Geeksploitation: Optimism and Monitoring-Aversion in Agency Relationships

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Abstract

This paper addresses the contracting implications of New Economy firms: informal, flexible organizations predominantly staffed by younger workers. The model incorporates two findings from the behavioral economics literature. First, workers may overestimate their own productivity (optimism). Second, workers may be monitoring-averse, with intense monitoring undermining intrinsic motivation. The combination of behavioral traits and work setting has deleterious consequences for workers. Despite higher monetary compensation and sometimes weaker incentives, they work harder in equilibrium, experience a higher disutility of effort than conventional workers, and also have a utility realization that is lower on average than their reservation utility. Optimism and monitoring-aversion are mutually reinforcing. When private information is introduced, both high- and low-productivity unconventional workers benefit, in contrast to standard agency models with asymmetric information. Both types of agents still experience a utility shortfall, however.
1 Introduction

This paper addresses the contracting implications of contemporary, so-called New Economy organizations. These work environments are characterized by flexible scheduling, informal dress, open office design, increased autonomy, and the use of company resources to provide non-work services to employees (meals, recreation, gym facilities); are staffed predominantly by younger workers; and are exemplified by Silicon Valley-based software and Internet firms. I incorporate two findings from the behavioral economics literature into the model. First, the workers in the model overestimate their own productivity (optimism). Second, in addition to being effort- and risk-averse, the workers are monitoring-averse. In a conventional agency model, more intense monitoring allows the principal to impose less risk on the agent. In my model, more intense monitoring, in the form of a more precise measurement of effort, also undermines the workers’ intrinsic motivation, making it more costly for the principal to implement a given effort level. I label optimistic and monitoring-averse workers as unconventional and compare their employment outcomes to conventional agents who are neither optimistic nor monitoring-averse.

The main finding of the paper is that the combination of behavioral traits and work setting has deleterious consequences for unconventional workers. In particular, the unconventional worker works harder in equilibrium and experiences a higher disutility of effort than the conventional worker, and also has a utility realization that is lower on average than his reservation utility. Surprisingly, these outcomes may be accompanied by lower incentives. The worker accepts the contract because his optimistic bias causes him to overestimate his expected utility. The fully rational principal anticipates that optimism will induce the agent to accept the contract. Thus, the firm benefits at the worker’s expense. In addition, the unconventional worker is always monitored less closely and has higher expected monetary compensation than the conventional worker. Casual observation of the pay level, apparently relaxed working conditions and low-powered incentives of the unconventional worker, then, might lead to the incorrect inference that he was extracting rents from the agency. This collection of outcomes is loosely consistent with the popular term *geekspolitation* (Brenwyn...
a term I will use at later points in the text.

Given the importance of realized utility to my thesis, I explore the implications of providing unconventional workers with the potential ability to extract rents from the agency relationship by including private information. I obtain the standard result that the contract offered to the high-type unconventional worker provides him with expected rents, at least as computed according to his optimistic beliefs. He does not realize the full amount of this rent because, as before, optimism leads to a utility shortfall. I show, in fact, that the shortfall more than offsets the expected rent under broad parameter conditions. Thus, the advantage accruing to the unconventional high-type worker from the private information fails in general to prevent geeksploration. In contrast to standard agency models, the welfare of the low worker also improves with private information. This occurs because the principal reduces the incentives on low type workers to make the low contract unattractive to high type workers. Weaker incentives imply that the low worker receives a smaller de facto utility penalty for his optimism, though still not realizing the reservation utility on average.

The paper is in the spirit of Ross (2004), who documents the lives of workers in Silicon Alley in New York City in the years preceding the dotcom crash. One of Ross’ main themes is that while the work environment afforded personal liberties unparalleled in typical corporate organizations, there were also hidden costs of long work hours and excessive risk-bearing by workers. While most dotcoms themselves have failed, Ross argues that the work environment changes they pioneered are more long-lived.

The behavioral features in the model critical to the results fit naturally into Ross’s vision of the no-collar workplace. The origin of the monitoring-aversion assumption is the extensive experimental literature addressing the relation between extrinsic and intrinsic motivation. In a landmark study, Deci (1971) finds that subjects receiving contingent pay for performing a task perform the task at a lower level than those not receiving contingent pay. Many other researchers have replicated the findings in other settings (see, for example, Deci (1972), Kruglanski, Friedman and Zeevi (1971), and Lepper, Greene and Nisbett (1973)). Exploration of the relation between extrinsic and intrinsic motivation led to studies examining the
interplay between monitoring and intrinsic motivation. Frey (1993) speculates that monitoring may be effective in abstract employment relationships, but might crowd out intrinsic motivation in more personal ones. The explanation of the crowding-out effect generally offered in the literature is that extrinsic incentives and monitoring violate an implicit contract of trust between principal and agent. Barkema (1992) finds evidence consistent with this hypothesis. In his survey, managers directly supervised by the CEO work longer hours than those monitored impersonally by the parent company. Dickinson and Villeval (2004) address this question in an experimental setting and find some evidence that monitoring may undermine intrinsic motivation when the employment relationship is based on interpersonal links.

I argue that implicit trust contracts between managers and workers are more likely to evolve in no-collar workplaces, characterized by the relaxation of the traditional rigidities of office culture, than in traditional workplaces. Though not addressing monitoring directly, Rankin, Schwartz and Young (2008) and Zhang (2008) provide experimental evidence consistent with the spirit of this argument. In a budgeting setting, Rankin, Schwartz and Young (2008) find that a preference for honesty manifests itself only when the agent, rather than the principal, has the final authority over the budget. Zhang (2008) finds that subjects in a multi-agent setting are more likely to report honestly and less likely to attempt to collude if they perceive the principal as fair. In both cases, non-pecuniary aspects of the agent’s relationship with the principal motivate the agent to act in a less self-serving way.

The source of the optimism assumption is the overconfidence/optimism experimental literature. In an early study, Lichtenstein and Fischoff (1977) demonstrate that subjects both overestimate the probability that they have correctly answered a question (optimism) and are overconfident in choosing confidence intervals (i.e., outcomes fall in their X% confidence interval significantly less than X% of the time). Researchers have validated these findings in a variety of settings. For example, see Klayman, Soll, Gonzalez-Vallejo and Barlas (1999), Barber and Odean (2001,) or Svenson (1981).

A branch of behavioral literature addresses optimism in entrepreneurs, who frequently fail
and, on average, have a lifetime income stream significantly lower than that which could have been achieved through conventional employment (Baldwin (1995), Dunne, Robertson and Samuelson (1988), Hamilton (2000), Moskovitz and Vissing-Jorgensen (2002)). Koellinger, Minniti, and Schrade (2007) document survey evidence suggesting entrepreneurs are overconfident about the extent to which they have the skills necessary to succeed. Camerer and Lavalla (1999), in an experimental entry-game setting, find results consistent with the prediction that overconfidence leads to suboptimal entry. All of these findings support the modeling in the paper.

I argue that the no-collar workplace is a natural setting in which to find optimistic workers because it attempts to foster an entrepreneurial culture within a corporate environment (intrapreneurism). Also, these types of organizations attract younger workers. I conjecture that younger workers are more likely to be optimistic because they are less likely to have collected enough data on their own productivity to make an accurate assessment of it.  

The paper makes several contributions. First, it improves the understanding of efficient contracting arrangements in informal, no-collar environments. Research is necessary to understand the manner in which internal control problems differ in these organizations from standard organizations. Chen, Hemmer, and Zhang (2008) examine a similar institutional setting and also find that high pay and loose monitoring are part of the optimal contracting arrangement. The explanation is different, however. In their model, high-potential firms differentiate themselves by adopting expensive contracting features such as high pay and loose monitoring that are unaffordable to low-potential firms. Another important distinction in their paper is that high pay results in expected utility in excess of the reservation utility, whereas high pay fails to compensate the unconventional worker for his higher effort and risk-bearing in mine. Finally, they obtain their results without extending the agency model beyond the canonical behavioral assumptions (risk- and work-aversion).

Second, my paper contributes to the literature on monitoring, albeit from a different perspective from some others in the accounting literature. Papers such as Baldenius, Melumad

\[1\] To my knowledge, the behavioral literature does not document this, however.
and Ziv (2002), Ziv (2000), and Ziv (1993) explore the optimal relationship between productive agents and other agents hired solely for monitoring purposes. In these papers, the supervisory agents are a technology that produces another signal on agent effort, reducing the risk premium paid to the agent in equilibrium. My approach to monitoring is more in the spirit of the aforementioned Chen, Hemmer and Zhang (2008) paper, in the sense that I measure monitoring as the degree of noise in the single measure of the agent’s performance. In Aghion and Tirole (1997), increased supervision by the principal undermines agent effort, as in my model. Better risk-sharing does not motivate the supervision in Aghion and Tirole (1997), however. Rather, the principal and agent both exert to discover the payoffs of feasible projects, over which their preferences diverge. The harder the principal works, interpreted by the authors as supervision, the more likely the principal is to implement her preferred project instead of the agent’s. As a result, the agent works less hard. One interpretation of the results in both Aghion and Tirole (1997) and this paper is that intrinsic incentives may be manipulable by the principal. Finally, in a recent experimental study in the accounting literature, Huntin, Mauldin and Wheeler (2008) demonstrate that continuous monitoring by the internal audit function can discourage managers from taking risky, long-term projects, a tension absent from my model.

