More monitoring can induce less effort[1]

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Abstract

If an agent's compensation decreases sharply for observed shirking rates above a critical level, shirking may increase the more information the principal has about the agent. Furthermore, monitoring decisions may be deliberately assigned to poorly informed principals. Compensation methods that disregard some information may be optimal. Signals about the agent may reduce the expected profits of the principal.

1. Introduction

Common wisdom in the economics literature suggests that the less the principal knows about the activities of his agents, the more agents will shirk. Pratt and Zeckhauser, 1985 (p. 5), for instance, present the following observations as self evident.

1. We tend to get less monitoring, or monitoring of poorer quality, when monitoring is expensive and/or substitutes for monitoring are cheap.
2. The agency loss is the most severe when the interests or values of the principal and agent diverge substantially, and monitoring is costly

Similar claims are made by Williamson (1967), Calvo and Wellisz (1978), Harris and Raviv (1979) and Grossman and Hart (1983).

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We show that under some conditions the opposite may hold–agents may shirk more the better informed is the principal. Profit maximization may therefore call for compensation schemes that ignore some information. Principals may limit their monitoring even when monitoring is costless.[2] Poor information for shareholders about managers, or for voters about candidates, need not imply severe agency problems.

2. The problem

The intuition behind our results is easily stated. Suppose that a prize, of exogenously fixed size, is awarded when an agent's observed performance exceeds some critical level. If the person making the award (the principal) has perfect information about the candidate for the reward (the agent), then the agent will have an incentive to perform at a level which just exceeds the critical level, and no more.

Perhaps the principal observes the agent with noise on only a single day. The agent cannot be assured that the particular observation will exceed the critical level. An agent intent on receiving the award must perform better to ensure that no negative signal is sent.

Professors and students implicitly recognize this reasoning when confronting examination policy. An examination with a single question may induce more effort than an examination with many. When only one question is asked, the student who wishes to ensure a passing grade must master all the material. With many questions, the student can get a passing grade with mastery of only seventy percent of the material. Professors may therefore limit the number of questions on the exam, while students may prefer that more questions be asked.

Our analysis is restricted in two important, but plausible, ways. First, it applies only for compensation schemes that award the agent on the basis of information which is observable to the principal, but not necessarily verifiable to a third party. Managers, for instance, may promote on the basis of information they collected about each of the candidates. Firms often hire workers on the basis of letters of recommendations. Editors rely on referee reports. Universities grant fellowships or admissions in accord with the opinions of a committee. In all these examples the principals seek to reward the most productive or most worthy agent; the principals have no incentive to dissemble about their beliefs.

Second, our analysis requires that rewards be fixed and indivisible. Grades, fellowships, tenure promotions, and election to public office provide examples of such exogenously set rewards. Within the context of organizational behavior, job promotions often satisfy the fixed reward assumption: an individual either receives the job or he does not.

When the reward is a promotion, firms may refuse to negotiate about the associated salary for several reasons.[3]

(a) The firms may wish to limit rent seeking and bargaining costs.
(b) Managers or owners may be tempted to renege on performance payments that have been earned.

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[2]Studying a related issue, O'Keefe et al. (1984) show that imperfect monitoring may be desirable if agents otherwise spend too much effort.

[3]This discussion is based on Milgrom and Roberts (1992), Chapter 11.

(c) Personnel who make salary or hiring decisions may not face the proper incentives because they are not spending their own money.

(d) Most generally, fixed rewards tend to occur when compensation is based upon the beliefs of the principal. If the beliefs of the principal cannot be independently verified, an exogenously fixed reward may prevent dissimulation, bickering over the true world-state, and loss of morale. If the principal rewards the best candidate with a promotion, no incentive to lie exists. If the principal rewards the best candidate with a varying bonus, the principal will try to underrepresent the achievements of that agent.

If the reward is fixed, reasonable compensation systems will make the award only when performance exceeds some critical level (we call this threshold compensation). Infact, Blinder and Rosen (1985) demonstrate that, in general, continuous incentives do not dominate threshold compensation. Harris and Raviv, 1979 (pp.251–257) provide a general proof that optimal principal–agent contracts contain some threshold compensation.

