not evaluate workers and all workers with expected productivity exceeding their productivity in other firms apply to the firm. Of course, as the firm does not evaluate applicants, applicants are indifferent between firms, leading to multiple equilibria in matching. However, the following proposition shows that the equilibrium in Part (i) of Proposition 3 can be obtained as the limit of equilibria in a game where applicant’s face a positive cost of application to the firm, as this cost vanishes.

**Proposition 4 (Equilibrium Refinement)**

TBD

## 6 The Effect of Improvements in Screening and Recruitment on Applicant’ Behavior

A basic theme of our analysis is that recruitment and selection are highly interdependent activities: improvements in one affect the effectiveness of the other. We now investigate such interdependence by deriving comparative statics on the firm’s hiring rule and applicant’s behavior following changes in the informativeness of their signals. It is useful to benchmark our results to the case when the applicant’s costs of evaluation are contractible.

We now turn to the case that the applicant’s type is unobservable. To streamline the analysis we consider the following abstract inference problem

\[
E[\theta|v_F, v_A \geq v_A] = w, \quad (17)
\]

\[
\Pr[v_F \geq v_F|v_A] = p, \quad (18)
\]

which determines the hiring standard \( v_F \) and marginal applicant \( v_A \) when the firm pays a wage \( w \) and the marginal applicant has a probability \( p \) of being hired. It is possible with normally distributed signals to derive (implicit) equations from (17) and (18) that separately define \( v_A(w, p) \) and \( v_F(w, p) \), and, through implicit differentiation, obtain the sought-after comparative statics. However, to provide some intuition we follow a different approach. From (17) define \( v_F^E(v_A) \) as the hiring standard that the firm would set when the marginal applicant is \( v_A \). Thus \( \partial v_F^E(v_A)/\partial h_i \), \( i \in \{A, F\} \), would be the effect of increasing \( h_i \) on the hiring standard of the firm holding constant
the composition of the applicant pool. Likewise, from (18), let $v^A_F(v_A)$ be the hiring standard for such that $v_A$ has a probability $p$ of being hired. Thus $\partial v^A_F(v_A)/\partial h_i$, $i \in \{A, F\}$, would be the change required in the hiring standard after increasing $h_i$ that leaves invariant the likelihood that $v_A$ is hired.

If

$$\frac{\partial v^A_F(v_A)}{\partial h_i} \geq \frac{\partial v^F_F(v_A)}{\partial h_i}$$

(19)

then increasing $h_i$ lowers the equilibrium $v_A$ given by (17) and (18). This follows as $v_A$ would be willing to beat a higher standard than the one the firm sets following $h_i$ increases. Conversely if (19) does not hold then increasing $h_i$, would lead to a higher marginal type.

**Applicant’s Prediction Problem** From (2), the applicants estimate of the interview score is $v_F|v_A \sim N[E[v_F|v_A], \sigma_{v_F|v_A}]$. Therefore changes in the precision $h_i$ will affect the applicant’s problem (18) only through changes in the applicant’s perceived mean and variance of the interview score. Consider first, the mean interview score $E[v_F|v_A] = v_A h_F / (h_0 + h_F)$. As the interview provides an unbiased signal of the underlying match value, the expected score is unaffected by the precision of the applicant’s type $h_A$. Increasing the interview’s precision, however, increases the responsiveness of the mean interview score to the applicant’s type. Consider now the uncertainty faced by the applicant over the interview $\sigma_{v_F|v_A} = (1 - \rho^2) \sigma_{v_F}^2$. From (2) we have that increasing either $h_A$ or $h_F$ increases the correlation $\rho$ between $v_A$ and $v_F$. For instance, when the applicant’s type is more precise, the applicant faces less uncertainty over his match value and thus a lower variance over the interview score. When the precision of the interview increases, however, the unconditional variance of $v_F$ also increases. Overall, a more informative test will reduce the applicant’s uncertainty iff both the precision of the applicant’s and firm’s estimates are sufficiently high, in particular

$$\frac{\partial \sigma_{v_F|v_A}}{\partial h_F} \leq 0 \iff h_0 \leq \frac{h_A h_F}{h_0 + h_F + h_A}.$$ 

(20)

The net effect $\partial v^A_F(v_A)/\partial h_i$ depends on the applicant’s likelihood of being hired $p$, as given in the following Lemma.

