Corporate Governance by Workers*

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Abstract

We show that the departure of informed workers can play a governance role for firms. When workers are compensated partly in equity, they may leave the firm if they observe low managerial effort, reducing the firm's value and the manager's own compensation. Therefore, diluting the manager's equity stake in the firm through worker equity grants can *increase* managers' effort incentives. Worker equity also exerts downward pressure on compensation, since worker exits are more costly to the firm and manager when workers are underpaid. The model provides a new explanation for the prevalence of worker equity compensation and generates several testable predictions regarding worker compensation packages, labor bargaining power, capital structure, and managerial performance.

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1 Introduction

Firms employ many individuals, and employees often possess private information about the firm. This paper asks a simple question: can informed rank-and-file workers play a role in corporate governance? More specifically, how are the effort incentives of managers and senior officers shaped by the presence of large numbers of informed workers and their decisions whether to remain employed at the firm? How does the nature of worker compensation influence their governance role? How does the firm's capital structure interact with the structure of worker compensation?

In this paper, we propose a new governance effect we call the *worker monitoring channel*. Suppose informed rank-and-file workers are paid partially in equity. If the workers observe the manager shirking, they anticipate that their equity grants are worth less, and are more likely to leave the firm. Managers, knowing that workers may leave if they shirk, thus have increased incentives for effort. Therefore, counterintuitively, diluting the manager's equity stake in the firm through worker equity grants can *increase* managers' effort incentives. Worker monitoring also exerts downward pressure on compensation, since underpaid workers harm the firm more when they leave, thereby providing stronger effort incentives for managers. This paper thus offers a novel explanation for the widespread use of equity compensation for workers, even when workers are too numerous for equity to provide effective direct incentives for effort, and delivers implications for compensation design, capital structure, and managerial performance.

We analyze a simple static moral-hazard model of firm financing, most similar to Holmstrom and Tirole (1997), to which we add a worker component. There is a manager who proposes an incentive contract, and then produces output by exerting costly private effort; when she is not a full residual claimant on output, she will be unable to commit to exerting the efficient level of effort. There is a competitive representative investor, who has a lower cost of capital than the manager, meaning that it is welfare-improving for the investor to fund the firm's operations. There is a set of workers, with a common random reservation wage, who can produce some exogenous output if they are employed at the firm. We assume the workers can observe the manager's effort, and condition their decision whether to work at the firm on the manager's effort.

We first consider a benchmark where the manager and investor hold equity shares in the firm, but workers are paid in fixed wages with no equity component. The manager and investor then face a classic tradeoff: equity granted to investors increases financing efficiency, but decreases the manager's effort incentives. On the worker side, the manager faces a monopsony pricing problem: she simply chooses the fixed wage which maximizes surplus extracted from workers, which is equal to the markdown between worker's output and their wage multiplied by the probability that workers are retained. In the fixed-wage benchmark, managerial effort is thus fully independent from the worker wage-setting problem.

The worker monitoring channel emerges when worker compensation is linked to firm performance. Managerial effort then influences worker retention, causing the problems of manager incentive provision and worker compensation to become intertwined. This mechanism relies on two key conditions. First, workers must care about managerial effort, which implies their compensation must be tied to firm performance. In the model, we restrict attention to wage-and-equity compensation; the performance-sensitive component of worker compensation is naturally equity. It is worth mentioning that a wide range of commonly observed compensation arrangements, such as employee stock options and bonus multipliers based on aggregate performance, can serve a similar purpose. Second, the manager must care about (specifically, must be harmed by) worker departure, so that the desire to retain workers increases the manager's incentives for effort. This force implies that the level of worker compensation must be lower than the monopsony-optimal wage level in the fixed-wage benchmark: if workers are compensated at the optimal fixed wage, the departure of a marginal worker has no first-order impact on the firm value and the manager's payoffs. In other words, workers must be "cheap" for the manager to care about retention.

Our model therefore rationalizes the practice of granting unvested equity to a collection of small workers. This practice is difficult to rationalize through the traditional incentive-provision channel: while equity can arguably create effort incentives for *large* workers, it is ineffective in motivating effort among many *small* workers, since effort incentives are diluted as the number of workers becomes large. In contrast, in our model, the optimal compensation structure for workers is pure equity. This is because the probability of worker retention – which determines the amount of surplus extracted from workers – only depends on total expected compensation, not the wage-equity split; thus, replacing fixed wages by equity strengthens the worker monitoring channel without adversely affecting profit extraction from workers.

We want to caution that this result should not be narrowly interpreted as an argument against the existence of fixed wages in practice, but rather as a qualitative explanation for the common practice of linking small workers' compensation to aggregate firm performance.[1] Finally, it is important that equity is *unvested*, so workers forfeit their equity grants when they leave the firm; such workers then decide to quit by comparing the expected value of their unvested equity to their outside options.

[1] Nonzero fixed wages could easily be rationalized through worker risk aversion, for example, which we abstract from for analytical tractability.

The most salient prediction of our model is that worker equity increases managerial effort, despite crowding out managerial equity stake in the firm. Since the manager can always eliminate the worker monitoring channel by offering either zero or monopsony compensation levels, the fact that underpaid workers are employed in equilibrium suggests that the worker monitoring channel always alleviates the underlying moral hazard problem and improves managerial incentives. The simplicity of the model allows us to extend it and study the effect of capital structure. Suppose the firm is financed with defaultable debt and can also default on wages, the fixed wages can be effective to induce worker monitoring if the firm is close to default, because the value of worker equity is insensitive to firm performance when the firm is close to default and equity is "zeroed out". Hence, the model implies that safer firms tend to use equity and riskier firms tend to use fixed wage to compensate workers. We can also consider bargaining power of workers, such as the existence of a labor union. If workers have high bargaining power such that they are overpaid (relative to the monopsony compensation level), they should be paid in fixed wages because otherwise, managers may deliberately shirk in order to motivate quitting of the overpaid workers. This prediction is similar to that of Bova and Yang (2017), but arises through a distinct theoretical channel.

Other comparative statics of our model are driven by the dual role of workers as both monitors and as profit sources for the firm. As compensation decreases from the monopsony-optimal level, workers are more effective as monitors for the manager, but profit extraction from workers is less efficient. The optimal compensation level trades off these two forces. Workers are more underpaid when output is more sensitive to manager effort, since the role of workers as monitors is more important. Conversely, when profits from workers are comparatively important for the firm, manager incentive provision through workers is more costly, and the optimal contract tends to underpay workers less.

Finally, we analyze the robustness of our results by allowing workers to have heterogeneous outside options or to have imperfect observations of the manager's effort. We show that heterogeneous outside option results in an additional coefficient to our worker monitoring channel and therefore does not change the qualitative takeaway that workers are underpaid and have compensation tied to firm performance. The imperfect observation of effort proofs to be equivalent to a mean preserving spread of workers' outside option and therefore has no qualitative impact on our key insights.

Our paper contributes to the corporate governance literature by showing how individually small stakeholders can discipline managerial behavior. Classic theories of governance emphasize *large* players, such as blockholders, activist shareholders, large creditors, or boards: parties who have sufficient incentives or control rights to overcome free-rider problems in monitoring management (Shleifer and Vishny, 1986; Edmans, 2014; Levit and Malenko, 2016; Levit, Malenko and Maug, 2023; Voss, 2025). "Small" workers would seem unlikely to play a governance role: individual workers have neither formal control nor strong incentives to engage in costly monitoring. Our core finding is that, when worker compensation is sensitive to firm performance, *exit* becomes a privately credible response to managerial shirking, allowing atomistic workers to discipline management without needing to explicitly coordinate on voice, voting, or other such interventions.

Our mechanism is related to banking models in which "small" depositors discipline banks through withdrawal, such as Calomiris and Kahn (1991) and Diamond and Rajan (2001). Unlike these papers, which study demandable debt and bank fragility, we study worker compensation in nonfinancial firms: our manager endogeneously chooses compensation structure to trade off exit-based discipline and the firm's desire to extract rents from workers.

This perspective also connects our paper to Hoffmann and Vladimirov (2025), who find that performance-linked pay can cause the exit decisions of small workers to be strategic complements, leading to inefficient worker runs. Compensation structures that reduce workers' exposure to coworkers' departures, such as dilutable compensation or shared bonus pools, can mitigate run risks. In contrast, we show that the threat of worker exit can improve governance by disciplining managerial effort. Thus, their paper highlights a cost of exit-based discipline, while our paper identifies a governance benefit.

