

Incentivizing Work to Be Reviewed

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Abstract

Organizations review work to improve decisions. Those decisions also supply evidence for rewarding the work being reviewed. This paper studies how the value of better managerial information depends on the records an organization preserves about earlier work. An analyst produces an assessment through hidden effort. A manager combines a noisy observation of it with independent state information and chooses the final decision. The principal chooses wages and costly records available after review. The decision can help establish what the analyst judged or whether that judgment was correct. Record prices determine which use is economical. With sufficiently inexpensive assessment records, better managerial information weakly lowers the cost of supporting effort. When the decision substitutes for recording the assessment, better information can raise combined wage and record costs enough to lower optimized profit, even while effort stays high and decisions improve. At the same parameters, a small information improvement can lower the most profitable equilibrium value available to the principal and raise the value she can guarantee across equilibria. Supporting high effort then uses the decision record; guaranteeing it uses assessment and state records directly. An extension shows how jointly choosing a manager bonus and the records used for both wages can reduce the cost of guaranteeing effort.

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1 Introduction

Organizations review preliminary work to improve the decisions based on it. An analyst investigates a problem and produces an assessment. A manager brings additional information and decides whether to follow that assessment. The organization must also reward the analyst's effort. If pay uses the manager's final decision, review changes the evidence on which those rewards depend. Preserving the initial assessment provides another source of evidence, at a cost. How should an organization choose compensation and records when better review changes both decision quality and the cost of inducing careful work?

The value of better review depends on the cost of documenting the assessment and the underlying state. The final decision can help establish what the analyst judged and whether that judgment was correct. When recording the state is inexpensive, using the decision as evidence of the assessment can save on direct records. Better managerial information can weaken that evidence as the manager becomes more willing to revise the assessment. The combined cost of wages and records can rise enough to lower profit even while effort stays high and decisions improve. When the assessment itself is inexpensive to record, the decision helps evaluate its accuracy. Better managerial information improves this use of the decision and weakly lowers the cost of supporting effort. Both comparisons allow the principal to reoptimize wages and records.

The model separates operational communication from measurement for payment. An analyst's hidden effort determines the accuracy of a binary assessment. A manager receives a noisy observation of it and an independent state signal. She chooses the final decision to maximize accuracy. Before effort, the principal commits to a nonnegative wage and to the precision of three records: the assessment, the state, and the decision. These measurements become available after the decision. Their quadratic acquisition costs enter the principal's profit alongside the analyst's wage. The communication channel used during review is fixed.

A contract determines the effort the manager expects and hence how she uses the assessment. Several effort expectations can be consistent with the same contract. Favorable evaluation uses a contract's most profitable equilibrium; robust evaluation uses its least profitable equilibrium. For each positive effort target, a cost-minimizing wage rewards agreement among all three records. The principal chooses their precisions to balance wage savings against acquisition costs, then compares the resulting profits across effort targets.

These changes in incentive costs also affect effort choice. A high value of accurate decisions can keep high effort optimal despite the increase in its cost. Under different conditions on decision value and signal noise, better information makes the principal stop purchasing high effort. The switch to zero wages and no records lowers decision accuracy, while profit remains continuous and nondecreasing.

Robust evaluation changes the cost of using the final decision as evidence. A wage that rewards effort when the manager expects reliable work can also sustain low effort when she expects poorer work and relies more on her own signal. We identify a region in which supporting high effort remains cheapest with the decision record, while guaranteeing it makes direct assessment and state records economical. The direct contract's cost is unchanged by better managerial information. The same information improvement therefore raises robust value through more accurate decisions while lowering favorable value through higher incentive costs.

The principal can also use compensation to influence review. In an extension, the manager receives a bonus when the assessment and decision records agree. We study contracts that make her follow the received assessment under every effort expectation. When she already does so under high effort, this payment changes her response to competing expectations and can reduce the cost of guaranteeing effort. The two wages share the same records. With the other record precisions fixed,

more precise assessment recording reduces both expected wages when bonuses adjust to maintain incentives. Record acquisition thus has an additional benefit through the manager’s payment. Reoptimizing the records strictly expands the range of the manager’s valuations of accuracy for which the arrangement is profitable. A numerical example in Appendix E.4 holds effort and decision accuracy fixed and shows that record adjustment changes whether the manager contract is adopted.

These comparisons concern autonomous review. A separate benchmark allows the principal to commit before effort to executing the received assessment. In the region with a local favorable loss, allowing her to choose between review and execution leaves optimized profit unchanged after a small information improvement. In the manager-contract comparison, free enforceable execution delivers the same high-effort outcome at lower cost.

Related literature

Managerial intervention can change the incentives for earlier effort. [Levitt and Snyder \(1997\)](#) jointly study compensation, early reporting, and project cancellation. Cancellation can weaken effort incentives, and an advance restriction on cancellation can improve the contract. [Cr  mer \(1995\)](#) shows how cheaper performance information can undermine a principal’s commitment to avoid renegotiation. [Arya and Glover \(2008\)](#) study selective correction of performance scores. They show that correction can strengthen incentives and that using both preliminary and final scores can attain the minimum expected wage available with contractible true scores. Here, the manager chooses the decision before the state is known. Her reliance on the assessment changes the evidence available to reward the analyst. We compare information improvements while optimizing wages and the precision of all three records.

The ability to commit to a decision rule also shapes incentives within organizations. [Aghion and Tirole \(1997\)](#) relate formal authority to information acquisition and effective control. [Baker et al. \(1999\)](#) study how a superior’s promise to respect a subordinate’s decision can be sustained through a relational contract. [Li et al. \(2017\)](#) use future decision authority to provide incentives and characterize the resulting dynamics of power. Our baseline fixes the manager’s authority and decision objective. The manager-contract extension uses enforceable bonuses on shared records to induce a specified execution rule. Its cost comparison identifies when jointly adjusting the two wages and their records makes that rule profitable.

Knowledge hierarchies organize the acquisition and use of expertise. [Garicano \(2000\)](#) studies specialization and the referral of problems to workers who can solve them. [Fuchs et al. \(2015\)](#) study contracting with privately known expertise and unobserved problem difficulty. Their efficient arrangement makes consultants residual claimants and rewards producers for solving problems without assistance. We hold the roles and operational signals fixed and study the hidden effort producing an assessment. The cost of that effort depends on the evidence preserved by subsequent review.¹

Agreement can itself provide incentives for information acquisition. [Gromb and Martimort \(2007\)](#) study compensation based on project outcomes and confirmation by other experts. [Azrieli \(2021\)](#) characterizes least-cost contracts that pay only for unanimous expert reports. He also shows that every contract in his environment admits a zero-effort equilibrium. In our model, agreement compares records of three distinct objects: an assessment, the state, and a subsequent decision. The manager’s anticipated reliance on the assessment changes the effort information in these comparisons. Acquiring direct records allows the principal to guarantee effort when a contract based on the decision also sustains low effort.

¹[Minni \(2026\)](#) documents how managers improve worker outcomes through the allocation of workers to jobs.

Accounting research distinguishes the decision and incentive uses of information. [Dye \(1985\)](#) shows that earnings disclosure can suppress information about managerial effort otherwise aggregated in stock prices. [Narayanan and Dávila \(1998\)](#) study productive effort, signal manipulation, and investment decisions. Their contractual remedies include separate control systems and pay based on downstream investment outcomes. [Hemmer \(1998\)](#) shows that purchasing an intermediate performance measure can change the optimal allocation of responsibilities; [Maskin et al. \(2000\)](#) also relate organizational form to performance information. Here, better managerial information changes the usefulness of the decision for measuring earlier work. Record prices determine whether it is economical to preserve direct evidence of that work.

The choice of payment evidence builds on the informativeness principle of [Holmström \(1979\)](#) and the joint design of compensation and monitoring. [Li and Yang \(2020\)](#) choose a costly classification of performance data along with wages. [Georgiadis and Szentes \(2020\)](#) jointly choose sequential monitoring and compensation to implement effort at minimum cost. Hidden information production is central to [Chade and Kovrijnykh \(2016\)](#), who study delegated information acquisition, and [Migrow and Squintani \(2023\)](#), who show why a manager sharing information can optimally be paid on the performance of the division that uses it. The decision measured in our model is itself chosen by a manager using the analyst’s work. Her inference about effort therefore enters the principal’s joint choice of compensation and records.

Implementation requirements can change both compensation and monitoring. [Winter \(2004\)](#) and [Halac et al. \(2021\)](#) characterize incentives that eliminate shirking equilibria. [Halac et al. \(2024\)](#) show that monitoring can be valuable for unique implementation even when it has no value for partial implementation. [Camboni and Carnehl \(2025\)](#) find that input tests are optimal under favorable equilibrium selection, while adverse equilibrium selection calls for combined input and output tests. [Ichihashi et al. \(2026\)](#) study a monitoring hierarchy that makes knowledge-production effort uniquely rationalizable. Contracts supporting effort in their model can reward agreement among three adjacent signals. Robust value in our model uses the least profitable continuation equilibrium. Holding technologies and record prices fixed, we identify a region in which the same improvement in managerial information lowers favorable value and raises robust value. The two criteria initially use different records.

The manager’s inference also connects the paper to observational learning. [Bikhchandani et al. \(1992\)](#) and [Smith and Sørensen \(2000\)](#) study how actions reveal private information. Information acquisition and observation are endogenous in [Burguet and Vives \(2000\)](#), [Ali \(2018\)](#), and [Song \(2016\)](#). [Smith et al. \(2021\)](#) implement efficient sequential learning with transfers based on an individual’s action and her successor’s action. [Winter \(2006\)](#) studies how later workers’ responses affect incentives in sequential production. We study how a subsequent decision enters the payment for hidden effort producing the initial assessment. The principal chooses how precisely to observe each object used for that payment.²

2 Model

An analyst investigates an unknown state and produces an assessment. A manager reviews the assessment and makes the final decision. A principal rewards the analyst’s work. She chooses both the wage schedule and the records used to determine payment.

The principal commits to wages and record precisions. The analyst chooses effort and produces the assessment. The manager observes her signals and decides. Recording and payment follow.

²[Gibbons \(1988\)](#) studies inference from strategic offers combined with independent evidence in arbitration. [Martinelli \(2022\)](#) studies political incentives and selection when rewards for higher office are optimized.

2.1 Information and decisions

The state is $\theta \in \{-1, +1\}$, with equal prior probabilities. Before receiving information, the analyst chooses effort $e \in \{L, H\}$. High effort costs $\kappa > 0$; low effort is costless. Effort generates an initial assessment $a_0 \in \{-1, +1\}$ with

$$\Pr(a_0 = \theta \mid \theta, e) = \alpha_e, \quad \frac{1}{2} < \alpha_L < \alpha_H < 1.$$

Thus high effort increases the probability of a correct assessment by $\Delta = \alpha_H - \alpha_L$. Effort is unobserved. The assessment is generated by this technology and passed to the manager.

The manager receives a noisy observation $M_0 \in \{-1, +1\}$ of the assessment, with communication precision $\Pr(M_0 = a_0 \mid a_0) = r_0 \in (1/2, 1)$. She also receives state information independently of the assessment, conditional on θ . This information takes the form

$$S = Z_r + \tau N, \quad \Pr(Z_r = \theta \mid \theta) = r \in (1/2, 1), \quad Z_r \in \{-1, +1\}, \quad N \sim \mathcal{N}(0, 1), \quad \tau > 0.$$

The parameter r is the accuracy of the binary signal Z_r , and τ is the standard deviation of its observation noise. The manager privately observes S and M_0 . The observation error in M_0 and the noise N are independent of all other primitive errors.

The manager chooses $d \in \{-1, +1\}$ to maximize the probability of a correct final decision. Her choice uses both the realization of her own signal and the accuracy she expects from the analyst's assessment. Neither the analyst nor the manager observes the state before this choice. The manager bears no wage or record acquisition costs.

2.2 Contracts and record acquisition

Before the analyst works, the principal publicly commits to a contract. She chooses how precisely to record three objects: the initial assessment, the state, and the final decision. After the manager decides, these measurements become available as the contractible record $R = (\hat{a}_0, \hat{\theta}, \hat{d}) \in \{-1, +1\}^3$. The chosen precisions $p = (p_0, p_\theta, p_d) \in [1/2, 1]^3$ satisfy

$$\Pr(\hat{a}_0 = a_0 \mid a_0) = p_0, \quad \Pr(\hat{\theta} = \theta \mid \theta) = p_\theta, \quad \Pr(\hat{d} = d \mid d) = p_d.$$

The recording errors are symmetric, mutually independent, and independent of the production and observation errors. The manager acts on her private observations (M_0, S) before these records become available. Communication precision r_0 is fixed; the principal chooses the precision of the subsequent records used for payment.

Write $x = 2p_0 - 1$, $y = 2p_\theta - 1$, and $z = 2p_d - 1$ for the centered record precisions. A centered precision of zero gives an uninformative record, and a precision of one gives an exact record. Acquisition costs are

$$C(x, y, z) = \frac{1}{2}(c_0 x^2 + c_\theta y^2 + c_d z^2), \quad c_0, c_\theta, c_d > 0.$$

The principal can purchase any $(x, y, z) \in [0, 1]^3$ and pays this cost in addition to wages. The prices may differ across the three records.

A contract specifies these precisions and a finite, nonnegative wage $w(R)$. Payment depends only on the records R . The analyst is risk neutral, has outside option zero, and receives expected wage less effort cost. The principal values a correct decision at $v > 0$. Her expected profit is

$$v \Pr(d = \theta) - \mathbb{E}[w(R)] - C(x, y, z).$$

She therefore purchases records for their effect on the cost of motivating the analyst. The manager's information determines how the resulting initial work contributes to the decision.

2.3 Equilibrium and the principal's problem

Fix a contract. Let $\sigma \in [0, 1]$ be the probability that the analyst chooses high effort. The resulting initial assessment accuracy is $q = \alpha_L + \sigma\Delta$. Write δ_q for the manager's optimal decision rule when she expects initial assessment accuracy q . A perfect Bayesian continuation equilibrium requires that this expectation agree with the analyst's strategy and that each decision maker act optimally.

For the analyst, the relevant comparison is between the expected payments from high and low effort under the same managerial rule. A secret effort deviation changes the distribution of the assessment while the manager continues to use δ_q . In particular, a high-effort equilibrium requires

$$\mathbb{E}[w(R) \mid H, \delta_{\alpha_H}] - \mathbb{E}[w(R) \mid L, \delta_{\alpha_H}] \geq \kappa.$$

At a low-effort equilibrium this difference, evaluated under δ_{α_L} , is at most κ . An interior effort probability requires equality under δ_q . These incentive conditions also ensure participation: the analyst can obtain a nonnegative payoff by choosing costless low effort.

An effort target specifies the probability σ of high effort, or equivalently the initial assessment accuracy $q = \alpha_L + \sigma\Delta$. A contract supports this target when it has an equilibrium with that probability of high effort. It guarantees high effort when the analyst chooses H in every continuation equilibrium.

The principal chooses records and wages subject to these equilibrium requirements. Write $A(q; r)$ for decision accuracy: the probability that $d = \theta$ when the initial assessment has accuracy q and the manager uses δ_q . Under *favorable evaluation*, the principal evaluates a contract at its highest-profit continuation equilibrium. Equivalently, she solves

$$\begin{aligned} V^F(r) = \sup_{p, w, q} \quad & vA(q; r) - \mathbb{E}[w(R) \mid q, \delta_q] - C(x, y, z) \\ \text{subject to} \quad & p \in [1/2, 1]^3, \quad 0 \leq w(R) < \infty \text{ for every } R, \\ & q \in [\alpha_L, \alpha_H] \text{ is supported in equilibrium by } (p, w). \end{aligned}$$

The expectation at q averages over the analyst's equilibrium effort choice and all signal and recording errors. Optimal effort under favorable evaluation is the effort in a contract–equilibrium pair that maximizes the principal's profit. A contract with zero wages and no informative records induces low effort uniquely. It gives profit $vA(\alpha_L; r)$ and is always available.

A contract can also have equilibria yielding different profits. Under *robust evaluation*, its value is the lowest profit among its continuation equilibria; $V^R(r)$ is the supremum of that value over contracts. Every finite contract has a nonempty compact set of continuation equilibria, and its highest and lowest profits are attained. Favorable value is also attained over contracts. Appendix A.1 establishes these existence and attainment statements.

3 Optimal wages and record acquisition

The contract affects the accuracy the manager expects from the assessment and hence how she uses it. Her decision rule determines how the available record comparisons respond to effort and how much the principal must pay to obtain it. When she relies on the assessment, effort has a strong effect on whether the final decision is correct. When she relies on independent evidence, her decision can help check the analyst's judgment. The principal chooses payments and records to use this evidence at least cost.

3.1 Managerial decisions and effort incentives

If the initial assessment has accuracy q , the assessment received by the manager has accuracy

$$\beta(q) = r_0 q + (1 - r_0)(1 - q).$$

The first term corresponds to a correct assessment received correctly; the second corresponds to an incorrect assessment reversed by the observation error. The manager weighs M_0 using this accuracy.

A positive realization of S favors state $+1$, and a negative realization favors state -1 . Based on S alone, the posterior probability of either state is at most r . Consequently, if $\beta(q) \geq r$, the manager always chooses $d = M_0$. If $\beta(q) < r$, sufficiently strong conflicting state evidence makes her override M_0 . There is a threshold $s_q > 0$: she follows M_0 for $|S| < s_q$ and the sign of S for $|S| > s_q$. Ties have probability zero. A higher expected initial assessment accuracy raises the evidence required to override it. Appendix B.1 derives the threshold.

Two probability differences connect this decision rule to the analyst's incentive. Define u_q and t_q by

$$\begin{aligned} \Pr(d = \theta \mid H, \delta_q) - \Pr(d = \theta \mid L, \delta_q) &= \Delta u_q, \\ \Pr(a_0 = d \mid H, \delta_q) - \Pr(a_0 = d \mid L, \delta_q) &= \Delta t_q. \end{aligned} \tag{1}$$

The coefficient u_q measures how much an improvement in initial assessment accuracy raises the probability of a correct decision, holding the manager's rule fixed. The coefficient t_q measures how much it raises the probability of agreement with the final decision under that same rule. These are consequences of the manager's Bayesian rule; they vary with her expected assessment accuracy and with her independent information.

Consider first a manager who always follows M_0 . Write $m = 2r_0 - 1$. Her decision has $u_q = m$ and $t_q = 0$. Under this rule, high effort raises the probability of a correct decision, while the probability that $a_0 = d$ is r_0 under either effort. When the manager also uses independent state evidence, t_q is positive: a more accurate assessment is more likely to agree with a decision informed by that evidence.

The principal must obtain records of the objects she wishes to compare. Independent recording errors reduce each effort-induced probability difference by the product of the relevant centered precisions:

Payment event	Increase in probability under high effort
$\hat{a}_0 = \hat{\theta}$	Δxy
$\hat{a}_0 = \hat{d}$	$\Delta t_q xz$
$\hat{\theta} = \hat{d}$	$\Delta u_q yz$

The first event compares the analyst's assessment directly with the state. The second uses the manager's independent evidence to check the assessment. The third uses the state record to evaluate a decision that partly reflects the analyst's work. Each individual record is equally likely to be -1 or $+1$ under either effort, so its relation to another record supplies the incentive information.

The manager's expectation matters for these comparisons. Where she uses both signals, a higher q increases u_q and reduces t_q : she relies more on the assessment and requires stronger evidence to reverse it. At fixed record precisions, a bonus for agreement between the state and decision records then provides a weakly greater return to effort. A bonus for agreement between the assessment and decision records provides a weakly smaller return. This dependence allows the same contract to sustain different effort expectations. For each proposed target, the principal must therefore compute the wage using the managerial rule appropriate to that target.

3.2 Optimal wages

Fix record precisions and a positive probability of high effort, represented by initial assessment accuracy $q \in (\alpha_L, \alpha_H]$. Supporting this probability requires high effort to be optimal when $q = \alpha_H$, or indifference between efforts when q is interior. The principal chooses payments across record realizations to minimize the expected wage while satisfying this incentive requirement.

Let $k = \kappa/\Delta$ be the effort cost per unit improvement in assessment accuracy. With exact assessment and state records, paying k whenever the assessment is correct supplies the required incentive. The expected wage at target q is kq , and the analyst receives rent $k\alpha_L$, since even low effort sometimes produces a correct assessment.

For any event E that becomes more likely under high effort, a bonus b supplies the additional expected payment $b[\Pr(E | H, \delta_q) - \Pr(E | L, \delta_q)]$. The smallest bonus that makes the analyst willing to choose high effort sets this amount equal to κ . Its expected cost at the target is therefore

$$\kappa \frac{\Pr(E | q, \delta_q)}{\Pr(E | H, \delta_q) - \Pr(E | L, \delta_q)}.$$

The denominator measures the incentive bought by a unit bonus; the numerator measures how often that bonus must be paid. An event that is common under both efforts can require a large wage bill even if it is more common under high effort.

