

# Employee Screening: Theory and Evidence

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## ABSTRACT

Arguably the fundamental problem faced by employers is how to elicit effort from employees. Most models suggest that employers meet this challenge by monitoring employees carefully to prevent shirking. But there is another option that relies on heterogeneity across employees, and that is to screen job candidates to find workers with a stronger work ethic who require less monitoring. This should be especially useful in work systems where monitoring by supervisors is more difficult, such as teamwork systems. We analyze the relationship between screening and monitoring in the context of a principal-agent model and test the theoretical results using a national sample of U.S. establishments, which includes information on employee selection. We find that employers screen applicants more intensively for work ethic where they make greater use of systems such as teamwork where monitoring is more difficult. This screening is also associated with higher productivity and higher wages and benefits, as predicted by the theory: The synergies between reduced monitoring costs and high performance work systems enable the firm to pay higher wages to attract and retain such workers. Screening for other attributes, such as cognitive ability, does not produce these results.

## 1. Introduction

Principal-agent models have been central to much of the work in economics, and they have been especially useful in understanding employment relationships. A considerable amount of research has been directed at understanding and addressing the inherent moral hazard problem associated with employment in principal-agent frameworks -- the incentives for individual employees to pursue their own interests at the expense of those of their employer. Virtually all that research focuses on economic governance schemes that provide incentives to induce employees to act in the interests of their employers (See, e.g., Gibbons 1998 and Prendergast 1999). These models begin with the definition of

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appropriate performance, include monitoring to measure performance, and conclude with economic rewards -- in some cases punishments -- to motivate employees. These agency-based models have been most extensively used in the context of executive employment where the agents have considerable control over their performance and where the effects of their performance can be readily observed, albeit at the firm-level. It may be fair to say that agency models have been used somewhat less for understanding production or hourly employment where job performance may be less within the control of the individual (e.g., more paced by machines or supervisors) and where individual performance may be more difficult to measure. Models that are directed especially at hourly workers include efficiency wage approaches and others that rely on punishment (e.g., the loss of premiums). They also require monitoring, however, and many have a strong agency feel to them.

There is a second way to address the moral hazard problems associated with principal-agent frameworks in employment, however. That approach relies on heterogeneity across employees in their abilities, specifically their interest in working hard, that is sometimes included under the heading of “unobserved human capital.” Under this view, some job applicants are simply better workers than others. Specifically, they may be willing to work harder for the same rates of pay and/or are less inclined to shirk their responsibilities, requiring less monitoring and supervision as a result. The complication for the firm is first that while the applicants know their own capabilities, it is difficult for the employer, short of hiring them, to tell. Hence the unobserved problem. Second, applicants who are not hard workers may have an incentive to pretend that they are, especially if regimes of low monitoring make it easier for them to shirk and if the jobs pay premiums of the kind that might be associated with having better workers.

The models used to provide solutions to moral hazard problems from this perspective often rely on self-selection: Potential applicants typically sort themselves out across opportunities such that those who lack the unobserved human capital associated with hard work do not apply for jobs that will require it while those that have it do. The complication with extending these models more broadly is that they require reasonably unique and sometimes complicated reward structures to create the separating equilibrium that attracts hard workers and scares away lazy ones, such as piece rate systems or

back-loaded compensation where workers have to demonstrate their performance in advance of the reward.

An alternative approach to self-selection is screening. Rather than requiring applicants to sort themselves out, the employer attempts to use proxies or other clues to identify which applicants have unobserved human capital in the form of a strong work ethic. The screening approach is easily applied to a wide range of unobserved human capital beyond work ethic and does not require that the applicant even be aware of their relevant attributes (e.g., first-time applicants have no relevant experience with which to ascertain all of their unobserved human capital).

In practice, virtually all employers use some level of applicant screening. It is a fundamental part of the human resources function in most firms as well as the basis of a substantial consulting industry. Further, screening and other forms of addressing the moral hazard problem are not mutually exclusive, and most employers make use of both screening and post-employment economic incentives (see for example Ichinowski et al. 1997, Morduch 1999, and Nagin et al 2002). Among popular screening practices are interviews, reference letters, obtaining the agent's past histories through credit bureaus or hiring detectives, written tests to uncover work attitudes and personality type, etc. (see Rynes and Cable 2003 for a review). Employers differ substantially in the extent to which they make use of applicant screening, however (see Wilk and Cappelli 2003), an issue that merits explaining.

**Work Ethic and Employment Practices.** Although different kinds of jobs may require different attributes, arguably the most fundamental attribute and the one that cuts across virtually all jobs can be described as work ethic, what we might think of as the ability to work hard independent of monitoring by employers or of reward. The seminal discussion of work ethic related it to social norms – the “Protestant Ethic” (see Weber 2002) - but in the context of understanding variations across individuals, it is more appropriate to think about factors that are intrinsic to an individual. The field of industrial/organizational psychology is devoted in large measure to understanding work-related differences across individuals, and there is extensive research there on the attributes of employees who appear to have strong work ethics. While there are several attributes that relate to this behavior, the closest match is with the personality construct known as "conscientiousness." This

attribute has been found to be a reliable and consistent dimension of personality that can be identified and measured across individuals. It also relates strongly to job performance across types of jobs. Further, it appears to have a dispositional element that is stable across jobs and contexts. That is, conscientiousness is a characteristic of individuals, and those with it perform at a high level across situations (see, e.g., Judge and Ilies 2002 for a survey).

The research on conscientiousness suggests that there is something very tangible to the notion of work ethic, that it is an attribute of individuals and affects performance across a range of settings. As a result, employers can expect to benefit from hiring conscientious workers and should be willing to make investments to do so. While it may be possible in some situations to create circumstances that cause applicants to sort themselves according to their work ethic, these circumstances are far from universal. In general, employers can be expected to have a keen interest in screening employees for work ethic. The effects of employees' intrinsic motivation on firm performance are discussed by Kreps (1997) and Rob and Zemsky (2002), among others.

Screening applicants for conscientiousness or work ethic involves costs, and firms therefore have to decide how much to spend on screening. There may well be a trade-off between screening and efforts to monitor employees: Greater use of screening can lead to a more conscientious work force that can perform at a given level with less monitoring, oversight, and performance-related incentives. Another option, in contrast, is to spend very little on screening but rely on intensive monitoring to maintain performance.

We might also expect relationships between the monitoring/screening decision and the choice of work systems. For example, employers with teamwork-based systems and those that rely on employee empowerment where monitoring by supervisors is more difficult should make greater investments in screening.

Because information about conscientiousness is not readily or accurately available in the market (employers have to screen to find it), conscientiousness does not necessarily raise one's market wage. Once workers with these characteristics are hired, however, they contribute value by reducing the need for monitoring costs, saving money for employers. In order to retain these conscientious workers, employers may be motivated to pay them higher compensation through rent sharing arrangements. We should therefore expect a

positive relationship between employer screening for work ethic and employee compensation. Alternatively, a regime of lower screening requires more intensive monitoring, which in turn makes it possible to hire less conscientious workers. They can be paid less than the more conscientious workers because their productivity is lower and there is no particular interest in retaining them.

Recent empirical research on high performance work systems has focused attention on arrangements where work organization makes extensive use of teamwork and employee involvement practices. These systems have drawn attention because they appear to be more productive (MacDuffie 1996; Ichniowski et al 1999). The central element of these arrangements is that employees are more involved in decision making (Cappelli and Neumark 2001), which reduces the need for supervision. But because monitoring is lower, these arrangements require employees who are more committed to the organization, hence the alternative phrase for these arrangements, high commitment work systems (see Applebaum and Batt 1994 for a survey).

Although some observers believe that work systems which increase employee empowerment make all workers more productive, an important part of these systems in practice appears to be screening employees carefully in order to identify those with unobserved human capital and dispositions that are consistent with the strong work ethic required in high commitment systems. Most of the research on employee screening in these contexts is anecdotal and based on case studies of individual companies such as NUMMI, the joint venture between Toyota and General Motors (Keller 1989), Saturn (Kochan and Rubenstein 2000), and Southwest Airlines (Hoffer-Gittel 2002). While more systematic studies of the relationship between applicant screening and other work practices seem largely neglected (see Wilk and Cappelli 2003 for an exception), descriptive findings like those above suggest that regimes with lower levels of employee monitoring should go together with practices of high investments in applicant screening.