Our paper is also related to theories of governance through exit or the "Wall Street Walk," such as Admati and Pfleiderer (2009) and Edmans and Manso (2011). In these models, exit disciplines managers through price impact in financial markets; our channel instead operates through the real effects of worker exit on firm output. We also relate to a corporate finance literature on internal governance of firms. Acharya, Myers and Rajan (2011) studies how subordinate managers contribute to providing incentives for top management, analyzing a model where non-CEO managers' effort incentives arise from the potential to be promoted to upper management. We instead focus on rank-and-file workers outside managerial promotion tournaments.

We also provide a new explanation for the prevalence of broad-based worker equity compensation. Equity is ineffective for inducing effort from "small" workers, because equity grants infinitesimal effort incentives when the number of workers is large (Holmstrom, 1982). The worker monitoring channel we propose does not suffer from this "dilution" problem: when a large number of workers are paid in equity, it remains true that each individual worker has incentives to quit if the firm is doing sufficiently poorly.

There are a number of other theories proposing other benefits of broad-based equity compensation, including financial constraints (Core and Guay, 2001; Kim and Ouimet, 2014; Sun and Xiaolan, 2019), outside-option risk under sticky wages (Oyer, 2004), favorable accounting treatment (Blasi, Conte and Kruse, 1996; Hall and Murphy, 2002, 2003; Freeman, Kruse and Blasi, 2010), improved employee sorting (Lazear, 2004; Bergman and Jenter, 2007) and retention (Oyer and Schaefer, 2005; Kedia and Rajgopal, 2009; Aldatmaz, Ouimet and Van Wesep, 2018), product market competitiveness (Bova and Yang, 2017), mutual monitoring (Hochberg and Lindsey, 2010), insuring workers against promotion risk (Chen, 2024), providing workers with incentives for information acquisition (Chen, 2023), and defense against hostile takeovers (Pagano and Volpin, 2005). Our goal is of course to provide a new theoretical channel, not to argue against the relevance of other channels discussed in prior literature.

More broadly, we also contribute to a literature on the determinants of worker wages. The classic moral hazard literature emphasizes that, as *agents* imperfectly observed by management, workers should be *overpaid* relative to their outside options (Solow, 1979; Shapiro and Stiglitz, 1984; Yellen, 1984). We consider workers in their capacity as *principals*, disciplining firm leadership through their credible threats to quit. We find that this channel requires workers to be *undercompensated*, relative to the monopsony-optimal fixed-wage benchmark.

The paper proceeds as follows. We introduce the model in Section 2, and discuss the fixed-wage benchmark in Section 3. Our main results are in Section 4. We explore implications and extensions of the model in Section 5, discuss empirical implications of our results in Section 6, and conclude in Section 7.

2 Setup

There is a single project, which requires a fixed upfront investment of $\bar{I} = 1$. There are three sets of agents: a manager, a unit mass of small homogeneous workers, and competitive investors. There is no discounting and all agents are risk-neutral.

Output. The project's output is the sum of contributions from the manager and workers. As is standard in the static moral-hazard literature, we assume the manager exerts effort e, at some private convex cost $c(e)$, such that $c''(e)$ is bounded away from 0 for any e.[2] The manager's contribution to output is a nonnegative amount $e + \tilde{\epsilon} > 0$, where $\tilde{\epsilon}$ is some mean-zero shock, whose distribution may depend on e. The "noise" $\tilde{\epsilon}$ is included only to justify

[2]Formally, there exists a constant $\epsilon > 0$ such that $c''(e) > \epsilon$ for all e. For example, any quadratic cost function trivially satisfies this condition.

why we cannot contract directly on managerial effort, and we will largely disregard it going forward, focusing on expected contribution e. We will assume the worker observes e, and can condition her decision to quit on e. The assumption that workers have private information about the firm, while somewhat unusual in the literature on theoretical corporate governance, is supported by a large academic literature and many institutional sources, which we discuss in Subsection 6.1. We assume workers observe effort perfectly for analytical simplicity; we show in Subsection 5.5 that allowing noisy signals would not qualitatively change our results.

The unit mass of workers produces nonrandom output Δ. The workers have some homogeneous random outside option $\omega \sim F(\cdot)$, which can be thought of as a prevailing wage offer from a competing firm, which is not observed by the manager at the time the compensation contract is written. The assumption that workers are identical greatly simplifies the analysis; we show in Subsection 5.4 that all conclusions of the model still hold in an extension where workers are heterogeneous. Under this simplification, only two outcomes are possible: either all workers stay employed, or all workers quit. The firm's expected output is thus

$$\begin{cases} e + \Delta & \text{if workers stay} \\ e & \text{if workers quit} \end{cases}.$$

We abstract from worker effort in the baseline model; in Subsection 5.3, we show that equity is ineffective at providing effort incentives when the number of workers is large, due to the classic incentive dilution problem (Holmstrom, 1982). We assume e and Δ affect output additively, so there are no complementarities in production: the only interactions between the worker and manager problems will be informational in nature.[3]

Investment. A group of competitive investors can provide funding for the firm. Investment is valuable because investors' cost of funds is 1, and the CEO's cost is some higher number $\theta > 1$.[4] Let I be the amount invested by the investors, and $(1 - I)$ by the CEO.[5] The investors' zero-profit condition implies that I must eventually equal investors' expected payoff from the firm.

[3]We also implicitly assume that there are no complementarities between workers: if a measure $\mu < 1$ of workers are employed, they produce output $\mu\Delta$. This has little effect on the main results, since workers are homogeneous, so for generic realizations of ω, either all workers will stay or none will.

[4]There are several closely related ways to motivate financing in moral hazard models. Holmstrom and Tirole (1997) assume that the firm has fixed initial wealth A, necessitating a fixed amount $I - A$ in external financing. Jensen and Meckling (1976) allow the scale of the firm to vary depending on the amount of external financing. In our model, we fix the size of the firm's investment, and assume there is a constant gap between the costs of inside and outside financing; this setup has economically similar intuitions to these models, and is analytically convenient for our setting. Our model can be thought of as simply fixing the "shadow value of equity", as discussed in Tirole (2010, ch. 3.4).

[5]In the case where $I > 1$, the CEO can save the surplus $(I - 1)$ at the interest rate θ.

Contracts. The CEO proposes a contract to maximize her anticipated surplus. We consider a simple class of wage-and-equity contracts. Workers can be paid through a combination of a fixed wage ψ, and an equity share s_W in the firm's residual profits. The manager and investor each receive equity shares s_M, s_I respectively. All parties have limited liability, implying that ψ, s_W, s_I, s_M must all be nonnegative. Moreover, equity shares must add to 1:

$$s_W + s_M + s_I = 1. \tag{1}$$

In our setting, this restriction lets us vary agents' residual claims on output in a parsimonious way, while abstracting from the richer design problems posed by general monotone nonlinear contracts.[6]

Throughout the baseline model, we assume the firm never defaults on wages, that is, $\Delta - \tilde{\epsilon} \geq \psi$ (or equivalently the support of the shock $\tilde{\epsilon}$ is sufficiently small around 0).[7] In Subsection 5.1, we relax the restriction and analyze the case of defaultable wages together with debt financing.

A compensation contract is thus described by a triple ψ, s_W, s_M. If workers stay employed, the expected payoffs of each party are:

$$Payoff_W = \psi + s_W\left(e + \Delta - \psi\right) \tag{2}$$

$$Payoff_M = s_M\left(e + \Delta - \psi\right) \tag{3}$$

$$Payoff_I = s_I\left(e + \Delta - \psi\right)$$

where, since all agents are risk-neutral, we suppress the $E\left[\epsilon\right] = 0$ terms in payoffs for notational simplicity. Intuitively, the manager and investor each receive their equity shares of residual output $(e + \Delta - \psi)$, and the worker gets her wage and her equity share.

If workers quit, they forfeit both the wage and equity components of their compensation. The manager and investors share the no-worker firm based on the relative equity shares s_M and s_I, attaining payoffs:

$$Payoff_M = \frac{s_M}{s_M + s_I} e \tag{4}$$

[6]A sizable literature, discussed in Opp (2025), analyzes technical conditions under which linear contracts are exactly optimal. Such contracts are not necessarily optimal in our setting; rather, we restrict attention to a simple wage-and-equity class for tractability. A few applied theory papers on worker compensation also work with similarly simple linear contract classes; see, for example, (Oyer, 2004; Pagano and Volpin, 2005; Bova and Yang, 2017).