**Lemma 5.** (i) For any $w$, $\partial v^A_F(v_A)/\partial h_A$ increases (decreases) in $p$ if $\partial \sigma_{v_F|v_A}/\partial h_A < 0$ ($\partial \sigma_{v_F|v_A}/\partial h_A > 0$). (ii) For any $w$, $\partial v^A_F(v_A)/\partial h_F$ increases in $p$ when $\partial \sigma_{v_F|v_A}/\partial h_F > 0$.

For a "strong" marginal applicant, meaning that $v_A$ is likely to be hired ($p > 1/2$), a more precise estimate of its match value reduces uncertainty over the interview test and increases her chances of being hired. If the marginal applicant is a "long-shot" ($p < 1/2$), less uncertainty over the interview score reduces option value and makes receiving an employment offer less likely.
Firm’s inference problem. From (2), the firm’s hiring standard can be written implicitly as
\[
u_F(w_A) + \frac{h_0 + h_A}{h_0 + h_F + h_A} \sigma_{v_A|w_F} h \left( \frac{v_A - E[v_A|w_F(v_A)]}{\sigma_{v_A|w_F}} \right) = w.
\]
Through implicit differentiation we have
\[
\frac{\partial v_F(w_A)}{\partial h_i} = -\frac{1}{\Delta} \frac{\partial}{\partial h_i} \left( \frac{h_0 + h_A}{h_0 + h_F + h_A} \right) \sigma_{v_A|w_F} h \left( \frac{v_A - E[v_A|w_F(v_A)]}{\sigma_{v_A|w_F}} \right) - \frac{1}{\Delta} \frac{h_0 + h_A - \sigma_{v_A|w_F} h \left( \frac{v_A - E[v_A|w_F(v_A)]}{\sigma_{v_A|w_F}} \right)}{h_0 + h_F + h_A} \left( \frac{v_A - E[v_A|w_F(v_A)]}{\sigma_{v_A|w_F}} \right),
\]
where \(\Delta = 1 - \frac{h_0 + h_A}{h_0 + h_F + h_A} h' \left( \frac{v_A - E[v_A|w_F(v_A)]}{\sigma_{v_A|w_F}} \right) > 0\). The first term on the rhs of (21) represents the change in the weight that the firm puts on the "application signal", i.e. on the fact that it is testing an applicant from a pool \(\{v_A : v_A \geq w_A\}\). The second term captures the effect of increasing \(h_i\) on the firm’s ability to "detect" which applicant is facing, that is the firm’s ability to sort "the wheat from the chaff" in the applicant pool. Thus raising \(h_i\) has two effects on the firm’s inference problem: (i) the firm puts relatively more weight on the signal whose informativeness has increased, and (ii) it changes the firm’s ability to detect "which" type of applicant they are evaluating. The following lemma provides the overall effect on the hiring standard \(v_F(w_A)\).

**Lemma 6.** For any \((p, w)\) we have (i) \(\frac{\partial v_F(w_A)}{\partial h_F} > 0\), and (ii) there exists \(p_F\) such that \(\frac{\partial v_F(w_A)}{\partial h_A} \leq 0\) if, and only if, \(p \leq p_F\).