Arguments about complementarities between screening and the use of high performance practices associated with regimes of low employee monitoring would contribute to existing research on the synergies among work and human resource practices (Holmstrom and Milgrom 1991; Ichniowski, Shaw, and Prenzushi 1997). Hamilton, Nickerson, and Owan (2001), for example, estimate the effects of teamwork on worker

productivity in a garment plant and find that team-based systems make greater use of collaborative skills, which are less valuable in individual production. The above arguments also suggest a rationale for the empirical findings where high performance practices are often associated with higher wages and employee productivity even when they are not associated with higher profits for firms (Lynch and Black 2003; Cappelli and Neumark 2001, Appelbaum, Bailey, and Berg 2000, Cappelli and Carter, 2000). More generally, these arguments complement the recent work in labor economics showing that non-cognitive skills are important elements for individual earnings (Heckman 1999, Bowles, Gintis, and Osborne 2001, Persico, Postlewaite, and Silverman 2004).

In the section that follows, we derive more formal hypotheses for the arguments above using a simple principal-agent model, which we then test empirically.

## 2. A Simple Principal-Agent Model

In this model, there is a continuum of agents indexed by  $i \in [0,1]$ . Principals are identical with unit mass. Each principal hires one agent from a pool of potential candidates to complete a project. The outcome is stochastic. If the agent makes the appropriate effort  $e$ , he produces  $h > 0$  with probability  $p \in [0,1]$  and 0 with probability  $1-p$ . If the agent shirks, the probability of getting  $h$  is  $q \in [0,1)$ , where  $q < p$ . The cost of effort is  $e^2$ , where  $hp - e^2 > hq$  holds so that making effort  $e$  is the socially optimal choice.<sup>1</sup> The reservation utility of agents/workers and the alternative return for principals/employers are normalized to zero.

We implicitly assume that all agents have the same cognitive ability  $h \geq 0$ , but they are heterogeneous in their levels of conscientiousness, or their work ethic, which we see as including a disposition to work hard and cooperate with others in pursuing the employer's goals. More specifically, an agent  $i$  has a cooperative tendency  $\alpha_i \geq 0$  which may take two different values. He is called a *cooperative type* if  $\alpha_i = \alpha > 0$ , or a *selfish type* if  $\alpha_i = 0$ . The proportion of cooperative type agents in the population is  $\rho \in (0,1)$ . In our model, the cooperative tendency measures the level of disutility or guilt he feels if he does

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<sup>1</sup>This parametric model is used for simplicity. A general formulation would yield similar results.

not choose the socially optimal action.<sup>2</sup> The joint distribution of cognitive ability  $h$  and cooperative tendency  $\alpha_i$  among agents indicates the quality of workforce in this economy.

Agents are risk averse and thus prefer a constant wage to outcome-contingent incomes. To reduce shirking associated with a fixed wage, the principal can use screening and monitoring. The timeline of the game is illustrated as follows: First, principals decide on a package of wage, benefits, screening and monitoring intensities. After observing the distribution of packages among firms, workers decide which firms to apply to for jobs. Some principals screen job candidates and hire only those perceived to be cooperative, while others randomly hire from the pool of job candidates. After the labor market clears where all workers and principals are matched, production starts on a project. Workers decide to work hard or shirk on the project, and they can consume the benefits immediately, regardless of whether shirking is eventually detected. Meanwhile, principals monitor workers to catch shirking. Finally, when the project is finished, principals pay wages to workers not found shirking and withhold them from those caught shirking – the equivalent of firing them. The game is then over.

Suppose for an agent with a cooperative tendency  $\alpha_i$ , a principal chooses wage  $w_i$  and a monitoring level  $m_i \in [0,1]$ , where  $m_i$  is the probability that shirking is observed. The total monitoring cost is  $m_i^2 k_m$ , where  $k_m$  measures the unit cost of using monitoring technologies such as video cameras and supervisors in the workplace. If the agent is caught shirking, he will get zero wage. A cooperative type agent incurs disutility or guilt  $\alpha$  whenever he shirks, regardless of being caught or not by the principal.

Let  $s \in [0,1]$  denote the screening intensity, such that the probability of detecting a selfish type agent is  $s$ , and the probability of misjudgment is  $1-s$ . A cooperative type agent is always revealed after being screened as long as the screening intensity is above a minimum level  $\underline{s} > 0$ . Under this screening scheme, a principal either screens agents with intensity  $s \geq \underline{s}$  to recruit some cooperative types, or she does not screen at all. The reason is straightforward. By choosing  $s' < \underline{s}$ , a principal cannot recognize any cooperative agent

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<sup>2</sup>It could also be interpreted as an agent's shirking cost. The results would not change if we use the pleasure derived from cooperation (instead of using the guilt from shirking) to model the cooperative tendency. As noted earlier, it essentially captures a person's conscientiousness, which Shavell (2002) argues is formed in

and hence she will always end up with a selfish agent; but this can be achieved at a lower cost by not screening at all.

If a principal screens with intensity  $s$ , a typical candidate screened is eventually hired with probability  $\rho + (1 - \rho)(1 - s) \equiv \frac{1}{r}$ , where  $r$  denotes the average number of candidates screened for a job opening. Conditional on being hired, the probability of the worker being a cooperative type is  $\rho r$ . Note that  $r$  is a positive monotonic transformation of  $s$  and measures the *selectivity* of the screening process. It follows from  $s \in [0, 1]$  that  $r \in [1, \frac{1}{\rho}]$ , where  $r = 1$  means no screening and  $r = \frac{1}{\rho}$  perfect screening. The total screening cost is assumed to be  $\frac{1}{2}(r^2 - 1)k_s$ , where  $k_s$  indicates the unit cost of using screening schemes such as interviews.

An implication of this screening process is that a proportion  $(1 - \rho)s \equiv 1 - \frac{1}{r}$  of selfish agents are not hired by screening firms. In the equilibrium, they would be absorbed by principals who choose not to screen at all. Because principals are otherwise identical, they must earn the same profit in equilibrium, regardless of screening or not. In other words, the proportion of screening principals is  $\frac{1}{r}$ , which is endogenously determined by the economy characterized by  $(\rho, \alpha, h, e^2, k_s, k_m, p, q)$ .

## 2.1 The Optimization Problems

The game is solved by backward induction. We first study a worker's decision as to whether to shirk or work hard, taking as given the incentive package  $(w_i, m_i)$  provided by firms. His utility is  $w_i^{\frac{1}{2}} - e^2$  when exerting effort  $e$ , and  $w_i^{\frac{1}{2}}(1 - m_i) - \alpha_i$  if not. So he would not shirk if

$$(1) \quad m_i \geq w_i^{-\frac{1}{2}}(e^2 - \alpha_i)$$

holds.<sup>3</sup> Because monitoring is costly, firms would always choose the minimum possible monitoring level to deter shirking. This leads to the relationship between wage and monitoring

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one's childhood and becomes a stable character through one's life.

<sup>3</sup>The condition holds trivially for agents with  $\alpha_i \geq e^2$  who would never shirk due to high intrinsic incentives. Since this is not our focus, we assume  $\alpha < e^2$ .

$$(2) \quad m_i = (w_i)^{-\frac{1}{2}}(e^2 - \alpha_i).$$

Note that fixing  $w_i$ ,  $m_i^*$  strictly decreases in  $\alpha_i$  so that a principal can save on monitoring costs by hiring a cooperative type agent as opposed to a selfish one. This gives her the incentives to use screening schemes to distinguish and hire cooperative agents. Because screening is also costly, the optimal combination of screening and monitoring is affected by their relative costs.