[7]Since the firm would never want to pay workers more than their output, $\Delta > \psi$ must hold in equilibrium. Hence, the assumption of risk-free wage is equivalent to assuming sufficiently small shocks $\tilde{\epsilon}$.

$$Payoff_I = \frac{s_I}{s_M + s_I} e$$

We have implicitly made three important assumptions about the nature of employee equity compensation: the employee is granted a fixed number of equity units in the firm; this grant vests to the employee conditional on employment; and if the employee leaves, the unvested portion of the equity award is cancelled, so the associated dilution of the managers' and investors' equity stakes is never realized. All three assumptions are important for our later analysis, and to our understanding they are standard practice in public firms.[8] Importantly, some firms set the size of equity grants based on a targeted dollar value *at the grant date*; however, the award must still be expressed as a fixed number of equity units once granted,[9] so such value-based approaches to equity grant sizing are consistent with our model's assumptions.

The game is divided into five stages as follows.

1. The CEO proposes a contract s_M, s_W, ψ.
2. Investment I is determined through investors' zero-profit condition.
3. The manager chooses effort e.
4. Workers observe their outside option ω and manager effort e, and decide whether to quit.
5. Firm payoffs are realized and the game ends.

We focus on the subgame perfect equilibrium. It is convenient to specify players' objectives backwards. In stage 4, the workers' expected compensation is

$$\Gamma(e, \psi, s_W) \equiv s_W (e + \Delta - \psi) + \psi, \tag{5}$$

and they quit the firm if $\Gamma(e, \psi, s_W)$ is less than their outside option ω. The probability the firm retains these workers is thus $F(\Gamma(e, \psi, s_W))$.

In stage 3, fixing investment I, the manager's effort problem is:

$$\mathcal{M} \equiv \max_e \frac{s_M}{s_M + s_I} e (1 - F(\Gamma(e, \psi, s_W))) + s_M (e + \Delta - \psi) F(\Gamma(e, \psi, s_W)) - c(e) - \theta(1 - I) \tag{6}$$

[8]For example, the discussion of share-based payment in the International Financial Reporting Standards (IFRS) 2 states: "a grant of shares or share options to an employee is typically conditional on the employee remaining in the entity's employ for a specified period of time."

[9]For example, the National Association of Stock Plan Professionals writes: "ultimately... grants must be expressed as a number of shares."

Intuitively, the manager's payoff is either (3) or (4), depending on whether the realization of ω makes workers stay or quit. In addition, the manager pays her private effort cost $c(e)$, and her cost of capital $\theta(1-I)$.

In stage 2, anticipating the manager's equilibrium effort decision $e^*(s_M, s_W, \psi)$, I is determined by the competitive investors' break-even condition:

$$I(s_M, s_I, s_W, \psi) = \underbrace{\frac{s_I}{s_M + s_I} e^* (1 - F(\Gamma(e^*, \psi, s_W)))}_{Workers\ Quit} + \underbrace{s_I (e^* + \Delta - \psi) F(\Gamma(e^*, \psi, s_W))}_{Workers\ Work}. \tag{7}$$

Since both the investors and the manager are equity holders, expression (7) is simply the manager's payoff gross of effort and financing costs in (6), with s_M replaced by the investor's share s_I.

Finally, in stage 1, the optimal compensation and financing structure $s_M^*, s_I^*, s_W^*, \psi^*$ is chosen to maximize the manager's ex-ante payoff $\mathcal{M}$, defined in (6), where I is given by (7).

3 Surplus Extraction from Workers and the Fixed-Wage Benchmark

3.1 Surplus Extraction from Workers

Before proceeding, we construct a key quantity which helps us understand the economic mechanisms driving our results.

Definition 1. The expected surplus extracted by the firm from the workers, denoted by $\Pi(\Gamma)$, is a function of workers' expected compensation level Γ:

$$\Pi(\Gamma) \equiv (\Delta - \Gamma) F(\Gamma) \tag{8}$$

Intuitively, $\Pi(\Gamma)$ is the monopsony revenue function: lower values of Γ increase the markdown component $(\Delta - \Gamma)$ of (8), while lowering retention probability $F(\Gamma)$, analogous to the markup-quantity tradeoff faced by a monopolist firm.

We further impose the standard assumption that $\Pi(\cdot)$ is strictly concave:[10]

$$\Pi''(\Gamma) < 0, \tag{9}$$

which ensures a unique compensation level Γ^*_{FW} that maximizes Π, given by the solution to

$$\Pi'(\Gamma^*_{FW}) = 0. \tag{10}$$

The subscript "FW" is short for "fixed-wage." As will be clear immediately below, when workers are offered a fixed wage without equity ($s_W = 0$), they receive the compensation level Γ^*_{FW}. For future use, the concavity of Π immediately implies:

$$\Gamma < \Gamma^*_{FW} \implies \Pi'(\Gamma) > 0,\ \Gamma > \Gamma^*_{FW} \implies \Pi'(\Gamma) < 0. \tag{11}$$

Proposition 1. *The manager's effort problem (6) can be expressed as*

$$\mathcal{M} = \max_e \underbrace{\frac{s_M}{s_M + s_I} e}_{Manager\ Output} + \underbrace{\frac{s_M}{s_M + s_I} \Pi(\Gamma(e, \psi, s_W))}_{Surplus\ Extracted\ From\ Workers} - c(e) - \theta(1 - I). \tag{12}$$

Similarly, investors' payoff (7) can be expressed as

$$I = \underbrace{\frac{s_I}{s_M + s_I} e^*(s_M, s_W, \psi)}_{Manager\ Output} + \underbrace{\frac{s_I}{s_M + s_I} \Pi(\Gamma(e^*(s_M, s_W, \psi), \psi, s_W))}_{Surplus\ Extracted\ From\ Workers}. \tag{13}$$

Finally, the manager's contract design problem in stage 1 can be expressed as

$$\mathcal{M} = \max_{s_M, s_I, s_W, \psi} \underbrace{\frac{s_M + \theta s_I}{s_M + s_I} e^*(s_M, s_W, \psi) - c(e^*(s_M, s_W, \psi))}_{Manager\ Surplus} + \underbrace{\frac{s_M + \theta s_I}{s_M + s_I} \Pi(\Gamma(e^*(s_M, s_W, \psi), \psi, s_W))}_{Surplus\ Extracted\ From\ Workers} - \theta \tag{14}$$

Proposition 1 provides an intuitive and important view of the firm. If we treat workers as if they are "outsiders" to the firm, the manager-investor firm contains both the stand-alone value of the managerial firm e, and the expected surplus $\Pi(\Gamma(e, \psi, s_W))$ extracted from workers. The manager receives a share $\frac{s_M}{s_M + s_I}$ of this firm as in (12) and the investors receive the remaining $\frac{s_I}{s_M + s_I}$ of this firm as in (13).

[10]Related conditions are commonly imposed for tractability in imperfect-competition models (Bulow and Pfleiderer, 1983; Caplin and Nalebuff, 1991) as well as the related literature on one-dimensional screening problems (Myerson, 1981; Maskin and Riley, 1984).

Rearranging (12) further, the comparison between the manager's ex-ante payoff objective ((14)) and his ex-post effort objective (12) reveals a standard tradeoff between external financing and incentive provision, similar to Holmstrom and Tirole (1997). On the one hand, raising equity from external investors is cheaper due to their lower cost of capital $1 < \theta$. On the other hand, external equity dilutes manager's stake in the firm, reducing effort incentives. Our focus is on how the presence of informed workers can alleviate this friction.

3.2 Fixed-Wage Contracts

We first consider the case in which workers are paid fixed wages, with no equity component: $\Gamma = \psi$ and $s_W = 0$. Relevant variables are subscripted by "FW." This case will be used as a benchmark to compare the general optimal contract to.