Third, my paper adds to the literature attempting to formalize aspects of human behavior documented by the psychology and experimental economics literatures, and to determine their implications in various institutional settings. Many researchers have examined overconfidence. Keiber (2006) models overconfidence in an agency, also using the LEN framework. Both the principal and agent are overconfident about the precision of an information signal used for contracting. The author finds that the mutual overconfidence mitigates the agency problem. Gervais, Heaton and Odean (2007) model overconfidence in a capital budgeting setting. The manager’s overconfidence takes the form of an overestimate of his ability to reduce the risk in a project. As in my model, the principal has correct beliefs. The authors show that the manager’s overconfidence may overcome risk aversion and result in better alignment of manager and shareholder interests. The authors also show that in a
competitive labor market in which the manager extracts the surplus from the agency relationship, the manager’s overconfidence can improve the manager’s welfare by mitigating agency losses. That is, the manager realizes higher average utility than he would if he had been rational. The realized average utility is, however, less than the manager expects (because he is overconfident). Goel and Thakor (2007) show that overconfident managers are more likely to be promoted to CEO. This occurs because the overconfident, risk-averse manager chooses a project that is too risky from a rational utility-maximizing perspective but more aligned with risk-neutral shareholder interests. As in my paper and Gervais, Heaton and Odean (2007), only the manager is overconfident, and the manager’s average utility realization is less than his expectation. The firm’s welfare is non-monotonic in overconfidence. High enough overconfidence leads to overinvestment. Finally, Sandroni and Squintani (2007) model overconfidence in an insurance setting. They find that while overconfidence provides a rationale for compulsory insurance, overconfidence and information asymmetry, the usual rationale for compulsory insurance, are not mutually reinforcing.

Accounting researchers have also incorporated behavioral aspects into both managerial and financial accounting models. Mittendorf (2006) examines a private information, capital budgeting setting in which managers value truth-telling. Fischer and Huddart (2008) explore a multi-agent setting in which the disutility of effort is partially determined by social norms, i.e., the level of effort chosen by the other workers. Finally, Fischer and Verrecchia (1999) and Fischer and Verrecchia (2004) analyze the implication of heuristic, rather than Bayesian, belief revision on optimal disclosure practices.

The organization of the rest of the paper is as follows. In section 2, I develop the model. In section 3, I analyze the full information setting. In section 4, I analyze the private information setting. I summarize and conclude in section 5.

2 Model

The principal is risk-neutral. I examine the contract characteristics for both conventional and unconventional agents/workers. Conventional workers are risk- and effort-averse. Unconven-
tional workers, in addition, are optimistic and monitoring-averse, in ways I will specify later. In general, the principal makes three decisions with respect to the employment relationship with the worker. First, the principal chooses whether to have a traditional or no-collar work environment. The work environment is relevant only to the unconventional worker, who is optimistic in both settings, but monitoring-averse only in a no-collar culture. Second, the principal chooses the intensity of monitoring. Third, the principal chooses the contract parameters (wage and bonus coefficient). Because my interest is in comparing the contract features and employment outcomes of the conventional worker and the unconventional/no-collar worker rather than the principal’s outcome, I suppress the choice of work environment.

I use the LEN model, which entails linear contracts, negative exponential utility, and normally distributed disturbance terms. I make no claim about the optimality of linear contracts in this setting, but rather evoke LEN for tractability. I believe qualitatively similar results would hold for different specifications of the agency relationship. I first describe the general model in the context of the conventional worker. After, I outline the ways in which the unconventional worker differs.

The principal is risk-neutral, and the worker (agent) is risk averse, with a negative exponential utility function, coefficient of risk aversion $r$, and reservation utility $U_R$ normalized to 0. The agent chooses an unobservable effort $a \in [0, \infty]$ that produces output $X = ba$. Output is not available as a performance measure. Instead, the principal relies on a signal that is a noisy function of effort, $Y = fa + \tilde{e}$, where $f$ is the multiplier on effort in the signal, $\tilde{e}$ is a normally distributed error term with variance $k^3 \sigma^2$, and $k \in \{1, \infty\}$. The parameter $k$ determines the intensity of monitoring, which in turn determines how precisely the signal measures effort. In order to focus on the effect of monitoring on incentives, I assume that the exogenous cost of the monitoring technology is independent of $k$, and that $k = 1$ is the maximum feasible intensity of monitoring. The contract is linear, $W + vY$. The conventional

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2The traditional office does not give rise to the implicit trust contract that is a precondition for monitoring to crowd out intrinsic motivation (or, more pertinently, for loose monitoring to increase intrinsic motivation).

3Please see the Appendix for a discrete effort choice version of the model.

4Table 2 provides a full Glossary of Notation.

5The multiplier on variance is $k^3$, rather than $k^2$ or $k$ so that the variance increase due to increased monitoring is convex enough to ensure an interior solution.
agent has disutility of effort $c(a) = \frac{1}{2}a^2$.

For tractability and ease of exposition, the parsimonious specification reduces various possible input and output measures to a single performance measure. As an example of a richer set of measures, consider the performance measurement of a mortgage broker. Possible measures of output include the number of loan applications completed, the proportion of loans that receive approval from underwriters, the dollar volume of loans generated, and the realized payment performance of the applicants receiving mortgages. Possible measures of input include the number of e-mails to potential applicants, the number of phone calls to potential applicants, the total number of applicants contacted, the number of meetings with potential applicants, the number of visits paid to potential applicants, etc. In principle, the broker’s incentive contract could include all of these input and output measures. To streamline the model, I consider only a single output measure. Alternative specifications would yield qualitatively similar results.⁶

The unconventional worker deviates from the conventional worker in two ways. First, the unconventional worker believes that the signal structure is $Y^U = \lambda f a + \tilde{e}$, with $\tilde{e}$ as described before. The parameter $1 < \lambda \leq 2$ captures the unconventional worker’s optimism. As $\lambda$ increases, the unconventional worker is more optimistic about his ability to shift the performance measure higher through effort. The modeling is in the spirit of the optimism literature in which the subject’s beliefs about his ability to perform a task are typically skewed toward overconfidence.

Unlike Keiber (2006), who assumes that both the principal and the agent are overconfident, I assume that the principal’s assessment of the agent is unbiased, consistent with Gervais, Heaton, and Odean (2007). The modeling is consistent with beliefs arising from a biased (optimistic) prior belief subject to Bayesian revision. Because an individual worker observes only one outcome realization per period, his optimism may dissipate more slowly.

⁶In particular, consider the following specification. The principal has two potential performance measures, a noisy output measure subject and a noisy input (effort) measure. Including the input measure in the compensation contract gives rise to incremental disutility of effort because of its perceived invasiveness. The principal balances a risk-premium-reducing additional observation on effort against an increase in disutility of effort, exactly as in my specification, leading to similar results. Note that only the output measure is subject to optimism in this alternative specification.
than the optimism of the principal, who observes the outcomes of many workers every period.
I do not explicitly model this process of Bayesian revision in my one period model, however.7

Second, in a no-collar environment, the intensity of monitoring affects the unconventional worker’s marginal disutility of effort. Specifically, disutility of effort is $c(a) = \frac{1}{2k^2}a^2$. As $k$ increases (monitoring becomes looser), the worker’s marginal disutility of effort decreases. In this sense, the principal, in designing the compensation contract, also partially controls the level of intrinsic motivation. The parameter $\gamma$ determines the unconventional worker’s sensitivity to monitoring, with the sensitivity increasing in $\gamma$. The modeling is consistent with the notion in the behavioral literature that higher monitoring saps the worker’s intrinsic motivation in organizational settings in which there is an implicit trust contract between supervisor and worker.

To summarize, the parameter $k$ operationalizes the link between monitoring and intrinsic motivation documented in the behavioral literature. An important function of monitoring in organizations is to measure a worker’s effort more accurately. The indirect measure of the worker’s effort in the model is the signal $Y$. In modeling terms, increasing the intensity of monitoring (decreasing $k$) reduces the noise in the signal. Admittedly, the signal, as is often the case in agency models, is a black box. As discussed above, increased monitoring could assume the form of tracking a plethora of inputs and outputs about the agent’s efforts. I have collapsed this range of possibilities to a single signal variance. Monitoring is not free, however. It may be expensive to implement monitoring technology, a cost suppressed in the model. Monitoring may also undermine intrinsic motivation, an idea that appears in both the formal literature and business press8:

But although workforce-monitoring software may provide what seems like useful information, it is no help when it comes to addressing the problems it uncovers. It may also undermine morale and mutual trust. Mr Cheese [managing director of Accenture’s talent and organization practice] warns: If you have to check up on employees all the time, then you probably have bigger issues than just productivity.

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7Gervais and Odean (2001) model overconfident traders. In their model, the traders’ initial self-perception is unbiased. Overconfidence evolves because they are not fully Bayesian and take too much credit for their own success. That is, learning is biased, rather than the initial self-perception.
Workers may resist video surveillance, automated keystroke recording, completing detailed timesheets, sitting in close proximity to supervisors, etc. The act of monitoring by the principal renders the task itself more onerous to the worker. Thus, increased monitoring is associated in the model with higher marginal disutility of effort. The final component of the argument, again echoing the literature, is that the degree to which monitoring undermines motivation depends on the implicit trust contract between principals and agents. One would expect this trust contract to exist only in some settings. Employees in military or governmental organizations, for example, would likely expect a high level of monitoring and submit to it without loss of morale, but a programmer or graphics designer might not.