The optimization problem for principals falls into two cases: some principals screen while others do not. We assume for now both types of agents prefer to work for principals who screen and monitor less (recognizing that screening may prevent selfish applicants from being hired), which would be realized in equilibrium (see Lemma 1).

### 2.1.1 Principals with No Screening

The optimization problem for a non-screening principal is very simple since her agents will certainly be of the selfish type. The optimal incentive package  $(w_n, m_n) > 0$  must satisfy condition (2) for  $\alpha_i = 0$ , which becomes  $w_n = m_n^{-2}e^4$ . Her objective function is

$$\begin{aligned} \max_{m_n} Q_n &= hp - w_n - m_n^2 k_m \\ \text{s.t. } w_n &= m_n^{-2} e^4. \end{aligned}$$

Solving this out, we get the optimal solution

$$\begin{aligned} m_n^* &= ek_m^{-\frac{1}{4}}, \\ w_n^* &= e^2 k_m^{\frac{1}{2}}. \end{aligned}$$

Higher than the reservation wage zero,  $w_n$  is indeed an *efficiency wage* to reward effort and help prevent shirking.

The profit is

$$Q_n^* \equiv hp - w_n^* - m_n^{*2} k_m = hp - 2e^2 k_m^{\frac{1}{2}},$$

where  $M_n^* \equiv w_n^* + m_n^{*2} k_m = 2e^2 k_m^{\frac{1}{2}}$  is the *economic governance cost* of a non-screening principal. The alternative choice of a non-screening principal is zero wage and no monitoring, under which the agent always shirks and produces  $hq$  on average. This implies that positive monitoring is chosen if and only if  $Q_n^* \geq hq$ , that is,

$$(A1) \quad k_m^{\frac{1}{2}} \leq h(p-q)/2e^2,$$

where the monitoring cost is low enough. This condition is assumed true.

### 2.1.2 Principals with Perfect Screening

Before solving the general optimization problem for screening principals, we first study the special case of perfect screening to illustrate the intuition. Principals choose the maximum screening intensity  $s=1$  so that only cooperative type agents are hired. As a result, the optimal incentive package  $(w_s, m_s) > 0$  must satisfy condition (2) for  $\alpha_i = \alpha$ , which becomes  $w_s = m_s^{-2}(e^2 - \alpha)^2$ ; and  $r = 1/\rho$  holds by definition. The objective function of a perfect screening principal is

$$\begin{aligned} \max_{m_s} Q_s &\equiv hp - w_s - m_s^2 k_m - \frac{1}{2} \left( \frac{1}{\rho^2} - 1 \right) k_s \\ \text{s.t. } w_s &= m_s^{-2} (e^2 - \alpha)^2. \end{aligned}$$

Solving this out, we get the optimal solution

$$m_s^* = (e^2 - \alpha)^{\frac{1}{2}} k_m^{-\frac{1}{4}}, \text{ and } w_s^* = (e^2 - \alpha) k_m^{\frac{1}{2}}.$$

Note both monitoring and wage levels are lower:  $m_s^* < m_n^*$  and  $w_s^* < w_n^*$ . So the economic governance cost  $M_s^* \equiv 2(e^2 - \alpha) k_m^{\frac{1}{2}}$  is also smaller than that of a non-screening principal  $M_n^* \equiv 2e^2 k_m^{\frac{1}{2}}$ . This is achieved, however, by incurring a screening cost  $\frac{k_s}{2\rho^2}$ . In other words, screening principals substitute screening for monitoring to handle moral hazard problems.

The resulted profit is

$$Q_s^* = hp - 2(e^2 - \alpha) k_m^{\frac{1}{2}} - \frac{1 - \rho^2}{2\rho^2} k_s.$$

Because principals are otherwise identical, those who screen could always get  $Q_n^*$  by not screening at all. Only when  $Q_s^* - Q_n^* \geq 0$  holds would principals choose to screen, which happens under assumption

$$(A2) \quad k_s \leq \frac{4\alpha\rho^2}{1 - \rho^2} k_m^{\frac{1}{2}}.$$

### 2.1.3 Principals with Some Screening

A typical screening principal has to choose an optimal package  $(w, m, r)$  to maximize her

profit. Actually the only reasonable set of  $(w, m)$  must satisfy condition (1) for  $\alpha_i = \alpha$  to guarantee that the cooperative type agent would not shirk, that is,  $w = m^{-2}(e^2 - \alpha)^2$  holds.<sup>4</sup> Given this package, a cooperative agent will exert effort and produce  $hp$ , which happens with probability  $\rho r$ ; a selfish agent will always shirk and produce  $hq$ , which happens with probability  $1 - \rho r$ . So a screening principal's objective function is

$$\begin{aligned} \max_{m,r} Q &\equiv \rho r(hp - w) + (1 - \rho r)(hq - (1 - m)w) - m^2 k_m - \frac{1}{2}(r^2 - 1)k_s \\ \text{s.t. } w &= m^{-2}(e^2 - \alpha)^2. \end{aligned}$$

Let  $(r^*, m^*)$  denote the optimal solution for screening principals. Its existence and characteristics are summarized in the following proposition.

**Proposition 1.** (i) *The optimal solution  $(r^*, m^*)$  is uniquely determined by*

$$(5) \quad r^* = \frac{\rho[h(p - q) - \frac{1}{2}(e^2 - \alpha)^2 - k_m m^{*3}]}{k_s - \frac{1}{2}\rho^2(e^2 - \alpha)^2},$$

$$(6) \quad \left(2 - \frac{\rho^2}{k_s}(e^2 - \alpha)^2\right)m^{*-1} - 2k_m(e^2 - \alpha)^{-2}m^{*3} + \frac{\rho^2}{k_s}h(p - q) - 1 = 0.$$

The optimal wage is  $w^* = m^{*-2}(e^2 - \alpha)^2$ . Perfect screening is a special case of this problem where  $m^*(r^* = \frac{1}{\rho}) = m_s^* = (e^2 - \alpha)^{\frac{1}{2}}k_m^{-\frac{1}{4}}$ .

(ii) *Based on condition (5),  $\frac{\partial r^*}{\partial m^*} < 0$ ,  $\frac{\partial r^*}{\partial h} > 0$ ,  $\frac{\partial r^*}{\partial k_m} < 0$ ,  $\frac{\partial r^*}{\partial k_s} < 0$ .*

(iii)  *$m^* < m_n^*$  holds where screening principals monitor less;  $Q^* > Q_n^*$  holds under (A2).*

**Proof.** In the appendix.

The proposition says that the optimal screening selectivity  $r^*$  is negatively related to the optimal monitoring intensity  $m^*$ , and both are uniquely determined by the economy. Conditional on the monitoring intensity, principals screen job candidates more selectively when the relevant cognitive ability  $h$  is higher and when screening and monitoring are less costly. The total surplus  $Q^*$  is higher under screening.

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<sup>4</sup>It is too expensive to adopt  $(w_n^* + m_n^*)$  to prevent the selfish type agents from shirking as the non-screening principals do, given that she has already spent  $\frac{1}{2}(r^2 - 1)k_s$  on screening. On the other hand, conditional on the wage level  $w$ , monitoring more than the minimum level  $w^{-\frac{1}{2}}(e^2 - \alpha)$  is more costly and does not

## 2.2 The Equilibrium

If a principal gets higher profit  $Q^*$  if she screens agents than if she does not, then all principals would prefer to screen agents. But this cannot be so in equilibrium. In fact, given that principals are identical with equal mass as agents, competition among principals will eventually drive profits to  $Q_n^*$ . The extra profit  $Q^* - Q_n^*$  will go to the agent.<sup>5</sup> So a cooperative employee/agent working for a principal with some screening would have income

$$I_c = w^* + Q^* - Q_n^*,$$

where  $w^* = m^{*-2}(e^2 - \alpha)^2$ . This must be at least as big as  $w_n^*$ , the income he would have gotten working for a non-screening principal. So the parameters of the economy must satisfy  $I_c \geq w_n^*$  to support an equilibrium where some principals screen job candidates. But this condition also implies that selfish agents would prefer to be hired by screening principals as well.