Since workers are paid a fixed wage, they quit with probability $F(\psi)$, independent of the manager's effort e. Furthermore, since $s_M + s_I = 1 - s_W = 1$, the manager's effort problem (12) in stage 3 reduces to

$$\max_{e} s_M \left[e + \Pi(\psi)\right] - c(e) - \theta(1 - I), \tag{15}$$

and the FOC for e implies that the unique optimal effort $e^*_{FW}(s_M)$ satisfies

$$c'(e^*_{FW}) = s_M. \tag{16}$$

Using the same simplification, the manager's contracting problem ((14)) in stage 1 reduces to

$$\max_{s_M,\psi} \left(s_M + \theta(1 - s_M)\right)\left[e^*_{FW}(s_M) + \Pi(\psi)\right] - c\left(e^*_{FW}(s_M)\right) - \theta. \tag{17}$$

This contract design problem is straightforward. It is unambiguously optimal to set wages to maximize the surplus extracted from workers $\Pi(\psi)$, which from (10) implies $\psi = \Gamma^*_{FW}$. The choice of s_M navigates a classic tradeoff between financing and incentive provision. Differentiating (17) and setting to 0, we have:

$$\frac{\partial}{\partial s_M}: \ (\theta - 1)\left[e^*_{FW}(s_M) + \Pi\left(\Gamma^*_{FW}\right)\right] = \left[\left(s_M + \theta(1 - s_M)\right) - c'\left(e^*_{FW}(s_M)\right)\right]\frac{\partial e^*_{FW}}{\partial s_M} \tag{18}$$

When s_M increases, the LHS captures the marginal cost from reduced financing, which is the cost difference $(\theta - 1)$ multiplied by total output. The RHS captures the marginal output gains from increasing the manager's effort incentives. Applying the implicit function theorem to (16), we have:

$$\frac{\partial e_{FW}^*}{\partial s_M} = \frac{1}{c''\left(e_{FW}^*\left(s_M\right)\right)}$$

Moreover, (16) implies that $c'\left(e_{FW}^*\left(s_M\right)\right) = s_M$; substituting into (18), we have the FOC:

$$(\theta - 1)\left[e_{FW}^*\left(s_M\right) + \Pi\left(\Gamma_{FW}^*\right)\right] = \frac{\theta\left(1 - s_M\right)}{c''\left(e_{FW}^*\left(s_M\right)\right)} \tag{19}$$

Expression (19), alongside $\psi = \Gamma_{FW}^*$, thus characterize the optimal contract without worker equity. Intuitively, when workers are paid a fixed wage, the contract design problem separates cleanly into the problem of optimally extracting surplus from workers through the wage ψ, and optimally trading off manager incentive provision and financing capacity through the equity share s_M.

What is interesting about the general contract, which we analyze next, is that these problems become intertwined: when workers are paid in equity, worker retention affects manager incentives, and the manager internalizes this effect in determining the level of worker compensation.

4 Results

4.1 Worker Retention

When workers hold equity s_W, their expected compensation Γ depends on managerial effort e, as in (5). Worker retention is thus sensitive to managerial effort. From (5), we have that:

$$\frac{\partial \Gamma}{\partial e} = s_W, \tag{20}$$

which in turn implies

$$\frac{d}{de} F\left(\Gamma\left(e, \psi, s_W\right)\right) = f\left(\Gamma\left(e, \psi, s_W\right)\right) s_W$$

Higher managerial effort increases worker retention probability, since it increases expected worker compensation $\Gamma\left(e, \psi, s_W\right)$. This effect is stronger when s_W is higher, since worker compensation is then more sensitive to firm output.

4.2 Manager Effort and the Worker Monitoring Channel

Differentiating (12) with respect to e, the manager's optimal effort must satisfy:

$$\frac{s_M}{s_M + s_I}\left(1 + \Pi'\left(\Gamma\left(e, \psi, s_W\right)\right)\frac{\partial \Gamma}{\partial e}\right) - c'\left(e\right) = 0. \tag{21}$$

Together with (20), we have the key result of this subsection.[11]

Proposition 2. *Under a contract s_M, s_W, ψ, optimal manager effort $e^*\left(s_M, s_W, \psi\right)$ is the unique solution to:*

$$c'\left(e\right) = \frac{s_M}{s_M + s_I}\left(1 + \Pi'\left(\Gamma\left(e, \psi, s_W\right)\right)s_W\right). \tag{22}$$

Proposition 2 captures the core economic force in our paper. When workers are compensated using equity, and observe managers' effort, their exit decisions depend on managers' effort choices. Since workers' exits can also influence firm profits, managers consider the effects of their effort on worker retention, as captured by the $\Pi'\left(\Gamma\left(e, \psi, s_W\right)\right)s_W$ term in (22). We call this the *worker monitoring channel.*

Two elements are necessary for the worker monitoring channel to increase effort incentives for the managers relative to the benchmark case (16). First, worker compensation must include an equity component $s_W > 0$: only then do workers care about the aggregate performance of the firm, and thus managerial effort. Second, the manager must also care about worker retention, which implies that workers must be under-compensated relative to the monopsony-optimal level: $\Gamma < \Gamma^*_{FW}$, or equivalently $\Pi'\left(\Gamma\right) > \Pi'\left(\Gamma^*_{FW}\right) = 0$. If workers are paid the monopsony-optimal compensation Γ^*_{FW}, since $\Pi'\left(\Gamma^*_{FW}\right) = 0$, workers quitting on the margin have no effect on equity values, because the change in retention rates is perfectly offset by the change in markdowns. If either element vanishes – $s_W = 0$ or $\Gamma = \Gamma^*_{FW}$ – condition (22) reduces to (16), and the presence of workers does not affect managerial effort incentives.

Counterintuitively, granting equity to workers can thus *increase* the manager's incentives for effort, even though the manager's financial equity stake in the firm is reduced. Specifically, holding the manager-investor split constant $k \equiv \frac{s_M}{s_M+s_I}$, an increase in worker equity s_W mechanically reduces the manager stake, $s_M = \left(1 - s_W\right)k$. However, condition (22) implies

[11] The second order condition can be easily verified. Using the fact that $\Pi\left(\cdot\right)$ is concave and $c\left(\cdot\right)$ is convex, we calculate another derivative of (21):

$$\frac{\partial^2}{\partial e^2}: \ \frac{s_M}{s_M + s_I}\Pi''\left(\Gamma\right)s_W^2 - c''\left(e\right) < 0$$

implying that (22) is a necessary and sufficient condition for the manager's optimal choice of e.

that managerial effort increases with s_W. Treating workers as "outsiders" of the firm, the potential dilution of managerial stake is accounted for as worker compensation in the $\Pi(\Gamma)$ term. The remaining net effect is that workers retention becomes more sensitive to managerial performance, and hence provides stronger effort incentive for the manager.

To visualize the effect of worker equity s_W, we plot the manager's stage 1 payoff and effort in Figure 1, for a fixed k and each worker equity level. We also decompose the payoff into managerial effort and worker surplus extraction components as in (14).

There is an interior level of $\tilde{s}_W$ which implements Γ^*_{FW}, and thus maximizes profit extracted from the worker (orange curve). At this point, the worker monitoring channel disappears as discussed above for ((22)). The manager effort (bottom panel) at $\tilde{s}_W$ coincides with the case without workers, $s_W = 0$. Therefore, worker equity $s_W \in [0, \tilde{s}_W]$ increases manager's effort incentive rather than diluting it, even though manager's equity $s_M = k(1 - s_W)$ is reduced.

Proposition 2 also implies a convenient property about the monopsony optimal compensation level Γ^*_{FW}.

Proposition 3. *Suppose $s_W < 1$, given the ratio between the manager's and investors' ownerships $k = \frac{s_M}{s_M + s_I}$, all worker compensation contracts $\{\psi, s_W < 1\}$ that deliver $\Gamma = \Gamma^*_{FW}$ in equilibrium are equivalent in that they generate the same managerial effort e^* and identical payoffs for all players.*

Intuitively, all worker contracts that implement compensation level $\Gamma = \Gamma^*_{FW}$ for the workers remove the governance channel for the manager. Hence, the managerial effort is insensitive to worker contract, which in turn implies that the equilibrium outcome is similarly unaffected. This is a useful benchmark to see how worker equity and underpayment can improve the outcome later.

With these intuitions in mind, we move on to characterize the optimal contracting problem faced by the manager in stage 1.

4.3 Optimal Contract Design

Finally, we consider the manager's choice of contract s_M, s_I, s_W, ψ in the first stage. We prove a number of claims characterizing the optimal contract, and show that workers must be compensated with equity $s^*_W > 0$ and $\psi^* = 0$. We then provide first-order conditions illustrating the main tradeoff the manager faces when choosing the equity shares for workers and investors.