3 Analysis

Though the solution technique for the LEN model is widely known, I develop the solution to the conventional worker’s contract explicitly in order to be able to make a more salient contrast with the unconventional worker’s contracting problem. The general optimization program is

$$\text{Max}_{W, v, a} \quad ba - E[W + vY]$$

subject to $EU[W + vY] \geq 0$ (IR)

$a$ maximizes $EU[W + vY]$, (IC)

where $EU$ designates expected utility. The solution method is to use the incentive compatibility constraint to solve for the optimal effort, the individual rationality constraint to solve for the required wage payment, and then to substitute $a^*(v, k)$ and $W^*(v, k)$ into the objective function and solve for the optimal slope $v^*(k)$. It is clear in the case of the conventional agent that the principal optimally sets the intensity of monitoring to its maximum level ($k = 1$) to minimize the risk premium.

The LEN assumptions imply that the conventional worker’s certainty equivalent is the expected compensation less the disutility of effort and a risk premium:

$$EU[W + vY] = E[W + v(fa + \hat{e})] - \frac{1}{2}a^2 - \frac{1}{2}rv^2\sigma^2.$$
The worker’s first-order condition implies that $a^*(v) = vf$. The individual rationality constraint and reservation utility of 0 jointly imply that

$$W^*(v) = -vf a + \frac{1}{2} a^2 + \frac{1}{2} r \sigma^2.$$  

After making the substitution for $W^*(v)$, the principal’s objective function is:

$$ba - vfa - \left(-vf a + \frac{1}{2} a^2 + \frac{1}{2} r v^2 \sigma^2\right) = ba - \left(\frac{1}{2} a^2 + \frac{1}{2} r v^2 \sigma^2\right).$$  

(1)

The principal anticipates that the worker will, on average, realize contingent pay of $vf a$, and therefore lowers the wage by the same amount to keep the expected utility equal to the reservation utility. The mathematical outcome is that the principal maximizes the output ($ba$) less the amounts necessary to compensate the agent for working ($\frac{1}{2} a^2$) and bearing risk ($\frac{1}{2} r v^2 \sigma^2$). Substitution of $a^*(v)$ into the objective function yields the unconstrained maximization:

$$\text{Max}_w \quad b v f - \frac{1}{2} v^2 f^2 - \frac{1}{2} r v^2 \sigma^2.$$  

The following lemma summarizes the conventional agent results. Please see the Appendix for all proofs.

**Lemma 1** The optimal linear contract with the conventional agent has slope $\frac{bf}{f^2 + r \sigma^2}$. The agent chooses effort $\frac{bf^2}{f^2 + r \sigma^2}$, experiences disutility of effort $\frac{b^2 f^4}{2 (f^2 + r \sigma^2)^2}$, and receives total compensation (wage plus expected contingent pay) of $\frac{1}{2} \frac{b^2 f^2}{f^2 + r \sigma^2}$. The conventional agent’s average utility realization is equal to the reservation utility.

Turning to the unconventional worker’s contract, the general optimization program is

$$\text{Max}_{w,v,a} \quad ba - E[w + vY]$$

subject to $EU[w + vY U] \geq 0$  

$I\!R$

$a$ maximizes $EU[w + vY U], \geq 0$  

$IC$
where $EU$ designates expected utility with respect to the error term, and $Y^U = \lambda fa + \tilde{e}$, reflecting the unconventional worker’s incorrect belief (optimism) about the structure of the signal. Note that the principal incorporates the correct signal $Y = fa + \tilde{e}$ in her optimization problem. The solution method is the same as before except that, after expressing the principal’s expected surplus as a function of monitoring $k$, I will solve for the optimal $k^*$. The unconventional worker’s certainty equivalent is

$$EU[w + vY^U] = E[w + v(\lambda fa + \tilde{e})] - \frac{1}{2k\gamma}a^2 - \frac{1}{2}rv^2k^3\sigma^2.$$ 

The agent’s first-order condition implies that $a^*(v, k) = vk\lambda f$. The effort is increasing in the slope of the contract ($v$), sensitivity to monitoring ($\gamma$), optimism ($\lambda$), and in the sensitivity of the performance measure to effort ($f$), and decreasing in the intensity of monitoring ($\frac{1}{k}$). Solving for the wage yields

$$W^*(v, k) = -v\lambda fa + \frac{1}{2k\gamma}a^2 + \frac{1}{2}rv^2k^3\sigma^2.$$ 

After making the substitution for $W^*(v, k)$, the principal’s objective function is:

$$ba - vfa - \left( -\lambda vfa + \frac{1}{2k\gamma}a^2 + \frac{1}{2}rv^2k^3\sigma^2 \right),$$

which is equivalent to

$$ba + (\lambda - 1)vfa - \left( \frac{1}{2k\gamma}a^2 + \frac{1}{2}rv^2k^3\sigma^2 \right).$$

Equation 2 serves as a useful counterpoint to equation 1. Unlike in the conventional case, the worker’s contingent pay ($vfa$) does not exactly offset the amount in the worker’s wage ($-\lambda vfa$). The resulting second term in equation 3, $(\lambda - 1)vfa$, does not appear in the standard LEN model. The unconventional worker’s optimism leads him to accept a wage based on his perception that one unit of effort shifts $Y$ in expectation by $\lambda f$. In reality, it will shift $Y$ only by $f$, which is less than $\lambda f$. The worker, then, will be disappointed on average by the utility realization. The fully rational principal knows that the agent will accept a fixed wage lower than that which is necessary to attain the reservation utility, and, therefore, benefits from the agent’s disappointment by the amount $(\lambda - 1)vfa$. 

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Substitution of $a^*(v, k)$ into the objective function yields the unconstrained maximization:

$$\text{Max}_v \quad bk v \gamma f + (\lambda - 1)kv^2 \gamma f^2 - \frac{1}{2} kv^2 \gamma \lambda^2 f^2 - \frac{1}{2} rv^2 k^3 \sigma^2.$$ 

Solving for the optimal slope yields $v^*(k) = \frac{bf^2 \gamma \lambda}{\lambda(2-\lambda) \gamma f^2 + rk^2 \sigma^2}$. Having solved for the optimal contract as a function of the monitoring intensity $k$ chosen at the first date, I now determine the optimal monitoring intensity. Plugging $v^*(k)$ back into the objective function and maximizing with respect to $k$ yields $k^* = f \sqrt{\frac{\lambda(2-\lambda)}{r \sigma^2}}$.

The following lemma summarizes the unconventional worker agent results for loose monitoring ($k^* > 1$). The strict monitoring ($k = 1$) solution, similar to the standard solution, appears in the appendix.

**Lemma 2** The principal sets the level of monitoring, $k$, at $\text{Min} \left\{ 1, f \sqrt{\frac{\lambda(2-\lambda)}{r \sigma^2}} \right\}$. The principal chooses loose monitoring if $\gamma > \frac{r \sigma^2}{f^2 \lambda(2-\lambda)}$. If so, then the optimal slope is $\frac{b f \gamma \lambda}{2 f^2 (2-\lambda)}$, the worker chooses effort $\frac{b f (\gamma \lambda)^{3/2}}{2 \sqrt{(2-\lambda)} \sigma^2}$, experiences disutility of effort $\frac{b^2 f (\gamma \lambda)^{3/2} \lambda^{5/2}}{8 \sqrt{(2-\lambda)} \sigma^2}$, and receives compensation of $\frac{b^2 f (\gamma \lambda)^{3/2}}{4 \sqrt{(2-\lambda)} \sigma^2}$. Also, the unconventional worker’s average utility realization is $\frac{b^2 f (\lambda-1)(\gamma \lambda)^{3/2}}{4 \sqrt{(2-\lambda)} \sigma^2}$ less than his reservation utility.

In setting the intensity of monitoring, the principal faces a tradeoff between increasing the agent’s intrinsic motivation and decreasing the risk premium. The intensity of monitoring $(\frac{1}{k})$ is decreasing in the sensitivity of the performance measure to effort $(f)$ and in the sensitivity of the disutility of effort to monitoring $(\gamma)$. As $\gamma$ increases, the benefit of reducing the marginal disutility of effort exceeds the cost of increasing the risk premium, leading the principal to relax monitoring. The coefficient of risk aversion $(r)$ and the baseline variance of the performance measure $(\sigma^2)$ affect only the risk premium. As a result, the principal monitors more intensely if they increase. Finally, the intensity of monitoring is increasing in optimism $(\lambda)$. An increase in optimism allows the principal to reduce the risk premium by increasing monitoring without sacrificing effort.
If $\gamma > \frac{r\sigma^2}{f^2\lambda(2-\lambda)}$, the principal chooses loose monitoring ($k^* > 1$). The threshold is increasing in $r\sigma^2$ because increases in risk motivate the principal to limit the risk premium by tightening monitoring. The threshold is also increasing in optimism, which allows the principal to trade off effort motivation and risk premium reduction.