**Lemma 1.** *If a cooperative agent prefers to work for a screening principal, then a selfish agent would also prefer to do so.*

**Proof.** In the appendix.

The lemma suggests that self-selection would not work here because the package that is attractive to cooperative agents would be just as attractive to selfish ones. So effective screening is necessary to help identify and separate the two types of employees. Though all agents prefer to work for principals who screen, some of those who are selfish are detected as a result of screening and hence are not hired by screening principals. These agents are of proportion  $(1 - \rho)s^* = 1 - \frac{1}{r^*}$ , and they have no choice but to work for non-screening principals. Other selfish agents are lucky enough to be missed by the screening process and secure jobs with the principals who screen, along with the cooperative agents. The following proposition summarizes the equilibrium result.

**Proposition 2.** *In equilibrium, a proportion  $\frac{1}{r^*}$  of principals screen job candidates with intensity  $r^*$ , monitor hired workers with intensity  $m^*$ , offer wage  $w^*$  and benefits*

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reduce shirking for either type of agents.

<sup>5</sup> The screening principals may share some of the extra profit with agents when there are market frictions.

$Q^* - Q_n^*$  to their agents; the other principals do not screen job candidates, monitor hired workers with intensity  $m_n^*$ , offer wage  $w_n^*$  with no benefits to their agents. Both types of agents prefer to work for screening principals.

## 2.3 The Empirical Implications

This simple model has many interesting empirical implications, which are tested empirically below. Its main prediction is of an inverse relationship between screening selectivity  $r^*$  and monitoring intensity  $m^*$ , which is given by condition (5). The corresponding econometric model is denoted by

$$(5') \quad r^* = \beta_0 + \beta_m m^* + \beta_h h + \beta_k k_m + \beta_s k_s + \beta_r \xi_r + \varepsilon_r.$$

where  $\varepsilon_r$  is a random element. The signs of coefficients  $\beta_m < 0$ ,  $\beta_h > 0$ ,  $\beta_k < 0$ , and  $\beta_s < 0$  are determined by the corresponding partial derivatives in Proposition 1. Note that estimating (5') using OLS may be biased since  $m^*$  is an endogenous variable simultaneously determined with  $r^*$ . This prompts us to use 2SLS where  $m^*$  is estimated first based on the linear approximation of (6). The term  $\xi_r$  denotes the set of control variables that may absorb the effects of difficult-to-measure variables in the model including the optimal effort level  $e$ , the stochastic features of production function captured by  $p$  and  $q$ , and the portion of cooperative agents in the population  $\rho$  and the level of cooperative tendency  $\alpha$ .

The second prediction is that the employee incomes are higher when the monitoring intensity is lower. In the model, a worker's income is composed of two distinct parts, one is the pure incentive wage  $w^*$  and a bonus  $Q^* - Q_n^*$ . In the data, it is plausible that the reported employee wage  $W$  contains both  $w^*$  and a base salary proportional to  $Q^* - Q_n^*$  such that  $W = w^* + \omega(Q^* - Q_n^*)$  with  $\omega \in [0,1)$ . And the reported level of employee benefits  $B$  is the residual part of  $Q^* - Q_n^*$  where  $B = (1 - \omega)(Q^* - Q_n^*)$ . Plugging  $Q^* - Q_n^* = \frac{B}{1 - \omega}$  and  $w^* = m^{*-2}(e^2 - \alpha)^2$  into the equation of  $W$ , we get

$$(7) \quad W = m^{*-2}(e^2 - \alpha)^2 + \phi_\omega B.$$

The corresponding econometric model is denoted by

$$(7') \quad W = \phi_0 + \phi_m m^* + \phi_\omega B + \phi_w \xi_w + \varepsilon_w,$$

The signs of coefficients  $\phi_m < 0$  and  $\phi_\omega \geq 0$  are derived from (7). Again  $\xi_w$  denotes control variables including effort  $e$  and cooperative tendency  $\alpha$ , and  $\varepsilon_w$  is a random term.

The third prediction is the positive relationship between screening intensity and worker productivity.<sup>6</sup> Among firms with some screening, the average productivity of workers is

$$(8) \quad P = \rho r^* h p + (1 - \rho r^*) h q = \rho h (p - q) r^* + h q,$$

which strictly increases in  $r^*$ . This equation is estimated by

$$(8') \quad P = \gamma_0 + \gamma_r r^* + \gamma_h h + \gamma_p \xi_p + \varepsilon_p,$$

where  $\gamma_r > 0$  and  $\gamma_h > 0$  should hold according to (8). The control variables in term  $\xi_p$  are  $p$  and  $q$ , some stochastic features of production, and  $\varepsilon_p$  is the residual term.

### 3. Data Description

Equations (5'), (7'), and (8') are estimated using data from the 1997 National Employer Survey, an establishment level survey of employment practices conducted by the U.S. Bureau of Census. It is a nationally representative sample of private establishments with more than 20 employees. In terms of criteria such as representativeness, response rate, and breadth of questions about work practices and organizational characteristics, it appears to be the broadest and best data available on employer practices and, therefore, for testing our results (see Cappelli 2001 for an extensive description of the NES). The summary statistics of variables are listed in Table A.

The NES97 asks a series of questions about how the employer selects employees -- what type of information about applicants do they collect and how important is each in their hiring decision. The stem of the question asks the plant or office manager: "After you have established your applicant pool and obtained information about potential [production or front-line job title provided earlier by the respondent] employee, what characteristics or attributes are most critical in making your hiring decision?" The importance scale ranges

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<sup>6</sup> Though it is possible to have three types of screening intensity ( $s = 0, s = 1, s \in (0, 1)$ ), most firms are likely to have  $s \in (0, 1)$ . Indeed, perfect monitoring and perfect screening may be feasible only in very small

from no value at 1 to important at 3 and to essential at 5. Respondents use this scale to assess twelve general characteristics and attributes about applicants. The details of these characteristics and their means and standard deviations are presented in Table A.

**Screening for Work Ethic.** Our first task is to measure the extent to which employers are attempting to identify the unobserved human capital that would be necessary for them to be productive in a regime of low supervision and monitoring, what we might think of as their intrinsic work ethic or cooperative tendencies. Four items seem specifically oriented toward that goal: screening for applicant attitude, high-quality performance at previous jobs, communication skills, and participation in community and/or extra-curricular activities. Applicant attitude may be the most general attribute and is presumably capturing a range of work-related attributes other than ability, such as motivation and willingness to work hard (see Cappelli 1995). It is also the most important criterion reported by employers, with mean 4.4 and standard error 0.78. In the absence of close supervision and monitoring, employees need to work together and communicate with each other to coordinate efforts and solve problems. Communication skills are therefore particularly important to effective work performance in a low monitoring environment. Participation in community and/or extra-curricular activities reveals a willingness to work on projects that may not offer monetary or even extrinsic rewards, consistent with conscientiousness and a strong work ethic. Community and extra-curricular activities typically involve group-based tasks, requiring cooperative skills, and community activities in particular may also capture an interest in altruistic goals. Performance in previous jobs may reflect a range of success factors in addition to intrinsic motivation and cooperative attributes. As such, we also examine the relationships without this variable. (All of the main results are unchanged when we use the attitude variable alone or when using the average of screening selectivity on attitude and communication skills in a robustness check.) The average importance of these four components is used to measure the employer's interest in screening for the attributes associated with operating in a regime of low monitoring and supervision. It has mean 3.57 and standard error 0.65.

**Screening Selectivity in Cognitive Ability.** We use the average importance of six other criteria -- including industry based credentials, education level (years completed),

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firms, which are ruled out in our data. So the empirical implications are restricted to firms with  $s \in (0,1)$ .

school reputation, academic performance, technical course work, and general course work -- to measure a different kind of screening, the effort to identify cognitive skills. Its mean is 2.81 with standard deviation 0.68. The cognitive requirement of jobs is examined separately by years of completed schooling for production and front-line employees, the focus of the study, across establishments.