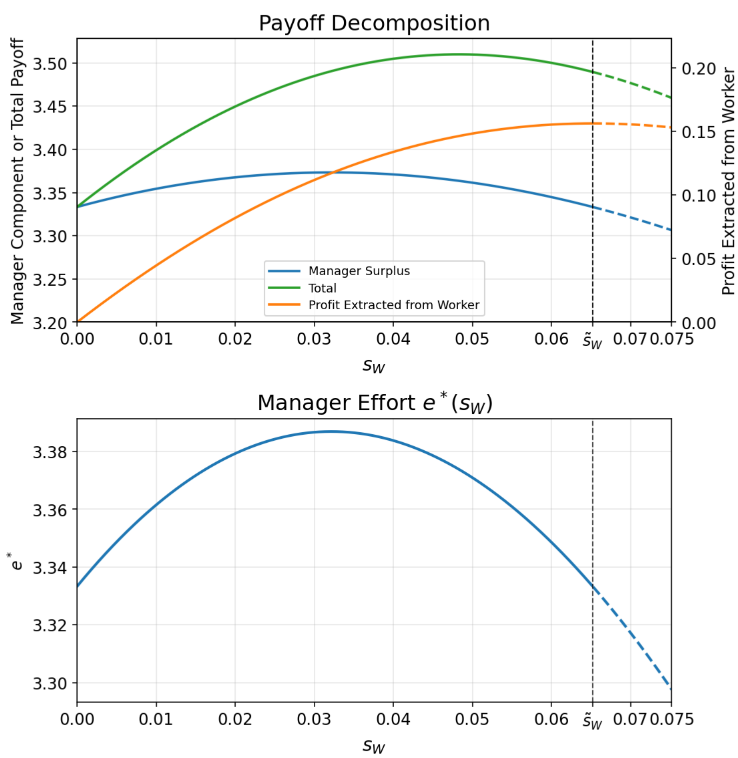
It is useful to remind ourselves that the manager's classic moral-hazard problem can be

Figure 1: Manager and Worker Components of Profit

Notes. This figure illustrates, for fixed k, how the choice of worker equity share s_W trades off the manager and worker components of surplus. The blue and orange colored lines show the manager and worker component of surplus in (14), and the green line shows their sum. The values of the manager component (blue) and the total payoff (green) corresponds to the left y-axis, and the profit extraction from workers (orange) corresponds to the right y-axis. For the numerical plot, the worker's outside option is uniformly distributed on $[0, \Delta]$, and manager has a quadratic effort cost:

$$c(e) = \frac{ae^2}{2}, \ \Pi(\Gamma) = (\Delta - \Gamma) F(\Gamma) = \frac{\Gamma(\Delta - \Gamma)}{\Delta} \tag{23}$$

The parameter values are $\theta = 1.5$, $\psi = 0$, $a = 0.15$, $\Delta = 0.5$, and $k = 0.5$.



framed as a commitment problem. The comparison between (12) and ((14)) shows that in stage 1, the manager would like to commit to extracting maximal surplus from workers, by setting cash compensation Γ_{FW}^*, and also exerting first-best effort, which is characterized by the FOC:

$$c'(e) = \frac{s_M + \theta s_I}{s_M + s_I}$$

However, in stage 3, after the investment is sunk, the manager cannot commit to exerting this effort as the FOC of (12) is

$$c'(e) = \frac{s_M}{s_M + s_I},$$

which means effort will be inefficiently low. In this subsection, we show how the optimal contract, in particular the workers' contract s_W and ψ, can be designed to alleviate this commitment problem.

The goal of contract design is to optimally trade off losses to the two components of (14), which will be graphically illustrated in Figure 1 as we establish the result in several steps.

Claim 1. The optimal financing structure features strictly positive internal and external equity $s_M^*, s_I^* > 0$.

The reason for strictly positive external equity ($s_I^* > 0$) is as follows. If the entire firm is owned by the manager (and possibly also partially by the worker), there is no "wedge" between the manager's ex-ante payoff objective ((14)) and his ex-post effort objective (12). Since the manager's ex-post effort choice is optimized, a marginal reduction in effort due to small equity dilution (s_I) also has a zero marginal cost on his ex-ante payoff. In contrast, by raising capital from investors, there is a discrete benefit of $\theta - 1$ per dollar raised. Hence, the optimal financing structure must feature some external equity.

Claim 2. For any $k = \frac{s_M}{s_M + s_I} \in (0, 1)$, there exists a pure equity contract for workers $\tilde{\psi} = 0$ and $\tilde{s}_W < 1$ such that their total compensation $\Gamma = \Gamma_{FW}^*$. Furthermore, holding k and $\psi = 0$ fixed, a small reduction of worker equity $\tilde{s}_W$ to $\tilde{s}_W - \delta$ increases the manager's payoff $\mathcal{M}$.

Proof sketch. The existence of $\tilde{s}_W$ is by construction. To see the second part of the claim, recall we expressed the manager's surplus $\mathcal{M}$ as the sum of manager surplus terms (the blue curve in Figure 1) and surplus extracted from workers Π (the brown curve in Figure 1), both of which are concave. If workers are compensated Γ^*, Π is maximized, but the manager surplus term is not. A small decrease in s_W from this point thus has no first-order effect on Π, since $\Pi'(\Gamma_{FW}^*) = 0$. In other words, marginal worker quitting when they are compensated Γ_{FW}^* has no marginal effect on the firm value. In contrast, a reduction in s_W frees up available equity for the manager, which increases managerial effort, which in turn has a first-order increase on the manager surplus term. The result then follows. The full proof is presented in Appendix A.4. □

This claim establishes a key step in showing that worker monitoring channel is present in equilibrium. Recall that Proposition 2 establishes the two necessary conditions for workers: positive worker equity, $s_W > 0$, and undercompensation for workers, $\Pi'(\Gamma) > 0$. It is not clear whether these conditions hold in equilibrium. The second part of Claim 2 shows that reducing worker equity from the benchmark Γ^*_{FW} level is beneficial. Proposition 3 shows that all contracts delivering Γ^*_{FW} are equivalent, which includes the best contract that can be attained by fixed wage $\psi^* = \Gamma^*_{FW}$. Hence, all fixed wage contracts are dominated and the worker monitoring channel must exist in equilibrium.

Graphically, Figure 1 illustrates Claim 2. A marginal reduction in s_W from $\tilde{s}_W$ has no first order impact on surplus extraction from workers Π. However, this modification has a first order improvement to the managerial effort as well as surplus due to a higher managerial equity.

The next proposition is the main result of this subsection, which formally summarizes the discussion so far and further establishes equity compensation as the optimal contract for workers.

Proposition 4. *The optimal contract always compensates workers entirely in equity:* $\psi^* = 0$ *and* $s^*_W \in (0,1)$. *Furthermore, workers are undercompensated in that* $s^*_W < \tilde{s}_W$ *or equivalently* $\Gamma^* < \Gamma^*_{FW}$.

Proof sketch. Intuitively, if worker compensation has a cash component ψ^*, the manager can always marginally swap the cash payment for some additional equity payment s^*_W, while maintain the total compensation to the worker. Such a modification makes the worker's payoff and hence his departure decision more sensitive to the firm's performance, providing a stronger effort incentive for the manager through the worker monitoring channel, i.e., the $\Pi'(\Gamma) s_W$ term in (22). Since the manager ex-ante prefers to commit to a higher effort level e^*, the modified contract therefore improves manager surplus in (14).

There is a secondary "feedback" effect: the higher managerial effort e^* in turn increases firm value and compensation to the worker Γ. Since workers are underpaid relative to the monopsony-optimal level, higher worker compensation additionally increases surplus extraction from workers $\Pi(\Gamma)$ in (14). Both effects work in the same direction and the conclusion follows. The proof in the Appendix shows the details.

□

Proposition 4 reduces the optimal contract problem to the choice of two free variables: $k = \frac{s_M}{s_M+s_I}$, which affects the amount of investment and the manager's baseline level of incentives; and s_W, which affects the tradeoff between worker surplus extraction, and manager incentive provision through worker monitoring. We now provide an FOC for the optimal choice of s_W.