The equilibrium slope is increasing in the productivity of effort $b$ and optimism $\lambda$, and decreasing in the sensitivity of the performance measure to effort $f$. The slope is fixed with respect to $\sigma^2$ and $r$. This would seem to be in contrast to conventional agency models in which incentives are decreasing in risk, but it is important to remember that the principal responds to increases in risk aversion or baseline variance ($\sigma^2$) by increasing the intensity of monitoring (lowering $k$). Though these effects cancel each other in the optimal slope, they do not cancel out in the total variance of the performance measure, $(k^*(\sigma^2))^3 r\sigma^2$, which is decreasing in $\sigma^2$. Similarly, $v^*$ is fixed with respect to the sensitivity of disutility to monitoring ($\gamma$); in equilibrium, as $k^*$ shows, the principal responds to increases in the sensitivity to monitoring by reducing the intensity of monitoring.

The unconventional worker’s optimism results in an average utility realization lower than the reservation utility. The worker views this as bad luck, not a negative rent. At the time of signing the contract, the worker believes the contract satisfies the individual rationality constraint. The utility shortfall is increasing in both the worker’s true productivity $b$ and the sensitivity of the performance measure to effort $f$. Thus, more talented employees experience a greater shortfall. Though monitoring aversion alone cannot give rise to a utility shortfall, monitoring aversion and optimism are mutually reinforcing: the more optimistic the agent is, the more loose monitoring will induce him to overwork.

I now compare the benchmark and unconventional worker cases with a set of conditions I refer to as geeksploration. The conditions are as follows. First, the principal motivates the unconventional worker to work harder in equilibrium than the conventional worker. Second, the unconventional worker’s resulting cost of effort is higher. Third, the unconventional worker’s resulting cost of effort is higher. Third, the unconventional

\[9(k^*)^3 r\sigma^2 = f^3 \gamma \lambda (2-\lambda) f \sqrt{\frac{3\lambda(2-\lambda)}{r^2 \sigma^2}}, \text{ decreasing in } r\sigma^2.\]

\[10 \frac{\partial EU}{\partial \lambda} = \frac{3\lambda^2 f^2 \sqrt{3\lambda(2-\lambda) \lambda}}{8(2-\lambda) \sqrt{(2-\lambda)^3 r\sigma^2}}, \text{ This is negative for } 1 \leq \lambda \leq 2, \text{ the parameter limits.}\]
worker’s average realized utility is lower than his reservation utility. Fourth, the unconventional worker’s monetary compensation is higher than the conventional worker’s.

Given monitoring-aversion (which lowers the marginal disutility of effort) and optimism (which raises the perceived value of effort), it is not surprising that the unconventional agent works harder in equilibrium than the conventional worker. Because the principal can lower the marginal disutility of effort by reducing the intensity of monitoring, however, it is possible the unconventional worker experiences lower disutility than the conventional agent even though effort is higher. The second condition, as a result, is not self-evident. The third condition is also not self-evident: higher effort and higher disutility from effort do not necessarily imply that the agent’s overall utility is lower because the total compensation may be higher. The fourth condition is that, even though failing on average to attain the reservation utility, the unconventional worker has higher monetary compensation than the conventional worker. Higher pay does not imply excess utility if the worker works long hours and bears high compensation risk. The next proposition summarizes the conditions under which the collection of outcomes described above occurs. I also characterize the intensity of incentives in the optimal contract.

**Proposition 1** For all parameter values, the unconventional worker chooses higher effort and receives higher compensation than the conventional worker, and has an average utility realization less than his reservation utility. If $k^* > 1$ (loose monitoring) and $\gamma < \bar{\gamma}$ (see the Appendix for the closed-form expression), the unconventional worker experiences a lower disutility of effort than the conventional worker. Otherwise, it is higher. Under loose monitoring ($k > 1$), the principal sets a lower slope for the unconventional worker unless the unconventional worker’s optimism ($\lambda$) exceeds $\frac{3}{2} - \frac{r\sigma^2}{2f^2}$.

The only aspect of geeksploration that does not hold for all parameter values is the disutility of effort. By loosening monitoring, the principal reduces the marginal disutility of effort. For low levels of monitoring-aversion, the reduction in the marginal disutility of effort
is proportionally higher than the increase in induced effort, and the agent experiences a lower
total disutility of effort. Though the agent continues, on average, to be disappointed with
his utility realization, loose monitoring has the arguably beneficial effect of producing more
effort at less perceived cost, mitigating geeksploration. In addition, it can be shown that the
unconventional worker bears more risk than the conventional worker. This can occur even if
the contract slope is lower because of loose monitoring.

The proposition also shows that high pay, overwork, and utility shortfalls are not nec-
essarily associated with higher extrinsic motivation. Rather, the unconventional agent may
still do worse than the conventional agent despite lower-powered incentives. If the princi-
pal monitors the unconventional worker tightly, then the unconventional worker’s optimism,
which increases the marginal effort from increasing the slope, induces the principal to set a
higher slope. If monitoring is loose, however, the principal faces a potential tradeoff between
incentives and the risk premium. If optimism is low, then the marginal benefit of reducing
the risk premium by reducing slope is greater than the marginal cost of inducing lower effort
and lower output. This shows that higher extrinsic motivation is not necessary for geeks-
ploration to occur if instead the principal can induce higher intrinsic motivation by looser
monitoring. Benabou and Tirole (2003) also find that lower-powered incentives can produce
higher effort. The mechanism in their model is different, however, as the principal signals
her private information that the agent is high type through the level of incentives. Still, the
desirability of lower-powered incentives occurs in both models.

Table 1 summarizes the role of each behavioral assumption in the results. The fourth
column, labeled Both Assumptions, restates the Proposition. The second and third columns
describe the results for each behavioral trait in isolation. Both traits generate higher effort, a
higher risk premium, and higher compensation. Not all of the results are the same, however.
The contract slope is strictly higher if optimism is the only behavioral trait. This occurs
because in setting the level of incentives, the principal balances effort motivation against the
risk premium. The worker’s optimism means that the marginal product of increasing the
slope from the conventional worker’s slope exceeds the marginal risk premium. Thus, the
principal sets a higher slope. Different forces come into play if monitoring-aversion is the only behavioral trait. Monitoring-aversion allows the principal to increase effort by lowering the intensity of monitoring. She faces the same tradeoff with the risk premium, however, because lower monitoring increases the multiplier on the baseline variance ($\sigma^2$). If $\sigma^2$ is low, then reducing monitoring is a more efficient way of motivating effort than increasing the slope, and the principal sets a lower slope than for the conventional worker. If the worker has both behavioral traits, the proposition shows that, under certain conditions, the optimal contract substitutes loose monitoring for intensity of incentives, resulting in a lower slope. The cost of effort result also differs across assumptions. If optimism is the only behavioral trait, higher effort implies higher cost of effort. If monitoring is the only trait, however, higher effort does not imply lower cost of effort because loose monitoring reduces the marginal disutility of effort. If both assumptions are present, the proposition establishes that there are conditions under which monitoring is sufficiently loose that higher effort translates into lower cost of effort. The final differences are with respect to the utility shortfall. Optimism is a necessary and sufficient condition for the utility shortfall to occur. If monitoring-aversion is the only trait, the fixed wage adjusts the worker’s expected utility to the reservation level.

[INSERT TABLE 1 ABOUT HERE]

4 Private information

In contrast with most agency models, the agent’s realized utility is a focus of the analysis in this paper. Specifically, the unconventional worker’s behavioral characteristics leave him vulnerable to a utility shortfall despite potentially higher surplus in the agency (if the gains from monitoring-aversion are greater than the loss from optimism). The question naturally arises as to how private information, which typically allows high type workers to extract rents, affects the distribution of surplus between the principal and the worker. In particular, does a privately informed unconventional worker still have an expected utility shortfall?

In this section, there are two types of unconventional workers, high and low, who differ in terms of their productivity. The principal knows the distribution of high and low workers,
but cannot observe their type. The workers, in contrast, know their own type. As in the previous sections, the principal knows the correct form of the signal used for contracting purposes, but both types of workers have optimistic beliefs about their ability to affect it.

The probability that a worker is high is $p$. The output is $X_i = b_ia$, with $i \in \{H, L\}$, and $b_H > b_L$. The actual realization of the signal is $Y = f_ia + \tilde{e}$, with $i \in \{H, L\}$, and $f_H > f_L$. The high and low type workers are equally optimistic, so they expect the signal realizations to be $\lambda f_Ha_H + \tilde{e}$ and $\lambda f_La_L + \tilde{e}$ respectively. The workers are also equally monitoring-averse, and have cost of effort function $\frac{1}{2\sigma}a_i^2$, with $i \in \{H, L\}$.

The principal offers two contracts consisting of a wage, a bonus slope, and a monitoring intensity: $\{W_H, v_H, k_H\}$ and $\{W_L, v_L, k_L\}$. The high worker sets effort equal to $a_H = \lambda \gamma f_H k_H v_H$ if he chooses the high contract, and the low worker sets effort equal to $a_L = \lambda \gamma f_L k_L v_L$ if he chooses the low contract. The non-conforming contract effort levels are $a^H = \lambda \gamma f_H k_L v_H$ and $a^L = \lambda \gamma f_L k_H v_H$ for the two types, respectively.