There are four possible patterns among three binary records: all agree, or one of the three differs from the other two. Symmetry permits the principal to give the same payment to both sign realizations of each pattern. Comparing their expected cost per unit of incentive yields agreement among all three records as a cheapest payment event. A wage paying on several patterns combines their costs and incentives and cannot improve on the cheapest one. Appendix B.2 verifies the four comparisons.

Proposition 1. *Fix an initial assessment accuracy $q \in (\alpha_L, \alpha_H]$, the manager's Bayesian rule δ_q , and centered record precisions $(x, y, z) \in [0, 1]^3$. Let u_q and t_q be the decision-rule coefficients defined by the probability differences in (1). Put $k = \kappa/(\alpha_H - \alpha_L)$ and $h_q = 2q - 1$. Define*

$$K_q = xy + t_q xz + u_q yz,$$

and $N_q = 1 + u_q xz + t_q yz + h_q K_q$. If $K_q > 0$, the wage

$$w_q(R) = \frac{2k}{K_q} \mathbf{1}\{\hat{a}_0 = \hat{\theta} = \hat{d}\}$$

minimizes expected payment among all finite nonnegative wages supporting q under the manager's rule δ_q . The minimum is

$$W_S(q; x, y, z) = \frac{kN_q}{2K_q} = \frac{k}{2} \left(2q - 1 + \frac{1 + u_q xz + t_q yz}{xy + t_q xz + u_q yz} \right). \quad (2)$$

If $K_q = 0$, no wage on these records supports q .

The probability of agreement among all three records is $N_q/4$ at the target and rises by $\Delta K_q/2$ under high effort. The bonus $2k/K_q$ therefore supplies exactly κ in additional expected payment. A more precise record can lower the expected wage by making the rewarded event more responsive to effort relative to its frequency. The coefficients u_q, t_q and the wage cost depend on r ; we write $W_S(q; x, y, z; r)$ when comparing information levels.

The wage saving reduces the analyst's rent. Under w_q , the effort incentive constraint binds, so choosing high or low effort gives the same net payoff under the target rule δ_q . The analyst's equilibrium rent is therefore the expected wage she would receive from choosing costless low effort under that rule:

$$W_S(q; x, y, z) - \kappa\sigma = \mathbb{E}[w_q(R) \mid L, \delta_q], \quad \sigma = \frac{q - \alpha_L}{\Delta}.$$

With noisy evidence, an incorrect assessment may also earn the bonus. Maintaining the required payment advantage for correct work then increases the wage bill. High effort raises the probability of a correct assessment by Δ , so the binding incentive constraint makes the conditional payment for a correct assessment exceed that for an incorrect assessment by k . The rent decomposition is

$$W_S(q; x, y, z) - \kappa\sigma = k\alpha_L + \mathbb{E}[w_q(R) \mid a_0 \neq \theta, \delta_q].$$

More precise records can reduce payments made when the initial assessment is wrong. When wages adjust to sustain the same effort probability, expected effort cost remains unchanged, so the wage saving reduces the analyst's rent by the same amount. With the manager's signal precision also unchanged, the manager uses the same decision rule and decision accuracy is unchanged. The principal purchases more precise evidence when the reduction in expected wages covers the additional acquisition cost. She can therefore spend more on records and less in total to obtain the same effort and decision accuracy.

3.3 Optimal record acquisition

The principal balances the wage saving from more precise evidence against its acquisition cost. For a target $q \in (\alpha_L, \alpha_H]$, her minimum total cost is

$$T_S(q; r) = \min_{(x, y, z) \in [0, 1]^3} \{W_S(q; x, y, z) + C(x, y, z)\}. \quad (3)$$

A zero incentive denominator is assigned infinite cost. The minimum is attained. Any minimizing precisions, together with the bonus in Proposition 1, give a least-cost contract supporting the target. At an interior precision choice, the marginal expected wage saving equals the marginal acquisition cost. A record is exact when its wage saving justifies paying for precision up to one.

In *direct evaluation*, payment depends only on the assessment and state records. With $z = 0$, averaging out the uninformative decision record in the optimal wage yields

$$w_D(R) = \frac{k}{xy} \mathbf{1}\{\hat{a}_0 = \hat{\theta}\}.$$

High effort raises this event's probability by Δxy , so the bonus supplies exactly κ in additional expected payment. The expected wage is $k[2q - 1 + (xy)^{-1}]/2$. Choosing the two precisions therefore amounts to

$$\min_{0 < x, y \leq 1} \left\{ \frac{k}{2xy} + \frac{c_0 x^2 + c_\theta y^2}{2} \right\}. \quad (4)$$

When both choices are interior, the first-order conditions give $c_0 x^2 = c_\theta y^2 = k/(2xy)$. Equal expenditure on the two records balances their contributions to the comparison, and the cheaper record is acquired more precisely. Denote the unique minimizing precisions by (x_D, y_D) , and their acquisition cost by $C_D = (c_0 x_D^2 + c_\theta y_D^2)/2$. Direct evaluation costs

$$T_D(q) = \frac{k}{2} \left(2q - 1 + \frac{1}{x_D y_D} \right) + C_D.$$

The precision choices are the same for every positive probability of high effort. The bonus has the same effect on effort under every managerial rule because its payment event concerns only the assessment and the state. Appendix B.3 gives the solution, including exact recording.

Acquiring a decision record can lower this cost by supplying evidence that would otherwise require more precise assessment or state records. When the manager relies on the assessment, her decision provides a second observation of it. When she uses independent state information, her decision can help check whether the assessment was correct. In the wage formula, these two uses correspond to u_q and t_q .

At the direct optimum $(x_D, y_D, 0)$, the marginal wage saving from recording the decision is proportional to

$$u_q y_D (1 - x_D^2) + t_q x_D (1 - y_D^2).$$

The first term is positive when the manager uses the assessment and its direct record is imperfect. The second is positive when she uses independent evidence and the state record is imperfect. Whenever this sum is positive, a sufficiently small positive centered precision z saves wages in proportion to z , at an acquisition cost proportional to z^2 . Some decision recording is then optimal at every finite price c_d . At high prices the principal buys little of it.

If the direct records already supply all of this evidence, the principal can stop recording the decision at a finite price. For a high-effort target, define $c_S^*(r)$ as the supremum of prices c_d for which including the decision strictly lowers total cost below $T_D(\alpha_H)$; set it to zero if there are no such prices. Thus $T_S(\alpha_H; r) < T_D(\alpha_H)$ exactly for $0 < c_d < c_S^*(r)$. Above the threshold all optimal record choices have $z = 0$. The threshold may be infinite. If the manager expecting high effort always follows M_0 , it is finite exactly when the direct alternative records the assessment exactly. If she also uses independent evidence, both direct records must be exact for the threshold to be finite. Appendix B.5 gives the full characterization.

The manager's use of the assessment affects both the value of producing it and the cost of rewarding its production. The principal chooses the effort probability by comparing its decision value with the optimized wage and record acquisition cost $T_S(q; r)$. Write $A_L(r) = A(\alpha_L; r)$ and $A_H(r) = A(\alpha_H; r)$. Her favorable value is

$$V^F(r) = \max \left\{ v A_L(r), \sup_{q \in (\alpha_L, \alpha_H]} [v A(q; r) - T_S(q; r)] \right\}.$$

The zero-wage alternative supplies the first term. A target $q > \alpha_L$ improves decision value by $v[A(q; r) - A_L(r)]$ and requires total cost $T_S(q; r)$. It is worth purchasing when the improvement exceeds that cost.

4 The value of managerial information

An increase in r makes the manager's independent signal $S = Z_r + \tau N$ more informative in the Blackwell order. The effort technology, communication precision r_0 , noise τ , decision value v , and record prices remain fixed. The principal can change wages, all three record precisions, and the effort she purchases.

At a fixed initial assessment accuracy, the better signal lets the manager make more accurate decisions. Decision accuracy weakly increases, and increases strictly once $r > \beta(q)$ and she sometimes overrides M_0 . Her decision then relies less on the assessment and more on independent evidence: u_q decreases and t_q increases. Keeping the same effort after this change may require a different bonus or different record precisions. The principal's gain from better decisions must therefore be assessed together with the cost of sustaining the initial work on which those decisions rely.

4.1 Record precision

Consider contracts that sustain the same probability of high effort as the manager's independent information improves. Fix the corresponding initial assessment accuracy $q \in (\alpha_L, \alpha_H]$ and compare $r_1 < r_2 \leq \bar{r} < 1$, with $r_2 > \beta(q)$ so that the manager's rule changes. At each r_i , the principal chooses wages and records to support q at minimum total cost. Denote any minimizing record choices by (x_i, y_i, z_i) .

When the state-record price is sufficiently low, the principal acquires an exact state record. In particular, if $c_\theta < k(1 - \bar{r})/(2\bar{r})$, every optimal record choice has $y = 1$ for every positive probability of high effort and every $r \leq \bar{r}$. With an exact state record, the principal still needs evidence of the analyst's initial assessment. She can obtain this evidence from the assessment record or from a decision that reflects the assessment.

As the manager relies more on independent information, her decision reveals less about the initial assessment. The principal responds by preserving that assessment more precisely:

$$x_2 \geq x_1.$$

This comparison allows the bonus and decision record precision to adjust. At unchanged record precisions with $y = 1$, the expected wage required to support q weakly rises, strictly so when $x < 1$ and $z > 0$. Even after optimizing the records, the minimum total cost of supporting the target weakly rises over this information comparison. The principal must replace evidence previously supplied by the decision or pay a larger wage for the remaining evidence.

A sufficiently low price for recording the initial assessment makes that record exact. If

$$c_0 \leq \frac{k(1 - m)}{2(1 + m)}, \quad m = 2r_0 - 1, \quad (5)$$

every optimal record choice has $x = 1$, for every positive probability of high effort and every $r \in (1/2, 1)$. With an exact assessment record, the principal can use the decision to help determine whether the assessment was correct. As the manager's independent evidence improves, the decision supplies more of the state information needed for this comparison. The principal weakly reduces state-record precision:

$$y_2 \leq y_1.$$

At unchanged record precisions with $x = 1$, the minimum expected wage weakly falls as r rises. Optimizing the records can reduce cost further.

The two comparisons concern different uses of the manager's decision. With an exact state record, the principal needs to establish the initial assessment. More independent managerial evidence makes the decision less useful for that purpose. With an exact assessment record, the principal needs to establish whether it was correct. More independent evidence makes the decision more useful for this comparison. Record prices determine which of these uses matters for compensation.

When $r_1, r_2 \leq \beta(q)$, the manager always follows M_0 and the set of optimal record choices is unchanged. Appendix C.2 proves these comparisons, including the boundaries at zero and exact recording. Appendix C.3 characterizes the corresponding changes in decision record precision.

When assessment recording costs satisfy (5), supporting cost $T_S(q; r)$ weakly falls at every target while decision accuracy weakly rises. Every previous target becomes at least as profitable, so $V^F(r)$ is nondecreasing. When the state-record price is sufficiently low, supporting cost moves in the opposite direction. Profit then depends on whether the additional decision value covers the increase in minimum total cost.

4.2 Profit under high effort

Suppose the state record is inexpensive enough to acquire exactly. A decision that follows the received assessment can help the principal economize on recording the assessment itself. Once the manager begins to revise it, the principal loses some of this evidence. A high value of accurate decisions can still make high effort worth purchasing, even though it has become more expensive to obtain.

The price of the decision record determines whether the organization was using this source of evidence. Let $\beta_H = \beta(\alpha_H)$, the accuracy of the assessment received by the manager after high effort. At $r = \beta_H$ the manager always follows M_0 under high effort. A sufficiently inexpensive decision record can then make an imperfect assessment record optimal. At prices above $c_S^*(\beta_H)$, direct evaluation already attains the lowest cost.

For sufficiently low state-record prices, the principal verifies the state exactly as r increases. For sufficiently high decision values, reducing effort sacrifices more decision value than it saves in wages and records. For an upper signal precision $\bar{r} > \beta_H$, the restrictions below keep $y = 1$ and effort high throughout $r \leq \bar{r}$. Write $u_L(r) = u_{\alpha_L}(r)$ and recall that $T_D(\alpha_H)$ is the optimized cost of obtaining high effort using assessment and state records alone.

Proposition 2. *Fix $\bar{r} \in (\beta_H, 1)$ and suppose*

$$c_\theta < \frac{k(1 - \bar{r})}{2\bar{r}}, \quad v > \max \left\{ \frac{k}{u_L(\bar{r})}, \frac{T_D(\alpha_H)}{A_H(\bar{r}) - A_L(\bar{r})} \right\}.$$

For every $c_d > 0$, high effort is the unique optimal effort under favorable evaluation throughout $r \in (1/2, \bar{r}]$. Every minimum-cost record choice supporting high effort has $y = 1$.

1. *If $c_d < c_S^*(\beta_H)$, every optimal record choice at β_H has $0 < x < 1$ and $z > 0$, and $V^F(r) < V^F(\beta_H)$ for all sufficiently small increases in r above β_H .*
2. *If $c_d \geq c_S^*(\beta_H)$, direct evaluation minimizes cost at β_H , and $V^F(r) > V^F(\beta_H)$ for every $r \in (\beta_H, \bar{r}]$.*

In both cases, decision accuracy is $A_H(r) > \beta_H$ for $r \in (\beta_H, \bar{r}]$.

Just above β_H , the manager first revises the received assessment when the two decisions have almost the same posterior probability of being correct. These revisions yield a small accuracy gain while weakening the relation between the initial assessment and the final decision. With an exact state record and an imperfect assessment record, that relation was helping the principal reward the analyst. The principal can adjust the bonus and record precisions or switch to direct evaluation. Near the revision threshold, even the least costly response raises wage and record costs by more than the gain in decision value. High effort remains optimal because reducing it sacrifices more decision value than it saves in wages and records.

If direct evaluation was already optimal, the principal can keep its wage and records as r rises. The analyst then has the same incentive, and the manager makes more accurate decisions. Profit therefore exceeds its value at $r = \beta_H$ for every $r \in (\beta_H, \bar{r}]$.

The threshold $c_S^*(\beta_H)$ is finite and strictly positive when

$$\frac{k(1 - m)}{2(1 + m)} < c_0 < \frac{k}{2}. \quad (6)$$

With these assessment-record prices, changing c_d alone can reverse the profit effect of a small information improvement. When recording the decision is cheap, the principal uses it to economize

on preserving the initial assessment. The resulting contract depends on the manager continuing to convey information about that assessment. Better independent evidence weakens this source of incentives. When recording the decision is expensive, the principal already preserves the assessment exactly and evaluates it against the state. That contract continues to provide the same incentive as the manager's information improves. The different profit responses follow from the records the principal found worth purchasing before the improvement.

For the prices and decision value in Proposition 2, if the assessment-record price also satisfies (6), an increase from $r = \beta_H$ to $r \in (\beta_H, \bar{r}]$ leads the principal to weakly increase assessment-record precision and weakly reduce decision record precision. Effort remains high. When $c_d < c_S^*(\beta_H)$, the optimized sum of wages and record costs exceeds its value at $r = \beta_H$ for all sufficiently small increases in r . If assessment recording is more expensive, $c_0 > k/2$, then $c_S^*(\beta_H) = \infty$: some decision recording remains optimal at every finite c_d , and the local profit decline occurs at every such price. Appendix C.4 proves these comparisons.

4.3 Effort choice

The principal can also respond to better managerial information by buying less initial effort. The relevant benefit of high effort is its decision value relative to the outcome available with zero wages. Independent managerial information improves this alternative and can reduce the amount the principal is willing to spend on initial work. Within this signal family, increasing r weakly reduces the decision accuracy gain from switching from low to high effort. At each expected initial assessment accuracy, the manager relies less on the assessment as her independent evidence improves. Initial effort and independent evidence are substitutes in producing accurate decisions.

In a benchmark without review, the organization executes the received assessment, $d = M_0$. The Bayesian manager makes the same decision under every effort expectation when $r \leq \beta_L$, where $\beta_L = \beta(\alpha_L)$. The observation error between the analyst and the decision is the same in both arrangements. In this benchmark, decision accuracy is $\beta(q)$ and the expected wage formula has $(u_q, t_q) = (m, 0)$. Let T_0 denote the minimum total cost of obtaining high effort in this benchmark, after all wages and records are optimized. The corresponding cost for another target $q > \alpha_L$ is $T_0 + k(q - \alpha_H)$. Both decision value and supporting cost are affine in the target. Comparing all effort probabilities therefore gives

$$V_0 = \max\{v\beta_L, v\beta_H - T_0\}. \quad (7)$$

The organization either purchases high effort with the least-cost agreement contract or pays zero and accepts low effort. Appendix B.6 gives the cost formula and the contract when the initial assessment and state records are inexpensive.

As r rises above β_L , the manager begins to revise assessments when she expects low effort. Under high effort she continues to follow M_0 until r exceeds β_H . Throughout $\beta_L < r \leq \beta_H$, the high-effort arrangement consequently retains decision accuracy β_H and cost T_0 , while the zero-wage arrangement becomes more accurate. If noise is small enough, every interior target yields less profit than either high effort or zero wages. Write Φ for the standard normal distribution function.

Proposition 3. *Let T_0 be the minimum total cost of supporting high effort when the received assessment is executed, $d = M_0$, under every effort expectation. Suppose*

$$v(\beta_H - \beta_L) > T_0, \quad v\Phi(-1/\tau) < k\alpha_L.$$

There is a unique $r^ \in (\beta_L, \beta_H)$ satisfying*

$$v[\beta_H - A_L(r^*)] = T_0. \quad (8)$$

Under favorable evaluation, the unique optimal effort is H for $r < r^*$ and L for $r > r^*$. Both pure efforts are optimal at r^* . For $r \in (1/2, 1)$, optimized profit is

$$V^F(r) = \begin{cases} v\beta_H - T_0, & r \leq r^*, \\ vA_L(r), & r \geq r^*. \end{cases}$$

Profit is continuous and nondecreasing. Switching from H to L at r^* lowers decision accuracy by T_0/v .

The inequality $v(\beta_H - \beta_L) > T_0$ makes high effort worth buying when the received assessment is executed. The bound on $\Phi(-1/\tau)$ limits the decision accuracy gain from an intermediate target where the manager uses independent evidence. Such a target still requires the analyst to be willing to incur the full high-effort cost whenever she chooses H , and therefore requires positive rent even if she rarely chooses it. Under the noise bound, its decision gain is too small to cover the required wage. Appendix C.5 establishes this comparison across all intermediate targets.

For $r < r^*$, the principal can retain the benchmark's least-cost high-effort contract. For $r > r^*$, she pays zero and acquires no records. At r^* the wage and record savings from abandoning high effort exactly offset the lost decision value. Profit is continuous although effort and decision accuracy change discretely. The manager's rule remains optimal given the initial assessment's reliability. Decision accuracy falls because the organization stops paying to produce the more accurate assessment.

This choice can discard work whose decision contribution still exceeds its resource cost. Write $T_0 = W_0 + C_0$, where W_0 is the expected wage and C_0 is record acquisition cost in a least-cost high-effort contract. At the threshold,

$$[v\beta_H - \kappa - C_0] - vA_L(r^*) = W_0 - \kappa \geq k\alpha_L > 0.$$

High effort generates greater decision value net of effort and record costs. The principal is indifferent because she also pays the analyst's rent. Abandoning effort saves her the entire wage, while it saves effort resources only by κ .

Record prices affect the threshold through the optimized cost T_0 . A reduction in prices weakly lowers T_0 , delays the exit to a higher r^* , and reduces the decision accuracy loss T_0/v , provided both price vectors satisfy the proposition's conditions. These effects are strict when the price reduction lowers T_0 . Less expensive evidence lets the organization retain high effort over a wider range of managerial information.

Propositions 2 and 3 describe different parameter regions. The high-value condition in Proposition 2 implies $v\Phi(-1/\tau) > k\alpha_L$, whereas Proposition 3 requires $v\Phi(-1/\tau) < k\alpha_L$. Appendix C.6 derives this comparison. Record prices determine which evidence the principal purchases within the high-effort region; decision value and signal noise also determine whether she continues purchasing high effort.

Appendix C.7 illustrates both effects with the same information and recording technologies and different decision values. The profit loss near the onset of revisions reflects the higher cost of maintaining high effort. The accuracy loss at the effort switch reflects the principal's choice to stop rewarding initial work.

5 Robust contracts

The cost-minimizing supporting wage in Proposition 1 makes the analyst willing to supply the target effort when the manager expects it. The same wage can give a weaker incentive when she

expects poorer work and relies more on her own evidence. A principal evaluating a contract at its lowest-profit equilibrium must take this response into account. She may need to change what the wage rewards, how precisely it is recorded, or the size of the bonus.