**Effect of improved screening on application decisions.** How would applicants react to an interview process that imposes the same costs but is more informative of their match value? Lemma 5 shows that the firm facing the same applicant pool would rationally increase their hiring standard. The effect on an applicant depends on the applicant’s initial hiring probability as well as the perceived uncertainty over the test score. Following Lemma 4, for a fixed hiring standard, a better test will increase the hiring probability of a "strong" applicant and decrease the hiring probability of an applicant that is a "long shot". The equilibrium effect is given in the following Proposition

**Proposition 5** Consider a fixed \(w\). Then, there exist two cut-off levels \(0 < p^{h_F} \leq \bar{p}^{h_F} < 1\) such that \(\partial v_A(w, p)/\partial h_F \leq 0\) if \(p \leq p^{h_F}\) or \(p \geq \bar{p}^{h_F}\) and \(\partial v_A(w, p)/\partial h_F > 0\) if \(p \in (p^{h_F}, \bar{p}^{h_F})\).

The proposition establishes that a more informative interview has a non-monotone effect on the composition of the applicant pool, as it dissuades applications when the marginal applicant faces an either high or low hiring probability, while it encourages applications for intermediate hiring probabilities. To gain some intuition on this result it is instructive to analyze two hypothetical cases: (i) the firm disregards the "application signal" when estimating the value of the match, and (ii) the applicant’s type can be credibly disclosed.
Suppose that the firm does not take into account the fact that is evaluating a self-selected applicant \( v_A \in \{ v_A : v_A \geq v_A \} \). To hire the applicant, then, the firm only considers the interview score and sets a hiring standard \( v_F = w \). In this case the equilibrium of (18) and (17) is given by

\[
\Pr[v_F \geq w|v_A] = p
\]  

(22)

Lemma 4 shows that the candidates response to a better interview is monotonic in \( p \), that is if a marginal applicant with a hiring probability \( p' \) is still willing to apply when the precision of the test increases, this will be true for any \( p > p' \). We then reach the intuitive result that a better interview encourages applications when the marginal applicant is "strong" but discourages applications when the marginal applicant is a "long-shot".

Now consider a setup where \( v_A \) can be credibly disclosed. The firm then weighs both pieces of information \( v_F \) and \( v_A \) and will set a hiring standard \( v_F(v_A) \) that depends on the applicant’s credentials \( v_A \) according to

\[
\frac{h_0 + h_F}{h_0 + h_F + h_A} v_F(v_A) + \frac{h_0 + h_A}{h_0 + h_F + h_A} v_A = w.
\]  

(23)

The applicant’s prediction of his hiring probability is simplified in this case as the law of iterated expectations implies that her estimated interview score is independent of the precision of the signals, i.e. \( E[E[\theta|v_F, v_A]|v_A] = v_A \). Moreover, the candidates conditional variance of \( E[\theta|v_F, v_A] \) given \( v_A \) is \( \frac{h_F}{(h_0 + h_A)(h_0 + h_F + h_A)} \), which increases in \( h_F \). That is, when credentials are "hard", the only effect of a better interview is to increase the variance of the firm’s final assessment. This discourages applications when the marginal applicant is "strong" (i.e. when \( p > 1/2 \)) but encourages applications when the marginal applicant a "long shot" (i.e. when \( p > 1/2 \)).

These two benchmark cases exhibit opposing effects of a more informative interview on the applicants’ willingness to engage in evaluation. Moreover, they provide good approximations to the equilibrium given by (17) and (18) for low and high \( p \). On the one hand, as \( p \) tends to zero, the applicant pool becomes indistinguishable from the general population of job seekers and

\[
E[\theta|v_F, v_A \geq v_A] \approx E[\theta|v_F, v_A \in \mathbb{R}] = v_F.
\]

In other words, when ex-ante sorting of applicants is muted, the firm rationally disregards the fact that an applicant is willing to be evaluated. On the other hand, when \( p \) is sufficiently large, the applicant pool is a fairly selective group from the population of job-seekers. The fact, then, that the hazard rate of a normal distribution increases without bound implies that the firm’s filtering problem can be approximated by

\[
E[\theta|v_F, v_A \geq v_A] \approx \frac{h_0 + h_F}{h_0 + h_F + h_A} v_F + \frac{h_0 + h_A}{h_0 + h_F + h_A} v_A
\]
In effect, when $p$ is sufficiently large the likelihood that a randomly chosen applicant is close to $v_A$ is large and the firm’s hiring rule approximates one in which there is no uncertainty over the applicant type being evaluated.