In equilibrium, the workers choose the contract conforming to their type, implying that the principal's objective function is

$$p(b_Ha_H - v_Hf_Ha_H - W_H) + (1 - p)(b_La_L - v_Lf_La_L - W_L).$$

Substitution of $a_H$ and $a_L$ from the previous paragraph yields

$$p[f_H k_H \gamma v_H (b_H - v_Hf_H) - W_H] + (1 - p)[f_L k_L \gamma v_L (b_L - v_Lf_L) - W_L].$$

A high agent’s certainty equivalent if he chooses the high contract is

$$W_H + v_H^2 f_H^2 k_H \gamma \lambda^2 - \frac{1}{2} v_H^2 f_H^2 k_H \gamma \lambda^2 - \frac{1}{2} r v_H^2 k_H^3 \sigma^2 = W_H + \frac{1}{2} v_H^2 f_H^2 k_H \gamma \lambda^2 - \frac{1}{2} r v_H^2 k_H^3 \sigma^2.$$  

A low agent’s certainty equivalent if he chooses the low contract is

$$W_L + v_L^2 f_L^2 k_L \gamma \lambda^2 - \frac{1}{2} v_L^2 f_L^2 k_L \gamma \lambda^2 - \frac{1}{2} r v_L^2 k_L^3 \sigma^2 = W_L + \frac{1}{2} v_L^2 f_L^2 k_L \gamma \lambda^2 - \frac{1}{2} r v_L^2 k_L^3 \sigma^2.$$  

The principal solves

$$\text{Max}_{W, v, k_i} p[f_H k_H \gamma v_H (b_H - v_Hf_H) - W_H] + (1 - p)[f_L k_L \gamma v_L (b_L - v_Lf_L) - W_L]$$
subject to

\[
\begin{align*}
W_H + \frac{1}{2} v_H^2 f_H^2 k_H \gamma \lambda^2 - \frac{1}{2} r v_H^2 k_H^3 \sigma^2 & \geq 0 \quad (IRH) \\
W_L + \frac{1}{2} v_L^2 f_L^2 k_L \gamma \lambda^2 - \frac{1}{2} r v_L^2 k_L^3 \sigma^2 & \geq 0 \quad (IRL)
\end{align*}
\]

\[
\begin{align*}
W_H + \frac{1}{2} v_H^2 f_H^2 k_H \gamma \lambda^2 - \frac{1}{2} r v_H^2 k_H^3 \sigma^2 & \geq W_L + \frac{1}{2} v_L^2 f_H^2 k_L \gamma \lambda^2 - \frac{1}{2} r v_L^2 k_L^3 \sigma^2 \quad (ICH) \\
W_L + \frac{1}{2} v_L^2 f_L^2 k_L \gamma \lambda^2 - \frac{1}{2} r v_L^2 k_L^3 \sigma^2 & \geq W_H + \frac{1}{2} v_H^2 f_L^2 k_H \gamma \lambda^2 - \frac{1}{2} r v_H^2 k_H^3 \sigma^2 \quad (ICL)
\end{align*}
\]

The first two constraints are the participation constraints. The last two constraints are the incentive compatibility constraints. In equilibrium, the individual rationality constraint of the low agent and the incentive compatibility constraint of the high agent bind. I solve these two constraints simultaneously to find \(W_H\) and \(W_L\) as a function of \(v_H, v_L, k_H,\) and \(k_L\):

\[
\begin{align*}
W_H(v_H, v_L, k_H, k_L) &= \frac{1}{2} [k_H v_H^2 (k_H^2 r \sigma^2 - f_H^2 \gamma \lambda^2) + (f_H^2 - f_L^2) \gamma k_L \lambda^2 v_L^2] \\
W_L(v_H, v_L, k_H, k_L) &= \frac{1}{2} k_L v_L^2 (k_L^2 r \sigma^2 - f_L^2 \gamma \lambda^2).
\end{align*}
\]

To solve for the optimal contract, I substitute \(W_H(\cdot)\) and \(W_L(\cdot)\) into the objective function, differentiate with respect to \(v_H\) and \(v_L\), and solve the two first-order conditions simultaneously to determine \(v_H^*(k_H, k_L)\) and \(v_L^*(k_H, k_L)\). Finally, I substitute the slopes into the surplus and maximize with respect to \(k_H\) and \(k_L\). The following lemma summarizes the optimal contracts.

**Lemma 3** The principal sets the following slopes:

\[
\begin{align*}
v_H^*(k_H) &= \frac{b_H f_H \gamma \lambda}{f_H^2 \gamma \lambda (2 - \lambda) + r k_H^2 \sigma^2}. \\
v_L^*(k_L) &= \frac{b_L f_L \gamma \lambda (1 - p)}{-\gamma \lambda [-f_H^2 \lambda p + f_L^2 (2p - 2 + \lambda)] + r k_L^2 \sigma^2 (1 - p)}.
\end{align*}
\]

The optimal monitoring intensities are \(k_H = Min\{1, \sqrt{\frac{2\lambda(2-\lambda)}{r \sigma^2}} f\}\) and \(k_L = Min\{1, \sqrt{\frac{\gamma \lambda [f_H^2 \lambda p - f_L^2 (2p - 2 + \lambda)]}{r \sigma^2 (1 - p)}}\}\).
The principal sets the high worker’s slope and monitoring equal to the full-information values, but distorts the low worker’s contract. In particular, the monitoring intensity and slope are both lower than in the full information case for the low agent. These results conform to the standard results in the mechanism design literature.

The next proposition summarizes the results pertaining to the expected and realized utilities of both types of agents. Due to the complexity of some of the closed-form expressions, I rely on a mixture of analytical and numerical results. To streamline the exposition, I assume that \( p \) is sufficiently high that the expression for \( k_L \) in the previous lemma is at least 1.

**Proposition 2**

i. The high type worker expects a rent of

\[
\frac{1}{3} \sqrt{\frac{k_L^4 f_H^4 (f_H^2 - f_L^2) \gamma^3 \lambda^5 (1-p)^3}{(f_H^4 - f_L^4)^3}}. 
\]

The rent is less than the utility shortfall, implying that the high worker’s average utility realization is negative, for wide ranges of parameter values.

ii. The low worker’s average utility realization is higher than the full information case, but still negative.

iii. For many parameter values, the low worker’s average utility realization exceeds the high worker’s

Figure 1 illustrates the Proposition. Panels A and B show the increase in average realized utility for both the high and low workers for a specific parameterization of the model. For the high workers, the increase corresponds to the expected rent, which is increasing in optimism and is highest if the proportion of high workers is low. For low values of \( p \), the principal needs to maintain close to full-information incentives for the low type workers who comprise most of the pool, and therefore also produce most of the output. As a result, she must increase \( W_H \) significantly to induce high types to choose the high contract, producing the higher rent.

\[111\text{The results are qualitatively similar, but with different closed-form expressions, if the } k_L = 1 \text{ constraint binds.}\]
Panel B shows that low workers also experience an increase in average realized utility in the private information setting. The result contrasts with the usual result that private information improves the welfare of only the high type worker, and follows from the earlier result that more talented unconventional agents experience a greater utility shortfall. The principal sets stronger incentives for talented agents, magnifying the negative effects of optimism on the worker’s utility realization. In the private information setting, the principal dampens the incentives of the low agent to make the low contract less attractive to the high worker. As a result, low workers overexert less, and suffer a lower de facto penalty for optimism. The increase in realized utility is lowest for low $p$ because the low-type incentives are close to full-information levels in this case.

Panels C and D show net realized utility. Both types of workers are still disappointed on average by their outcomes. If there are relatively few high workers ($p = .10$ line in panel C), then the high-worker disappointment is less in absolute terms than the rent for a relatively wide range of optimism levels, implying a positive rent. Otherwise ($p = .30, .50, .70$ lines), even high workers fail to meet their reservation utility unless optimism is negligible. Utility shortfalls can be severe for highly optimistic high agents. Private information, then, fails to relieve the geeksploration of high workers for much of the parameter space. Low workers fail to obtain the reservation utility on average for all parameter values. Ex post, both high and low types are disappointed on average by their utility realization despite the actual increase in their welfare due to private information. The disappointment for the high worker is the same as in the full-information scenario because only the fixed wage changes in the contract.

To summarize, both types of workers enjoy higher average realized utility under private information than under full information. The high workers expect the improvement as an information rent. Because the improvement for low workers is the reduction of an unexpected utility shortfall, low workers cannot anticipate their welfare improvement. Optimism implies that both types are disappointed by the average outcome. Also, except for a small range of parameters for the high worker, both types still fail to attain their reservation utility.
In addition to documenting a parameterization of the model, Panel C illustrates the general point that optimism and the proportion of high workers are important determinants of whether the high worker attains his reservation utility. As optimism or the proportion of high workers increases, the high worker obtains the reservation utility under a narrower set of the remaining parameters. If the proportion of high workers is high, then Panel C shows that the realized utility is negative for almost all values of optimism. Similarly, if the worker is highly optimistic, then the utility is negative for almost all proportions of high workers. With respect to the other parameters in the problem, the high worker’s expected utility is decreasing in both the multiplier on effort in the signal \( f_H \) and productivity \( b_H \), implying that, all other things equal, increases in these parameters reduce the parameter space over which the high worker obtains the reservation utility. In general, parameter changes that result in increased incentives exacerbate the high worker’s utility shortfall because they magnify the effects of optimism. Finally, the shortfall is indeterminate with respect to the sensitivity to monitoring \( \gamma \), implying that changes in \( \gamma \) have little effect on the parameter space for which the shortfall occurs.