5.1 The cost of guaranteeing high effort

Consider an optimal supporting contract with an exact state record and an informative decision record, $y = 1$ and $z > 0$. These are the record choices in the local profit-loss comparison of Proposition 2. Write $K_L = K_{\alpha_L}$ and $K_H = K_{\alpha_H}$, and use the same subscripts for u_q, t_q, N_q . Also write $h_L = 2\alpha_L - 1$ and $h_H = 2\alpha_H - 1$. For $r > \beta_L$, the bonus event is more responsive to effort when the manager expects high effort: $K_H > K_L$. Thus the bonus $2k/K_H$, which just supports high effort, gives an analyst facing a low-effort expectation net gain

$$\frac{2k}{K_H} \frac{\Delta K_L}{2} - \kappa = \kappa \left(\frac{K_L}{K_H} - 1 \right) < 0$$

from choosing high effort. Low effort is also an equilibrium.

The reason is the manager's dependence on the assessment. With an exact state record, the contract uses the decision partly as evidence of what the analyst initially concluded. A manager expecting more reliable work uses it more. The same bonus then provides a larger return to producing an accurate assessment. Differentiating with respect to the effort expectation q where the manager uses both signals gives $u'_q > 0$ and $t'_q = -(2q - 1)u'_q$, giving $K'_q = zu'_q[y - (2q - 1)x]$. This derivative is positive when $y = 1$ and $z > 0$. This dependence of incentives on the manager's expectation allows both the high- and low-effort expectations to be self-consistent.

To guarantee high effort, the principal must provide a sufficient incentive at every possible effort expectation. For an agreement bonus, the weakest incentive occurs at one of the two endpoints:

$$\min_{q \in [\alpha_L, \alpha_H]} K_q = \min\{K_L, K_H\}. \quad (9)$$

Consequently, a bonus strictly above $2k/\min\{K_L, K_H\}$ makes high effort strictly optimal under every managerial rule. The principal can reduce this required bonus by changing the records as well.

Let $T_G(r)$ be the infimum combined wage and acquisition cost of contracts that induce high effort in every equilibrium. Optimization over all nonnegative wages and record precisions gives

$$T_G(r) = \min_{(x,y,z) \in [0,1]^3} \left\{ \frac{kN_H}{2 \min\{K_L, K_H\}} + C(x, y, z) \right\}. \quad (10)$$

A zero denominator is assigned infinite cost. The payment probability under high effort is $N_H/4$. The required bonus, $2k/\min\{K_L, K_H\}$, uses the smaller incentive response across the two effort expectations. At a minimizing precision vector, multiplying the bonus $2k/\min\{K_L, K_H\}$ by $1 + \varepsilon$ guarantees high effort for every $\varepsilon > 0$. Its cost converges to T_G as ε tends to zero. Appendix D.1 proves the lower bound over all wage schedules and the endpoint comparison.

The principal can always use the direct wage based on the assessment and state. Its effort incentive is independent of the manager's expectation. The three relevant costs therefore satisfy

$$T_S(\alpha_H; r) \leq T_G(r) \leq T_D(\alpha_H).$$

The infimum cost of guaranteeing high effort equals the minimum cost of supporting it exactly when some minimum-cost record choice for supporting high effort satisfies $K_L \geq K_H$. Otherwise, the principal must spend more to make effort worthwhile when the manager expects low effort. Direct evaluation bounds this extra expense.

5.2 Optimal record acquisition

The guarantee requirement changes the prices at which recording the final decision is worthwhile. Define $c_G^*(r)$ as the supremum of prices c_d for which $T_G(r) < T_D(\alpha_H)$, taking zero if there are none. The cost ordering implies $c_G^*(r) \leq c_S^*(r)$. Above $c_G^*(r)$, every minimizing record choice in (10) has $z = 0$. Including the decision record is worthwhile when it supplies sufficient incentives under both expectations to cover its acquisition cost.

Start with $r \leq \beta_L$, when the manager follows M_0 under every effort expectation, and increase r to (β_L, β_H) . When she expects high effort she still follows M_0 . When she expects low effort she sometimes revises it. The minimum cost of supporting high effort remains T_0 , but the incentive supplied at a low-effort expectation changes. Its difference from the high-effort incentive is

$$K_L - K_H = z\{t_L x - (m - u_L)y\}.$$

The term $t_L x$ reflects the independent evidence now supplied by the decision when compared with the assessment record. The term $(m - u_L)y$ reflects the loss of the assessment's influence on the probability of a correct decision. A bonus for agreement between the state and decision records can therefore become more expensive when it must guarantee high effort.

This can make the organization replace the decision record with more expensive direct records. Consider prices for which the optimal direct records (x_D, y_D) are both imperfect. In the benchmark without review, the final decision supplements the assessment record, so some decision recording reduces cost at every finite c_d . For the guarantee after review is introduced, the effect depends on how recording changes payments under high effort and incentives under a low-effort expectation. At prices satisfying the strict inequality in Lemma D.3, increasing decision record precision raises the frequency of bonus payments under high effort proportionally more than it improves incentives under the low-effort expectation. The expected wage needed to guarantee high effort therefore rises at $(x_D, y_D, 0)$. Under this condition, $c_G^*(r)$ is finite. At every price above it, $(x_D, y_D, 0)$ minimizes (10), so the infimum cost of guaranteeing high effort is $T_D(\alpha_H) > T_0$.

When $v(\beta_H - r) > T_D(\alpha_H)$, high effort is worth purchasing under both evaluation criteria, including comparison with all interior targets. The favorable contract keeps its old high-effort outcome and cost. The robust value is approached by slightly increased direct bonuses that guarantee the same effort. The values are

$$V^F(r) = V_0 = v\beta_H - T_0, \quad V^R(r) = v\beta_H - T_D(\alpha_H).$$

Effort and decision accuracy are the same as in the benchmark. Under high effort, the manager continues to choose $d = M_0$. The direct bonus also makes high effort worthwhile when she expects low effort and sometimes revises the received assessment. Its incentive effect is the same under either expectation because payment depends on the initial assessment and the state. The principal pays more to acquire these records: acquisition cost rises from C_0 to C_D , and the robust profit value falls by $T_D(\alpha_H) - T_0$. The additional expense secures high effort against the competing low-effort equilibrium.

More precise direct records can reduce expected wages even when total cost rises. In this comparison, if $x_D^2 > 1/3$, they lower the expected wage at all sufficiently large finite decision-record prices. The increase in record acquisition cost more than offsets that wage saving. If $x_D^2 < 1/3$, the expected wage is higher at sufficiently large prices as well. For each such price, sufficiently small bonus increases preserve these wage comparisons. Appendix D.5 gives these component comparisons.

5.3 Effort choice

The principal may prefer to reduce effort when guaranteeing high effort becomes expensive. Her comparison includes the zero-wage contract, contracts guaranteeing high effort, and contracts uniquely inducing an interior effort probability. Appendix D derives the infimum total cost for every interior target and the resulting robust value. For an interior target q with $\beta(q) < r$, let $T_I(q; r)$ be the infimum cost of uniquely inducing that target. Robust value is

$$V^R(r) = \max \left\{ vA_L(r), vA_H(r) - T_G(r), \sup_{\substack{q \in (\alpha_L, \alpha_H) \\ \beta(q) < r}} [vA(q; r) - T_I(q; r)] \right\}.$$

The three terms compare zero wages, a high-effort guarantee, and all uniquely implemented interior targets. An interior target gives lower decision value than high effort but can require lower implementation cost. The principal compares these terms after optimizing its wage and records.

Under the small-noise condition $v\Phi(-1/\tau) < k\alpha_L$, the same wage lower bound used in Proposition 3 excludes profitable interior effort. The robust problem then becomes

$$V^R(r) = \max\{vA_L(r), vA_H(r) - T_G(r)\}.$$

On $\beta_L < r < \beta_H$, favorable evaluation purchases high effort when its additional decision value $v[\beta_H - A_L(r)]$ exceeds T_0 . Robust evaluation requires it to exceed $T_G(r)$. When the value lies strictly between these costs, favorable evaluation retains high effort and robust evaluation chooses low effort.

If the benchmark purchased high effort, this robust switch lowers both decision accuracy and profit relative to that benchmark. Decision accuracy falls from β_H to $A_L(r)$, and the profit change is $T_0 - v[\beta_H - A_L(r)] < 0$. The organization gives up initial effort because sustaining it under all equilibrium expectations has become too costly. Once the additional decision value also falls below T_0 , both criteria choose low effort; the savings in wages and record acquisition cost then raise profit relative to the benchmark.

Direct evaluation limits how costly managerial review can be. It can always deliver high effort at total cost arbitrarily close to $T_D(\alpha_H)$, while review weakly improves decision accuracy at that effort. If the direct contract already minimizes cost in the benchmark without review, review therefore weakly raises the robust value. More generally, the potential loss is bounded by the benchmark's saving from using the final decision, less the decision gain from review. Appendix D.4 states this bound. Section 7 considers the principal's choice between review and execution of the received assessment.

5.4 Favorable and robust values

The two evaluation criteria can give opposite responses to the same improvement in managerial information. At $r = \beta_H$, the manager still follows M_0 when high effort is expected. A supporting contract can use the decision record to economize on recording the initial assessment. A contract that guarantees high effort may already find direct evaluation cheaper. Better managerial information then changes the cost of the supporting contract while preserving the direct contract's incentive.

Proposition 4. *Fix $\bar{r} \in (\beta_H, 1)$ and suppose*

$$0 < c_\theta < \frac{k(1 - \bar{r})}{2\bar{r}}, \quad \frac{k(1 - m)}{2(1 + m)} < c_0 < \frac{k}{2}.$$

The decision-record price thresholds satisfy

$$0 \leq c_G^*(\beta_H) < c_S^*(\beta_H) < \infty.$$

For every $c_d \in (c_G^*(\beta_H), c_S^*(\beta_H))$, there is a finite v_* , depending on the fixed technologies and record prices, such that for every $v > v_*$ there is $\delta \in (0, \bar{r} - \beta_H]$ with

$$\begin{aligned} V^F(r) &< V^F(\beta_H), \\ V^R(r) &= vA_H(r) - T_D(\alpha_H) > V^R(\beta_H) = v\beta_H - T_D(\alpha_H) \end{aligned} \quad (\beta_H < r < \beta_H + \delta).$$

High effort is the unique optimal favorable effort throughout $r \in (1/2, \bar{r}]$. At β_H , every minimum-cost supporting design has $0 < x < 1$, $y = 1$, and $z > 0$. On $[\beta_H, \beta_H + \delta)$, the guarantee precision problem has the unique minimizer $(1, 1, 0)$, and direct-record contracts with strict analyst incentives approach the robust value.

Appendix D.7 establishes the price interval and compares high effort with every interior target. Under favorable evaluation, the organization initially saves on direct evidence by using the manager's decision. When the manager starts revising high-effort assessments, replacing this evidence costs more than the gain in decision value. Under robust evaluation, the organization has already purchased exact assessment and state records to guarantee effort. Their cost and incentive effect remain unchanged, so the same information improvement raises profit through more accurate decisions.

6 Contracting with the manager

Paying the manager can lower the cost of guaranteeing the analyst's effort. Consider $\beta_L < r < \beta_H$. An unpaid manager follows M_0 when she expects high effort, but sometimes revises it when she expects low effort. The principal can pay her to follow M_0 under both expectations. This preserves the high-effort decision and its accuracy, while changing the evidence available under a low-effort expectation. The records then serve two purposes: rewarding the analyst and inducing the manager's use of the assessment.

The principal commits before effort to finite nonnegative wages $w_A(R)$ and $w_M(R)$ and to the three shared record precisions. The analyst retains her preferences. The manager is risk neutral, with outside option zero and expected payoff $\gamma \Pr(d = \theta) + \mathbb{E}[w_M(R)]$, where $\gamma > 0$ measures her monetary value of accuracy. She chooses d after observing (M_0, S) ; records arrive afterward and are acquired once. The principal deducts both wages and $C(x, y, z)$ from decision value. The manager's private observations remain outside the wage contract.

6.1 Manager incentives and shared records

Consider agreement bonuses

$$w_M(R) = b \mathbf{1}\{\hat{a}_0 = \hat{d}\}, \quad b \geq 0, \quad (11)$$

and require $d = M_0$ at every effort expectation $q \in [\alpha_L, \alpha_H]$. For $x, z > 0$, the smallest bonus inducing this behavior is

$$b^* = \frac{\gamma \lambda^*(r)}{xz}, \quad \lambda^*(r) = \frac{2r - 1 - mh_L}{m - (2r - 1)h_L} \in (0, 1). \quad (12)$$

The binding requirement comes from the low-effort expectation and the strongest conflicting state evidence. Since the signal likelihood ratio approaches its bound only in the tails, this minimum bonus makes the manager strictly prefer M_0 at every finite signal realization. Her expected wage under either actual effort is

$$\mathbb{E}[w_M] = \gamma G_r(x, z), \quad G_r(x, z) = \frac{\lambda^*(r)}{2} \left(\frac{1}{xz} + m \right). \quad (13)$$

Following M_0 makes $\Pr(a_0 = d) = r_0$ under either actual effort. The manager's expected wage therefore depends on the two recording precisions through xz , while remaining the same under both efforts.

Once the manager follows M_0 at all effort expectations, the minimum analyst wage supporting high effort at fixed records $x, y, z > 0$ is

$$\frac{k}{2} \left[h_H + \frac{1 + mxz}{y(x + mz)} \right]. \quad (14)$$

For $\varepsilon > 0$, the wage

$$w_A^\varepsilon(R) = (1 + \varepsilon) \frac{2k}{y(x + mz)} \mathbf{1}\{\hat{a}_0 = \hat{\theta} = \hat{d}\} \quad (15)$$

gives high effort a net payoff advantage εk under every expectation. It therefore uniquely induces high effort, with accuracy β_H . Optimizing both wages and all shared records within (11), subject to these decision requirements, gives the infimum cost

$$T_M(\gamma; r) = \min_{0 < x, y, z \leq 1} \left\{ \frac{k}{2} \left[h_H + \frac{1 + mxz}{y(x + mz)} \right] + C(x, y, z) + \gamma G_r(x, z) \right\}. \quad (16)$$

For $\gamma > 0$, the record minimum is attained. Strict analyst incentives approach this cost as $\varepsilon \downarrow 0$. At $\gamma = 0$, the continuous extension is the execution cost T_0 .

6.2 Adoption of the manager contract

Proposition 5. *Fix $r \in (\beta_L, \beta_H)$ and positive record prices, and suppose*

$$T_G(r) > T_0, \quad v(\beta_H - r) > T_D(\alpha_H). \quad (17)$$

Robust value with an unpaid manager is $V^R(r) = v\beta_H - T_G(r)$. For manager wages $w_M(R) = b\mathbf{1}\{\hat{a}_0 = \hat{d}\}$, $b \geq 0$, requiring $d = M_0$ at all effort expectations and guaranteeing high effort, there is a unique finite adoption threshold $\gamma^\dagger(r) > 0$ satisfying

$$T_M(\gamma^\dagger; r) = T_G(r). \quad (18)$$

For $\gamma > 0$, there exists a finite contract satisfying these requirements that strictly improves on $V^R(r)$ exactly when $\gamma < \gamma^\dagger(r)$. At equality the value suprema coincide.

Let (x^0, y^0, z^0) be any record vector attaining T_0 , and define

$$\gamma_{\text{fixed}}(x^0, y^0, z^0; r) = \frac{T_G(r) - T_0}{G_r(x^0, z^0)}. \quad (19)$$

Then

$$0 < \gamma_{\text{fixed}}(x^0, y^0, z^0; r) < \gamma^\dagger(r) \leq \frac{T_G(r) - T_0}{r_0 \lambda^*(r)}. \quad (20)$$

The adoption decision depends on the joint choice of compensation and records. The assessment record supports both the analyst's effort incentive and the manager's incentive to follow the received assessment. Holding the state and decision record precisions fixed, more precise assessment recording reduces the expected payments required for both incentives. Paying the manager therefore adds a reason to improve this record, which the principal weighs against its acquisition cost.

The strict threshold comparison measures the benefit of adjusting records to this additional use. Records attaining T_0 minimize the cost of rewarding the analyst when following M_0 can be enforced without compensating the manager. Once a manager bonus is needed, increasing assessment-record precision from that choice strictly lowers the combined cost of wages and records. Jointly choosing the records and both wages thus makes the paid arrangement profitable for a larger range of the manager's valuation of accuracy.

Appendix E.4 illustrates how this adjustment can change the adoption decision. With an unpaid manager, guaranteeing effort is cheapest with exact assessment and state records. An agreement bonus permits a different design: a less precise assessment record combined with a decision record. This saves on acquisition costs while adding a manager wage. Keeping the records chosen under freely enforceable execution makes the paid arrangement too expensive; choosing records for both wages makes it profitable. All three arrangements induce high effort and the same decisions. Their comparison shows how manager compensation can substitute for some direct documentation, with its value depending on the records used to enforce both agents' incentives.

An organization choosing between contracts with an unpaid manager and this paid arrangement has robust value

$$\max\{V^R(r), v\beta_H - T_M(\gamma; r)\}. \quad (21)$$

The decision-value restriction in (17) makes a direct high-effort guarantee more profitable than any outcome with accuracy at most r . Every contract with an unpaid manager that fails to guarantee high effort admits such an equilibrium. Under this condition, the favorable value with an unpaid manager is already $v\beta_H - T_0$. The paid arrangement improves the guarantee by reducing its cost toward T_0 , while keeping actual effort and decisions unchanged. Appendix E also gives the comparison at a fixed $r \in (\beta_H, r_0]$, where enforcing M_0 gives up some decision accuracy.

7 Commitment and reporting

The preceding comparisons hold the review institution fixed. This section considers two changes in the principal's instruments: an enforceable choice to execute the received assessment, and additional information for determining the analyst's payment.

7.1 Commitment to a decision rule

Suppose the principal can publicly commit before contracting and effort to either autonomous review or execution of the received assessment, $d = M_0$. Transmission, recording technologies, and acquisition costs are the same in both institutions. For evaluation criterion $j \in \{F, R\}$, the institutional-choice value is therefore

$$\hat{V}^j(r) = \max\{V_0, V^j(r)\},$$

where V_0 is the execution value in (7). A small increase in managerial information leaves this value constant in the parameter region of Proposition 4. In that region, $V_0 = V^F(\beta_H)$ and $V^F(r) < V_0$ immediately to the right of β_H . Since $V^R(r) \leq V^F(r)$, both criteria select execution and give $\hat{V}^F(r) = \hat{V}^R(r) = V_0$.

Execution also provides a useful comparison for the manager contract in Section 6. When $T_G(r) > T_0$ and $v(\beta_H - r) > T_D(\alpha_H)$, executing M_0 guarantees high effort at cost arbitrarily close to T_0 . The paid arrangement gives the same decision and effort outcome at cost $T_M(\gamma; r) > T_0$. Free enforceable execution is consequently strictly more profitable than this paid arrangement. The manager contract supplies a way to induce the execution rule through compensation when review is autonomous. Direct enforcement supplies the same rule without the manager payment. Both comparisons concern a public commitment made before effort.

7.2 Managerial reporting

Return to the baseline manager, who maximizes decision accuracy and receives no wage. Her private observation can become an input to the payment system. Consider first an unverified message from a finite set, sent after the final decision. Suppose it can affect the analyst's wage and has no effect on subsequent actions, measurements, or the manager's payoff. The manager is then indifferent among messages. Every contract admits constant-message equilibria corresponding to a contract on the original records. Optimized robust value is unchanged. Truthful reporting can also be optimal for the manager and can expand the outcomes available under favorable evaluation.

Suppose the received assessment M_0 can be recorded truthfully and at no cost for use in the wage contract. This additional record becomes available after the decision, with the other recording technologies retained. If the favorable optimum in this expanded contract space is attained with high effort at $r = \beta_H$, favorable and robust values coincide there. A payment based on M_0 and the direct records can preserve that effort incentive as r rises, while the manager makes more accurate decisions. Both values then strictly exceed their values at β_H . Appendix F proves these statements.

The reporting benchmarks change the evidence available after the decision. Giving the purchased assessment record to the manager before she acts would also change her operational information. That timing would make assessment-record precision a joint choice of communication and payment evidence.

8 Conclusion

The value of better review depends on the evidence available to reward the work being reviewed. A final decision can substitute for recording an initial assessment or help evaluate its accuracy. Record prices determine which use is economical and how compensation responds to better managerial information.

Sufficiently inexpensive assessment records protect effort incentives and make favorable value weakly increase with better information. With inexpensive state records and a useful decision record, a small information improvement can raise the cost of supporting high effort by more than its decision benefit. Under different value and noise conditions, better information makes the principal stop purchasing high effort, lowering decision accuracy.