We measure performance by the degree of shirking. We say an agent shirks whenever he undertakes an activity that (ignoring the effects on direct compensation) reduces the principal's profit. For example, a CEO can shirk by taking excessive non-pecuniary compensation at shareholder expense, or by choosing investments with low returns but high managerial perquisites. In politics, a legislator shirks when he votes against his constituents' interests.

We assume that the principal maximizes expected profits, which decrease with the agent's shirking and decrease with the probability that he pays the reward. The principal first sets the threshold which determines when he will award the prize. After the agent's performance for the period is over, the principal pays the reward only if the agent's observed shirking rate was lower than the threshold.

An agent's utility increases in the probability that he wins the prize, and increases in his shirking rate. The agent's indifference curves are assumed to have the usual convex shape; this shape implies increasing marginal disutility of effort.

3. The principal's inferences

To make the discussion concrete, we use a particular random process to describe the principal's information about the agent. In each period the agent undertakes a fixed number of activities; he may or may not shirk on each activity. For each activity, the principal may hear a message which accurately describes whether the agent shirked.

The number of messages the principal hears about the agent follows a Poisson distribution[4] with mean M. Thus, the probability that the principal hears exactly H messages about the agent is $e^{-M}M^H/H!$. The probability that B out of H messages that the principal receives report on a shirking activity follows the binomial distribution.

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[4]The Poisson distribution approximates the binomial when the number of trials is large and the probability of an event is small; in our terms this means that the agent undertakes many activities, of which the principal hears only a small proportion.

The agent receives the reward if the principal heard at least one message about the agent,[5] and if the fraction of messages reporting shirking is less than or equal to a critical value k.[6] Thus, the probability that the agent with shirking rate S receives the prize is:

$$P(S) = \sum_{H=0}^{\infty} e^{-M} M^H / H! \sum_{B=0}^{\text{int}(Hk)} (H) S^B (1 - S)^{H-B}.$$

The expression int(Hk) represents the largest integer less than or equal to Hk. If $M=\infty$, then $P=1$ for $S \leq k$, and $P=0$ for $S> k$. If $M=0$ then $P=0$ for all S. If $M>0$ and $k>0$ then $P(S)$ is a downward sloping function of S. An increase in the principal's information is measured by an increase in the expected number of messages he hears.

The principal might benefit by reoptimizing after each message. The prize would be awarded in parts and the threshold for further rewards would be reset after the principal receives each piece of information. The marginal return to an agent's effort remains high if the principal can act this way. We rule out such contracts for two reasons. First, some rewards are fixed and costly to divide, as discussed above. Second, the principal may find it too costly to calculate and publicize a reoptimization after each message. We define our problem as applying over the interval when such reoptimization does not occur. (Changes in the overall threshold are considered in Section 5 below.)

This model can be generalized to consider multiple principals. If messages to different principals are independently distributed, $P(S)$ represents the fraction of principals who believe that the agent should be rewarded. Even if the principals do not make decisions by majority rule, the size of $P(S)$ is likely to determine the agent's reward: a salesman's chance of promotion is likely to be greater when more managers support his promotion.

4. Shirking under a fixed threshold

We first consider changes in information when the standard (k) applied to the agent is fixed. The agent's utility-maximizing shirking rate depends on his opportunity set (which describes the probability he gets the prize for any shirking rate he chooses), and on his preferences. Fig. 1 depicts opportunity curves as solid lines for two different levels of the mean number, M, of messages the principal receives about the agent. A higher level of M means that, on average, the principal has more information about the agent. The dashed curves in Fig. 1 are the agent's indifference curves as a function of his shirking rate and probability of the reward he receives. Indifference curves further from the origin represent higher utility. As Fig. 1 indicates, an increase in the principal's information may induce the agent to shirk more. When $M=3$ the agent maximizes utility at point A, where indifference curve U_0 is tangential to the opportunity curve. When $M=4$, the agent

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[5] Our results do not change fundamentally if a principal who hears no messages awards the prize with some probablity greater than zero.