Continuing with Figure 1, Panel E directly compares high and low worker average realized utilities under private information. Low workers have better outcomes unless either optimism or the proportion of high workers is low. Panel E represents improvement for high workers, however, because low workers have higher average realized utilities under full information.

The results show that while private information mitigates the full-information utility shortfalls for both high and low types, the shortfalls still exist under broad conditions. In a more extreme characterization of the labor market, the agent would hold all the power. That is, firms would bid up the high worker’s expected utility to the point that a zero-profit constraint for all firms was met. The high worker would surpass his reservation utility in this setting. I argue that this is not a compelling characterization of the labor market, especially for the younger workers addressed in this model. While CEO-level agents may have considerable bargaining power, lower-level workers likely do not.
5 Conclusion

This paper addresses contracting outcomes for workers who are optimistic and monitoring-averse. The results are particularly applicable to young workers in information-related service industries with no-collar work environments (i.e., characterized by flexible scheduling, informal dress, open office design, relaxed bureaucratic requirements, in-house dining and recreational facilities, etc.), but also applicable to more traditional organizations adopting some of the same practices. The main finding is that, though lightly monitored in equilibrium, having low incentives, and receiving high monetary compensation, the worker overexerts and receives an average utility realization below the reservation utility. Private information mitigates, but does not in most cases eliminate, the utility shortfall.

I borrow the term geeksploitation from popular culture to describe this paradoxical outcome. In the sense that the worker, based on his overestimate of his productivity, freely accepts the contract, one could argue that no exploitation occurs. The principal, however, incorporates knowledge of the worker’s behavioral traits into the design of the optimal contract in such a way as to benefit herself. The results are in the spirit of Ross (2004), who documents the initial feelings of empowerment but ultimate disillusionment experienced by many of the workers in his study of the no-collar environment.

The model depends on assumptions of optimism (the worker overestimates his productivity) and monitoring-aversion (more intense monitoring increases the worker’s disutility for effort) borrowed from the experimental and behavioral literatures. Monitoring aversion is an example of extrinsic motivation driving out intrinsic motivation. Especially important to the study is the finding that more intense monitoring is more likely to sap motivation in a setting in which an implicit trust contract exists between principals and agents. I argue that this is more descriptive of a no-collar work environment (software engineering, for example) than a traditional one (law enforcement agency, for example). Optimism and monitoring aversion are mutually reinforcing in the model. Optimism alone is responsible for the utility shortfall. Monitoring aversion alone is responsible for the possibility of a lower contract slope.

The results have implications beyond the immediate scope of the paper. I have modeled
a single-period principal-agent employment exchange in which the principal has no reason not to exploit the worker’s behavioral characteristics. That is, the principal regards the existence of optimism and monitoring aversion as an opportunity to maximize short-term surplus. In a multi-period setting, however, such exploitation could be costly. For example, overwork and disappointing utility realizations could lead to dissatisfaction, burnout, and costly employee turnover, especially as the most talented agents are the most disappointed. That is, the principal may regard the behavioral characteristics as impediments to a long-term profitable employment relationship. My paper provides insights into how the principal could modulate the contract to mitigate these implicit costs. The paper also suggests a benefit to adopting a Balanced Scorecard integrating measures related to work-life balance. As a check against overwork, for example, the principal could discourage unused paid vacation days. The Innovation and Learning perspective in the Balanced Scorecard would be the natural area to include these measures. The principal would not adopt these measures for paternalistic reasons, but rather as part of an optimal long-term employee retention program.

The notion that the principal can influence intrinsic motivation also has applications in organizational design and performance evaluation beyond the scope of the paper. Just as the framing of a choice affects preferences\textsuperscript{12}, the presumably external features of an organization may affect intrinsic motivation. In designing the management control system, then, managers must adjust performance measurement and incentive systems to the subtleties of the workers' altered preferences. A specific lesson from the paper is that implementing automated monitoring technologies may entail implicit costs if they undermine intrinsic motivation. This lesson is particularly salient as technological improvements lower the outlay cost and increase the scope of monitoring systems.

\textsuperscript{12}See, for example, Johnson and Goldstein (2003), which documents that a significantly higher percentage of people opt for organ donation if the choice is framed as an opt-out (the default is that the subject will donate organs and must check no to prevent it) rather than an opt-in (the default is that the subject will not donate organs and check yes to donate).
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Appendix: Binary Choice Model

In this appendix, I sketch out a discrete effort version of the full-information model, replicating the basic results. The agent chooses effort from \{e_H, e_M, e_L\}. The cost of low effort is 0. The cost of high and medium effort is \(k^{ij}\), where the superscript \(i \in \{h, m\}\) designates the effort level and the superscript \(j \in \{h, l\}\) designates the monitoring regime. I assume that \(k^{ih} > k^{il}\), but impose no ordering between \(k^{hl}\) and \(k^{mh}\).

If the agent selects effort \(e_i\), the eventual cash flows are \(C_H\) with probability \(p_i\) and \(C_L < C_H\) with probability \(1 - p_i\), with \(i \in \{h, m\}\) and \(p_h > p_m > \frac{1}{2}\). If the agent chooses \(e_l\), the eventual cash flows are \(C_L\) with probability 1. The agent is risk averse with utility function \(G(\cdot)\) has reservation utility \(\bar{U} > 0\).

The cash flows occur too late to be useful for contracting purposes. There is instead a signal on output (indirectly on effort). The signal can have a Good \((S_G)\) or Bad \((S_B)\) realization. In a high monitoring regime, the high state of nature (which produces the eventual cash flow \(C_H\)) generates \(S_G\) with probability \(s\), where \(s > \frac{1}{2}\). The low state of nature generates \(S_G\) with probability \(1 - s\). Looser monitoring results in a noisier signal in which the high state of nature generates \(S_G\) \((S_B)\) with probability \(s - e\) and \(1 - s + e\) respectively, where \(e > 0\) and \(s - e > \frac{1}{2}\), so that \(S_G\) really is good news under low monitoring.

The principal has six contracting choices: high effort/high monitoring, high effort/low monitoring, medium effort/high monitoring, medium effort/low monitoring, low effort/high monitoring, and low effort/low monitoring. To replicate the results of the LEN model, I need to find a setting such that the surplus from high effort/low monitoring exceeds the surplus from medium effort/high monitoring, which in turn exceeds the surplus from high effort/high monitoring.\(^{13}\) In this setting, looser monitoring induces the principal to motivate high effort instead of medium effort.

I will examine the high effort/high monitoring case first.

\(^{13}\)It is also necessary that shirking is dominated.
Let $U_{ij}^g$ and $U_{ij}^b$ designate the utility levels implied by the payments that the principal makes to the agent for the realization of Good and Bad signals, respectively. The superscripts have the same meaning as the superscripts for the effort costs. The participation and incentive compatibility constraints are:\textsuperscript{14}

\begin{align*}
[p_h s + (1 - p_h)(1 - s)]U_{gh}^{hh} + [p_h(1 - s) + (1 - p_h)s]U_{bh}^{hh} - k^{hh} & \geq \bar{U} \\
[p_h s + (1 - p_h)(1 - s)]U_{gh}^{hh} + [p_h(1 - s) + (1 - p_h)s]U_{bh}^{hh} - k^{hh} & \geq \\
[(1 - p_h)s + p_h (1 - s)]U_{gh}^{hh} + [(1 - p_h)(1 - s) + p_h s]U_{bh}^{hh} - k^{hh}.
\end{align*}

I assume that $\bar{U}$ is high enough that both constraints bind, implying that I can solve the two constraints simultaneously to find the optimal utility levels:

\begin{align*}
U_{gh}^{hh} & = \bar{U} + \frac{k^{hh} (p_m + s - 2p_m s) - k^{mh} (p_h + s - 2p_h s)}{(p_h - p_m)(2s - 1)}. \\
U_{bh}^{hh} & = \bar{U} + \frac{k^{mh} (1 - p_h - s + 2p_h s) - k^{hh} (1 - p_m - s + 2p_m s)}{(p_h - p_m)(2s - 1)}.
\end{align*}

The expected surplus, designated $ES^{hh}$, is

\begin{align*}
ES^{hh} & = p_h C_H + (1 - p_h)C_L - [p_h s + (1 - p_h)(1 - s)]G^{-1}(U_{gh}^{hh}) - \\
& \quad [p_h (1 - s) + (1 - p_h)s]G^{-1}(U_{bh}^{hh}),
\end{align*}

where $G^{-1}(\cdot)$ is the inverse of the utility function.

I now address the optimal medium effort/high monitoring contract. Note that the binding incentive compatibility constraint implies that $U_{gh}^{hh}$ and $U_{bh}^{hh}$ generate equal utility for high and medium efforts. The binding participation constraint for high effort, therefore, implies that medium effort also generates the reservation utility. The contract motivating medium effort, then, is the same as the contract motivating high effort.\textsuperscript{15} As a result, the expected surplus from motivating medium effort with high monitoring is:

\begin{align*}
ES^{mh} & = p_m C_H + (1 - p_m)C_L - [p_m s + (1 - p_m)(1 - s)]G^{-1}(U_{gh}^{hh}) - \\
& \quad [p_m (1 - s) + (1 - p_m)s]G^{-1}(U_{bh}^{hh}).
\end{align*}

\textsuperscript{14}I assume the parameters are such that the incentive compatibility constraint for low effort is not binding. The agent’s utility if he chooses low effort is $(1 - s)U_{gh}^{hh} + sU_{bh}^{hh}$.