The requirement to guarantee effort changes the evidence worth buying. At the same parameters, supporting high effort can remain cheapest with the decision record while guaranteeing it calls for direct assessment and state records. The same information improvement then lowers favorable value locally and raises robust value. A manager bonus can also reduce the cost of guaranteeing effort by changing review under competing effort expectations. Reoptimizing the shared records expands the range of manager valuations of accuracy for which this contract is profitable.

Compensation and records allow the principal to influence the cost of autonomous review. A freely enforceable decision rule gives her another instrument. In the region with a local favorable loss, the option to execute the received assessment preserves profit after a small information improvement. In the manager-contract comparison, it delivers the same high-effort outcome at lower cost than paying the manager to follow that rule.

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A Equilibrium

A.1 Equilibrium existence and value attainment

Fix records, finite nonnegative wages, and r . The manager's coefficients u_q, t_q are continuous in q , including at $\beta(q) = r$. Define the conditional payment difference by

$$D_w(q) = \mathbb{E}[w(R) \mid a_0 = \theta; \delta_q] - \mathbb{E}[w(R) \mid a_0 \neq \theta; \delta_q].$$

It is continuous in q . The gain from high effort is $\Delta D_w(q) - \kappa$, so the equilibrium conditions use the threshold $k = \kappa/\Delta$. If $D_w(\alpha_L) \leq k$, low effort is an equilibrium; if $D_w(\alpha_H) \geq k$, high effort is an equilibrium. In the remaining case, $D_w(\alpha_L) > k > D_w(\alpha_H)$, continuity gives an interior root $D_w(q) = k$. The endpoint inequalities and the interior equality define a closed, nonempty subset of $[\alpha_L, \alpha_H]$. Expected wages and profit are continuous on this set, so the principal's highest and lowest continuation profits are attained.

Favorable optimization over all contracts also attains its value. To bound the relevant wages, continuity and $u_q + t_q < 1$ give

$$\min_{q \in [\alpha_L, \alpha_H]} (1 - u_q - t_q) > 0.$$

Every raw history (θ, a_0, d) has probability at least

$$\frac{1 - \alpha_H}{4} \min_{q \in [\alpha_L, \alpha_H]} (1 - u_q - t_q) > 0.$$

The independent symmetric measurement channels are doubly stochastic, so the same lower bound holds for every recorded realization, uniformly over the precision cube. A contract–equilibrium pair with nonnegative profit consequently satisfies

$$w(R) \leq \frac{4v}{(1 - \alpha_H) \min_{q \in [\alpha_L, \alpha_H]} (1 - u_q - t_q)} \quad \text{for every } R.$$

Zero wages provide positive profit, so favorable optimization can be restricted to this wage bound. The equilibrium graph is closed in the resulting compact domain, and the continuous profit function attains a maximum. The wage bound follows from full support and the objective.

For robust evaluation, a limit of strict incentives can add a low-effort equilibrium. Its value is the supremum over contracts. A direct bonus approaching its binding incentive level illustrates why strict high-effort implementation can require such a limit.

B Wages and record acquisition

B.1 The manager's rule

Conditional on $\theta = +1$, the density of S is a mixture of normal densities centered at $+1$ and -1 , with weights r and $1 - r$. Conditional on $\theta = -1$, the weights are reversed. The ratio of the two normal component densities at S is $\exp(2S/\tau^2)$. Conditional independence and the equal prior give posterior log odds

$$M_0 \log \frac{\beta(q)}{1 - \beta(q)} + \log \frac{r \exp(2S/\tau^2) + 1 - r}{(1 - r) \exp(2S/\tau^2) + r}.$$

The manager chooses $+1$ when this expression is positive and -1 when it is negative. The state-evidence likelihood ratio lies between $(1 - r)/r$ and $r/(1 - r)$. If $\beta(q) \geq r$, the posterior therefore

always favors M_0 . If $\beta(q) < r$, setting the log odds to zero at $M_0 = -1$ gives $\exp(2s_q/\tau^2) = [r + \beta(q) - 1]/[r - \beta(q)]$, which yields

$$s_q = \frac{\tau^2}{2} \log \frac{r + \beta(q) - 1}{r - \beta(q)}. \quad (22)$$

Symmetry gives the threshold $-s_q$ when $M_0 = +1$.

Symmetry permits the conditional representation

$$\mathbb{E}[d \mid a_0, \theta; \delta_q] = u_q a_0 + t_q \theta.$$

Changing actual effort from L to H changes the distribution of a_0 while holding this rule fixed. It raises the probability of a correct decision by Δu_q and agreement $a_0 = d$ by Δt_q , so these coefficients coincide with the probability-difference definitions in the text. With $h_q = 2q - 1$, decision accuracy is

$$A(q; r) = \frac{1 + h_q u_q + t_q}{2}.$$

The coefficients satisfy $u_q > 0$, $t_q \geq 0$, and $u_q + t_q < 1$. For any fixed rule, the probability of a correct decision is affine in q . Maximizing over rules makes $A(q; r)$ convex, and the envelope condition gives $\partial A(q; r)/\partial q = u_q$.

Let Φ and ϕ be the standard normal distribution function and density, respectively. Set $s_q = \infty$ when $\beta(q) \geq r$, and write $s_e = s_{\alpha_e}$ for $e \in \{L, H\}$. The decision coefficients are

$$\begin{aligned} u_q &= m [\Phi((s_q - 1)/\tau) - \Phi((-s_q - 1)/\tau)], \\ t_q &= (2r - 1) [\Phi((1 - s_q)/\tau) - \Phi((-1 - s_q)/\tau)]. \end{aligned}$$

At $s_q = \infty$, these formulas give $(u_q, t_q) = (m, 0)$. In the range $r > \beta(q)$, differentiating the cutoff and normal probabilities with respect to q gives $u'_q > 0$ and $t'_q = -h_q u'_q$. The latter identity also follows from the envelope condition for decision accuracy. It implies $dt/du = -h_q$, which decreases with q . Thus t is strictly concave as a function of u in that region. The range where $d = M_0$ contributes a single endpoint to this relation.

For $\beta(q) \leq r$, the bound $A(q; r) \leq r$ can also be seen from the binary experiment (M_0, Z_r) . If the manager observes both binary signals, she follows the more accurate Z_r when they disagree, and is correct with probability r . Observing S in place of Z_r is a garbling of this experiment.

B.2 Optimal supporting wages

For a general wage, define its conditional payment difference by

$$D_w(q) = \mathbb{E}[w(R) \mid a_0 = \theta; \delta_q] - \mathbb{E}[w(R) \mid a_0 \neq \theta; \delta_q].$$

The gain from choosing high effort is $\Delta D_w(q) - \kappa$. Consequently, H is an equilibrium when $D_w(\alpha_H) \geq k$, L is an equilibrium when $D_w(\alpha_L) \leq k$, and an interior equilibrium requires $D_w(q) = k$.

Proof of Proposition 1. Simultaneously reversing the state, assessment, and decision leaves all probabilities unchanged. Averaging a wage with its sign reversal preserves its expected payment and effort incentives. Index the four resulting record classes by $s = \hat{a}_0 \hat{\theta}$ and $j = \hat{a}_0 \hat{d}$, each in $\{-1, +1\}$. At the fixed manager rule, define

$$L_{sj} = 1 + u_q x z j + t_q y z s j, \quad K_{sj} = x y s + t_q x z j + u_q y z s j.$$

The class probability at target q is $(L_{sj} + h_q K_{sj})/4$ and its probability difference between actual efforts is $\Delta K_{sj}/2$. Agreement among all three records corresponds to class $(s, j) = (+1, +1)$.

For classes with $K_{sj} > 0$, minimizing expected wage per unit of incentive is equivalent to maximizing K_{sj}/L_{sj} . Cross multiplication between class $(+1, +1)$ and each other class gives, writing $u = u_q$ and $t = t_q$,

$$\begin{aligned} 2z[tx(1 - y^2) + uy(1 - x^2)] &\geq 0, \\ 2y[x(1 - t^2z^2) + u^2xz^2 + uz(1 + x^2)] &\geq 0, \\ 2x[y(1 - u^2z^2) + t^2yz^2 + tz(1 + y^2)] &\geq 0. \end{aligned}$$

The inequalities use $x, y, z \in [0, 1]$ and $u, t \geq 0$, $u + t < 1$. Classes with $K_{sj} \leq 0$ cannot improve the minimum wage. Paying only when all three records agree, and setting its bonus to make the effort constraint bind, therefore yields $b = 2k/K_q$. Multiplication by its probability $N_q/4$ gives (2). If $K_q = 0$, the effort-induced probability difference is zero for every class, so high effort cannot be optimal. $\square$

B.3 Optimal precision for direct evaluation

For $c_0 \leq c_\theta$, the unique minimizer is

$$(x_D, y_D) = \begin{cases} ((k/2)^{1/4} c_\theta^{1/8} c_0^{-3/8}, (k/2)^{1/4} c_0^{1/8} c_\theta^{-3/8}), & k \leq 2c_0^{3/2}/\sqrt{c_\theta}, \\ (1, (k/(2c_\theta))^{1/3}), & 2c_0^{3/2}/\sqrt{c_\theta} < k < 2c_\theta, \\ (1, 1), & k \geq 2c_\theta. \end{cases} \quad (23)$$

For $c_0 > c_\theta$, interchange the coordinates and their prices.

Derivation of the direct-record optimum. The objective in (4) is strictly convex on its positive domain. Its interior first-order conditions equate $c_0 x^2 = c_\theta y^2$ to $k/(2xy)$. Solving them gives the first row of (23). If $c_0 \leq c_\theta$, the unconstrained assessment record reaches one first, at $k = 2c_0^{3/2}/\sqrt{c_\theta}$. Conditional on $x = 1$, minimization gives $y = (k/(2c_\theta))^{1/3}$ until $k = 2c_\theta$. Thereafter both coordinates equal one. The expressions agree at the boundaries. The target-dependent term $kh_q/2$ is additive, so these precisions apply to every target $q \in (\alpha_L, \alpha_H]$. $\square$

For equal prices $c_0 = c_\theta = c > k/2$, the optimal bonus is $\sqrt{2kc}$, and

$$x_D = y_D = \left(\frac{k}{2c}\right)^{1/4}, \quad T_D(q) = \frac{kh_q}{2} + \sqrt{2kc}.$$

Half of the target-independent cost is expected wage and half is record acquisition cost. With these two records, high effort is optimal under favorable evaluation exactly when

$$v[A_H(r) - A_L(r)] \geq \frac{k(2\alpha_H - 1)}{2} + \sqrt{2kc},$$

with low effort also optimal at equality. This compares the additional decision value with the optimized wage and acquisition costs.

The direct-record cost $T_D(q)$ is affine in q . Since $A(q; r)$ is convex, an interior target cannot improve on both pure choices under this record restriction. The favorable value using only the initial assessment and state records is therefore

$$V_D^F(r) = \max\{vA_L(r), vA_H(r) - T_D(\alpha_H)\}.$$

When high effort gives greater profit, the principal uses (x_D, y_D) and pays $k/(x_D y_D)$ on recorded agreement. When low effort gives greater profit, she pays zero and acquires no records.

Under the state-record price restriction in Proposition 2, $y_D = 1$ and $x_D = \min\{1, (k/(2c_0))^{1/3}\}$. The high-effort cost is

$$T_D(\alpha_H) = \frac{k(2\alpha_H - 1)}{2} + \frac{c_\theta}{2} + \begin{cases} k/2 + c_0/2, & c_0 \leq k/2, \\ \frac{3}{2}c_0^{1/3}(k/2)^{2/3}, & c_0 > k/2. \end{cases}$$

B.4 Conditional record acquisition

Fix z and a target q . Write $u = u_q$, $t = t_q$, $X = x + uz$, $Y = y + tz$, and $d_0 = 1 - (u^2 + t^2)z^2 > 0$. The ratio in the expected wage formula is

$$\frac{1 + uxz + tyz}{xy + txz + uyz} = \frac{d_0 + uzX + tzY}{XY - utz^2}.$$

Where the expected wage is finite, $XY > utz^2$. Expanding the denominator as a geometric series expresses this ratio as a positive sum of functions $X^{-a}Y^{-b}$ with $a, b \geq 0$. These functions are convex; their pointwise series limit is convex. Adding the positive quadratic acquisition cost makes the conditional objective strongly convex. At its unique minimizer, the first-order conditions are

$$\begin{aligned} c_0 x &= \frac{k\{(y + t_q z)(1 + t_q yz) - u_q^2 z^2 y\}}{2K_q^2}, \\ c_\theta y &= \frac{k\{(x + u_q z)(1 + u_q xz) - t_q^2 z^2 x\}}{2K_q^2}, \end{aligned}$$

whenever the respective coordinate is interior. At a precision of one, the corresponding marginal wage saving is at least its marginal acquisition cost. In particular, both direct records are exact if and only if

$$c_0 \leq \frac{k}{2} \frac{1 + (t_q - u_q)z}{1 + (u_q + t_q)z}, \quad c_\theta \leq \frac{k}{2} \frac{1 + (u_q - t_q)z}{1 + (u_q + t_q)z}. \quad (24)$$

Minimizing the resulting conditional value over $z \in [0, 1]$ determines the joint precision choice.

The principal can also vary all three precisions in a fixed proportion. Fix $n = (n_0, n_\theta, n_d) \geq 0$ with $\max_j n_j = 1$ and $K_q(n) > 0$, and write $(x, y, z) = \sqrt{s}n$, where $0 < s \leq 1$ determines their level. Let $K_q(n)$ and $N_q(n)$ be the agreement-event coefficients evaluated at n , and put $c_n = c_0 n_0^2 + c_\theta n_\theta^2 + c_d n_d^2$. Total cost is

$$\frac{k}{2sK_q(n)} + \frac{k[N_q(n) - 1]}{2K_q(n)} + \frac{sc_n}{2}.$$

Differentiating with respect to s gives the unique minimum at

$$s^*(n) = \min \left\{ 1, \sqrt{\frac{k}{c_n K_q(n)}} \right\}.$$

For a high-effort guarantee, take a direction satisfying $\min\{K_L(n), K_H(n)\} > 0$. The same calculation replaces the incentive denominator $K_q(n)$ by $\min\{K_L(n), K_H(n)\}$ and evaluates the payment numerator at high effort.

B.5 Decision-record price threshold

Fix high effort, and write $u_H = u_{\alpha_H}$, $t_H = t_{\alpha_H}$, and $T_D = T_D(\alpha_H)$. The derivative of the minimum expected wage at the optimized direct records is

$$\left. \frac{\partial W_S}{\partial z} \right|_{(x_D, y_D, 0)} = - \frac{k\{t_H x_D(1 - y_D^2) + u_H y_D(1 - x_D^2)\}}{2x_D^2 y_D^2}. \quad (25)$$

Here $c_S^*(r)$ is the supremum of prices $c_d > 0$ for which $T_S(\alpha_H; r) < T_D$, with value zero for an empty set.

Lemma B.1. *Fix the high-effort target, its Bayesian manager rule, and prices $c_0, c_\theta > 0$. Vary the decision-record price $c_d > 0$. Let (x_D, y_D) be the unique direct-evaluation optimum and $T_D = T_D(\alpha_H)$ its total cost. The threshold $c_S^*(r)$ is the supremum of prices at which a decision record strictly lowers supporting cost, with value zero if there are no such prices. Then:*

1. $T_S(\alpha_H; r) < T_D$ exactly when $0 < c_d < c_S^*(r)$. At every price $c_d > c_S^*(r)$, all record choices minimizing supporting cost have $z = 0$.
2. The price threshold is infinite exactly when

$$t_H x_D(1 - y_D^2) + u_H y_D(1 - x_D^2) > 0. \quad (26)$$

Otherwise it is finite, possibly zero.

In particular, if the high-effort manager chooses $d = M_0$, the price threshold is finite exactly when $x_D = 1$.

Proof of Lemma B.1. The optimized cost is an infimum of functions affine and nondecreasing in the price vector, so it is concave and nondecreasing. Suppose one price increases from c to c' and its corresponding optimal centered precision changes from ξ to ξ' . Adding the two optimality inequalities gives $(c' - c)[(\xi')^2 - \xi^2] \leq 0$.

Direct evaluation is available at every c_d , so $T_S(\alpha_H; r) \leq T_D$. Strict improvement requires $z > 0$. The improving-price set is downward closed and open at every positive finite endpoint by continuity of the value function. If an optimal record choice had $z > 0$ at a price above the threshold, the same record choice at a slightly lower price still above the threshold would strictly improve on T_D . This is a contradiction.

For finiteness, let $F(x, y, z)$ be the objective in (3) at $q = \alpha_H$ with $c_d z^2/2$ removed. The exact threshold is

$$c_S^*(r) = \max \left\{ 0, \sup_{\substack{x, y \in [0, 1] \\ z \in (0, 1]}} \frac{2[T_D - F(x, y, z)]}{z^2} \right\}.$$

Write $\gamma_S = \partial_z F(x_D, y_D, 0)$. If $\gamma_S < 0$, evaluating this quotient at (x_D, y_D, z) and sending z to zero makes it unbounded. If $\gamma_S \geq 0$, strong convexity of the direct objective and a Taylor bound around its unique minimizer give positive constants a, b, c such that

$$F(x, y, z) \geq T_D + a\|(x, y) - (x_D, y_D)\|^2 + \gamma_S z - b\|(x, y) - (x_D, y_D)\|z - cz^2.$$

The one-sided first-order terms at active upper bounds are nonnegative on the feasible cube. Completing the square bounds the right side below by $T_D + \gamma_S z - c'z^2$. Any improving sequence with $z \rightarrow 0$ approaches the unique direct optimum. Away from $z = 0$ the threshold quotient is bounded, since $F \geq 0$. This proves finiteness. Substituting (25) gives (26); when $(u_H, t_H) = (m, 0)$, its left side is positive exactly when $x_D < 1$. $\square$

B.6 The optimal contract without managerial review

When $d = M_0$, put $h_H = 2\alpha_H - 1$. A wage schedule minimizing expected payment while supporting high effort pays $2k/[y(x + mz)]$ when all three records agree. Its total cost, minimized over records, is

$$T_0 = \min_{(x,y,z) \in [0,1]^3} \left\{ \frac{k}{2} \left[h_H + \frac{1 + mxz}{y(x + mz)} \right] + C(x, y, z) \right\}.$$

When $d = M_0$ under every effort expectation, all coefficients except h_q in (3) are independent of q . Thus $T_S(q) = T_0 + k(q - \alpha_H)$, and profit is affine in q on $(\alpha_L, \alpha_H]$, with slope $vm - k$. If this slope is positive, H yields the highest profit among these targets. If it is nonpositive, every target $q > \alpha_L$ yields less than $v\beta_L$: its decision gain is at most $vm(q - \alpha_L)$, and its expected wage is at least kq . Comparing with the zero-wage contract proves (7) for favorable evaluation. Multiplying an optimal supporting bonus by $1 + \varepsilon$ makes effort strictly optimal under the fixed rule $d = M_0$, proving the robust equality in value.

In particular, if

$$c_0 \leq \frac{k(1 - m)}{2(1 + m)}, \quad c_\theta \leq \frac{k}{2}, \quad (27)$$

then exact direct records are optimal: $x = y = 1, z = 0$. The wage is k on $\hat{a}_0 = \hat{\theta}$, and $T_0 = k\alpha_H + (c_0 + c_\theta)/2$.

At $u = m, t = 0$, conditions (24) hold for every z whenever (27) holds. Conditional on $x = y = 1$, the wage is kq and independent of z , so the positive acquisition price makes $z = 0$ optimal. This gives the explicit contract above.

C The value of managerial information

C.1 Record acquisition and profit

For $r > \beta(q)$, the threshold in (22) decreases strictly in r and increases strictly in q . Let $P_+(s)$ and $P_-(s)$ be the upper-tail probabilities of the normal components centered at $+1$ and -1 , respectively:

$$P_+(s) = \Phi((1 - s)/\tau), \quad P_-(s) = \Phi((-1 - s)/\tau).$$

The managerial coefficients are

$$u_q = m[1 - P_+(s_q) - P_-(s_q)], \quad t_q = (2r - 1)[P_+(s_q) - P_-(s_q)]. \quad (28)$$

Consequently u_q decreases strictly and t_q increases strictly with r whenever $r > \beta(q)$. They are constant in the remaining region. The envelope theorem gives the derivatives of decision accuracy:

$$\frac{\partial A(q; r)}{\partial q} = u_q(r), \quad \frac{\partial A(q; r)}{\partial r} = P_+(s_q) - P_-(s_q) > 0 \quad (r > \beta(q)).$$

Terms involving the derivative of the threshold cancel because the manager is indifferent at the switching observation. It follows that $u_q(r) \geq u_L(\bar{r}) > 0$ for all $q \in [\alpha_L, \alpha_H]$ and $r \leq \bar{r}$, and that $A_H(r) - A_L(r) = \int_{\alpha_L}^{\alpha_H} u_q(r) dq$ is nonincreasing in r .