Proposition 5. *The optimal choice of s_W, fixing $k = \frac{s_M}{s_M+s_I}$, satisfies:*

$$\left[\left(\theta + (1-\theta)\, k\right) - c'\left(e^*\left(k, s_W\right)\right)\right] \frac{de^*}{ds_W} + \\ \left(\theta + (1-\theta)\, k\right) \Pi'\left(\Gamma\left(e^*\left(k, s_W\right), s_W\right)\right) \frac{d\Gamma}{ds_W} = 0 \quad (24)$$

Where:

$$\frac{d\Gamma}{ds_W} = e^*\left(k, s_W\right) + \Delta + s_W \frac{de^*}{ds_W} \quad (25)$$

$$\frac{de^*}{ds_W} = \frac{k\left(\Pi'\left(s_W\left(e^*\left(k, s_W\right) + \Delta\right)\right) + s_W\left(e^*\left(k, s_W\right) + \Delta\right) \Pi''\left(s_W\left(e^*\left(k, s_W\right) + \Delta\right)\right)\right)}{c''(e) - k\Pi''\left(s_W(e+\Delta)\right) s_W^2} \quad (26)$$

Intuitively, Proposition 5 states that, at the optimal contract, the effect of a small change in s_W on the manager and worker components of surplus should be equal. These terms are the products of "wedge" terms:

$$\left[\left(\theta + (1-\theta)\, k\right) - c'\left(e^*\left(k, s_W\right)\right)\right], \Pi'\left(\Gamma\left(e^*\left(k, s_W\right), s_W\right)\right)$$

and "passthrough" terms $\frac{de^*}{ds_W}$ and $\frac{d\Gamma}{ds_W}$, which ultimately each depend on the curvature properties of the cost function $c(\cdot)$ and the profit function $\Pi(\cdot)$.

A simple implication of Proposition 5 is that $\frac{de^*}{ds_W}$ must be negative at the optimal contract (reflected by the downward sloping blue curve at the optimal point s_W^* in Figure 1): if $\frac{de^*}{ds_W} > 0$, then all terms in (24) are positive, and an increase in s_W unambiguously makes the manager better off. In the range where both effort and worker compensation are below their optimal values, (24) can only hold if $\frac{de^*}{ds_W}$ is negative and $\frac{d\Gamma}{ds_W}$ is positive.

Proposition 6. *The optimal choice of $k \equiv \frac{s_M}{s_M+s_I}$ satisfies:*

$$\underbrace{(1-\theta)\left[e^*\left(k, s_W\right) + \Pi\left(\Gamma\left(e^*\left(k, s_W\right), s_W\right)\right)\right]}_{Financing\ Benefits} + \\ \underbrace{\left[\left(\theta + (1-\theta)\, k\right) - c'\left(e^*\left(k, s_W\right)\right)\right]\left[\frac{\partial e^*}{\partial k} - \frac{\partial e^*}{\partial s_W} \frac{s_W \frac{\partial e^*}{\partial k}}{e^*\left(k, s_W\right) + \Delta + s_W \frac{\partial e^*}{\partial s_W}}\right]}_{Effort\ Costs} = 0 \quad (27)$$

where $\frac{\partial e^*}{\partial s_W}$ *is defined in (26), and:*

$$\frac{\partial e^*}{\partial k} = \frac{1 + \Pi'\left(s_W\left(e + \Delta\right)\right)s_W}{c''\left(e\right) - k\Pi''\left(s_W\left(e + \Delta\right)\right)s_W^2} \tag{28}$$

Intuitively, (27) states that the choice of the ratio $k = \frac{s_M}{s_M + s_I}$ – the relative shares of manager versus investor equity – is pinned down by the classic tradeoff between financing and incentive provision, generalizing (18) in the fixed-wage problem in Section 3.2. The first term in (27) reflects the marginal financing gains from increasing k, and the second term reflects the net cost from reducing the manager's effort, multiplied by the "wedge"

$$\left(\theta + \left(1 - \theta\right)k\right) - c'\left(e^*\left(k, s_W\right)\right)$$

The effort term is slightly complex, because changing k changes the worker component of profit as well as the manager's effort; the $\frac{\partial e^*}{\partial s_W}$ term in (27) reflects the shift in worker equity s_W needed to keep worker profit Π constant, which in turn has a feedback effect on the manager's optimal effort level. Essentially, we derive (27) in Appendix A.7 by differentiating $\mathcal{M}$ with respect to k, and then substituting the s_W FOC from (24) and simplifying, to eliminate the effects of k on the worker profit component of surplus.

4.4 Model Simulations

We conclude this section with a numerical simulation to illustrate how the degree of manager's moral hazard problem and worker productivity affect the equilibrium outcomes and the manager and worker components in (14). Following the numerical setting of Figure 1, the manager's cost parameter is controlled by a. When a is large, the manager is harder to incentivize and the manager component of surplus is less important in (14). The workers' productivity is controlled by Δ with higher Δ reflecting larger contribution of workers in the production.

In Figure 2, we plot the optimal contract – characterized by a k, s_W pair – as we vary a and Δ. We plot the ratios of managerial effort e, worker compensation Γ, manager surplus, and worker profit extraction respectively to their values if manager surplus and worker profit extraction respectively are optimized in isolation. More specifically, the effort level that maximize manager surplus in (14) is defined as

$$e^*_{MS} \equiv \arg\max_e \frac{s_M + \theta s_I}{s_M + s_I}e - c\left(e\right),$$

and the level of worker compensation that maximizes surplus extraction from workers is simply Γ^*_{FW} from earlier definition (10). Denote $MS_{\max} \equiv \frac{s_M+\theta s_I}{s_M+s_I} e^*_{MS} - c\left(e^*_{MS}\right)$ and $WS_{\max} \equiv \Pi\left(\Gamma^*_{FW}\right)$ the highest value of the two components at their respective maximal. The equilibrium values in the plot are normalized by these individual-component-optimal quantities.

When a decreases and the manager is easier to incentivize, worker monitoring is more effective. In equilibrium, workers are more underpaid and worker profit extraction is less efficient, but manager effort and the manager component of surplus increase. Conversely, when Δ increases and worker surplus is more important, the manager component is more distorted and the worker component is less distorted.

5 Implications and Extensions

5.1 Defaultable Wage and Risky Debt

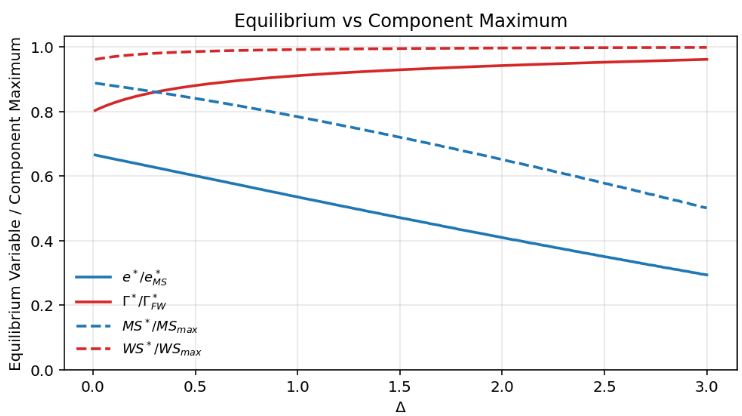
So far we have only considered equity financing from external investors. The result is that equity compensation s_W is necessary to create the worker monitoring channel because equity loads worker pay directly on manager's effort and output. Fixed wage in contrast is insensitive to the firm performance. In this subsection, we consider a mix of equity and debt financing, and the possibility that the firm may default on external debt and fixed wage promised to workers. The extension yields some interesting insights. First, the fixed wage can create worker monitoring incentive because the probability of receiving it depends on the firm's performance, which in turn depends on manager's effort. Second, equity is no longer necessarily the optimal compensation contract to the worker.

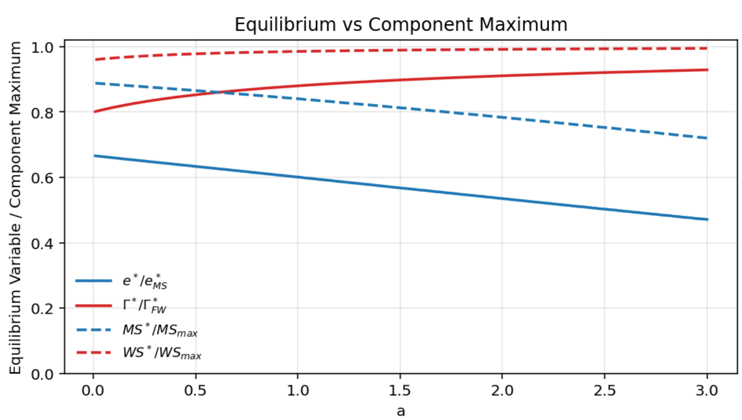
Suppose the firm can raise debt from investors with a face value of D in addition to issuing s_I shares. Following legal practice in the US, in the event of a default, we assume wage ψ is more senior than external debt.[12] Other ingredients are identical to the baseline model in Section 2. Since default is the focus of this subsection, the random shock $\tilde{\epsilon}$ in the production becomes important, and we denote its CDF by $H\left(\tilde{\epsilon}\right)$. In what follows, we denote $x^+ \equiv \max\left(x, 0\right)$.