\textsuperscript{15}I assume that the agent follows the principal’s preference if he is indifferent.
\[ p_m(1 - s) + (1 - p_m)s \] \( G^{-1}(U_{b}^{hh}) \).

The expected cash inflow is lower under medium effort, but \( U_{g}^{hh} \) is also paid out less often. Hence, either effort level can maximize net profits, depending on the parameters of the problem.

I now examine the optimal contract motivating high effort in the low monitoring setting. The participation and incentive compatibility constraints are\(^{16}\)

\[
[p_h(s - e) + (1 - p_h)(1 - s + e)]U_{g}^{hl} + [p_h(1 - s + e) + (1 - p_h)(s - e)]U_{b}^{hl} - k_{hl} \geq \bar{U}
\]

\[
[p_h(s - e) + (1 - p_h)(1 - s + e)]U_{g}^{hl} + [p_h(1 - s + e) + (1 - p_h)(s - e)]U_{b}^{hl} - k_{hl} \geq
\]

\[
[(1 - p_h)(s - e) + p_h(1 - s + e)]U_{g}^{hl} + [(1 - p_h)(1 - s + e) + p_h(s - e)]U_{b}^{hl} - k_{ml}.
\]

The equilibrium utility levels are

\[
U_{g}^{hl} = \bar{U} + \frac{k_{hl}(1 - 2p_m) - k_{ml}(1 - 2p_h) + \frac{k_{hl} - k_{ml}}{2(s - e) - 1}}{2(p_h - p_m)}.
\]

\[
U_{b}^{hl} = \bar{U} + \frac{k_{ml}[1 - p_h - s - e + 2p_h(s - e)] - k_{hl}[1 - p_m - s - e + 2p_m(s - e)]}{(p_h - p_m)[2(s - e) - 1]}.
\]

All other things equal, the principal must impose more risk on the agent to motivate effort because the low-monitoring signal is noisier. Balancing this, however, is the lower cost of effort under low-monitoring. The expected surplus under high effort/low monitoring is:

\[
ES^{hl} = p_hC_H + (1 - p_h)C_L - [p_h(s - e) + (1 - p_h)(1 - s + e)]G^{-1}(U_{g}^{hl})
\]

\[
- [p_h(1 - s + e) + (1 - p_h)(s - e)]G^{-1}(U_{b}^{hl}).
\]

Using an argument analogous to before, the expected surplus under medium effort/low monitoring is

\[
ES^{ml} = p_mC_H + (1 - p_m)C_L - [p_m(s - e) + (1 - p_m)(1 - s + e)]G^{-1}(U_{g}^{hl})
\]

\[
- [p_m(1 - s + e) + (1 - p_m)(s - e)]G^{-1}(U_{b}^{hl}).
\]

\(^{16}\) Again assume that the low effort incentive compatibility constraint is not binding. The agent’s utility for low effort in this setting is \( (1 - s + e)U_{g}^{hl} + (s - e)U_{b}^{hl} \).
\[-p_m (1 - s + e) + (1 - p_m)(s - e)]G^{-1}(U^h) \].

A setting in which \( ES^{hh} < ES^{mh} < ES^{hl} \) and \( ES^{hl} > ES^{ml} \) replicates the monitoring-aversion features of the LEN version of the model. The principal optimally induces high effort under low monitoring, but medium effort under high monitoring, and low monitoring dominates high monitoring. A binary contract makes it difficult to compare the intensity of incentives directly because there is no slope. Because I have not yet included optimism in the model, the agent earns the reservation utility in expectation.

Rather than attempting to solve for the necessary conditions in closed form, I specify the utility function to be \( G(x) = \sqrt{x} \) and provide a numerical example: \( p_h = \frac{17}{20}, \ p_m = \frac{13}{20}, \ s = \frac{9}{10}, \ e = \frac{1}{10}, \ C_H = 425, \ C_L = 200, \ k^{hh} = 3\frac{3}{8}, \ k^{mh} = 1, \ k^{hl} = 2\frac{1}{8}, \ k^{ml} = \frac{1}{2}, \) and \( \bar{U} = 12. \) Table 3 summarizes the results.

Under high monitoring, the principal optimally motivates medium effort. Under low monitoring, the principal motivates high effort. Furthermore, the high effort/low monitoring surplus exceeds the medium effort/high monitoring surplus, so that the optimal organization design is to have low monitoring.\(^{17}\)

I now include optimism in the model by assuming that \( s \) represents the agent’s beliefs about the indirect effect of effort on the signal realization. Let \( w < s \) be the actual probability that the high (low) state generates \( S_G \) (\( S_B \)), with \( w - e > \frac{1}{2} \) so that \( S_G \) is truly good news under low monitoring. The utility levels from the previous example remain the same because they are functions of the agent’s beliefs. The expected surplus calculations are slightly different because the principal knows the correct distribution of wage payments implied by \( w \). Under optimism, the following hold:

\[
ES^{hh} = p_h C_H + (1 - p_h) C_L - [p_h w + (1 - p_h)(1 - w)]G^{-1}(U^{hh}_g) \\
- [p_h (1 - w) + (1 - p_h) w]G^{-1}(U^{hh}_b),
\]

\(^{17}\)The agent’s expected utility from shirking with this contract is 5.82, less than the reservation utility of 12 obtained under any of the effort scenarios. That is, the low-effort incentive compatibility constraint is not binding and can be ignored. The principal’s surplus if she decides to induce shirking by paying the worker a flat wage is \( 200 - 12^2 = 56. \)
\[ \begin{align*}
ES^{mh} &= p_m C_H + (1 - p_m) C_L - [p_m w + (1 - p_m)(1 - w)] G^{-1}(U_{gh}^{hh}) \\
&\quad - [p_m (1 - w) + (1 - p_m) w] G^{-1}(U_{gh}^{hh}).
\end{align*} \]

\[ \begin{align*}
ES^{hl} &= p_h C_H + (1 - p_h) C_L - [p_h (w - e) + (1 - p_h)(1 - w + e)] G^{-1}(U_{gh}^{hl}) \\
&\quad - [p_h (1 - w + e) + (1 - p_h)(w - e)] G^{-1}(U_{gh}^{hl}).
\end{align*} \]

\[ \begin{align*}
ES^{ml} &= p_m C_H + (1 - p_m) C_L - [p_m (w - e) + (1 - p_m)(1 - w + e)] G^{-1}(U_{gh}^{hl}) \\
&\quad - [p_m (1 - w + e) + (1 - p_m)(w - e)] G^{-1}(U_{gh}^{hl}).
\end{align*} \]

I extend the previous example, setting \( w = \frac{1}{20} \). Table 4 summarizes the results.

[INSERT TABLE 4 ABOUT HERE]

The utility payments are the same as in the no-optimism example because they are based on the same agent beliefs about the information structure. The expected surpluses are higher because the principal pays the high payment less often than the agent anticipates. This also explains the negative average utility shortfall. The ordering of expected surpluses is the same as the earlier example. Thus, this example replicates the key features from the continuous LEN version of the model.
Appendix: Proofs

Proof of Lemma 1

The slope is the first-order condition to the principal’s problem. Substitution yields the equilibrium effort and cost of effort. The total compensation is the sum of the disutility of effort \( \frac{b^2 f^4}{2(f^2 + r\sigma^2)^2} \) and the risk premium of \( \frac{rb^2 f^2 \sigma^2}{2(f^2 + r\sigma^2)} \).

Proof of Lemma 2

Solving the first-order condition for \( v \) yields the slope \( v(k) = \frac{b f^3 \sqrt{(2-\lambda) \sigma^2}}{\lambda (f^2 + r\sigma^2) \lambda^2} \). Plugging this back into the expression for the principal’s surplus yields \( \frac{b^2 f^2 \gamma^2 k^2 \lambda^2}{2(f^2 + r\gamma^2 \sigma^2)^2} \). Solving the first-order condition with respect to \( k \) is \( k^* = f \sqrt{\frac{\gamma \lambda (2-\lambda)}{r\sigma^2}} \). Substitution of \( k \) into the expressions for effort and disutility of effort yield the expressions in the lemma. Total compensation is the sum of the wage and the contingent pay (\( v^* f a^* \)) of \( \frac{b^2 f^3 \gamma^3 (\lambda^2 - 1)}{4(\lambda - \lambda^3)^2 r \sigma^2} \), and is equal to \( \frac{b^2 f^3 (\gamma \lambda)^{3/2}}{4(\lambda - \lambda^3)^2 r \sigma^2} \).

The average utility realization is the difference between the total compensation and the sum of the cost of effort and the risk premium of \( \frac{b^2 f^3 (\gamma \lambda)^{3/2}}{8(\lambda - \lambda^3)^2 r \sigma^2} \), and is equal to \( -\frac{b^2 f^3 (\gamma \lambda)^{3/2} (\lambda^2 - 1)}{4(\lambda - \lambda^3)^2 r \sigma^2} \).

Proof of Proposition 1

I will first show for the \( k = f \sqrt{\frac{\gamma \lambda (2-\lambda)}{r\sigma^2}} \) case.