[6] Uncertainty about the threshold level of achievement does not change the basic results.
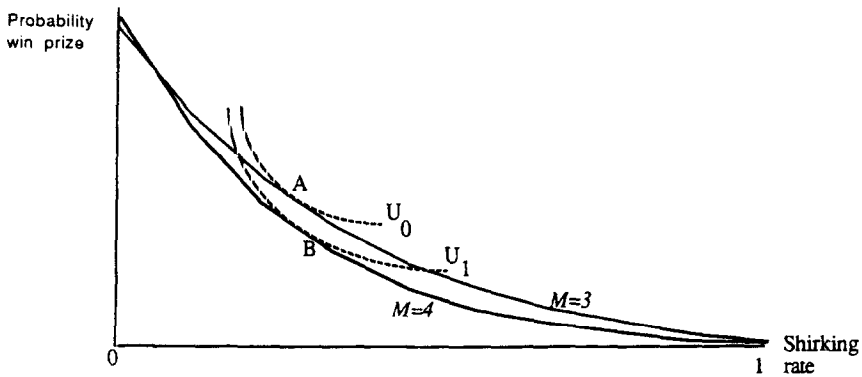
Fig. 1. Opportunity curves.

chooses point B which lies on indifference curve U_1. Point B shows more shirking than point A.[7]

Fig. 1 decomposes the results into two effects—the locations of the curves and the slopes of the curves. First, in some range of shirking rates, one opportunity curve lies above the other. An increase in the principal's mean level of information creates an income effect on the agent. For instance, if a talented agent can easily meet the threshold, an increase in the principal's information increases the agent's probability of winning the prize. If shirking is a normal good, the income effect which accompanies the increased probability of winning the prize induces the agent to shirk more. A related result occurs when the agent has low ability. The agent has only a small chance of winning the prize, and additional information may cause that agent to give up trying altogether.

Second, the slopes of the opportunity curves differ. The substitution effect can induce the agent to shirk either more or less. The sum of these two effects implies that the agent may shirk less when the principal is poorly informed.

A comparison between situations where the principal has perfect and imperfect information is of particular interest. Under perfect information, the agent is rewarded only if his shirking rate is less than the threshold. Fig. 2 shows the agent's opportunity curve to be a horizontal line at height 1 for shirking rates less than k, and a horizontal line at height 0 for shirking rates greater than k. For a given level of M which represents less

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[7] Related analyses appear in several areas. Townsend (1979), Baiman and Demski (1980), Kanodia (1985), Reinganum and Wilde (1985), Border and Sobel (1987) examine the optimal monitoring strategy, but do not consider the primary issue of our paper. In Townsend's model, for instance, monitoring reveals agent compliance or noncompliance with certainty. The benefits of random monitoring in his model result from the reduction of monitoring costs, rather than improved agent discipline; threshold compensation is not considered. Spence and Zeckhauser (1971), Shavell (1979), Harris and Raviv (1979), Holmstrom (1979), Baron and Besanko (1984), Laffont and Tirole (1986) consider imperfect monitoring. But these articles use some special assumptions which rule out our result (for example, in Baron and Besanko there is either an audit or not; no marginal increase in auditing is allowed). Although Harris and Raviv, 1979 (p.248) claim that "monitoring is always beneficial," their proof (p.249) demonstrates only that some amount of monitoring is better than none, not that additional monitoring is always beneficial. Holmstrom, 1979 (p. 86), however, notes cryptically that "If, for administrative reasons, one has restricted attention a priori to a limited class of contracts (e.g. linear price functions or instruction-like step functions), then informativeness may not be sufficient for improvements..."
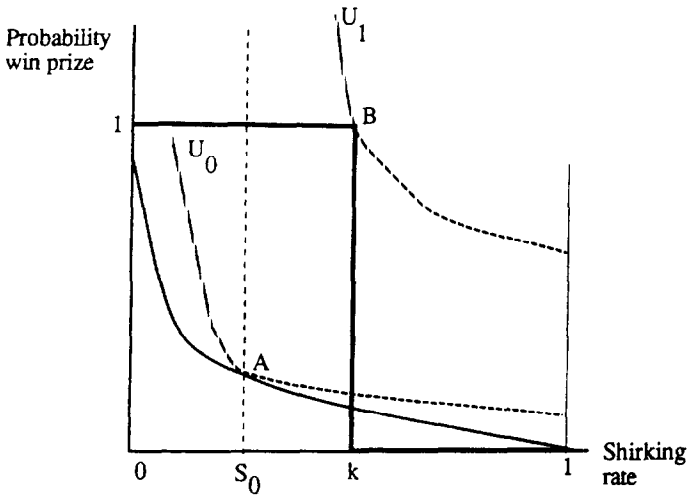
Fig. 2. Perfect information increase shirking (S_0<k).