The Blackwell comparison can also be verified directly. For $r_1 < r_2$, multiply an observation from the r_2 experiment by an independent random sign whose mean is $(2r_1 - 1)/(2r_2 - 1)$. Symmetry of the Gaussian noise gives the r_1 experiment. The distribution of M_0 conditional on a_0 is unchanged.

For fixed record precisions and a target q , suppress the target subscripts on u and t . With $x = 1$, the minimum expected wage is

$$W_S = \frac{k}{2} \left[h_q + \frac{1 + y\{tz/(1 + uz)\}}{y + tz/(1 + uz)} \right]. \quad (29)$$

As r increases, t rises and u falls, so $tz/(1 + uz)$ rises. The wage is decreasing in this quantity when $y < 1$ and constant when $y = 1$. With $y = 1$, the corresponding expression is

$$W_S = \frac{k}{2} \left[h_q + \frac{1 + x\{uz/(1 + tz)\}}{x + uz/(1 + tz)} \right]. \quad (30)$$

Now $uz/(1 + tz)$ falls with r . The wage consequently rises when $x < 1$, $z > 0$, and the manager's rule changes with r .

Lemma C.1. *For each target $q \in (\alpha_L, \alpha_H]$, every record choice that minimizes supporting cost has $x = 1$ if $c_0 \leq k(1 - m)/[2(1 + m)]$, where $m = 2r_0 - 1$ and $k = \kappa/(\alpha_H - \alpha_L)$. For any $\bar{r} \in (1/2, 1)$, every record choice that minimizes supporting cost has $y = 1$ at all $r \leq \bar{r}$ if $c_\theta < k(1 - \bar{r})/(2\bar{r})$.*

Proof. Fix z and a managerial rule, and suppress target subscripts. At $y = 1$, the marginal wage saving from state-record precision is

$$-\partial_y W_S(x, 1, z) = \frac{k}{2} \frac{(x + uz)(1 + uxz) - t^2 z^2 x}{[(1 + tz)x + uz]^2}.$$

For $a \geq 0$, $0 \leq b < 1$, and $a + b < 1$, define

$$f(x; a, b) = \frac{(x + a)(1 + ax) - b^2 x}{[(1 + b)x + a]^2}.$$

On its finite domain,

$$\partial_x f = \frac{[a^2 - (1 + b)^2][(1 - b)x + a]}{[(1 + b)x + a]^3} \leq 0.$$

Thus, with $a = uz$ and $b = tz$,

$$f(x; uz, tz) \geq f(1; uz, tz) = \frac{1 + uz - tz}{1 + uz + tz} \geq \frac{1 - t}{1 + t} \geq \frac{1 - \bar{r}}{\bar{r}}.$$

The last inequality uses $t \leq 2r - 1 \leq 2\bar{r} - 1$. If the state price satisfies the stated condition, the derivative of $W_S + C$ at $y = 1$ is strictly negative for every x, z that can generate a positive incentive. The objective is strictly convex in y conditional on x, z . Its minimum therefore has $y = 1$.

Interchanging x, y and u, t gives

$$-\partial_x W_S(1, y, z) \geq \frac{k}{2} \frac{1 - u}{1 + u} \geq \frac{k}{2} \frac{1 - m}{1 + m}.$$

The inequality $u \leq m$ follows from (28). Strict convexity in x and the weak price inequality imply $x = 1$. If fixing the other coordinates makes the wage infinite for every positive precision, that pair of coordinates cannot be part of an optimal record choice and can be omitted from the argument. $\square$

Under the first condition of Lemma C.1, (29) shows that the wage at every formerly optimal record choice weakly decreases as r increases. Acquisition costs are unchanged. Hence $T_S(q; r)$ is nonincreasing at each target. Taking the supremum over $q \in (\alpha_L, \alpha_H]$ and comparing with the zero-wage alternative proves the global nondecrease of V^F asserted after (5).

C.2 Assessment and state record precision

Fix $q \in (\alpha_L, \alpha_H]$, prices $c_0, c_\theta, c_d > 0$, and all other primitives except r . Consider $r_1 < r_2$ with $r_2 > \beta(q)$. For $i = 1, 2$, write $u_i = u_q(r_i)$ and $t_i = t_q(r_i)$, and let (x_i, y_i, z_i) be any minimizer of $T_S(q; r_i)$. Then $u_2 < u_1$ and $t_2 > t_1$. If every minimizer at both signal precisions has $y = 1$, then $x_2 \geq x_1$. If every minimizer at both signal precisions has $x = 1$, then $y_2 \leq y_1$. When $r_1 < r_2 \leq \beta(q)$, the objectives coincide and the optimal sets are equal.

Proof. First suppose all minima have $y = 1$. For a fixed pair $u = u_q(r) > 0$ and $t = t_q(r) \geq 0$, use the change of variable

$$\eta = \frac{uz}{1+tz}, \quad z = \frac{\eta}{u-t\eta}, \quad 0 \leq \eta \leq \frac{u}{1+t}.$$

The denominator is positive on this domain. Up to the constant $kh_q/2 + c_\theta/2$, the cost is

$$F(x, \eta) + Q(\eta; u, t), \quad F(x, \eta) = \frac{k}{2} \frac{1+x\eta}{x+\eta} + \frac{c_0 x^2}{2}, \quad Q(\eta; u, t) = \frac{c_d}{2} \left(\frac{\eta}{u-t\eta} \right)^2.$$

At $x = \eta = 0$ assign infinite cost. Since $u + t < 1$, every feasible η is less than one. Conditional on η , the minimizer $x(\eta) \in [0, 1]$ is unique, because

$$F_{xx} = c_0 + \frac{k(1-\eta^2)}{(x+\eta)^3} > 0, \quad F_{x\eta} = \frac{k(1+x\eta)}{(x+\eta)^3} > 0.$$

The conditional minimizer is therefore nonincreasing in η , including where it equals one.

Let $F_*(\eta) = \min_{x \in [0,1]} F(x, \eta)$ and $Q_i(\eta) = Q(\eta; u_i, t_i)$. The remaining problem minimizes $F_*(\eta) + Q_i(\eta)$ on $[0, u_i/(1+t_i)]$. Its acquisition marginal cost is

$$Q'_i(\eta) = \frac{c_d u_i \eta}{(u_i - t_i \eta)^3}.$$

For $\eta > 0$, decreasing u_i and increasing t_i strictly raise this marginal cost. Thus $Q_2 - Q_1$ is strictly increasing on the common domain, and the upper feasible bound falls. Suppose two minimizers satisfied $\eta_2 > \eta_1$. Both choices would be feasible at both signal precisions. Their optimality inequalities imply

$$F_*(\eta_1) + Q_1(\eta_1) \leq F_*(\eta_2) + Q_1(\eta_2), \quad F_*(\eta_2) + Q_2(\eta_2) \leq F_*(\eta_1) + Q_2(\eta_1).$$

Adding gives $(Q_2 - Q_1)(\eta_2) \leq (Q_2 - Q_1)(\eta_1)$, a contradiction. Hence $\eta_2 \leq \eta_1$, and the unique conditional choice gives $x_2 = x(\eta_2) \geq x(\eta_1) = x_1$.

Now suppose all minima have $x = 1$. If $t > 0$, set

$$\eta = \frac{tz}{1+uz}, \quad z = \frac{\eta}{t-u\eta}, \quad 0 \leq \eta \leq \frac{t}{1+u}.$$

The same conditional problem applies to y , replacing c_0 by c_θ . Its unique minimizer $y(\eta)$ is nonincreasing in η . The decision-record acquisition cost now has marginal cost

$$\frac{c_d t \eta}{(t - u\eta)^3}.$$

Increasing t and decreasing u strictly lower this marginal cost at positive η , while expanding the feasible interval. The two optimality inequalities consequently rule out $\eta_2 < \eta_1$. It follows that $y_2 \leq y_1$. If $t_1 = 0$, the wage at r_1 is independent of z , so $z_1 = \eta_1 = 0$. Then $\eta_2 \geq 0$ directly implies $y_2 \leq y(0) = y_1$. Finally, where the manager follows M_0 both coefficients are constant, so the entire objective and its optimal set are unchanged. $\square$

If exact state recording is optimal at both signal precisions, then $T_S(q; r_2) \geq T_S(q; r_1)$. Equation (30) orders wages at every record choice with $y = 1$, and acquisition costs are unchanged. Taking the minima over that common set preserves the ordering. The corresponding argument with (29) gives the reverse cost ordering when the assessment record is exact at both optima.

C.3 Decision record precision

Fix $q \in (\alpha_L, \alpha_H]$, positive acquisition prices, and all other primitives except r . Compare $r_1 < r_2$ with $r_2 > \beta(q)$, and let (x_i, y_i, z_i) be any record choice minimizing supporting cost at r_i . If every minimizer at both signal precisions has $y = 1$ and $c_0 \leq 2k$, then $z_2 \leq z_1$. If every minimizer at both signal precisions has $x = 1$ and $c_\theta \leq 2k$, then $z_2 \geq z_1$.

With an exact state record, the bound on c_0 makes replacing the lost evidence through the assessment record inexpensive enough to yield the first direction of adjustment. Under the second comparison, decision-record precision weakly increases and expenditure on the state record weakly falls.

Proof. The two cases share a conditional cost problem. With an exact state record, set $(\ell, a, b, c) = (x, u_q, t_q, c_0)$; with an exact assessment record, set $(\ell, a, b, c) = (y, t_q, u_q, c_\theta)$. Define

$$\eta = \frac{az}{1+bz}, \quad g(\eta) = \min_{0 < \ell \leq 1} \left\{ \frac{k}{2} \frac{1+\ell\eta}{\ell+\eta} + \frac{c\ell^2}{2} \right\}.$$

Here $a, b \geq 0$, $a + b < 1$, and $\eta < 1$. The conditional minimizer $\ell(\eta)$ is unique and positive by the strict convexity established in Appendix C.2. At an interior solution,

$$c\ell = \frac{k(1-\eta^2)}{2(\ell+\eta)^2}, \quad \ell'(\eta) = -\frac{2\ell(1+\ell\eta)}{(1-\eta^2)(3\ell+\eta)}.$$

The marginal saving from η is

$$M(\eta) = -g'(\eta) = \frac{k[1-\ell(\eta)^2]}{2[\ell(\eta)+\eta]^2}.$$

It is positive when $\ell < 1$ and zero when the direct record is exact.

The price bound $c \leq 2k$ implies $M + \eta M' > 0$ wherever $\ell < 1$. For $\eta = 0$ this follows from $M > 0$. For $0 < \eta < 1$, the first-order condition gives

$$\frac{1-\eta^2}{\ell(\ell+\eta)^2} = \frac{2c}{k} \leq 4.$$

The left side is strictly decreasing in ℓ and equals $8/(1+\eta) > 4$ at $\ell = (1-\eta)/2$. Hence $\ell > (1-\eta)/2$. Differentiation gives

$$M + \eta M' = M \frac{P(\ell, \eta)}{(1-\eta^2)(3\ell+\eta)(1-\ell^2)},$$

where

$$P(\ell, \eta) = (1+\eta^2)(3\ell+\eta)(1-\ell^2) - 2\eta(1+\ell\eta)(1-3\ell^2).$$

For fixed η , its derivative is

$$P_\ell = -9(1-\eta^2)\ell^2 + 2\eta(5-\eta^2)\ell + 3 + \eta^2.$$

This quadratic has one positive and one negative root, so P first increases and then decreases on the positive half-line. Its minimum on $[(1 - \eta)/2, 1]$ occurs at an endpoint, and

$$P((1 - \eta)/2, \eta) = \frac{(1 - \eta)^2(1 + \eta)(9 + 8\eta - 5\eta^2)}{8} > 0,$$

$$P(1, \eta) = 4\eta(1 + \eta) > 0.$$

This proves the claimed inequality and also gives $2M + \eta M' > 0$. On an interval with $\ell = 1$, $M = 0$ and both weak inequalities hold. The marginal saving is continuous across this boundary, so the derivative comparisons below extend across it by integration.

After optimizing the direct record, the cost that varies with z is

$$J(z; a, b) = g\left(\frac{az}{1 + bz}\right) + \frac{c_d z^2}{2}.$$

At differentiability points, its derivatives satisfy

$$J_z = c_d z - M(\eta) \frac{a}{(1 + bz)^2},$$

$$J_{za} = -\frac{M + \eta M'}{(1 + bz)^2} \leq 0,$$

$$J_{zb} = \frac{az}{(1 + bz)^3} (2M + \eta M') \geq 0.$$

The last two inequalities are strict when $a > 0$, $z > 0$, and $M > 0$. With an exact state record, $a = u_q$ falls and $b = t_q$ rises as r increases. Thus the new cost minus the old cost is nondecreasing in z .

Any global optimum with $z > 0$ has $\ell < 1$: at $\ell = 1$ the wage is independent of z , and setting $z = 0$ would save its positive acquisition cost. Suppose $z_2 > z_1$. At z_2 , the new conditional optimum therefore has $M > 0$. The old value of η at this same z_2 is larger, so its conditional direct precision is also below one. The cost difference is strictly increasing on an interval just below z_2 . Writing $J_i(z) = J(z; a_i, b_i)$, global optimality gives

$$J_1(z_1) \leq J_1(z_2), \quad J_2(z_2) \leq J_2(z_1),$$

and hence $(J_2 - J_1)(z_2) \leq (J_2 - J_1)(z_1)$, a contradiction. This proves $z_2 \leq z_1$, including boundary and nonunique optima.

With an exact assessment record, $a = t_q$ rises and $b = u_q$ falls. The cost difference is nonincreasing in z . If $z_1 > z_2$, positive use at the old optimum z_1 supplies the same strictness, contradicting the two optimality inequalities. Thus $z_2 \geq z_1$. If $t_q(r_1) = 0$, the old wage is independent of z and its optimum has $z_1 = 0$, which gives the result directly. $\square$

The opposite adjustment can occur when the assessment record is expensive. Fix the same target and information comparison, set $u_i = u_q(r_i)$, and suppose

$$c_\theta < \frac{k(1 - r_2)}{2r_2}, \quad c_d > \frac{k}{2u_2}.$$

The first condition makes state recording exact at every optimum. Hold these prices fixed and let c_0 increase. Then every optimal record choice satisfies

$$x_i \longrightarrow 0, \quad z_i \longrightarrow \left(\frac{k}{2c_d u_i}\right)^{1/3} < 1.$$

Since $u_2 < u_1$, for all sufficiently large finite c_0 , every optimal decision record precision at r_2 strictly exceeds every optimal decision record precision at r_1 .

Here the principal purchases a more precise observation of a decision that has become less informative about the initial assessment.

To establish the limit, a feasible record choice with $x = 0$, $y = 1$, and $z > 0$ bounds cost independently of c_0 . Every optimizing sequence therefore has $x \rightarrow 0$, while z stays bounded away from zero because the wage diverges as the incentive denominator vanishes. At $x = 0$, the only terms depending on z are

$$\frac{k}{2u_i z} + \frac{c_d z^2}{2}.$$

This function is strictly convex and has the unique interior minimizer displayed above. Comparing any limit point with this feasible record choice shows that all optimal decision record precisions converge to that minimizer. The strictly ordered limits imply the ordering at sufficiently large finite assessment-record prices. The finite-price problem continues to optimize all three record precisions.

C.4 Profit near the revision threshold

Proof of Proposition 2. Lemma C.1 gives $y = 1$ at all record choices minimizing supporting cost in the stated range. First take a price $0 < c_d < c_S^*(\beta_H)$. At $r = \beta_H$, the minimum supporting cost is strictly below the direct-record cost, so every optimal record choice has $z > 0$. If also $x = 1$, the wage in (30) is independent of z . Reducing z to zero then lowers acquisition cost without changing the wage. Hence an optimal record choice with $z > 0$ has $x < 1$. At $x = 0$ and $z > 0$, the wage derivative with respect to x is strictly negative because $0 < uz/(1 + tz) < 1$, whereas the acquisition derivative is zero. Thus $0 < x < 1$ at each of these record choices.

For fixed record precisions with $y = 1$, differentiation with respect to the target gives

$$\partial_q \left(\frac{u_q z}{1 + t_q z} \right) = \frac{z u'_q [1 + t_q z + h_q u_q z]}{(1 + t_q z)^2} \geq 0,$$

where $t'_q = -h_q u'_q$. Since for $\xi \geq 0$, $\frac{\partial}{\partial \xi} [(1 + x\xi)/(x + \xi)] = (x^2 - 1)/(x + \xi)^2 \leq 0$, $\partial_q W_S \leq k$. The same bound holds on an interval where the manager follows M_0 and across its continuous boundary. Taking an optimal record choice at a lower target and applying it at a higher target therefore gives

$$T_S(q_2; r) - T_S(q_1; r) \leq k(q_2 - q_1) \quad (\alpha_L < q_1 < q_2 \leq \alpha_H).$$

Decision accuracy increases by at least $u_L(\bar{r})(q_2 - q_1)$. The first bound on v makes $vA(q; r) - T_S(q; r)$ strictly increasing on $(\alpha_L, \alpha_H]$. Moreover,

$$v[A_H(r) - A_L(r)] \geq v[A_H(\bar{r}) - A_L(\bar{r})] > T_D(\alpha_H) \geq T_S(\alpha_H; r).$$

This proves strict optimality of high effort in the favorable problem for every $c_d > 0$. With $y = 1$ and $z = 0$, minimizing $k/(2x) + c_0 x^2/2$ on $(0, 1]$ gives $x_D = \min\{1, (k/(2c_0))^{1/3}\}$, which also establishes the displayed direct-cost formula.

For the local information comparison, put $h = 2\alpha_H - 1$ and let $r \downarrow \beta_H$ from above. Then $s_H \rightarrow \infty$. Gaussian tail ratios satisfy $P_-(s_H)/P_+(s_H) \rightarrow 0$. With $\varepsilon = m - u_H = m[P_+(s_H) + P_-(s_H)]$,

$$\frac{t_H}{\varepsilon} = \frac{2r - 1}{m} \frac{P_+(s_H) - P_-(s_H)}{P_+(s_H) + P_-(s_H)} \rightarrow h.$$

Thus $t_H = h\varepsilon + o(\varepsilon)$, and $A_H - \beta_H = (t_H - h\varepsilon)/2 = o(\varepsilon)$. The derivative of decision accuracy above makes this change strictly positive.

Let $\mathcal{M}_c \subset [0, 1]^3$ be the set of centered precision triples minimizing supporting cost at $r = \beta_H$, and set $K_c = y(x + mz)$. Expanding the wage at a fixed precision vector gives

$$W_S(\alpha_H; x, y, z; r) - W_S(\alpha_H; x, y, z; \beta_H) = -\varepsilon \Gamma(x, y, z) + o(\varepsilon),$$

where

$$\Gamma(x, y, z) = \frac{kz}{2K_c^2} \left[h(x + mz)(1 - y^2) - (y + hmoz)(1 - x^2) \right].$$

The expansion is uniform on a compact neighborhood of the optimal set with K_c bounded away from zero. Such a neighborhood contains every optimizer for sufficiently close r : direct evaluation gives a uniform total-cost bound, while $W_S \geq k/(2K_q)$ excludes sequences with $K_q \rightarrow 0$.

Uniform expansion and compactness give the optimized-value formula

$$[vA_H(r) - T_S(\alpha_H; r)] - [v\beta_H - T_S(\alpha_H; \beta_H)] = \varepsilon \max_{(x, y, z) \in \mathcal{M}_c} \Gamma(x, y, z) + o(\varepsilon). \quad (31)$$

The upper bound follows by evaluating each new optimizer in the old problem and taking a convergent subsequence. Its limit belongs to $\mathcal{M}_c$. The lower bound follows by retaining an old optimizer that maximizes Γ . The contribution from decision accuracy is $o(\varepsilon)$ because v is fixed.

At a price below $c_S^*(\beta_H)$, every $(x, y, z) \in \mathcal{M}_c$ has $y = 1$, $x < 1$, and $z > 0$, so

$$\Gamma(x, y, z) = -\frac{kz(1 - x^2)(1 + hmoz)}{2(x + mz)^2} < 0.$$

Continuity and compactness imply $\max_{(x, y, z) \in \mathcal{M}_c} \Gamma(x, y, z) < 0$. Equation (31), together with high effort's strict optimality, proves the asserted decrease of V^F .