**Monitoring Intensity.** We use several variables to measure the extent of employee monitoring across establishments, especially the low monitoring environment associated with teamwork, employee involvement, and high performance work systems. The regularly scheduled meetings where employees discuss workplace problems is the most extensively used of the low monitoring practices with 85% of all establishments in the sample report making at least some use of them. In comparison, only 41% firms adopt self-managed teams. Regularly scheduled meetings to discuss work related issues may also be the most basic type of employee involvement (Cappelli and Carter 2000) while self managed teams, where the team takes over much of the traditional responsibilities of supervisors, may be the most intensive application of a low monitoring environment. While teamwork of this kind reduces monitoring by management, in closely-knit teams, group norms become important, and the group members may end up policing each other's performance (Kandel and Lazear 1992).

An alternative measure of monitoring intensity is the employee-supervisor ratio (Leonard 1987), the number of employees supervised by an individual manager. The assumption is that a lower ratio allows for closer supervision and monitoring by managers. On closer inspection, however, this measure has several drawbacks as a proxy for monitoring. Monitoring may take place through ways other than one's immediate supervisor, the relationship measured by supervisory ratios. And supervisors perform tasks in addition to monitoring. For example, about 20 percent of supervisors' time is devoted to providing informal training (see 1994 NES survey). They may also perform some of the tasks that their supervisees perform, especially if the supervisor operates in the mode of a lead worker. If the supervisory ratio captures in part efforts to train and instruct the workforce and perform some worker tasks, it may be driven in part by factors other than the interest in monitoring employees. More troubling, it may covary with factors considered below in unexpected ways. For example, supervisory ratios may be higher for

less skilled workers, independent of work ethic, because supervisory training is substituting for employee skill. Nonetheless, the employee-supervisory ratio is used as an alternative measure of monitoring intensity in the robustness check.

Other measures of work practices such as the adoption of re-engineering, job rotation, and organizational benchmarking, are included as controls to capture potentially omitted variables that may covary with selection intensity. They capture the extent to which an employer has more sophisticated practices of all kinds, takes management more seriously, or differs in approaches to management that may affect the behavior of employees. These variables have little effect on our main results. We also include detailed industry and size dummies to control for potential variations in the costs or ability to screen and monitor employees (e.g., scale economies) and conduct the analyses separately for manufacturing and non-manufacturing sectors. The fact that the questions in our survey are focused on front-line production employees greatly narrows the range of possible jobs being examined and helps control for exogenous sources of variation. The percentage of minorities and the percentage of women among employees are used as a proxy for diversity of the workforce, which may also affect screening costs. Other potential factors affecting monitoring costs are the use of computers on the job (possibly making tasks easier to monitor) and union strength (possibly restricting the ability of the employer to monitor or to take actions based on monitoring). Some of these variables, such as computer usage, may be determined simultaneously with screening and monitoring intensity and hence may cause endogeneity problems. To check for this, we also run regressions excluding possible endogenous inputs to test for robustness.

The remaining elements in the model are parameters of the production functions that are very difficult to observe, including the desired effort level  $e$ , the stochastic features of production function captured by  $p$  and  $q$ , and workforce characteristics such as the portion of cooperative agents in the population  $\rho$  and the level of cooperative tendency  $\alpha$ . As long as they vary systematically across industry, occupation, and size, however, the detailed industry, sector, and size dummies and the restriction to production jobs should capture the important aspects of production functions. Though various specifications are used to check the robustness of our results, it is always important to keep the effects of omitted variables in mind and be cautious when interpreting the results.

## 4. Estimation Results

### 4.1 Screening and Monitoring

Results of the analyses examining the relationship between screening for work ethic and monitoring intensity are presented in Table 1. They are based on equation (5'), which is presented below using variable names:

$$\text{ScreenSelectivity} = \beta_0 + \beta_m \text{MonitorIntensity} + \beta_k \text{MonitorCost} + \beta_s \text{ScreenCost} \\ + \beta_h \text{WorkerCognitiveSkills} + \beta_r \text{Controls} + \varepsilon_r,$$

We first use employee involvement in regular work meetings as the measure of monitoring intensity where more extensive use of work-related meetings proxy less intensive monitoring of performance.<sup>7</sup> The coefficients of regular work meetings are almost always significant at 1% level across various specifications. Both the scale and significance levels increase when computer usage, minority and union ratios are excluded (results not reported here). These results suggest that there is a synergy between screening employees for work ethic consistent with cooperative behavior and the use of low-monitoring work practices that make use of such behavior. In other words, these practices are complementary. More generally, the results are consistent with the notion that there may be a trade-off between management approaches that rely on conscientious workers and empowered working arrangements versus those that rely on high levels of monitoring.

For a robustness check, the bottom rows of table 1 show the results of using two alternative measures of monitoring intensity instead of regular work meetings. The results are very similar. The coefficients of teamwork are positive and significant at 1% level across various specifications. In the case of the employee-supervisor ratio, its coefficients are positive and significant in 2SLS specifications for the whole sample and the manufacturing sector, though they are insignificant for non-manufacturing sectors or under OLS.<sup>8</sup> The pattern of insignificant relationships in non-manufacturing is common across studies of high performance work systems (Cappelli and Neumark 2001; Lynch and Black

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<sup>7</sup> In the first stage regression of regular work meetings, the controls listed in the table are used as well as women ratio, job rotation and hierarchy levels. The last two variables are not correlated with the screening selectivity at p value 0.1.

<sup>8</sup> Note the relevant coefficients of monitoring intensity in 2SLS specification are (at least) about five times as large as those under OLS.

2004) and may reflect greater heterogeneity across non-manufacturing jobs and less clarity in the use of concepts like teamwork there.

In the last column, we include the effects associated with selectivity on cognitive ability. Because screening for cognitive skills is likely to be endogenous, it is regressed first on the same set of controls as listed in the table as well as on schooling and working hours of the four categories of employees. Employee involvement in regular work meetings is still significant at the 1% level, although its scale is slightly reduced.<sup>9</sup> The large coefficient and high significance level of selectivity on cognitive skills suggest that firms that are selective in screening for good work ethic are also selective in screening cognitive skills. To rule out the possibility that a common underlying factor is driving the results in both cases, we switch the positions of cognitive skill selectivity and screening selectivity for work ethic in a 2SLS regression. Involvement in regular work meetings is no longer significant, as predicted. This suggests screening for other attributes, such as cognitive ability, does not produce the above results.

We also examine the ratio of minorities as a positive indicator of screening costs (Alesina and La Ferrara 2002). It indeed appears to have negative effects on screening selectivity, as predicted by the model. The effects of computer use both by supervisors and production employees increases screening for work ethic. Computer use may suggest greater operating autonomy by employees, more difficulty in monitoring (n.b., using a computer does not mean that work output is computerized), and a greater need for more cooperative employees. The ratio of employees represented by unions reduces this screening in all specifications. Unionization may be a proxy for workplaces that have less employee empowerment and therefore less need for this screening. Higher computer usage appears to reduce the unit monitoring cost while higher union coverage increases it. These results are consistent with our model where screening selectivity decreases with monitoring costs once the effect of monitoring intensity is controlled. The level of schooling as an indicator of cognitive ability, in addition to the selectivity on cognitive skills, has positive and mostly significant effects on screening selectivity for work ethic. This is also consistent with our model. Months to reach job proficiency, a measure of

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<sup>9</sup> In the OLS regression and 2SLS for the manufacture sector, the results including selectivity on cognitive skills as an additional regressor are similar to those presented.

firm-specific skills which may affect screening selectivity through channels of firm-specific training and longer tenures, is never significant.

For a robustness check, we also investigate whether screening predicts various measures of low monitoring. Since monitoring and screening intensities are determined simultaneously in the model, it should not matter which one is treated as the dependent variable. The empirical results (available upon request) are exactly as predicted. In 2SLS regressions using either regular meeting, teamwork, or the employee-supervisor ratio as the dependent variable and the same set of controls, the coefficients of screening are positive and significant in all three cases. These results are robust to various controls in the first stage regression.