than perfect information by the principal, let the agent's utility-maximizing shirking rate be S_0<k, as shown at point A. At this point indifference curve U_0 is at a tangent to his opportunity curve. As Fig. 2 illustrates, the agent necessarily shirks more under perfect information than under imperfect information: by assumption S_0<k, so point A lies to the left of B.

Matters may differ when the principal has imperfect information and the agent chooses a shirking rate higher than k. A shift to perfect information by the principal can induce the agent to either shirk more or less. In Fig. 3 point A lies to the right instead of to the left of B. Since under perfect information the agent prefers point B over a shirking rate of 1, Fig. 3 shows that perfect information reduces shirking. Fig. 4, like Fig. 3, shows point A
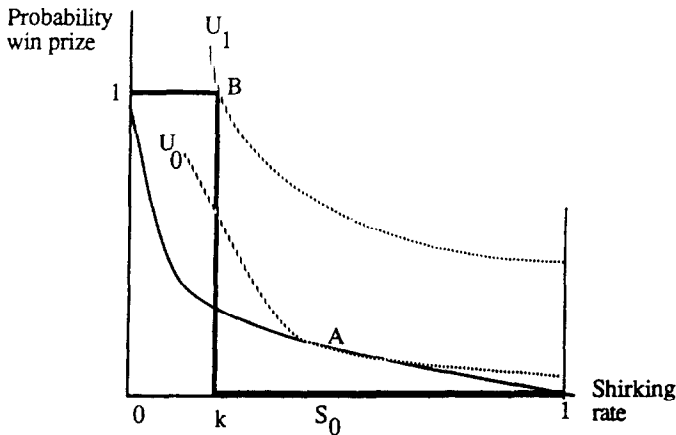

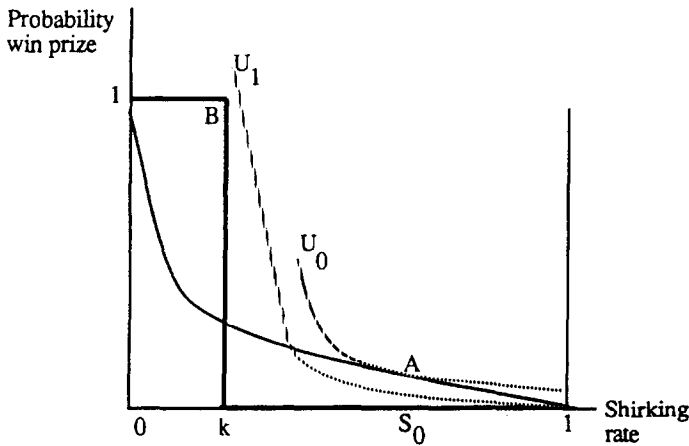Fig. 3. Perfect information reduces shirking (S_0>k).

Fig. 4. Perfect information increases shirking ($S_0 > k$).

to the right of B. But here indifference curve U_1 (which contains point $(1, 0)$) lies above point B. Under perfect information the agent always shirks; under imperfect information he does not.

The agent's response when $S_0 > k$ is ambiguous. The change to perfect information means that at the initial shirking rate the agent is sure not to receive the prize. He may react in two ways. He may decide that the prize is not worth the effort, and so shirk more. Alternatively, the agent may decide to shirk less to be assured of winning the prize. The result depends, of course, on the shapes of the indifference curves.