If $c_d \geq c_S^*(\beta_H)$, direct comparison is optimal at $r = \beta_H$. For a positive finite threshold, this includes equality by continuity of the optimized cost in c_d . Its wage and acquisition cost are independent of the managerial rule. Retaining the optimal assessment and state records after the information improvement gives

$$V^F(r) \geq vA_H(r) - T_D(\alpha_H) > v\beta_H - T_D(\alpha_H) = V^F(\beta_H) \quad (\beta_H < r \leq \bar{r}).$$

Finally, if $c_0 > k/2$, then $x_D < 1$. The optimal assessment and state records give

$$\partial_z(W_S + C)|_{(x_D, 1, 0), r=\beta_H} = -\frac{km(1 - x_D^2)}{2x_D^2} < 0.$$

This strict first-order wage saving dominates the quadratic acquisition cost of a sufficiently small z at every finite c_d . Thus the direct record choice never minimizes supporting cost, and $c_S^*(\beta_H) = \infty$. $\square$

To verify the positive finite price interval in (6), let $a = c_0/k$. The direct optimum has $x = y = 1$. At the auxiliary price $c_d = 0$, taking $y = z = 1$ and $x = 1$ gives exactly the direct cost. The objective's derivative in x there is

$$c_0 - \frac{k}{2} \frac{1 - m}{1 + m} > 0.$$

Reducing x therefore saves total cost. The strict saving persists for sufficiently small positive c_d , proving $c_S^*(\beta_H) > 0$.

For finiteness, define

$$z_0 = \frac{1 - 2a}{m(1 + 2a)} \in (0, 1).$$

At $r = \beta_H$ and $y = 1$, the objective conditional on z is strictly convex in x . Its derivative at $x = 1$ is nonpositive for $z \leq z_0$, so its conditional minimum has $x = 1$. Such a record choice has the direct wage and the additional positive cost $c_d z^2/2$. For $z \geq z_0$, acquisition cost alone exceeds $T_D(\alpha_H)$ when $c_d > 2T_D(\alpha_H)/z_0^2$. Hence direct evaluation is optimal at every sufficiently large c_d , and $c_S^*(\beta_H) < \infty$.

C.5 The effort threshold

Proof of Proposition 3. If the manager follows $\text{sign}(S)$, her decision is correct with probability $r - (2r - 1)\Phi(-1/\tau)$, so

$$A_L(r) \geq r - (2r - 1)\Phi(-1/\tau).$$

At any target with $\beta(q) \leq r$, even observing the ungarbled pair (M_0, Z_r) gives a probability of a correct decision of at most r : the more accurate binary signal is Z_r . Hence

$$v[A(q; r) - A_L(r)] \leq v(2r - 1)\Phi(-1/\tau) < k\alpha_L < kq.$$

Every positive-effort equilibrium requires an expected wage of at least kq . Such targets consequently yield less profit than zero wages and zero acquisition, including at $\beta(q) = r$.

If an interior target satisfies $\beta(q) > r$, the manager follows M_0 throughout the interval from q to α_H . Analyst indifference at the interior target implies that all targets in this interval are equilibria of the same contract. Per unit of initial assessment accuracy, the expected wage difference is k and the decision accuracy difference is m . The principal's equilibrium profit has slope $vm - k$. If the slope is positive, high effort gives strictly higher profit. If the slope is nonpositive, the additional decision value over low effort is at most $vm(q - \alpha_L)$, which is smaller than the required wage kq . Zero wages again give strictly higher profit. All interior targets have therefore been excluded from a favorable optimum.

For $r \leq \beta_H$, high effort has decision accuracy β_H and minimum total supporting cost T_0 . Favorable value is

$$V^F(r) = \max\{vA_L(r), v\beta_H - T_0\}.$$

For $r \geq \beta_H$, the first argument applies to every target $q > \alpha_L$, and zero wages are strictly optimal.

The function $A_L(r)$ equals β_L for $r \leq \beta_L$ and is continuous and strictly increasing thereafter. By assumption, $v(\beta_H - \beta_L) > T_0$. At the other endpoint,

$$v[\beta_H - A_L(\beta_H)] \leq v(2\beta_H - 1)\Phi(-1/\tau) < k\alpha_L < T_0,$$

where $T_0 \geq k\alpha_H$ follows from the wage bound. Continuity and strict monotonicity yield the unique solution $r^* \in (\beta_L, \beta_H)$ to (8). The value formula, effort choices, and decision accuracy difference follow. At the threshold, $\beta_H - A_L(r^*) = T_0/v$, so switching from high to low effort lowers decision accuracy by T_0/v . $\square$

C.6 Comparison of sufficient conditions

For $\bar{r} > \beta_H$, the accuracy bounds used in Appendix C.5 give

$$A_H(\bar{r}) \leq \bar{r}, \quad A_L(\bar{r}) \geq \bar{r} - (2\bar{r} - 1)\Phi(-1/\tau).$$

Thus

$$A_H(\bar{r}) - A_L(\bar{r}) \leq (2\bar{r} - 1)\Phi(-1/\tau).$$

The decision-value restriction in Proposition 2, together with $T_D(\alpha_H) \geq k\alpha_H$, implies

$$v\Phi(-1/\tau) > \frac{T_D(\alpha_H)}{2\bar{r} - 1} \geq \frac{k\alpha_H}{2\bar{r} - 1} > k\alpha_L.$$

This is the reverse of the noise restriction in Proposition 3. The sufficient conditions of the two propositions therefore select disjoint parameter regions.

C.7 Profit and effort under better information

The two examples illustrate Propositions 2 and 3. They use the same information and recording technologies and different decision values.

Information comparison	Effort	Accuracy and profit
Just above β_H	H remains optimal	Accuracy rises; profit falls relative to $V^F(\beta_H)$.
Across $r^* \in (\beta_L, \beta_H)$	H switches to L	Accuracy falls at the switch; profit is continuous and nondecreasing.

Set the assessment accuracies to $\alpha_L = .55$ and $\alpha_H = .90$, with high-effort cost $\kappa = .35$. Fix communication precision $r_0 = .90$ and state-signal noise $\tau = .50$. The record cost coefficients are $c_0 = .20$, $c_\theta = .01$, and $c_d = .001$, making state and decision records inexpensive relative to assessment records. We vary managerial information precision r and compare two decision values v . Then $k = 1$, $\beta_L = .54$, $\beta_H = .82$, and $T_D(\alpha_H) = 1.005$. At $\bar{r} = .85$, the decision-value lower bound in Proposition 2 is approximately 201.364, so $v = 300$ satisfies its conditions. At β_H , the feasible records $(.5, 1, 1)$ cost approximately $0.968962 < 1.005$, so the decision record strictly reduces supporting cost and the local profit loss occurs. The high decision value keeps high effort optimal despite this cost increase.

With $v = 10$ and all other primitives unchanged, $v\Phi(-2) \simeq .227501 < .55$ and $v(\beta_H - \beta_L) = 2.8 > T_D(\alpha_H) \geq T_0$. Proposition 3 then applies, with the switching precision approximately $r^* = .733550$. These two examples hold the information and recording technologies fixed and use different decision values.

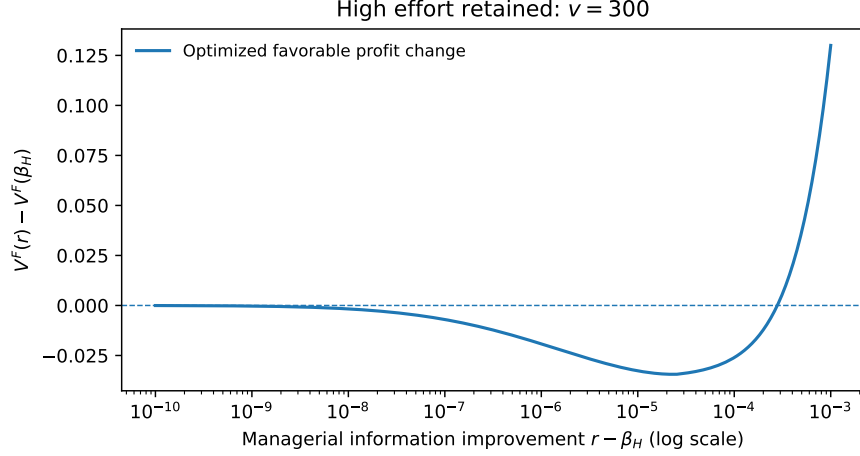


Figure 1: Favorable profit near the onset of revisions, with $v = 300$ and the other parameters specified in Appendix C.7. The horizontal axis measures $r - \beta_H$ on a logarithmic scale. Profit falls relative to its value at β_H for sufficiently small improvements and recovers at larger precisions.

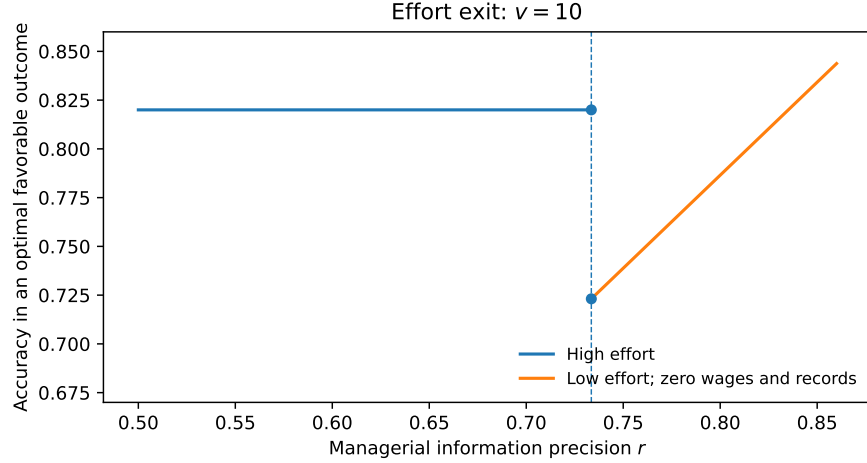


Figure 2: Accuracy under favorable evaluation, with $v = 10$ and the other parameters specified in Appendix C.7. At $r^* \simeq .733550$, the organization switches from high to low effort. The accuracy loss is $T_0/v \simeq .096890$. Both endpoint outcomes are optimal exactly at the crossing.

D Robust contracts

D.1 The cost of guaranteeing high effort

Derivation of the guarantee cost. Every contract guaranteeing H satisfies $D_w(\alpha_L) > k$ and $D_w(\alpha_H) \geq k$. Relax the first requirement to a weak inequality. At a fixed precision vector, averaging payments across sign reversals preserves the high-effort wage bill and both incentive requirements. The resulting wage problem is a linear program on four record classes, indexed by $(\hat{a}_0\hat{\theta}, \hat{a}_0\hat{d})$. It has an optimum with at most two positive payments.

Any two distinct classes are interchanged by reversing one recorded coordinate. If their payments are $a \geq b \geq 0$, reduce that coordinate's centered precision from ξ to $\xi(a-b)/(a+b)$ and pay $a+b$ on the first class. Conditional record probabilities are affine in ξ . The new wage therefore has the same expected payment conditional on each realization (a_0, θ, d) , preserves incentives at every effort expectation, and weakly reduces acquisition cost.

A wage paying on one remaining class can be reduced to a bonus for agreement among all three records. For the class $(+1, -1)$, the incentive coefficient is $xy - t_qxz - u_qyz$, and

$$\frac{xy - t_Hxz - u_Hyz}{1 - u_Hxz - t_Hyz} \leq xy.$$

Deleting the decision record and using the direct bonus $k/(xy)$ weakly reduces the high-effort wage bill and satisfies both constraints. For the class $(-1, +1)$, the coefficient $t_qxz - xy - u_qyz$ decreases with q , so the high endpoint binds. At $q = \alpha_H$, its ratio K_{sj}/L_{sj} decreases in y : the derivative has numerator

$$-(x + u_Hz)(1 + u_Hxz) + t_H^2xz^2 < 0.$$

Deleting the state record and rescaling the bonus improves the binding incentive per unit of expected payment; monotonicity preserves the incentive constraint at the low-effort expectation.

For the class $(-1, -1)$, the coefficient $u_qyz - xy - t_qxz$ increases with q , so the low endpoint binds. Put $a_H = t_H + h_Hu_H$ and $b_H = u_H + h_Ht_H$. The high-effort wage ratio is

$$\frac{1 + a_Hyz - x(h_Hy + b_Hz)}{u_Lyz - x(y + t_Lz)}.$$

Its derivative in x has numerator

$$(y + t_Lz)(1 + a_Hyz) - (h_Hy + b_Hz)u_Lyz \geq y(1 - u_Lu_Hz^2) + t_Lz > 0.$$

Deleting the assessment record lowers the wage bill. After the deletion in each of the last two cases, the remaining event is equivalent in distribution to agreement among all three records. Each precision reduction lowers acquisition cost, so these comparisons establish the lower bound over all wage schedules and record choices.

For a bonus paid when all three records agree, K_q is concave as a function of u_q . Its minimum is attained at an endpoint, giving (9). The relaxed minimum is therefore exactly (10). Multiplying the minimizing bonus by $1 + \varepsilon$ makes $D_w(q) > k$ for all q and guarantees H . The associated costs converge to the relaxed value. The numerator of the wage ratio is bounded below by a positive constant on the cube; cost consequently diverges at a zero denominator. Compactness gives a minimizing precision vector.

Pointwise comparison with the supporting objective gives $T_S \leq T_G$, and direct evaluation gives $T_G \leq T_D$. A record choice minimizing supporting cost with $K_L \geq K_H$ also minimizes the expression in (10). Conversely, when the two values coincide, any minimizer of that expression must also minimize supporting cost, and its two denominators must agree. Thus $K_L \geq K_H$ there. $\square$

D.2 Effort choice

Let $T_I(q; r)$ be the infimum total cost of contracts whose only continuation equilibrium has initial assessment accuracy $q \in (\alpha_L, \alpha_H)$, with $\beta(q) < r$.

Lemma D.1. *For $q \in (\alpha_L, \alpha_H)$ with $\beta(q) < r$, the infimum total cost of unique implementation is*

$$T_I(q; r) = \min_{\substack{(x,y,z) \in [0,1]^3 \\ K_L \geq K_q}} \left\{ \frac{kN_q}{2K_q} + C(x, y, z) \right\}. \quad (32)$$

A zero denominator is assigned infinite cost. The optimal robust value is

$$V^R(r) = \max \left\{ vA_L(r), vA_H(r) - T_G(r), \sup_{\substack{q \in (\alpha_L, \alpha_H) \\ \beta(q) < r}} [vA(q; r) - T_I(q; r)] \right\}. \quad (33)$$

If no interior target satisfies the stated restrictions, the supremum term is omitted.

The inequality $K_L \geq K_q$ is the weak form of the incentive requirement at the low-effort expectation. When it binds, the proof uses a contract perturbation to exclude the competing low-effort equilibrium while approaching the stated cost.

Proof. For the interior target q , relax the wage problem to $D_w(q) = k$ and $D_w(\alpha_L) \geq k$. Its fixed-precision linear program has an optimum with at most two positive payments. The reduction of two payments to one by adjusting record precision in the preceding proof preserves both constraints. For a wage paying only when all three records agree, the constraint is $K_L \geq K_q$ in (32). The increasing class $(-1, -1)$ cannot satisfy the incentive inequality at the low-effort expectation and equality at the target in the region $\beta(q) < r$. For the decreasing class $(-1, +1)$, deleting the state record improves incentive efficiency at the target; the resulting assessment–decision agreement has its effort-induced probability difference decreasing in the manager’s expected initial assessment accuracy and hence satisfies the incentive inequality at the low-effort expectation. For $(+1, -1)$, direct comparison lowers target wages and has a constant effort-induced probability difference. This establishes the lower bound in (32) over all wages and precisions.

Consider first a minimizing record choice in (32) with $K_L > K_q$. Strict concavity of t in u where $\beta(q) < r$ implies $K_s > K_q$ for $\alpha_L \leq s < q$ and $K_s < K_q$ for $q < s \leq \alpha_H$. The bonus $2k/K_q$ uniquely implements q . At a weak minimum with $K_L = K_q$ and $z > 0$, the identity

$$K_L - K_q = z[(t_L - t_q)x - (u_q - u_L)y]$$

shows that a small reduction in y makes the inequality strict. Both x and y are positive in this equality case: otherwise the strict variation of t or u would violate either $K_q > 0$ or the equality. Rescale the bonus to retain target indifference. Costs converge to the weak minimum.

If the minimizing record choice has $z = 0$, then $xy > 0$. For $\varepsilon > 0$, acquire $z = \varepsilon$ and use

$$w_\varepsilon(R) = b_D \mathbf{1}\{\hat{a}_0 = \hat{\theta}\} + b_A \mathbf{1}\{\hat{a}_0 = \hat{d}\}, \quad b_D = \frac{k - b_A t_q x \varepsilon}{xy},$$

where $b_A > 0$ tends to zero with ε . These payments are nonnegative for sufficiently small ε . At effort expectation s ,

$$D_{w_\varepsilon}(s) = k + b_A x \varepsilon (t_s - t_q).$$

It exceeds k below q and is below k above q , so the wage uniquely implements the target and approaches the direct cost. This establishes the infimum characterization even when the optimal assessment and state records solve the weak problem.

A contract with a low-effort equilibrium has robust profit at most $vA_L(r)$. If it excludes low effort, its incentive there is strict. Each interior equilibrium with $\beta(q) < r$ is then bounded by the corresponding relaxed cost (32). If its only equilibrium has high effort, its profit is bounded by $vA_H - T_G$. The remaining case has all its equilibrium targets in a range where $d = M_0$, including an interior target. Analyst indifference throughout that range implies a high-effort equilibrium. Continuity and the absence of equilibria below the range where the manager follows M_0 imply $D_w(s) > k$ there. A small multiplicative increase in all payments then guarantees H , and its high-effort wage bill converges to that of the original contract. The original robust payoff is at most its high-effort payoff and hence at most $vA_H - T_G$. These cases prove the upper bound in (33). Zero wages, the high-effort guarantees, and the unique interior implementations prove the reverse bound. $\square$

D.3 Decision-record prices and guarantee costs

Write

$$F_G(x, y, z) = \frac{kN_H}{2 \min\{K_L, K_H\}} + \frac{c_0x^2 + c_\theta y^2}{2}.$$

This objective excludes the acquisition cost of the decision record. The pair (x_D, y_D) minimizes $F_G(x, y, 0)$ uniquely, with value $T_D(\alpha_H)$.

Let $\gamma_G = \partial_z^+ F_G(x_D, y_D, 0)$ be the right derivative with respect to decision record precision at the direct optimum. With $h_H = 2\alpha_H - 1$, it equals

$$\begin{aligned} \gamma_G = \frac{k}{2x_D y_D} & \left[(u_H + h_H t_H)x_D + (t_H + h_H u_H)y_D \right. \\ & \left. - \left(h_H + \frac{1}{x_D y_D} \right) \min_{i \in \{L, H\}} (t_i x_D + u_i y_D) \right]. \end{aligned} \quad (34)$$

Lemma D.2. *Fix the high-effort guarantee problem, the manager's decision rules, and $c_0, c_\theta > 0$, and vary $c_d > 0$. Let $T_D(\alpha_H)$ be the minimum direct-evaluation cost and F_G the guarantee objective excluding the decision-record acquisition cost. The price threshold is*

$$c_G^*(r) = \max \left\{ 0, \sup_{\substack{(x, y, z) \in [0, 1]^3 \\ z > 0}} \frac{2[T_D(\alpha_H) - F_G(x, y, z)]}{z^2} \right\}. \quad (35)$$

It is infinite exactly when $\gamma_G < 0$, with γ_G given by (34). If $\gamma_G > 0$ and $0 < c_G^(r) < \infty$, precision z in strictly improving optimal record choices stays bounded away from zero as c_d increases to $c_G^*(r)$. Moreover, $c_G^*(r) \leq c_S^*(r)$.*

Proof. A record choice with $z > 0$ strictly improves on direct evaluation exactly when its threshold ratio in (35) exceeds c_d . This proves the formula and the strict improving-price characterization. If an optimal record choice had $z > 0$ at a price strictly above $c_G^*(r)$, decreasing the price slightly while remaining above the threshold would produce a strict improvement, a contradiction. The ordering follows from $T_S \leq T_G$.

At $z = 0$, the two endpoint expressions for expected wages agree. The right derivative of their maximum is the larger of their derivatives. Differentiating gives (34). If it is negative, evaluating (35) at (x_D, y_D, z) and letting z decrease to zero makes the ratio arbitrarily large.