## 4.2 Wage, Monitoring, and Non-cognitive Skills

The results examining the relationship between wages and monitoring intensity are presented in Table 2. They are based on equation (7') displayed below in variable names.

$$\text{Logwage} = \phi_0 + \phi_m \text{MonitorIntensity} + \phi_w \text{EmployeeBenefits} + \phi_c \text{Controls} + \varepsilon_w.$$

The monitoring intensity is again measured by employee involvement in regular work meetings. The R-square and the coefficients for the control variables (schooling, employee benefits, the ratios of minority and women, union representation, and working hours per week) are strikingly similar and stable across various specifications using OLS. The signs are also intuitively correct. Once these important variables are controlled, screening selectivity for cognitive skills has no significant effects on the wage level in all specifications. Its effects are negative once selectivity on work ethic is included and in the 2SLS specification as well. Note that the coefficient of regular work meetings in 2SLS specification is about ten times as high as those under OLS.<sup>10</sup>

In sharp contrast, screening for work ethic is always positive and significant across specifications, even when work practice variables are included, as in the last column. The implication is quite clear: screening for unobserved human capital associated with work ethics is associated with higher wages. This result supports and extends the notion that wages are higher where firms use high performance work practices because those practices

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<sup>10</sup> In the first stage regression of regular work meetings, only hierarchy level is included as control because it is the only work practice variable that is uncorrelated with wages at p value 0.01. Both selectivity on

demand more from employees. What they demand, though, are competencies associated with a strong work ethic and cooperative tendencies rather than cognitive ability. The results are similar in all specifications when education levels and working hours by occupations are included to control for the potential complementarities or substitution of educational human capital between different categories of employees in the same firm.

In our model, an employee's wage is uniquely determined when the monitoring level is chosen. Wages and monitoring are always negatively related across firms for the same employee because both represent explicit incentives aimed to reduce shirking. So wages should be positively related to employee involvement in regular work meetings. Across both employee and firm, the relationship becomes more complicated because high monitoring firms with no screening may still pay higher wages to employees to encourage efficiency wage effects. Because of this relationship, we control for screening selectivity in the last two columns of the wage equation. The fact that screening selectivity and monitoring intensity are uniquely determined may explain why the coefficients and R-squared change little across various OLS specifications.

### 4.3 Productivity, Screening, and Monitoring

The NES data also allow us to examine how screening and monitoring may be related to some aspects of productivity. A question in the data about average worker productivity asks the plant or establishment manager, “Compared to your major competitors, do you consider your employees' productivity to be higher, lower, or the same?” About half of the respondents consider their employees' productivity higher and the other half lower or the same, which suggests that this subjective productivity measure may be a reliable measure. We construct a dichotomous variable named “relative productivity,” which equals 1 if it is higher than competitors and 0 if not. The corresponding econometric equation (8') is displayed below in variable names.

$$\text{Pr}(\text{higher productivity}) = \gamma_0 + \gamma_r \text{ScreenSelectivity} + \gamma_h \text{CognitiveAbility} + \gamma_p \text{Controls} + \varepsilon_p.$$

This relationship between screening and productivity is a reduced form derived in the model. The intuition is that with better screening, workers hired are more conscientious

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cognitive skills and average benefits are regressed first on schooling and working hours of other categories of employees in addition to the controls listed in the table.

and thus shirk less, so the average productivity should be higher. Since the relative employee productivity is not a choice variable but a result of many elements, we can treat screening selectivity as an exogenous variable not correlated with the random term when relevant elements are controlled.

In the probit regressions of various specifications shown in Table 3, the screening selectivity of cooperative behavior is indeed positively and significantly related to a firm's relative productivity. Average education levels of employees have positive, though often not significant, effects on a firm's relative productivity. The variable for cognitive skills screening is often significant at the 10% level. Firms with similar job requirements may have employees with similar education levels, but perhaps screening for both cooperative behavior and cognitive skills represents a less well-known approach to finding an effective workforce by measuring difficult-to-observe human capital. The effects of working hours per week on productivity are positive, though not significant when more work practices are controlled. The minority ratio and the union variable tend to reduce a firm's relative productivity, while the ratio of women has a positive, though not significant, influence. When work practices are included as regressors, the coefficients of screening selectivity on work ethic are reduced slightly, suggesting complementarities between them.

Comparing the results of the last two columns, we can see the positive and significant effects of regular work meetings on relative productivity controlling for other work practices. Teamwork (not shown in the table) also has a positive and significant influence in these two regressions, while other control variables (including benchmarking, reengineering, job rotation, employee-supervisor ratio, and hierarchy level) remain insignificant. The main results are robust when we include more regressors such as a firm's capital stock, new equipment, production costs, temporary workers, education levels of other occupations, computer usage, etc. The results with these additional controls are available upon request. It is worth noting, however, that this productivity measure does not necessarily estimate costs and therefore efficiency. It is possible that the costs associated with screening – including higher wages -- may offset any productivity gains.

The amount of sale per employee is an alternative productivity measure that has been used before with NES97 data. For a robustness check, we also examined the effect of screening selectivity on this measure. The main results can be summarized as follows

(details are available upon request). In the OLS regressions, there are positive and significant effects of selectivity for work ethic on sales for the manufacturing sector, which are robust to various controls. The effects are positive but not significant for the non-manufacturing sector. This pattern is similar to the results found by other researchers (Cappelli and Neumark 2001; Lynch and Black 2004). The effects of selectivity in cognitive skills are never significant and sometime negative.

## 5. Conclusions

We analyze the relationship between screening selectivity and monitoring intensity in the context of a principal-agent model and test the theoretical results using a national sample of U.S. establishments. We find that more selective screening for work ethic, but not for cognitive ability, is indeed related to less monitoring and greater use of high involvement work practices that require cooperative employee behavior. It also leads to higher worker productivity and higher wages and benefits. The underlying intuition is that a screening firm hires conscientious workers who are willing to work hard with less monitoring. These employers can then make use of practices that involve workers more and monitor them less. Reduced monitoring costs improve firm performance and allow the firm to share rents in the form of higher wages in order to attract and retain these good workers. Our theoretical model also provides a useful framework to interpret many empirical results in previous studies about work practices and their effects on productivity and worker compensation. In future work, it would be interesting to examine in more detail the choices that employers make with respect to the screening of job applicants.

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Table A: Summary Statistics

Variable Names	Mean (Std. Dev.)	Obs.
<b><u>Screening Selectivity</u></b>		
“After you have established your applicant pool and obtained information about potential [production or front-line job title] employees, what characteristics or attributes are most critical in making your hiring decision?” Please rank each method (5 = Essential, 4 = Very Important, 3 = Important, 2 = Is of Some Value, 1 = No Value).		
<b>Screening Selectivity on Cooperative Tendency</b>	<b>3.57 (.65)</b>	<b>2741</b>
Attitude	4.40 (0.78)	2746
Previous job performance	3.99 (0.96)	2749
Communication skills	3.80 (1.03)	2749
Extra-curricular activities	2.11 (0.97)	2747
<b>Selectivity on Cognitive Skills</b>	<b>2.81 (0.68)</b>	<b>2722</b>
Full-time work experience	3.83 (0.93)	2751
After-school or summer work	2.55 (1.03)	2742
Industry based credentials	3.33 (1.23)	2749
Education level (years completed)	3.05 (1.00)	2746
School reputation	2.04 (0.98)	2746
Academic performance	2.52 (1.06)	2748
Technical course work	2.79 (1.14)	2742
General course work	2.38 (0.95)	2745
<b><u>Work Organization and Design</u></b>		
What percent of non-managerial and non-supervisory employees are involved in <b>regularly scheduled meetings</b> to discuss work-related issues?	<b>.57 (.43)</b>	<b>2898</b>
<b>Teamwork:</b> What percent or how many of non-managerial and non-supervisory employees are currently involved in self-managed teams?	<b>.16 (.30)</b>	<b>2928</b>
Has your establishment participated in any <b>benchmarking</b> programs that compare your practices and performances with other organizations?	<b>.33 (.47)</b>	<b>2861</b>
Has your establishment undergone <b>re-engineering</b> within the past three years?	<b>.38 (.49)</b>	<b>2934</b>
What percent or how many of non-managerial and non-supervisory employees are currently involved in <b>job rotation</b> ?	<b>.20 (.31)</b>	<b>2935</b>
<b>Hierarchy levels:</b> How many levels are there between a front-line supervisor and the top official in your establishment?	<b>2.6 (2.7)</b>	<b>2903</b>
<b>Employee-supervisor ratio:</b> On average, how many employees report to each front-line supervisor?	<b>19 (21)</b>	<b>2771</b>
<b><u>Workforce Characteristics</u></b>		
What percent or how many of your permanent employees are <b>women</b> ?	<b>.39 (.26)</b>	<b>2883</b>
What percent or how many of your permanent employees are <b>minorities</b> ?	<b>.27 (.26)</b>	<b>2829</b>