Although perfect information can induce the agent to shirk less, the principal's profit need not increase. The reduction in the agent's shirking increases his chance of winning the reward, and therefore increases the principal's expected payments to the agent. Whether the principal's profits increase depends on his marginal benefit from reduced agent shirking. That is, even ignoring the costs of gathering information, the principal may prefer to collect little information about the agent.[8] Fig. 2 illustrates that the agent shirks more under perfect information than under imperfect information, yet the principal must incur the cost of the prize with certainty rather than with a probability less than one. Both effects reduce profits.

5. Optimal threshold

We now suppose that the principal can choose the threshold of observed shirking. We continue to assume that the size of the reward is exogenously fixed. Fig. 5 portrays the agent's indifference curves as dashed curves; it also shows two opportunity curves for the

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[8]We assume that under alternative opportunity curves the agent has sufficient utility to induce him to accept the job or task. Otherwise, the principal must give the agent additional compensation, either with a payment unrelated to the prize, or else by changing the critical threshold level, k.
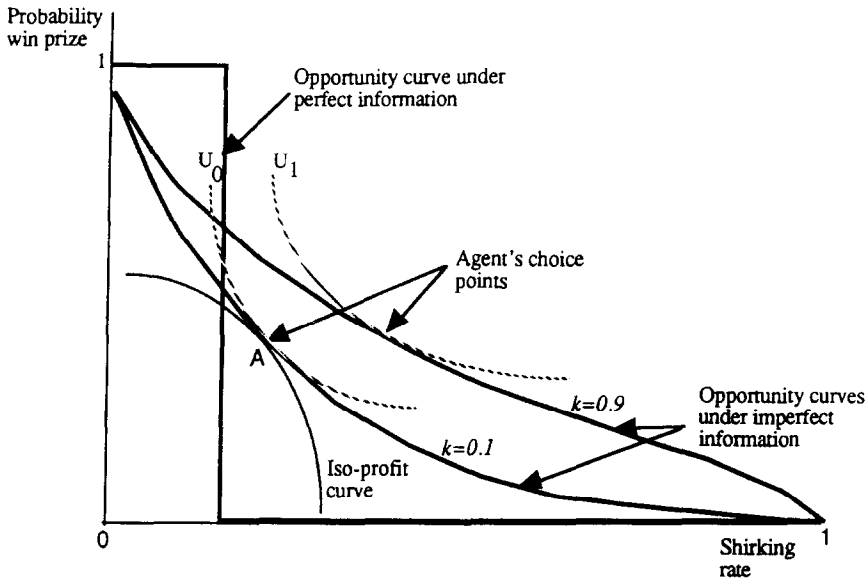
Fig. 5. Optimal choice of threshold.

agent corresponding to different values of k but identical values of M. Also shown is an iso-profit curve for the principal. The iso-profit curve has a negative slope and is concave: the more the agent shirks, the higher the marginal damage to the principal. The principal's profits are higher the closer is an iso-profit curve to the origin. For a given level of M (the mean number of messages the principal hears), the optimal choice of k is 0.1 in this diagram; the agent then chooses the interior point A. At point A four conditions are met. (a) The agent does not prefer a shirking rate of 1 over a shirking rate less than 1. (b) The agent maximizes his utility by choosing a point on his opportunity frontier at a tangent to an indifference curve. (c) The principal maximizes his profits because point A lies on the lowest iso-profit curve which is at a tangent to an opportunity curve of the agent. (d) The agent enjoys at least his reservation utility level.

Once again, profits may be lower under perfect information. The opportunity curve facing the agent is then a horizontal line at height 1 for shirking rates below the specified value of k, and a horizontal line at height 0 for higher shirking rates. Consider values of k that induce the agent to shirk at a rate less than 1. The relevant portion of the opportunity curve with perfect information lies above the iso-profit curve which is at a tangent to point A. The principal's profits are therefore lower. Only if the principal wants a shirking rate of 1 would he maximize profits by having perfect information.