If $\gamma_G \geq 0$, take an endpoint expression for expected wages whose right derivative is γ_G . In a neighborhood of the direct optimum, smoothness and strong convexity of the direct objective give constants $a, b, c > 0$ with

$$F_G(x, y, z) \geq T_D + a\|(x, y) - (x_D, y_D)\|^2 + \gamma_G z - b\|(x, y) - (x_D, y_D)\|z - cz^2.$$

At an upper precision bound of one, the first-order optimality inequality contributes a nonnegative term, so the same lower bound holds on the feasible cube. Completing the square gives $F_G \geq T_D + \gamma_G z - c'z^2$. Every sequence with $z \rightarrow 0$ and $F_G < T_D$ approaches the unique direct minimizer. The threshold ratio is consequently bounded near $z = 0$. Away from zero it is bounded above by $2T_D/z^2$, which proves finiteness. If $\gamma_G > 0$, the local bound excludes strict improvement for all sufficiently small positive z , proving that optimal positive precision stays bounded away from zero. $\square$

D.4 Managerial review and record acquisition

Lemma D.3. *In the benchmark, managerial state evidence has precision at most β_L , and the received assessment is executed at every effort expectation. After the improvement, precision is $r \in (\beta_L, \beta_H)$. All other primitives are unchanged. Let (x_D, y_D) minimize the high-effort cost using only initial-assessment and state records, and write that cost as $T_D(\alpha_H) = W_D + C_D$. Suppose $x_D, y_D < 1$ and*

$$m(x_D + h_H y_D) > \left(h_H + \frac{1}{x_D y_D} \right) (t_L x_D + u_L y_D), \quad (36)$$

where u_L, t_L describe the manager's rule at the low-effort expectation after the improvement. Suppose also

$$v(\beta_H - r) > T_D(\alpha_H). \quad (37)$$

The threshold $c_G^*(r) = \sup\{c_d > 0 : T_G(r) < T_D(\alpha_H)\}$, with value zero for an empty set, is finite. For every finite price $c_d > c_G^*(r)$:

1. In the benchmark, every minimum-cost record choice supporting high effort uses an informative decision record. Write its total cost as $T_0 = W_0 + C_0$.
2. After the improvement, $(x_D, y_D, 0)$ minimizes the expression in (10), giving

$$T_G(r) = T_D(\alpha_H) > T_0, \quad C_D > C_0.$$

3. High effort is optimal under favorable evaluation at both information precisions. The robust values are approached by contracts guaranteeing high effort. Decision accuracy is β_H in these outcomes, and

$$V_0 = V^F(r) = v\beta_H - T_0, \quad V^R(r) = v\beta_H - T_D(\alpha_H),$$

where V_0 is the benchmark value under either evaluation.

When the benchmark without review chooses high effort, direct evaluation also gives the bound

$$V_0 - V^R(r) \leq T_D(\alpha_H) - T_0 - v[A_H(r) - \beta_H]. \quad (38)$$

Proof of Lemma D.3. In the stated information interval, $(u_H, t_H) = (m, 0)$, so the high-effort supporting cost equals T_0 . The high-endpoint derivative in the guarantee objective at the direct optimum is $-km(1 - x_D^2)/(2x_D^2 y_D) < 0$. Condition (36) says that the low-endpoint derivative is

strictly positive. Hence $\gamma_G > 0$, and Lemma D.2 gives a finite guarantee price threshold. The negative supporting derivative makes $T_0 < T_D$ at every finite c_d , yielding the stated strict cost comparison.

A target with $\beta(q) \leq r$ has $A(q; r) \leq r$, so its profit is at most vr . Condition (37) gives a direct high-effort profit $v\beta_H - T_D > vr$. On the remaining range, the manager follows M_0 and minimum supporting cost has slope k in q . The same condition implies $vm > k$, since $T_D \geq k\alpha_H$ and $\beta_H - r < m\alpha_H$. Favorable profit is therefore increasing on this range, and high effort is the global optimum. For robust evaluation, a contract with a mixed equilibrium in the range where the manager follows M_0 also has an equilibrium at the lower boundary of that range or below: either low effort or a target satisfying $\beta(q) \leq r$. Such a contract has value at most vr . Therefore every contract whose robust value exceeds vr guarantees H . This proves the value comparison and also shows that every sufficiently near-optimal robust contract guarantees H .

At the interior direct optimum, the first-order conditions give

$$C_D = c_0 x_D^2 = c_\theta y_D^2 = \frac{k}{2x_D y_D}, \quad T_D - \frac{kh_H}{2} = 2C_D.$$

At any benchmark minimizer, feasible radial contraction implies $C_0 \leq k/(2K_H)$. The expected wage expression implies $W_0 - kh_H/2 \geq k/(2K_H)$. Therefore

$$2C_0 \leq T_0 - \frac{kh_H}{2} < T_D - \frac{kh_H}{2} = 2C_D.$$

Finally, direct high-effort guarantees are available under review at costs approaching T_D . Thus $V^R(r) \geq vA_H(r) - T_D$. Subtracting from $V_0 = v\beta_H - T_0$ proves (38). $\square$

D.5 Expected wages and record acquisition costs

Suppose the optimal direct precisions $X = x_D$ and $Y = y_D$ lie in $(0, 1)$. Set $J = k/(2XY)$ and $a = km(1 - X^2)/(2X^2Y) > 0$. For each c_d , consider a minimum-cost contract supporting high effort when $d = M_0$. Write its expected wage, acquisition cost, and decision record precision as W_0, C_0, z_0 , respectively. As $c_d \rightarrow \infty$, every such contract satisfies

$$z_0 = \frac{a}{c_d} + O(c_d^{-2}),$$

$$T_0 - T_D = -\frac{a^2}{2c_d} + O(c_d^{-2}), \tag{39}$$

$$W_0 - W_D = \frac{amJ(3X^2 - 1)}{4Xc_d} + O(c_d^{-2}), \tag{40}$$

$$C_D - C_0 = \frac{amJ(1 + X^2)}{4Xc_d} + O(c_d^{-2}). \tag{41}$$

Here T_D and W_D are evaluated at high effort. Thus $W_0 > W_D$ for sufficiently large finite prices when $X^2 > 1/3$, and $W_0 < W_D$ when $X^2 < 1/3$.

Derivation. Write the benchmark objective excluding the decision-record acquisition cost as

$$F(x, y, z) = \frac{kh_H}{2} + \frac{k(1 + mxz)}{2y(x + mz)} + \frac{c_0 x^2 + c_\theta y^2}{2}.$$

Every global minimizer converges to $(X, Y, 0)$ as $c_d \rightarrow \infty$: comparison with T_D forces $z \rightarrow 0$, and compactness together with the unique direct optimum then forces $(x, y) \rightarrow (X, Y)$. Near that point

the conditional (x, y) problem is smooth and strongly convex. Its optimum is an interior smooth function of z . Let H_D be the Hessian of the direct objective. Gradients are with respect to (x, y) . The Hessian at (X, Y) and the derivative with respect to z at zero satisfy

$$H_D = J \begin{pmatrix} 3/X^2 & 1/(XY) \\ 1/(XY) & 3/Y^2 \end{pmatrix}, \quad F_z(x, y, 0) = \partial_z F(x, y, 0) = -\frac{km(1-x^2)}{2x^2y}.$$

The conditional optimum therefore has expansion

$$\begin{pmatrix} x(z) \\ y(z) \end{pmatrix} = \begin{pmatrix} X \\ Y \end{pmatrix} - H_D^{-1} \nabla F_z(X, Y, 0)z + O(z^2).$$

Since $F_z(X, Y, 0) = -a$, minimization over z gives $z_0 = a/c_d + O(c_d^{-2})$ and the total-cost change in (39). The objective after minimizing over x and y is locally strictly convex for all sufficiently large c_d , so these expansions apply to every global optimum.

Let $W_D(x, y) = k[h_H + (xy)^{-1}]/2$ and $C_D(x, y) = (c_0x^2 + c_\theta y^2)/2$ denote the expected wage and record acquisition cost functions for direct evaluation. The gradients of these two functions are evaluated at (X, Y) , and ∇F_z is evaluated at $(X, Y, 0)$. The first-order condition gives $\nabla W_D = -\nabla C_D$, with $\nabla C_D = J(1/X, 1/Y)$. Calculation gives

$$\nabla C_D^\top H_D^{-1} \nabla F_z = \frac{mJ(3-X^2)}{4X}.$$

The change in expected wages is consequently

$$W_0 - W_D = \left[\frac{mJ(3-X^2)}{4X} - a \right] z_0 + O(z_0^2) = \frac{mJ(3X^2-1)}{4X} z_0 + O(z_0^2),$$

which yields (40). The acquisition change is

$$C_0 - C_D = -\frac{mJ(3-X^2)}{4X} z_0 + \frac{c_d z_0^2}{2} + O(z_0^2).$$

Using $a = mJ(1-X^2)/X$ proves (41). □

D.6 Pure effort under small observation noise

If $v\Phi(-1/\tau) < k\alpha_L$, then for every $r \in (1/2, 1)$,

$$V^R(r) = \max\{vA_L(r), vA_H(r) - T_G(r)\}.$$

If $vA_H(r) - T_G(r) > vA_L(r)$, contracts guaranteeing high effort approach the robust value. If $r \geq \beta_H$, the contract with zero wages and no informative records is optimal.

Derivation. At a target $q > \alpha_L$ with $\beta(q) \leq r$, the decision accuracy bounds $A(q; r) \leq r$ and $A_L(r) \geq r - (2r-1)\Phi(-1/\tau)$ give

$$v[A(q; r) - A_L(r)] \leq v(2r-1)\Phi(-1/\tau) < k\alpha_L < kq.$$

Expected wages are at least kq , so zero wages give strictly higher profit. A contract with a low-effort equilibrium is also bounded by vA_L . If an interior equilibrium satisfies $\beta(q) > r$, the analyst is indifferent throughout the interval up to α_H where the manager follows M_0 . Continuity extends that indifference to its lower boundary: either α_L , or a target with $\beta(q) = r$. Either equilibrium bounds the contract's robust value by vA_L . The remaining contracts guarantee high effort, and their profit supremum is $vA_H - T_G$. This proves the formula. For $r \geq \beta_H$, the first bound applies to every positive probability of high effort. □

D.7 Favorable and robust values

Throughout this subsection, impose the prices in Proposition 4 and write $r_c = \beta_H$. The direct optimum is $(1, 1, 0)$ and

$$T_D(q) = kq + \frac{c_0 + c_\theta}{2}. \quad (42)$$

The supporting-price analysis gives $0 < c_S^*(r_c) < \infty$.

Decision-record price thresholds. At r_c , $u_H = m$ and $t_H = 0$. At this information precision, the low-effort cutoff s_L and its normal tail probabilities are

$$s_L = \frac{\tau^2}{2} \log \frac{r_c + \beta_L - 1}{r_c - \beta_L}, \quad P_+(s_L) = \Phi\left(\frac{1 - s_L}{\tau}\right), \quad P_-(s_L) = \Phi\left(\frac{-1 - s_L}{\tau}\right).$$

Both tails are positive. The coefficient formulas imply

$$m - u_L - t_L = m[(1 - h_H)P_+(s_L) + (1 + h_H)P_-(s_L)] > 0.$$

At the direct design, the low-expectation branch of the guarantee objective,

$$\frac{kN_H}{2K_L} + C(x, y, z),$$

has derivatives in (x, y, z) equal to

$$c_0 - \frac{k}{2} < 0, \quad c_\theta - \frac{k}{2} < 0, \quad \frac{k}{2}(1 + h_H)(m - u_L - t_L) > 0. \quad (43)$$

This branch is smooth near $(1, 1, 0)$ and equals $T_D(\alpha_H)$ there. The full guarantee objective is at least this branch. Hence, on a neighborhood of the direct design, it exceeds $T_D(\alpha_H)$ by a positive constant times $(1 - x) + (1 - y) + z$ away from that design. This bound is uniform for decision-record prices in a compact neighborhood of $c_S^*(r_c)$.

Set $c_d = c_S^*(r_c)$. The minimum supporting cost equals $T_D(\alpha_H)$. A guarantee minimizer must also minimize supporting cost. The exact-state result gives $y = 1$. If it had $z > 0$, then

$$K_H - K_L = z[(m - u_L) - t_L x] > 0,$$

so its guarantee cost would strictly exceed its supporting cost. Every guarantee minimizer therefore has $z = 0$, and uniqueness of the direct optimum gives $(1, 1, 0)$.

The cost gap away from the direct design persists after a small reduction of c_d . A guarantee objective bounded by a finite number M satisfies

$$\min\{K_L, K_H\} \geq \frac{k}{2M},$$

because $N_H \geq 1$ and acquisition costs are nonnegative. Thus bounded-cost sublevels have denominators bounded away from zero and are compact. This bound is uniform for r in a closed neighborhood of r_c and for prices in a compact neighborhood of the stated price. On such a sublevel outside the direct neighborhood, uniqueness gives a strictly positive gap above $T_D(\alpha_H)$. Reducing c_d by a given amount changes any design's cost by at most half that amount. A sufficiently small positive reduction preserves this gap, while the local bound from (43) handles the direct neighborhood. Direct evaluation is consequently guarantee-optimal at a price strictly below $c_S^*(r_c)$, proving

$$0 \leq c_G^*(r_c) < c_S^*(r_c) < \infty.$$

Implementation costs near high effort. Fix $c_d \in (c_G^*(r_c), c_S^*(r_c))$. At this price the guarantee minimizer at r_c is uniquely $(1, 1, 0)$. The strict derivative signs in (43) persist for r close to r_c and give a uniform local lower bound above the direct cost. The gap away from the direct design persists by the same compact-sublevel argument. There is therefore $\epsilon_r > 0$, with $r_c + \epsilon_r \leq \bar{r}$, such that

$$T_G(r) = T_D(\alpha_H) \quad (r_c \leq r \leq r_c + \epsilon_r), \quad (44)$$

with unique minimizing precisions $(1, 1, 0)$.

For an interior target and $z > 0$, the constraint $K_L \geq K_q$ can be written

$$y \leq \frac{t_L(r) - t_q(r)}{u_q(r) - u_L(r)} x.$$

The denominator is positive near $(q, r) = (\alpha_H, r_c)$. At that point,

$$\frac{t_L(r_c)}{m - u_L(r_c)} < h_H < 1.$$

Indeed, integrating $dt/du = -h_q$ from α_L to α_H makes the ratio a weighted average of $h_q < h_H$. Continuity bounds the ratio uniformly by a constant less than one on a neighborhood. Positive- z feasible designs in this neighborhood consequently lie in a closed cone separated from $(1, 1, 0)$.

If positive- z feasible designs with cost at most $T_D(q)$ existed arbitrarily close to (α_H, r_c) , take a sequence with $q \rightarrow \alpha_H$ and $r \rightarrow r_c$. Their costs are uniformly bounded, and $N_q \geq 1$ bounds K_q away from zero. A convergent precision subsequence has a limit satisfying $K_L \geq K_H$. At this limit, supporting and guarantee objectives coincide, and its cost is at most $T_D(\alpha_H)$. It is a guarantee minimizer in the separated cone, contradicting uniqueness of $(1, 1, 0)$. Shrinking ϵ_r if necessary, there is $\epsilon_q \in (0, \alpha_H - \alpha_L)$ for which

$$T_I(q; r) = T_D(q), \quad \alpha_H - \epsilon_q < q < \alpha_H, \quad r_c \leq r \leq r_c + \epsilon_r. \quad (45)$$

The $z = 0$ part of the relaxed interior problem attains its minimum at the direct design. The implementation perturbations in Appendix D approach this cost with a unique interior effort equilibrium.

Comparison across effort targets. The preceding neighborhoods depend only on technologies and record prices. A finite sufficient decision value is

$$v_* = \max \left\{ \frac{k}{u_L(\bar{r})}, \frac{T_D(\alpha_H)}{A_H(\bar{r}) - A_L(\bar{r})}, \frac{k}{u_L(r_c + \epsilon_r)}, \frac{T_D(\alpha_H)}{u_L(r_c + \epsilon_r)\epsilon_q} \right\}. \quad (46)$$

All denominators are positive. For every $q \in [\alpha_L, \alpha_H]$ and $r \in [r_c, r_c + \epsilon_r]$,

$$\frac{\partial A(q; r)}{\partial q} = u_q(r) \geq u_L(r_c + \epsilon_r) > 0.$$

For $v > v_*$ and $q \in (\alpha_H - \epsilon_q, \alpha_H)$, (42) and (45) give

$$\begin{aligned} & [vA_H(r) - T_D(\alpha_H)] - [vA(q; r) - T_I(q; r)] \\ & \geq [vu_L(r_c + \epsilon_r) - k](\alpha_H - q) > 0. \end{aligned}$$

For $q \in (\alpha_L, \alpha_H - \epsilon_q]$, nonnegative implementation costs give

$$[vA_H(r) - T_D(\alpha_H)] - [vA(q; r) - T_I(q; r)] \geq vu_L(r_c + \epsilon_r)\epsilon_q - T_D(\alpha_H) > 0.$$

The same value bound dominates the zero-wage low-effort alternative, since $\epsilon_q < \alpha_H - \alpha_L$. Every interior target satisfies $\beta(q) < r$ on this information interval. The robust-value formula in Lemma D.1, together with (44), therefore yields

$$V^R(r) = vA_H(r) - T_D(\alpha_H).$$

Direct bonuses with a vanishing positive increase guarantee high effort and approach this value. Interior targets tending to α_H also have profits approaching it. Since $A_H(r) > \beta_H$ for $r > r_c$, the robust value strictly rises to the right of r_c .

The first two terms of (46) are the high-effort conditions in Proposition 2. With $c_d < c_S^*(r_c)$, that proposition gives $V^F(r) < V^F(r_c)$ for all sufficiently close $r > r_c$ and the stated supporting precisions at r_c . Intersecting the right neighborhoods proves Proposition 4.

E Contracting with the manager

E.1 The minimum manager bonus

Fix an effort expectation $q \in [\alpha_L, \alpha_H]$, write $h = 2q - 1$, and let $j = M_0 \in \{-1, 1\}$. The Gaussian-mixture signal gives

$$\ell(S) = \mathbb{E}[\theta \mid S] = (2r - 1) \tanh(S/\tau^2), \quad |\ell(S)| < \rho := 2r - 1$$

at every finite S . Conditional independence gives

$$\mu = \mathbb{E}[\theta \mid j, S] = \frac{\ell + mhj}{1 + mhj\ell}, \quad \nu = \mathbb{E}[a_0 \mid j, S] = \frac{h\ell + mj}{1 + mhj\ell}.$$

For decision d , the conditional probability of recorded agreement is $(1 + xz d \nu)/2$. With $\lambda = bxz/\gamma$, the manager's payoff gain from choosing j over $-j$ is

$$\gamma \frac{m(h + \lambda) + (1 + \lambda h)j\ell(S)}{1 + mhj\ell(S)}. \quad (47)$$

The denominator is positive. The limiting constraint from the strongest conflicting evidence is

$$m(h + \lambda) \geq \rho(1 + \lambda h). \quad (48)$$

For $r \leq r_0$, $m - \rho h > 0$. Before imposing nonnegativity, the required lower bound is $(\rho - mh)/(m - \rho h)$, whose derivative in h is $(\rho^2 - m^2)/(m - \rho h)^2 \leq 0$. The largest requirement is therefore at h_L . In (β_L, β_H) it yields (12).

At this bonus, the numerator in (47) can be written as

$$[m(h + \lambda) - \rho(1 + \lambda h)] + (1 + \lambda h)[j\ell(S) + \rho] > 0.$$

The first term is nonnegative and the second is strictly positive at every finite signal. A smaller bonus violates (48) at h_L , so a positive-probability set of finite conflicting signals induces revision. This proves minimality within (11). For any $r \leq r_0$, the same calculation gives $\lambda^* = \max\{0, (\rho - mh_L)/(m - \rho h_L)\}$; at $r = r_0$ this equals one and still induces strict decisions at every finite signal.

Under $d = M_0$, $\mathbb{E}[a_0 d] = m$ under either actual effort. The manager's payment probability is $(1 + mxz)/2$, proving (13). If $xz = 0$, her expected agreement payment is independent of her decision and supplies no incentive to follow M_0 when $r > \beta_L$.

Under actual effort $e \in \{L, H\}$, the analyst's three-record agreement probability is

$$\frac{1 + mxz + (2\alpha_e - 1)y(x + mz)}{4}.$$

Changing effort from L to H raises it by $(\alpha_H - \alpha_L)y(x + mz)/2$. Wage (15) gives net effort advantage $\varepsilon\kappa > 0$ at every expectation. Together with the manager's strict decisions, this gives a unique continuation effort outcome, H , and accuracy β_H .

E.2 Contracting costs and profit comparisons

For the calculations in this appendix, denote the expression in (14) by $W_E(x, y, z)$. The wage characterization in Proposition 1, applied to $d = M_0$, gives this minimum. Since the rule is independent of the effort expectation, a binding analyst incentive leaves both efforts optimal at every expectation. The infimum wage for unique high effort is W_E , approached by (15). Within (11), any $b > b^*$ induces the same behavior at a higher expected payment. This proves the joint cost formula (16) over all analyst wages, the three records, and the specified manager bonus.