**Effect of improved recruitment on application decisions** A main insight of job-market matching is that reducing informational frictions would improve matching outcomes (Shimer and Smith 2000). How is the propensity to apply and exert effort during the evaluation stage affected by the applicant’s precision of their match value? In our setup, increasing $h_A$ affects both (i) the ex-ante distribution of types $v_A$, (ii) and the equilibrium hiring standard and marginal applicant determine by (17) and (18). We first consider the latter and analyze the effect of higher $h_A$ on the marginal applicant $v_A$.

As the applicant’s expected score does not depend on the precision of his type, the only effect of a higher $h_A$ is to increase the correlation between $v_F$ and $v_A$, reducing the applicant’s uncertainty over the interview score. Following Lemma 4, this effect further encourages applications from "strong" marginal applicants but dissuades applications when the marginal applicant is a "long shot". The firm reacts to a higher $h_A$ by putting more weight on the fact that the applicant is willing to be evaluated, as given by Lemma 5. That is, the firm will reduce the hiring standard require when the marginal applicant is "strong" and increase the hiring standard when the marginal applicant is a "long-shot". As both effects work in the same direction, the following Proposition shows that the overall effect is monotonic in the marginal applicant’s hiring probability.

**Proposition 6.** Consider a fixed $w$. Then, there exists a single cut-off $p^{h_A}$, $0 < p^{h_A} < 1$ such that $\frac{\partial v_A(w, p)}{\partial h_A} \leq 0$ iff $p \geq p^{h_A}$.

Improving job-seekers’ information has a monotone effect on the identity of the marginal applicant, as it improves the hiring chances for a "strong" marginal applicant while it reduces the hiring chances for an applicant that is a "long shot". Again, we can provide some intuition on this proposition by looking at the two benchmark cases where the firm disregards the application decision, and the applicant’s credentials are "hard" information. As the firm’s hiring rule has been described in the previous section, we concentrate on the effect on the marginal applicant.

First, when the firm disregards the composition of the applicant pool, it sets a hiring standard $v_F = w$ and the marginal applicant is determined by (22). As a higher $h_A$ reduces the conditional variance of the interview score, it dissuades long shots but encourages strong applicants. Second, when credentials are "hard" the firm sets a hiring standard according to (23). When credentials become more informative, the firm will increase their weigh, reducing the hiring standard required for strong applicants but increasing it for weak applicants. In this case, both benchmark cases
exhibit the same comparative statics.

7 Equilibrium Returns to Improving Screening and Recruitment
TBD

8 Extensions

8.1 Changes in applicant’s perceptions of the hiring process.
TBD

8.1.1 Heterogeneous precisions.
TBD

8.1.2 Applicants misconceptions of the hiring process
TBD

8.2 Costly Firm Evaluation.
TBD

8.3 The Effectiveness of More General Mechanisms.
TBD

9 Discussion and Empirical Implications
TBD

10 Conclusions

What are the factors that determine a firm’s adoption of new selection procedures? When does a firm find it advantageous to publicize information about its culture/job characteristics to prospective workers? In this paper we show that these two questions are intimately related: the returns to a better interview depend on the effect of job-seeker’s perceptions over the likelihood that they gain a job, while better informed job-seeker can be more willing to engage in a costly evaluation process.
One simplification of the model is that there is only uncertainty about the productivity of workers when matched with a single firm. In equilibrium, this leads to both positive assortative matching and positive selection. This setup can well approximate situations where general human capital can be easily observable, albeit there is uncertainty over the fit of a candidate to a firm, where firm is independent of general human capital. Nevertheless, there are situations where general human capital is uncertain and can be (imperfectly) appraised by firms through interviews. In this case, a high type that indicates a high match value with a given firm also implies a higher outside option when matching with other firms. This effect can then lead to adverse selection and matching may fail to be assortative. Alonso (2012) provides an initial exploration of this scenario.

TBF
References


[12] Rees 1966