The ratio of conventional to unconventional effort is \( \frac{2f^2 \sqrt{(2-\lambda) r \sigma^2}}{(f^2 + r\sigma^2)^2} \). This is equal to 1 if \( \gamma = \left[ \frac{2f^2 \sqrt{(2-\lambda) r \sigma^2}}{(f^2 + r\sigma^2)^2} \right]^{2/3} \). The expression on the right is decreasing in \( \lambda \). Setting \( \lambda = 1 \) to maximize it, yielding \( \frac{(2f^2)^{2/3} (r \sigma^2)^{1/3}}{(f^2 + r \sigma^2)^{2/3}} \). This expression is maximized by setting \( f^2 = r \sigma^2 \), yielding \( \frac{(2f^2)^{2/3} (f^2)^{1/3}}{(f^2 + r \sigma^2)^{2/3}} = 1 \). Therefore, the ratio is lower than 1, and unconventional effort is greater than conventional effort, as long as \( \gamma > 1 \).

The ratio of the cost of effort for the unconventional agent to the cost of effort for the conventional agent is \( \frac{4f^3 \sqrt{(2-\lambda) r \sigma^2}}{(f^2 + r \sigma^2)^{3/2} \lambda^{3/2} \gamma^{1/2}} \). This exceeds 1 as long as \( \gamma > \frac{2\lambda^2 f^2}{\lambda^2 [f^2 + r \sigma^2]^{3/2}} \).

The ratio of total compensations is the same as the ratio of efforts.

I will now show the \( k = 1 \) case.

If \( k = 1 \), then effort is \( \frac{b f^2 \gamma^2}{(2-\lambda) f^2 + r \sigma^2} \). This is maximized with respect to \( \lambda \) at \( \lambda = 1 \). Substituting \( \lambda = 1 \) yields \( \frac{b f^2 \gamma^2}{f^2 + r \sigma^2} \). At \( \gamma = 1 \), this is the same as conventional effort.
derivative with respect to $\gamma$ is \( \frac{b^2 f^2 (f^2 + r \sigma^2)}{(f^2 + r \sigma^2)^2} > 0 \). So unconventional effort is strictly higher if either $\gamma > 1$ or $\lambda > 1$.

The unconventional cost of effort at $k = 1$ is \( \frac{b^2 f^4 \gamma}{2(f^2 + r \sigma^2)} \). This is maximized with respect to $\lambda$ at $\lambda = 1$. Making the substitution $\lambda = 1$ yields cost of effort \( \frac{b^2 f^4 \gamma}{2(f^2 + r \sigma^2)} \). This is the same as the conventional cost of effort at $\gamma = 1$ and strictly increasing in $\gamma$. Therefore, the unconventional cost of effort exceeds the conventional cost of effort at $k = 1$ if either $\gamma$ or $\lambda$ exceeds 1.

The utility shortfall in the $k = 1$ case is \(-\frac{b^2 f^4 \gamma^3 (\lambda - 1) \lambda^3}{(f^2 \gamma (2 - \lambda) + r \sigma^2)^2}\).

**Proof of Proposition 2**

Part i. The rent is derived from computation of the high worker’s expected utility from the closed-form expressions for slope, wage, and monitoring intensity. Numerical examples establish the relation between the size of the rent and the utility shortfall.

Part ii. The low worker’s average realized utility is

\[
\frac{b^2 f^4 L \gamma^3 (\lambda - 1)(1 - p)^6}{4[\gamma(1 - p)^2(L_H^2 \lambda p - L_L^2 (2p - 2 + \lambda)](1 - p)^3 r \sigma^2} < 0.
\]

The utility shortfall is equal to $(\lambda - 1)v_L a_L$, which after substituting in for $a_L$ is $(\lambda - 1)v_L^2 f_L^2 \gamma \lambda k_L$. Only $v_L$ and $k_L$ change in the private information setting, so the amount of the shortfall is less if $v_L^2 k_L$ is less than in the full information case. If $p = 0$, then this term is identical to the full information case. The derivative of $v_L^2 k_L$ with respect to $p$ is

\[
\frac{3b^2 (f_H^2 - f_L^2)(f_L^2 \lambda p - f_L^2 (2p - 2 + \lambda))]}{8(L_H^2 \lambda p - f_L^2 (2p - 2 + \lambda))} \frac{\sqrt{\gamma \lambda (1 - p)^2(L_H^2 \lambda p - f_L^2 (2p - 2 + \lambda) \sqrt{(1 - p)^0 r \sigma^2}}}.
\]

The only term with a possibly ambiguous sign is $[f_H^2 \lambda p - f_L^2 (2p - 2 + \lambda)]$. This is positive for the possible parameters of the problem. Hence, the derivative itself is negative in $p$. Therefore, the low worker’s utility shortfall is lower under private information.

Part iii. Numerical examples establish the result.
### TABLE 1: Incremental Effects of Assumptions on Results

<table>
<thead>
<tr>
<th></th>
<th>Only Optimism $\lambda &gt; 1, \gamma = 1$</th>
<th>Only Monitoring Aversion $\lambda = 1, \gamma &gt; 1$</th>
<th>Both Assumptions $\lambda &gt; 1, \gamma &gt; 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope</td>
<td>Higher</td>
<td>Higher or Lower</td>
<td>Higher or Lower</td>
</tr>
<tr>
<td>Effort</td>
<td>Higher</td>
<td>Higher</td>
<td>Higher</td>
</tr>
<tr>
<td>Cost of effort</td>
<td>Higher</td>
<td>Higher or Lower</td>
<td>Higher or Lower</td>
</tr>
<tr>
<td>Risk premium</td>
<td>Higher</td>
<td>Higher</td>
<td>Higher</td>
</tr>
<tr>
<td>Total compensation</td>
<td>Higher</td>
<td>Higher</td>
<td>Higher</td>
</tr>
<tr>
<td>Reservation utility met</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Symbol</td>
<td>Interpretation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$r$</td>
<td>coefficient of risk aversion</td>
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</tr>
<tr>
<td>$U_R$</td>
<td>reservation utility</td>
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<td></td>
</tr>
<tr>
<td>$X$</td>
<td>unobservable output</td>
<td></td>
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</tr>
<tr>
<td>$b,(b_H,b_L)$</td>
<td>the multiplier on agent effort in output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$a,(a_H,a_L)$</td>
<td>agent effort</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$Y$</td>
<td>the signal on output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$Y^U$</td>
<td>the signal as perceived by the agent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f,(f_H,f_L)$</td>
<td>multiplier on effort in signal</td>
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<td></td>
</tr>
<tr>
<td>$\tilde{e}$</td>
<td>noise term in signal</td>
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</tr>
<tr>
<td>$k$</td>
<td>inverse of intensity of monitoring</td>
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</tr>
<tr>
<td>$\sigma^2$</td>
<td>variance of noise term in signal</td>
<td></td>
<td></td>
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<tr>
<td>$W,(W_H,W_L)$</td>
<td>fixed wage in linear contract</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$v,(v_H,v_L)$</td>
<td>bonus coefficient in linear contract</td>
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<tr>
<td>$\gamma$</td>
<td>sensitivity to monitoring</td>
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</tr>
<tr>
<td>$\lambda$</td>
<td>degree of optimism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$p$</td>
<td>proportion of high workers in private information model</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 3: Binary Model (Monitoring-Aversion Only)

<table>
<thead>
<tr>
<th></th>
<th>High Monitoring</th>
<th>Low Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>$U^h_s$</td>
<td>18.641</td>
<td>18.052</td>
</tr>
<tr>
<td>$U^h_b$</td>
<td>3.797</td>
<td>4.510</td>
</tr>
<tr>
<td>Surplus (high effort)</td>
<td>117.05</td>
<td>153.98</td>
</tr>
<tr>
<td>Surplus (medium effort)</td>
<td>125.34</td>
<td>145.64</td>
</tr>
</tbody>
</table>
### TABLE 4: Binary Model (Monitoring-Aversion and Optimism)

<table>
<thead>
<tr>
<th></th>
<th>High Monitoring</th>
<th>Low Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>$U^h$</td>
<td>18.641</td>
<td>18.052</td>
</tr>
<tr>
<td>$U^b$</td>
<td>3.797</td>
<td>4.510</td>
</tr>
<tr>
<td>Surplus (high effort)</td>
<td>128.71</td>
<td>164.67</td>
</tr>
<tr>
<td>Surplus (medium effort)</td>
<td>130.33</td>
<td>150.22</td>
</tr>
<tr>
<td>Average utility shortfall (high effort)</td>
<td>-0.842</td>
<td>-0.474</td>
</tr>
<tr>
<td>Average utility shortfall (medium effort)</td>
<td>-0.223</td>
<td>-0.203</td>
</tr>
</tbody>
</table>
Panels A and B indicate the increase in average realized utility for both types of workers in the private information setting, as a function of optimism. The four lines correspond to different proportions of high workers in the employment pool, varying from $p = .10$ to $p = .70$.

Panels C and D show the average realized utility for both types of workers in the private information setting, as a function of optimism. The four lines correspond to different proportions of high workers in the employment pool, varying from $p = .10$ to $p = .70$. High workers average less than their reservation utility of 0 for much of the parameter space. Low workers always average less than their reservation utility.

The high worker and low worker have the same utility for points along the line in Panel E. The low worker has strictly higher utility to the northeast of the line. The high worker has strictly higher utility to the southwest of the line. The low worker always has higher utility in the full information setting.