[12]Under 11 U.S.C. §507, employee wage claims earned within 180 days before bankruptcy filing, up to a statutory cap, are senior to all general unsecured debt, including corporate bonds, trade credit, unsecured bank loans, lawsuit judgments, and lease obligations.

Figure 2: Numerical Simulation: Manager v.s. Worker Components

Notes. This figure illustrates how features of the optimal contract vary as we shift a, the coefficient on managers' costs in (23), and Δ, which parametrizes the worker productivity in (23). In each panel, we show four lines: equilibrium manager effort normalized by e^*_{MS}, fixing the value of k at the optimal contract; worker compensation Γ^* divided by its fixed-wage optimal value Γ^*_{FW}; and the ratios of manager surplus and profit extracted from workers, as defined in (14), to their respectively maximized values $MS_{\max}$ and $WS_{\max}$. The parameters in the plots are given by $\theta = 1.5$, $\psi = 0$, $a = 2$ (top panel), and $\Delta = 1$ (bottom panel).





If the worker stays, the total output is $V_1 \equiv e + \tilde{\epsilon} + \Delta$, and

$$\begin{cases} W(V_1) \equiv \min\{V_1^+, \psi\} & \text{fixed wage payoff} \\ B_1(V_1) \equiv \min\{(V_1 - \psi)^+, D\} & \text{debt payoff} \\ E_1(V_1) \equiv (V_1 - \psi - D)^+ & \text{equity payoff} \end{cases}.$$

If the worker quits, the total output is $V_0 \equiv e + \tilde{\epsilon}$, and

$$\begin{cases} B_0(V_0) = \min\{V_0^+, D\}, & \text{debt payoff} \\ E_0(V_0) = (V_0 - D)^+. & \text{equity payoff} \end{cases}.$$

Expected worker compensation is

$$\Gamma(e) = \mathbb{E}\big[W(V_1) + s_W E_1(V_1)\big]. \tag{29}$$

Let $\bar{E}_i(e) \equiv \mathbb{E}[E_i(V_i)]$ denote the expected equity value where the expectation is taken over $\tilde{\epsilon}$. The manager's optimal effort choice is given by

$$(1 - F(\Gamma))\, k\bar{E}_0(e) + F(\Gamma)\, s_M \bar{E}_1(e) - c(e), \tag{30}$$

where $k = \frac{s_M}{s_M + s_I}$. Define

$$\begin{cases} S(e) \equiv \mathbb{E}[V_1^+ - V_0^+] & \text{additional value creation by workers} \\ \Delta B(e) \equiv \mathbb{E}[B_1(V_1)] - \mathbb{E}[B_0(V_0)] & \text{debt-overhang leak to creditors} \end{cases}.$$

Essentially, the value creation captures the additional output from the workers' production. In the baseline model, it is simply Δ. In this subsection, since wage can be defaulted upon, which means that the output net of wage can be negative, the workers' contribution to the "before-wage-claim" firm value $S(e)$ in expectation is smaller than Δ. The presence of worker has another effect due to the debt in place. Some of the workers' value creation goes to the creditors by making their debt safer, and the $\Delta B(e)$ term captures the "debt-overhang leak" to creditors.

Using the accounting identities $V_1^+ = W + B_1 + E_1$, $V_0^+ = B_0 + E_0$, and the fact that $s_M = k(1 - s_W)$, the manager's objective function can be rewritten as

$$k\left[\bar{E}_0(e) + F(\Gamma)\,(S(e) - \Delta B(e) - \Gamma(e))\right] - c(e), \tag{31}$$

which is similar to (12) in our baseline model.[13] Essentially, the workers' value creation net of debt-overhang leakage and the workers' compensation is the net contribution to equity value. The first-order condition of (31) determines the optimal managerial effort:

$$c'(e) = k\bar{E}_0'(e) + k\Big(f\,(\Gamma)\,\Gamma'(e)[S - \Delta B - \Gamma] + F\,(\Gamma)\,[S' - \Gamma' - \Delta B']\Big). \tag{34}$$

where the derivatives are given by the likelihood of outcomes in the relevant regions:

$$\begin{cases} \Gamma'(e) = \Pr(0 < V_1 < \psi) + s_W \Pr(V_1 > \psi + D), \\ \Delta B'(e) = \Pr(\psi < V_1 < \psi + D) - \Pr(0 < V_0 < D), \\ S'(e) = \Pr(-\Delta < V_0 \leq 0). \end{cases}$$

These derivatives capture the additional economic forces and insights. First, the $\Gamma'(e)$ term captures the sensitivity of worker expected compensation to managerial effort as in our baseline model. Interestingly, worker equity is no longer necessary or sufficient. Wage matters for incentives only in the "partially-paid wage" region $0 < V_1 < \psi$, hence fixed wage ψ may create the strongest worker monitoring channel if wage is risky. In contrast, when firm is unlikely to default ($V_1 > \psi + D$), equity provides stronger monitoring channel as we saw in the baseline model. As in standard debt overhang literature, the leakage to creditors hinders managerial effort, which is reflected by the negative coefficients in front of $\Delta B'(e)$ in (34). Finally, $S'(e)$ captures the worker's gross value added increases managerial effort only insofar as effort makes the worker pivotal for avoiding total bankruptcy. Otherwise, the gross value added is a constant Δ as in our baseline model and does not create managerial effort incentives.

To summarize, the main implication of our analysis is:

Claim 3. When the firm is safe (resp. risky), worker equity s_W (resp. fixed wage ψ) is more likely to provide significant effort incentive for the manager.

[13] To see the derivation, from $s_M = k(1 - s_W)$ expression (30) becomes

$$k\bar{E}_0(e) + kF\,(\Gamma)\left[(1 - s_W)\bar{E}_1(e) - \bar{E}_0(e)\right] - c(e) \tag{32}$$

and from the accounting identities, we have

$$S(e) = W + \Delta B(e) + \bar{E}_1(y) - \bar{E}_0(y).$$

Plugging in the definition of Γ from (29) yields:

$$(1 - s_W)\bar{E}_1(y) - \bar{E}_0(y) = S(y) - \Gamma(y) - \Delta B(y). \tag{33}$$

Substituting into (32) yields (31).

5.2 Worker Bargaining Power

This section extends the baseline model to incorporate worker bargaining power. We find that, if workers have high bargaining power and are able to negotiate high total compensation, the worker monitoring channel becomes ineffective, and workers are optimally compensated with fully fixed wages.

To introduce workers' bargaining power formally, in stage 1 of the game as described in Section 2, we assume that the manager first agrees to an external equity financing term: $k = \frac{s_M}{s_M + s_I}$. Then the workers' compensation package s_W, ψ is negotiated through generalized Nash bargaining between the CEO and workers; all later game stages are unchanged. The actual game between the manager and external investors that endogenizes k is inconsequential, as the result in this subsection holds for any given k.[14]

At expected compensation Γ, the worker's expected surplus, over uncertainty in ω, is:[15]

$$\mathcal{W}(\Gamma) = \int_{\omega=-\infty}^{\Gamma} (\Gamma - \omega)\, dF(\omega) = \int_{\omega=-\infty}^{\Gamma} F(\omega)\, d\omega \tag{35}$$

The chosen worker contract maximizes the weighted geometric average of manager and worker surplus:

$$\max_{s_W, \psi} \left(\mathcal{M}(s_W, \psi) - \mathcal{M}_0\right)^{1-\alpha} \left(\mathcal{W}\left(\Gamma\left(e^*(s_W, \psi), \psi, s_W\right)\right)\right)^{\alpha} \tag{36}$$

where $\mathcal{M}_0$ is the surplus the manager obtains if the worker were to leave entirely, and α parametrizes the worker's bargaining power.[16] As $\alpha \to 0$, the outcome simply maximizes $\mathcal{M}$, as in the baseline model; as $\alpha \to 1$, the outcome maximizes worker surplus $\mathcal{W}$ conditional on delivering at least $\mathcal{M}_0$ to the manager.

We solve (36) by characterizing the Pareto frontier of the set of $(\mathcal{M}, \mathcal{W})$ pairs, which we call Φ. It is clear that $\mathcal{W}$ is a strictly increasing function of expected compensation Γ; thus, any Pareto-optimal $(\mathcal{M}, \mathcal{W})$ must maximize $\mathcal{M}$ conditional on delivering some value of Γ to

[14] Bova and Yang (2017) assume that firms commit to contract structure – fixed wages versus wage-and-equity compensation – before bargaining begins. This allows firms to preserve surplus by committing to wage-only contracts when worker bargaining power is high. In our model, in contrast, contract structure is an outcome of bargaining.