For $\gamma > 0$, a finite-cost sublevel set bounds xz away from zero through $\gamma\lambda^*/(2xz)$. The bound $W_E \geq k/[2y(1 + m)]$ also bounds y away from zero. The remaining feasible set is compact and the objective is continuous, so the record minimum is attained. The positive analyst bonus increase remains necessary for strict implementation.

Every execution optimum has $y^0 > 0$. If $T_G > T_0$, none can have $z^0 = 0$, since that would give $T_0 = T_D \geq T_G$. At $x^0 = 0, z^0 > 0$, the derivative of $W_E + C$ in x is strictly negative. At $x^0 = 1, z^0 > 0$, the wage equals $k[h_H + 1/y^0]/2$ and is independent of z ; deleting the decision record saves cost. Thus every execution optimum satisfies $0 < x^0 < 1$ and $y^0, z^0 > 0$.

One sufficient primitive price region for $T_G(r) > T_0$ is

$$c_0 > k/2, \quad 0 < c_\theta < \frac{k(1 - r)}{2r}, \quad 0 < c_d < \infty. \quad (49)$$

The exact-state result gives $y = 1$ at every supporting optimum. Direct evaluation has assessment-record precision $(k/(2c_0))^{1/3} < 1$, so adding a small positive z strictly lowers supporting cost at every finite c_d . Every supporting optimum therefore uses $z > 0$. Since $r < \beta_H < r_0$, the low-effort cutoff is finite. The tail representation at the current low-effort cutoff $s_L = s_{\alpha_L}(r)$ gives

$$m - u_L = m[P_+(s_L) + P_-(s_L)] > (2r - 1)[P_+(s_L) - P_-(s_L)] = t_L.$$

At every such optimum, $K_L - K_H = z(t_L x + u_L - m) < 0$. Equality of the attained relaxed guarantee cost and T_0 would require a supporting minimizer with $K_L \geq K_H$, which is impossible. Hence $T_G > T_0$. In this price region,

$$T_D(\alpha_H) = \frac{kh_H}{2} + \frac{c_\theta}{2} + \frac{3}{2}c_0^{1/3}(k/2)^{2/3}.$$

To compare effort outcomes with an unpaid manager, put $q_c = (1 + (2r - 1)/m)/2 \in (\alpha_L, \alpha_H)$, so $\beta(q_c) = r$. For $q \leq q_c$, the bound $A(q; r) \leq r$ limits equilibrium profit to vr . If a contract with an unpaid manager has an interior equilibrium $q > q_c$, analyst indifference holds under $d = M_0$. The same rule holds throughout $[q_c, \alpha_H]$, making q_c another equilibrium and bounding the contract's robust value by vr . A low-effort equilibrium gives the same bound. Every contract with an unpaid manager and robust value above vr therefore guarantees H .

The condition $v(\beta_H - r) > T_D$ allows slightly increased direct bonuses to give robust value above vr . The guarantee-cost characterization (10) then gives $V^R = v\beta_H - T_G$. For favorable evaluation,

targets above q_c have cost $T_0 + k(q - \alpha_H)$ and accuracy $\beta(q)$, giving profit slope $vm - k$. Since $T_D \geq k\alpha_H$ and $\beta_H - r = m(\alpha_H - q_c) < m\alpha_H$, the value condition implies $vm > k$. High effort is the favorable optimum, with value $v\beta_H - T_0$.

E.3 Proof of Proposition 5

For fixed r , $T_M(\gamma; r)$ is a pointwise infimum of affine functions of γ and is therefore concave. At every feasible vector,

$$G_r(x, z) \geq \frac{\lambda^*}{2}(1 + m) = r_0\lambda^* > 0.$$

Consequently, for $\gamma_2 > \gamma_1 > 0$,

$$T_M(\gamma_2; r) - T_M(\gamma_1; r) \geq r_0\lambda^*(\gamma_2 - \gamma_1). \quad (50)$$

The function is finite, continuous, strictly increasing, and unbounded. An execution optimum with positive $x^0 z^0$ gives

$$T_0 \leq T_M(\gamma; r) \leq T_0 + \gamma G_r(x^0, z^0),$$

so its right-hand limit at zero is T_0 . Since $T_G > T_0$, exactly one positive finite $\gamma^\dagger$ satisfies (18). When $T_M < T_G$, take minimizing records and choose

$$0 < \varepsilon < \frac{T_G - T_M}{W_E(x, y, z)}.$$

The resulting finite contract strictly exceeds robust value with an unpaid manager. When $T_M \geq T_G$, the cost lower bound rules out a strict gain within the specified arrangement. At equality the value suprema coincide. Taking the better of the two contractual arrangements gives (21).

At $\gamma = \gamma_{\text{fixed}}(x^0, y^0, z^0; r)$, retaining the execution records costs T_G . Since $0 < x^0 < 1$, their original first-order condition in x is zero, whereas

$$\partial_x[W_E + C + \gamma G_r](x^0, y^0, z^0) = -\frac{\gamma\lambda^*}{2(x^0)^2 z^0} < 0.$$

A feasible increase in x strictly lowers cost, proving $\gamma_{\text{fixed}} < \gamma^\dagger$. The upper bound follows from $T_M \geq T_0 + \gamma r_0\lambda^*$.

For the record comparison, write $D(x, z) = \frac{1}{2}[(xz)^{-1} + m]$ and $\omega = \gamma\lambda^*(r)$. The objective is $W_E + C + \omega D$. Adding the optimality inequalities at $\omega_1 < \omega_2$ gives

$$(\omega_2 - \omega_1)[D(x_2, z_2) - D(x_1, z_1)] \leq 0.$$

Thus $x_2 z_2 \geq x_1 z_1$ for arbitrary choices from the two optimal sets. The conditional comparison in r follows from

$$\frac{d\lambda^*(r)}{dr} = \frac{2m(1 - h_L^2)}{[m - (2r - 1)h_L]^2} > 0.$$

Adoption thresholds at different r also depend on the changing alternative $T_G(r)$.

At an interior record optimum, the first-order conditions are

$$\begin{aligned} c_0 x &= \frac{k(1 - m^2 z^2)}{2y(x + mz)^2} + \frac{\gamma\lambda^*}{2x^2 z}, \\ c_d z &= \frac{km(1 - x^2)}{2y(x + mz)^2} + \frac{\gamma\lambda^*}{2xz^2}, \\ c_\theta y &= \frac{k(1 + mxz)}{2y^2(x + mz)}. \end{aligned}$$

At a precision of one, marginal benefit is at least marginal acquisition cost. The manager payment adds marginal benefits to both the assessment and decision records, with substitution between their precisions.

E.4 Record acquisition and contract adoption

This example illustrates how record acquisition can determine whether the principal adopts the manager contract in Proposition 5. We compare three arrangements that all guarantee high effort and have decision accuracy .82: an unpaid manager, a paid manager with records fixed at the optimum for freely enforceable execution, and a paid manager with records chosen for both wages. The comparison concerns the combined cost of wages and records.

Table 1 gives the parameter values and their meanings. High effort raises assessment accuracy from .55 to .90 at a cost of .35, so the effort cost per unit of accuracy is $k = \kappa/(\alpha_H - \alpha_L) = 1$. The communication precision $r_0 = .90$ then gives received-assessment accuracies $\beta_L = .54$ and $\beta_H = .82$. The manager's independent information satisfies $\beta_L < r = .70 < \beta_H$. Thus an unpaid manager follows the received assessment when she expects high effort and sometimes revises it when she expects low effort. Paying her to follow it under every expectation preserves the high-effort decisions.

Parameter	Value	Economic meaning
α_L, α_H	.55, .90	Probability that the initial assessment is correct under low and high effort.
κ	.35	Analyst's cost of high effort; low effort is costless.
r_0	.90	Probability that the manager receives the analyst's assessment correctly.
r	.70	Probability that the latent binary signal Z_r matches the state.
τ	.50	Standard deviation of the noise added to Z_r ; the manager observes $S = Z_r + \tau N$.
v	10	Principal's value of a correct decision.
c_0	.20	Quadratic cost coefficient for the assessment record.
c_θ, c_d	.01, .01	Quadratic cost coefficients for the state and decision records.
γ	.057	Manager's monetary value of a correct decision, relative to her wage.

Table 1: Parameters for the comparison of manager contracts. Record costs are $C(x, y, z) = (c_0x^2 + c_\theta y^2 + c_d z^2)/2$.

State and decision records are inexpensive relative to assessment records. These prices make the cost of documenting the initial work central to the comparison. The value $v = 10$ keeps high effort optimal: the decision-value inequality in (17) holds because $10(.82 - .70) = 1.2 > T_D = 1.005$. We choose $\gamma = .057$ between the two adoption thresholds calculated below, so the example displays a change in the adoption decision.

Table 2 compares the three arrangements. The first column gives the optimal guarantee with an unpaid manager. It uses exact assessment and state records and no decision record, with total cost $T_G = T_D = 1.005$ and robust value 7.195.

The second column starts from the records that minimize the cost of rewarding the analyst when following the received assessment can be enforced without manager compensation. These records attain T_0 at $(x^0, y^0, z^0) = (.518054715, 1, 1)$, with $T_0 = .973402961$. We then add the agreement bonus needed to induce the manager to follow the assessment while keeping those records fixed. Her expected wage raises the total cost to 1.006167, above the unpaid-manager cost.

The third column chooses records jointly for the two wages. Increasing assessment-record precision from .518055 to .611818 lowers both expected wages. Their combined reduction covers the additional acquisition cost, bringing total cost below the unpaid-manager alternative. The table uses centered record precisions: zero is uninformative and one is exact. For the assessment record, the change corresponds to an increase in recording accuracy from about .759 to .806, since $p_0 = (1 + x)/2$.

	Unpaid manager direct records	Paid manager, fixed records	Paid manager, adjusted records
Assessment record precision x	1	.518055	.611818
State record precision y	1	1	1
Decision record precision z	0	1	1
Analyst wage	.900000	.936565	.927495
Manager wage	.000000	.032764	.029214
Acquisition cost	.105000	.036838	.047432
Total cost	1.005000	1.006167	1.004141

Table 2: Costs of guaranteeing high effort at $\gamma = .057$. All three arrangements have decision accuracy .82. Fixed records minimize cost under freely enforceable execution; adjusted records minimize the cost of both wages and records. Costs are infima over contracts with strict analyst incentives.

Compared with the unpaid-manager guarantee, the paid arrangement uses a decision record and a less precise assessment record. This lowers acquisition expenditure enough to cover the manager wage and the increase in the analyst wage. The gain comes from changing how the organization provides incentives while preserving effort and decision accuracy.

For fixed records attaining T_0 , the paid arrangement is cheaper than the unpaid-manager guarantee when $\gamma < \gamma_{\text{fixed}}$. With records chosen jointly for both wages, the corresponding condition is $\gamma < \gamma^\dagger$. The thresholds are

$$\gamma_{\text{fixed}} = .054970532\dots, \quad \gamma^\dagger = .058678047\dots$$

Record adjustment raises the threshold by 6.74%. The chosen $\gamma = .057$ lies between them, so adoption depends on whether the principal adjusts the records.

A finite contract delivers the improvement shown by the cost infima. Multiplying the last column's analyst bonus by 1.0001 gives a finite nonnegative contract with net effort advantage .000035 and profit $7.195766261 > 7.195$, exceeding the unpaid-manager robust value supremum. The calculations below verify the global record optima and the thresholds.

The example has $m = h_H = .8$, $h_L = .1$, $k = 1$, and $\lambda^* = 8/19$. The low-expectation cutoff is $s_L = \log(3/2)/8 < .051$. The normal formulas give

$$u := u_L = .008801530\dots, \quad t := t_L = .381355705\dots$$

The bounds $0 < u < .02$ and $0 < t < .4$ suffice for the global argument. Let ϕ denote the standard normal density. Its monotonicity gives $u \leq .8(2s_L/.5)\phi(1.8) < .8(.204)(.08) < .02$, while $t = (2r - 1)[P_+(s_L) - P_-(s_L)] < .4$.

Contracts with an unpaid manager. The guarantee-cost formula (10) makes the wage the maximum of

$$W_H = \frac{1 + mxz + h_H y(x + mz)}{2y(x + mz)}, \quad W_L = \frac{1 + mxz + h_H y(x + mz)}{2[y(x + uz) + txz]}.$$

Both numerators evaluate expected payment at actual high effort; the subscripts identify the expectation at which the incentive constraint is imposed. The first satisfies $-\partial_y W_H \geq 1/2$ on its finite domain. For the second, put $h = h_H$ and differentiate:

$$-2\partial_y W_L = \frac{(1 + mxz)(x + uz) - htzx(x + mz)}{[y(x + uz) + txz]^2} \geq \frac{1 - mht}{(1 + t)^2(1 + u)}.$$

The numerator is at least $(1 - mht)(x + uz)$, using $m - ht > 0$ and $z \leq 1$, and the denominator is at most $(1 + t)^2(x + uz)^2$. These bounds imply $-\partial_y W_L > .18607$. Both wage expressions plus the state cost strictly decrease in y , since $c_\theta y \leq .01$. Every optimum therefore has $y = 1$.

At $y = 1$, $tx + u < m$, so the low-expectation denominator binds for $z > 0$. For $x \leq .1$, it is at most $.1(1 + .4) + .02 = .16$, making the wage at least $3.125 > T_D$. A competitive design has $x > .1$. The numerator determining the sign of $\partial_z W_L$ then satisfies

$$(m - ht)x^2 + (mh - t - hu)x - u \geq .48x^2 + .224x - .02 > 0.$$

Guarantee cost increases in z , so its minimum uses $z = 0$. With $y = 1, z = 0$, its derivative in x is $-.5/x^2 + .2x < 0$, giving $x = 1$. Thus the global guarantee cost is $T_G = T_D = .9 + .105 = 1.005$. The inequality $v(\beta_H - r) = 1.2 > T_D$ gives the effort comparison established above and hence robust value 7.195.

Contracts with a paid manager. Since $(1 + mxz)/(x + mz) \geq 1$, the joint objective has derivative $-(1 + mxz)/[2y^2(x + mz)] + .01y < 0$ in y . Every optimum therefore has $y = 1$. For $0 \leq \gamma \leq .06$, any design with $x \geq .9$ has cost at least

$$.9 + .1(.9)^2 + .005 + \gamma(8/19)(.9).$$

Here .9 is the high-effort wage lower bound and $\gamma r_0 \lambda^*$ bounds manager pay from below. The feasible vector $(.52, 1, 1)$ costs less throughout the stated interval. Both comparands are affine in γ , so checking its endpoints suffices. At zero its cost is .973403637 against the lower bound .986; at .06 its cost is below 1.007801, while the bound exceeds 1.008736. Thus every optimum has $x < .9$.

For $x < .9$ and $z \leq 1$, the marginal analyst-wage saving from z is at least

$$\frac{.8(1 - .9^2)}{2(.9 + .8)^2} > .02629 > .01 \geq c_d z.$$

The manager wage adds a nonnegative saving. Cost strictly decreases in z , so every optimum has $z = 1$. The remaining derivative is

$$.2x - \frac{.18}{(x + .8)^2} - \frac{\gamma(8/19)}{2x^2}. \quad (51)$$

Its derivative in x is $.2 + .36/(x + .8)^3 + \gamma(8/19)/x^3 > 0$. It has exactly one zero in $(0, .9)$, the unique global optimum. At $\gamma = 0$, the same argument computes T_0 .

High-precision bisection gives

$$\gamma_{\text{fixed}} = .0549705320126522\dots, \quad \gamma^\dagger = .0586780474677958\dots$$

The second lies between .05867804 and .05867806, where the joint costs are respectively 1.004999996182... and 1.005000006408.... The threshold therefore lies inside the interval on which

the global reduction holds. At $\gamma = .057$, the scalar optimizer is $x = .6118182438560045 \dots$. At the critical analyst bonus, it gives

$$\begin{aligned}\mathbb{E}[w_A] &= .9274951650351097 \dots, \\ \mathbb{E}[w_M] &= .0292136681449210 \dots, \\ C &= .0474321563515045 \dots, \\ T_M &= 1.0041409895315352 \dots\end{aligned}$$

The values in Table 2 are rounded; these unrounded roots define the contracts. With $\varepsilon = .0001$, the two bonuses are $b = .0392273362898419 \dots$ and $2k(1 + \varepsilon)/(x + m) = 1.4167546061290354 \dots$. Expected analyst wages under high and low effort are $.9275879145516132 \dots$ and $.5775529145516132 \dots$. Their difference exceeds κ by $.000035$. Actual total cost is $1.0042337390480387 \dots$ and profit is $7.1957662609519613 \dots$.

E.5 Manager compensation above the revision threshold

The bonus and cost calculations extend to fixed $r \in (\beta_L, r_0]$. Suppose at some $r > \beta_H$ the favorable-loss result gives $V^F(r) < v\beta_H - T_0$. Put $B_F(r) = v\beta_H - V^F(r) > T_0$. Continuity, strict monotonicity, and unboundedness of T_M give a unique positive crossing of $B_F(r)$. Below it, a sufficiently small analyst bonus increase yields a finite contract improving on favorable value with an unpaid manager, with accuracy β_H in place of $A_H(r)$.

For fixed $\gamma > 0$, requiring execution at every effort expectation has a positive payment cost at the onset of high-effort revisions:

$$\lambda^*(\beta_H) = \frac{h_H - h_L}{1 - h_H h_L} > 0, \quad T_M(\gamma; r) \geq T_0 + \gamma r_0 \lambda^*(r).$$

The favorable loss with an unpaid manager tends to zero as $r \downarrow \beta_H$, while this additional payment stays bounded away from zero. Consequently, at a fixed positive γ , this paid arrangement remains more expensive than the favorable optimum with an unpaid manager for all sufficiently small increases in r above β_H .

F Managerial reporting

The manager is unpaid and maximizes decision accuracy, as in Section 2. These benchmarks extend the analyst's payment information while retaining that decision objective.

F.1 Unverified messages

Let $\mathcal{A}$ be a nonempty finite message set. After choosing d , the manager sends a message $a \in \mathcal{A}$ that can enter the analyst's nonnegative wage $w(R, a)$. Messages leave subsequent decisions, measurement, and the manager's payoff unchanged. Acquisition technologies and costs remain those of Section 2.

Fix a message $a^* \in \mathcal{A}$. The wage $w_{a^*}(R) = w(R, a^*)$, together with the same record precisions, is a feasible baseline contract. Every continuation equilibrium under this contract extends to a message-game equilibrium in which all manager types send a^* . Such reporting is optimal because the manager is indifferent among messages. The extended contract's worst equilibrium therefore gives profit no greater than the worst equilibrium of w_{a^*} , which is bounded above by $V^R(r)$. Taking the supremum over extended contracts gives this same upper bound. Ignoring the message attains the baseline value as a supremum, proving equality.

F.2 A truthful record of the received assessment

Add a free truthful contractible record of M_0 after the decision. Write $\tilde{V}^F$ and $\tilde{V}^R$ for the values with this record and all original acquisition choices available. Suppose the favorable optimum at $r = \beta_H$ is attained with high effort. The values satisfy

$$\tilde{V}^F(\beta_H) = \tilde{V}^R(\beta_H), \quad \tilde{V}^j(r) \geq \tilde{V}^j(\beta_H) + v[A_H(r) - \beta_H], \quad r > \beta_H, \quad j \in \{F, R\}.$$

The second inequality compares each larger information precision with the revision threshold. Its gain is strictly positive because high-effort decision accuracy exceeds β_H after revisions begin.

Under the proposed high-effort equilibrium at β_H , $d = M_0$. This decision rule remains fixed under a secret effort deviation. Average the optimal wage $w(M_0, \hat{a}_0, \hat{\theta}, \hat{d})$ over the decision-record error conditional on $d = M_0$. The resulting wage $\bar{w}(M_0, \hat{a}_0, \hat{\theta})$ is finite and nonnegative. It preserves expected payments under each actual effort at this rule. Dropping the decision record weakly reduces acquisition cost. Optimality of the initial arrangement implies that this high-effort contract has the same favorable value.

The distribution of the retained payment variables conditional on actual effort is independent of the manager's decision rule and of r . The wage therefore preserves its high-effort incentive for every effort expectation and every r . If the incentive binds, multiplying the wage by $1 + \varepsilon$ makes high effort strictly optimal and raises expected payment by a quantity tending to zero with ε . Robust value at β_H consequently approaches favorable value. The reverse inequality follows from the definitions of the two criteria. Retaining this contract at larger r preserves its cost and adds the decision benefit $v[A_H(r) - \beta_H]$, proving the stated bounds.