Variable Names (cont.)	Mean (std. dev.)	Obs.
What is the average number of years of completed <b>schooling</b> for the following categories of employees?		
the production employees	<b>12 (1.3)</b>	<b>2663</b>
Office/clerical/sales/customer service	12.64 (1.05)	2700
Technical/technical support supervisors	14.30 (1.66)	2129
Management/professionals	13.31 (1.48)	2415
	15.35 (1.48)	2801
How many <b>hours per week</b> , including overtime, do the following categories of employees typically work?		
the production employees	<b>43.05 (6.02)</b>	<b>2740</b>
Office/clerical/sales/customer service	40.69 (3.41)	2780
Technical/technical support supervisors	43.72 (5.33)	2192
	45.99 (5.55)	2481
Management/professionals	47.39 (6.36)	2878
<b><u>Compensation and Benefits</u></b>		
What is the <b>average pay</b> for the full-time production employees?	<b>27322</b> <b>(12230)</b>	<b>2495</b>
<b>Average employee benefits:</b> Does your establishment contribute toward any of the following employee benefits? (a) Pension plan, (b) Severance plan, (c) Medical or health insurance (d) Dental care benefits, (e) Child care benefits, (f) Family leave, (g) Life insurance, (h) Sick pay, (i) Paid vacation/holidays, (j) Stock options or profit sharing	<b>.70 (.19)</b>	<b>2855</b>
<b>Union:</b> What percent or how many of your non-managerial, non-supervisory employees are covered by a collective-bargaining agreement?	<b>.20 (.36)</b>	<b>2943</b>
<b><u>Other Variables</u></b>		
<b>Relative productivity:</b> Compared to your major competitors, do you consider your employees' productivity to be higher, lower, or the same?	<b>.50 (.50)</b>	<b>2804</b>
<b>Computer usage (supervisors):</b> What percent of your managers and supervisors use computers in their jobs?	<b>.82 (.28)</b>	<b>2732</b>
<b>Computer usage (production employees):</b> What percent of your production [sales/customer service/other front line] and non-supervisory employees use computers in their jobs?	<b>.45 (.38)</b>	<b>2699</b>
<b>Training expenditure:</b> What did your establishment spend last year on formal training programs? (in thousand)	<b>19.07</b> <b>(17.32)</b>	<b>1682</b>
How many <b>weeks</b> does it take to fill a typical [production job title] opening?	<b>3.19 (3.13)</b>	<b>2693</b>
How many <b>candidates</b> do you interview for each [production job title] opening?	<b>6.71 (8.29)</b>	<b>2557</b>
<b>Manufacture sector</b>	<b>.59 (.49)</b>	<b>3081</b>
<b>5 size dummies and 21 industry dummies</b>		<b>3081</b>

Table 1: The Relationship between Screening Selectivity for Cooperative Tendency and Monitoring Intensity (as Measured by Regular Work Meetings)

	2SLS (All Sectors)	2SLS Manufacture	2SLS Non-man.	OLS	2SLS
Regular work meetings	.0082** (.0022)	.0075** (.0026)	.0098* (.0036)	.0014** (.0003)	.0061** (.002)
Schooling	.048** (.014)	.0005 (.028)	.066** (.017)	.06** (.012)	.014 (.017)
Minority ratio	-.0023* (.0005)	-.0016* (.0007)	-.0013 (.001)	-.0014** (.0005)	-.0008 (.0006)
Union ratio	-.0002 (.0004)	-.0002 (.0005)	-.0001 (.0009)	-.0007 (.0004)	-.001** (.0004)
Working hours per week	.002 (.003)	.002 (.004)	.005 (.005)	.002 (.003)	.002 (.003)
Computer usage (supervisors)	.0009 (.0006)	.0011 (.0008)	.0004 (.001)	.0018** (.0005)	.0007 (.0007)
Computer usage (production employees)	.0006 (.0005)	.0001 (.0008)	.0015* (.0008)	.0012** (.0004)	.00005 (.0005)
Months to reach job proficiency	.0018 (.0012)	.0035 (.0018)	-.0004 (.0017)	.0018 (.0012)	.0004 (.001)
selectivity on cognitive skills					.31 (.19)^
Industry and size dummies	Included	Included	Included	Included	Included
Observation	2087	1337	750	2138	1363
R-square	-	-	-	0.17	-
Teamwork <sup>#</sup>	.012** (.003)	.009** (.003)	.017^ (.009)	.0016** (.0004)	.010** (.003)
Employee-supervisor ratio <sup>#</sup>	.023** (.007)	.012* (.005)	-.015 (.018)	.0007 (.0007)	.012** (.004)

\*\* p<.01, \* p<.05, ^ p<.1.

<sup>#</sup> The variable is used in place of regular meetings to measure monitoring intensity, while other inputs are the same as above.

Table 2: The Relationship between Log Wage and Monitoring Intensity  
(as Measured by Regular Work Meetings)

	OLS	2SLS	OLS	OLS	OLS
Regular work meetings	.0003* (.00015)	.0037^ (.002)		.0003* (.00015)	.0003^ (.0002)
Screening selectivity on cooperative tendency			.041** (.012)	.040** (.012)	.041** (.013)
selectivity on cognitive skills	.014 (.0096)	-.0038 (.16)	-.0052 (.012)	-.007 (.012)	-.0025 (.013)
Schooling	.095** (.0058)	.080** (.011)	.093** (.0058)	.094** (.0058)	.093** (.0065)
Employee benefits	.35** (.038)	.93^ (.49)	.35** (.037)	.34** (.038)	.35** (.044)
Minority ratio	-.0012** (.0002)	-.0007^ (.0004)	-.0012** (.0002)	-.0012** (.0002)	-.001** (.0003)
Ratio of women	-.0045** (.0003)	-.0048** (.0006)	-.0045** (.0003)	-.0045** (.0003)	-.0045** (.0004)
Union ratio	.0018** (.0002)	.0016** (.0004)	.0018** (.0002)	.0018** (.0002)	.0018** (.0002)
Working hours per week	.018** (.001)	.015** (.002)	.017** (.001)	.017** (.001)	.017** (.001)
Other work practices^^					Included
Industry and size dummies	Included	Included	Included	Included	Included
Observation	2182	1272	2200	2179	1728
R-square	0.56	-	0.56	0.56	0.57

\*\* p<.01, \* p<.05, ^ p<.1.

^^ --The other work practices include teamwork, benchmarking, re-engineering, job rotation, hierarchy level, and employee-supervisor ratio.

Table 3: The Relationship between Relative Productivity and Screening

	Probit (1)	Probit (2)	Probit (3)	Probit (4)
Screening selectivity on cooperative tendency	.16** (.054)	.19** (.07)	.13* (.058)	.11^ (.058)
Schooling	.053* (.025)	.07* (.03)	.038 (.027)	.034 (.027)
Selectivity on cognitive skills	.089^ (.051)	.038 (.068)	.098^ (.054)	.098^ (.054)
Minority ratio	-.002^ (.0011)	-.0016 (.0014)	-.0023* (.001)	-.0012** (.0002)
Ratio of women	.0023 (.0015)	.003 (.002)	.0013 (.0016)	.0015 (.0016)
Union ratio	-.002** (.0002)	-.003** (.001)	-.003** (.0008)	-.003** (.0008)
Working hours per week	.0086^ (.005)	.011^ (.007)	.0075 (.0053)	.007 (.005)
Regular work meetings				.0026** (.0007)
Other working practices^^			Included	Included
Other control variables^^^		Included		
Industry and size dummies	Included	Included	Included	Included
Observation	2362	1392	2126	2115
Pseudo R square	0.043	0.046	0.049	0.053

\*\* p<.01, \* p<.05, ^ p<.1.