6. Implications

Firms may wish to assign personnel decisions to managers who are poorly informed. Contrary to Williamson (1967), an increase in the size of the firm which reduces

information may be profitable. Imperfect monitoring, however, need not imply the deliberate choice of stupid or incompetent managers. Instead, firms may want to have a continual supply of new managers. New managers know little about the skills of workers, and talented workers must prove themselves as if starting from scratch. We are all familiar with working hard to impress a new boss.

A different problem concerns time consistency. Suppose the principal heard several messages, which all reported no shirking. Suppose also the agent knows the principal has this information. Since the agent's observed shirking rate was low, the agent can shirk with impunity in the future: the favorable messages on him from the past virtually assure him of receiving the prize. The principal may therefore wish either to change the threshold, or to ignore the favorable information he obtained, and let the agent start as if with a blank slate. Similarly, if the messages received report much shirking, the agent may believe his chances of receiving the prize are ruined; the expected cost of additional shirking is then small. Once again, the principal may prefer to ignore this information (or pretend to ignore it) and thereby induce the agent to shirk less in the future.

For similar reasons, random compensation plans can be optimal even when agents are risk averse.[9] Suppose a principal has perfect information about agents. If this information is used to reward the agent, the agent will work just enough to meet the threshold. We can imagine a different payment system, however, which induces greater effort by ignoring some information. Rather than rewarding an agent whose observed performance exceeds a certain threshold, payments could be based on a random variable related to the agent's effort. The principal may decide, for instance, to observe the agent directly several random times a week. The agent's reward would be determined by the number of times the agent was found shirking, which is a random variable.[10] This payment system, of course, emulates a principal with imperfect information, and may thus induce additional effort.

Our argument also has implications for the theory of signalling (Spence, 1973). Signalling theory typically assumes that principals benefit from information contained in signals. If better information increases the agent's incentives to shirk, however, this assumption need not hold. Instead, talented agents may signal so that they may later shirk more without fear of losing rewards. Without signalling, the principal must rely on noisy information about the agent's marginal product (ability plus effort). A signal may tell the principal with certainty that the agent's marginal product exceeds some level. If this skill level is high, the agent can shirk often without fear of ruining his reputation as a high-productivity worker.

Principals may therefore prefer not to receive the agent's signal, or at least not let the agent know that the signal was received. By remaining in a state of less perfect

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[9]Reinganum and Wilde (1988) use related reasoning to explain that tax compliance can be higher when taxpayers are uncertain about the level of cheating that brings forth penalties. McCubbins and Schwartz (1984) claim that Congress oversees the bureaucracy not by continual monitoring, but instead by strongly reacting when congressmen learn of an action that violates congressional intent. Our argument implies that this "fire alarm system" can reduce congressional information and can induce the bureaucracy to follow congressional desires more closely.

[10]Stiglitz (1982) argument for random taxation, in contrast, takes advantage of differential risk tolerances across agents to achieve an efficient sorting.

information about innate competence or feigning such a state, the principal may induce more effort from agents. Again, this possibility corresponds to a simple intuition. Bosses may not wish to reveal how much they are impressed with an incoming employee's credentials.

Finally, our arguments can be applied to political elections. Compelling evidence shows that voters know little about candidates, issues, or the effects of different policies.[11] Political competition, however, may approximate the preferences of the median voter in spite of the imperfect information. Voters with good information may attach little weight to a single instance of shirking. But if voters are largely ignorant, a candidate must be careful in almost all he does. A single mistake may become a dominant campaign issue and cost the politician the election[12].

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[11]A national survey conducted in 1978 reported that almost 60% of the respondents could not even say whether they agreed or not with their congressman's votes on bills Hinckley, 1980 (p. 644). In the early 1960s, Miller and Donald (1963) painted a picture of an abysmally ignorant congressional voter. In fact, 54% of the voters reported that they had not read or heard anything about either candidate.

[12]To give a few examples, Congressman Charles Wilson of California lost his seat after 18 years in office once it was revealed that he accepted a 600 dollar wedding gift from Tongsun Park. Congressman John Flynt of Georgia lost a campaign in which a major issue was the profits he made from renting land to an automobile company whose position on emission standards he later supported. Senator Gruening of Alaska lost reelection after his opponent accused him of supporting a bill to commit Alaska to environmental purity.

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