^^ -- The other work practices include teamwork, benchmarking, re-engineering, job rotation, hierarchy level, and employee-supervisor ratio.

^^^ -- Other control variables include training expenditure, weeks to fill a job opening, and the number of candidates interviewed. Only training is significant.

## Appendix

### 1. The proof for proposition 1.

A screening principal's objective function is

$$\begin{aligned} \max_{m,r} Q &\equiv \rho r(hp - w) + (1 - \rho r)(hq - (1 - m)w) - m^2 k_m - \frac{1}{2}(r^2 - 1)k_s \\ &= \rho rhp + (1 - \rho r)(hq + m^{-1}(e^2 - \alpha)^2) - m^{-2}(e^2 - \alpha)^2 - m^2 k_m - \frac{1}{2}(r^2 - 1)k_s, \end{aligned}$$

where the second equality holds by plugging in  $w = m^{-2}(e^2 - \alpha)^2$ . The interior first order conditions are

$$(9) \quad r^* \in (1, \frac{1}{\rho}]: \quad \rho h(p - q) - \rho m^{-1}(e^2 - \alpha)^2 - rk_s = 0,$$

$$(10) \quad m^* : -(1 - \rho r)(e^2 - \alpha)^2 + 2m^{-1}(e^2 - \alpha)^2 - 2m^3 k_m = 0.$$

Solving the term  $m^{-1}(e^2 - \alpha)^2$  from condition  $m^*$  and plugging it into  $r^*$ , we get condition (5):

$$r^* = \frac{\rho[h(p - q) - \frac{1}{2}(e^2 - \alpha)^2 - m^3 k_m]}{k_s - \frac{1}{2}\rho^2(e^2 - \alpha)^2}.$$

A sufficient condition for  $r^* \geq 0$  is

$$(A3) \quad k_s > \frac{1}{2}\rho^2(e^2 - \alpha)^2.$$

Solving out  $r$  from condition (9) and plugging it to (10), we get

$$Q_m(m, r(m)) = (e^2 - \alpha)^2 \left[ \frac{\rho^2}{k_s} h(p - q) - 1 \right] + \left[ 2 - \frac{\rho^2}{k_s} (e^2 - \alpha)^2 \right] m^{-1} (e^2 - \alpha)^2 - 2m^3 k_m = 0.$$

This is exactly condition (6), which uniquely determines  $m^*$  since its second derivative

$$Q_{mm} = -\left[ 2 - \frac{\rho^2}{k_s} (e^2 - \alpha)^2 \right] m^{-2} (e^2 - \alpha)^2 - 6m^2 k_m < 0$$

is strictly negative under assumption (A3).

This in turn implies that  $r^*$  is uniquely determined by condition (5), which obviously decreases in  $m^*$  when all exogenous parameters  $(\rho, \alpha, h, e^2, k_s, k_m, p, q)$  are controlled. Conditional on  $m^*$  and other parameters,  $r^*$  increases in the cognitive ability  $h$  and in the absolute effect of employee shirking  $h(p - q)$ .

It is easy to check that  $m^* < m_n^*$ . Plug  $m_n^* = ek_m^{-\frac{1}{4}}$  into (10) we get  $-(1 - \rho r)(e^2 - \alpha)^2 + 2e^{-1}k_m^{\frac{1}{4}}[(e^2 - \alpha)^2 - e^4] < 0$ . Since the second derivative of (10) w.r.t.  $m$  is strictly negative,  $m^* < m_n^*$  must be true. That is, screening principals indeed adopt lower monitoring intensity than non-screening principals. The optimal wage is  $w^* = m^{*-2}(e^2 - \alpha)^2$  by condition (2).

Perfect screening is a special case of this solution where principals choose the maximum screening intensity such that  $r = 1/\rho$  and only cooperative type agents are hired. Plugging  $r^* = \frac{1}{\rho}$  into the first order conditions we get  $m_s^* = (e^2 - \alpha)^{\frac{1}{2}} k_m^{-\frac{1}{4}}$  from (10), and

$\frac{k_s}{\rho^2} \leq h(p-q) - (e^2 - \alpha)^{\frac{3}{2}} k_m^{\frac{1}{4}}$  from (5). When

$$(11) \quad \frac{k_s}{\rho^2} > h(p-q) - (e^2 - \alpha)^{\frac{3}{2}} k_m^{\frac{1}{4}}$$

is true, we get  $r^* \leq \frac{1}{\rho}$  from (5). That is,  $m^* < m_s^*$  if (11) holds, while  $m^* = m_s^*$  otherwise.

This means  $Q(m_s^*, r(m_s^*)) \leq Q(m^*, r(m^*)) \equiv Q^*$  must be true when (11) is true. Since  $Q_n^* < Q(m_s^*, r(m_s^*)) = Q_s^*$  under assumption (A2), it follows that  $Q^* > Q_n^*$  must also hold.

To guarantee  $r^* > 1$ , (9) must be positive when  $r = 1$  is plugged in. That is,  $\frac{k_s}{\rho} < h(p-q) - m_1^*(e^2 - \alpha)^2$  should hold, where  $m_1^* \equiv m^*(r=1)$ . But we know  $m_1^* < m_n^*$ , which means  $\frac{k_s}{\rho} < h(p-q) - m_n^*(e^2 - \alpha)^2$  or

$$(12) \quad \frac{k_s}{\rho} < h(p-q) - \left(1 - \frac{\alpha}{e^2}\right)^{\frac{1}{2}} (e^2 - \alpha)^{\frac{3}{2}} k_m^{\frac{1}{4}}$$

is a sufficient condition for  $r^* > 1$ . Since  $\rho < 1$ , both (11) and (12) can be true.

## 2. The proof for lemma 1.

Note that a selfish agent gets utility  $w^{\frac{1}{2}}(1 - m^*) + Q^* - Q_n^*$  if he is hired by a screening principal, and  $w_n^{\frac{1}{2}} - e^2$  if hired by a non-screening principal. He prefers to work for a screening principal when  $Q^* - Q_n^* \geq w_n^{\frac{1}{2}} - w^{\frac{1}{2}} + (w^{\frac{1}{2}} m^* - e^2)$  holds. And this is indeed true: condition (2) implies  $w^{\frac{1}{2}} m^* = (e^2 - \alpha) < e^2$ ;  $I_c \geq w_n^*$  implies  $Q^* - Q_n^* \geq w_n^* - w^*$  and hence  $Q^* - Q_n^* \geq w_n^{\frac{1}{2}} - w^{\frac{1}{2}}$ , given that  $w_n^* - w^* \geq w_n^{\frac{1}{2}} - w^{\frac{1}{2}}$  holds for any  $w^* \geq 0.25$ .

Though we do not have an analytical form for  $I_c \geq w_n^*$ , we can find a sufficient condition for it. The same cooperative type agent, if he works for a principal with perfect screening, gets income  $I_s = w_s^* + Q_s^* - Q_n^*$ . Since  $m^* < m_s^*$  under (11) and

$w^* = m^{*-2}(e^2 - \alpha)^2$ , it is true that  $w^* > w_s^* = m_s^{*-2}(e^2 - \alpha)^2$ . We also know  $Q^* > Q_s^*$  from the above proposition. Since  $I_s \geq w_n^*$  holds when  $k_s \leq \frac{2\alpha\rho^2}{1-\rho^2} k_m^{\frac{1}{2}}$  is true, it follows

immediately that  $I_c > I_s \geq w_n^*$  holds as well.