[15] For the second equality, we have:

$$\int_{-\infty}^{\Gamma} (\Gamma - \omega) dF(\omega) = \underbrace{\left[(\Gamma - \omega)F(\omega)\right]_{-\infty}^{\Gamma}}_{0} - \int_{-\infty}^{\Gamma} F(\omega)(-d\omega) = \int_{-\infty}^{\Gamma} F(\omega) d\omega$$

[16] Note that (36) has no $\mathcal{W}_0$ term because we accounted for workers' outside option in the definition of worker surplus in (35).

the worker. Thus, we can thus trace out Φ by solving, for different choices of $\tilde{\Gamma}$:

$$\max_{s_W,\psi} \mathcal{M}(s_W,\psi)$$
$$s.t.\ \Gamma\left(e^*\left(s_W,\psi\right),\psi,s_W\right)=\tilde{\Gamma} \quad (37)$$

Essentially, different levels of workers' bargaining power is reflected by different values of total worker compensation $\tilde{\Gamma}$ in equilibrium.

Let Γ^* be the Γ value from the manager-optimal contract, characterized in Propositions 5 and 6. Clearly, it is never optimal to have $\Gamma < \Gamma^*$, since this is detrimental to both $\mathcal{M}$ and $\mathcal{W}$. It is clear that manager's outside option $\mathcal{M}_0$ is attained in (37) when $\Gamma = \Delta$, since workers' presence does not affect the equity value of the firm in this case, and the outcome is equivalent to having no workers. Thus, Φ is spanned by the solutions to (37) for values $\Gamma \in [\Gamma^*, \Delta]$.

Claim 4. When $\tilde{\Gamma} < \Gamma^*_{FW}$, the constrained-efficient contract pays the worker only in equity; $\psi = 0$. When $\tilde{\Gamma} > \Gamma^*_{FW}$, the constrained-efficient contract pays the worker only in fixed wages; $s_W = 0$.

Proof. The proof is essentially a repetition of the third and final step in the proof of Proposition 4. When $\tilde{\Gamma} > \Gamma^*_{FW}$, paying a fixed wage $\psi = \tilde{\Gamma}$ maximizes the manager's effort incentive since workers are over paid $\Pi'(\Gamma) < 0$ and manager therefore benefits from their departure. Hence, manager has incentive to shirk and thereby motivating workers to quit. Minimizing worker equity s_W reduces manager's desire to shirk.

When $\tilde{\Gamma} < \Gamma^*_{FW}$, we have shown in the proof of Proposition 4 that replacing fixed pay by equity pay is a Pareto improvement for both the manager and workers. Hence, the optimal contract is pure equity in this case.

□

Claim 4 shows that, on the Φ-frontier, the efficient contract "jumps" from a full-equity contract to a full fixed-wage contract. Intuitively, worker equity is only effective at increasing managerial incentives when workers are undercompensated and their departure harms the firm and the manager. In contrast, if workers have enough bargaining power to demand $\Gamma > \Gamma^*$, they are overcompensated and their departure is therefore beneficial. In this case, worker equity induces a reduction in managerial effort, because slacking off in fact increases worker profit extraction by driving away overcompensated workers.

5.3 Worker Equity and Worker Effort

A key implication of our model is that the equity component in workers' compensation package is crucial for workers to play a governance role. There is a classic explanation for equity compensation in the moral hazard literature: performance-based pay provides effort incentives for players. While this explanation is plausible for large workers, such as C-suite executives, we argue that it is unlikely the explanation for equity compensation for small workers, because of a classic *dilution problem*: with any nontrivially large number of workers, equity has no quantitatively meaningful effects on workers' effort incentives (Holmstrom, 1982; Oyer, 2004). In this subsection, we demonstrate this by calculating the optimal contract for effort provision when a manager collaborates with N workers, and show that as $N \to \infty$, the collective equity compensation for workers tends to zero.

Suppose there are $N+1$ players: 1 manager, labeled as player 0, and N workers, indexed by $i = 1, 2, ..., N$. The manager has a technology to produce an average output of e with a private cost of $c(e)$. The N workers can each produce an average output of $\frac{e_i}{N}$ at the private cost of $c_i\left(e_i\right) \equiv \frac{c(e_i)}{N}$ for $i \geq 1$. Hence, in terms of production technology, the manager is "equivalent to" the collection of N small players. When $N = 1$, the setting is a standard team production with two members; and when $N \to \infty$, the setting is a big manager with many infinitesimal workers. The total output (equity) of the firm is

$$e_0 + \frac{\sum_{i=1}^{N} e_i}{N}$$

Denote by s_i $(i = 0, 1, ..., N)$ the equity share of each player. We are interested in the optimal equity allocation that maximizes the total surplus:

$$\max_{s_i} e_0^* + \frac{\sum_{i=1}^{N} e_i^*}{N} - c\left(e_0^*\right) - \frac{1}{N}\sum_{i=1}^{N} c\left(e_i^*\right). \tag{38}$$

s.t. the incentive compatibility condition of each player

$$e_i^* = \arg\max s_i \left(e_0 + \frac{\sum_{i=1}^{N} e_i}{N}\right) - c_i\left(e_i\right), \tag{39}$$

and the natural restriction that sum of equity shares is 1:

$$\sum_{i=0}^{N} s_i = 1. \tag{40}$$

While the conclusion holds for more general cost function, for illustration, we specify the cost function as

$$c(e_i) = \frac{1}{2}e_i^2.$$

A simple calculation in the appendix yields the optimal equity allocation.

Claim 5. The optimal equity allocation that maximizes the total surplus is $s_0^* = 1 - \frac{N}{N^2+1}$ and $s_i^* = \frac{1}{N^2+1}$ for all $i \geq 1$. Furthermore, the equity shares that workers collectively receive $\sum_{i=1}^N s_i^* = \frac{N}{N^2+1} \to 0$, as $N \to \infty$.

When $N = 1$, the firm is a partnership of two identical players, and hence the optimal equity share is $s_0^* = s_1^* = \frac{1}{2}$. When the number of workers N becomes large, despite the fact that workers collectively possess the same production technology as the manager, their collective equity share in equilibrium vanishes, and the entire equity optimally belongs to the manager. Intuitively, as individual workers become small, they do not respond to performance pay (equity), because their individual effort has a negligible impact on the outcome. Hence, all incentive pay is allocated to the large player (manager).

Our worker monitoring channel does not suffer from this dilution problem. Technically, worker equity compensation in our setting is constrained not by the dilution of other parties' incentives, but instead by workers' limited liability constraint. It is optimal to pay workers entirely in equity, making worker exit decisions as sensitive to managerial effort as possible, without delivering negative payoffs to the worker in some states of the world. It is thus equivalent whether the representative worker, pushed against her $\psi = 0$ constraint, is thought of as a single worker or an arbitrary number of identical workers: their exit decisions, and thus their effects on managerial incentives, are identical. Interestingly, as we discussed, dilution is not even an issue for *managers*: from (12) and Proposition 2, worker equity can be viewed as having no direct dilution effect on managers' incentives, instead only influencing effort through the profit term $\Pi(\Gamma(e, \psi, s_W))$.

5.4 Robustness: Heterogeneous Workers and Run Incentives

In our baseline model, we have assumed that workers are homogeneous in that they have the same (randomly realized) outside option. The representative worker assumption is a technical simplification, which allows us to analyze interactions between workers' decisions and the manager's decision, while disregarding interactions between workers. We sacrifice some realism here to sharpen the economic insights the stylized model produces.

In this subsection, we modify the model slightly to consider a continuum of ex-post heterogeneous workers with different realizations of reservation payoffs. Other aspects of the model remain the same. We show the additional complication of incentive to run among workers, and illustrate why this complication does not materially change our insight.

Instead of having two cases based on whether workers stay or quit as in Section 2, the expected equity value in the modified model becomes

$$e + (\Delta - \psi) F(\Gamma),$$

where $F(\Gamma)$ is the mass of employed workers from the Law of large numbers, and the expected compensation to worker becomes

$$\Gamma = \psi + s_W [e + (\Delta - \psi) F(\Gamma)]. \tag{41}$$

Immediately, we can see that there is a fixed point problem in Γ from (41): The more workers quit, the lower the equity value, which in turn motivates workers to quit. As standard in coordination games, there may be multiple solutions to (41), and hence a run incentive among workers. To proceed, one either has to specify a selection rule among the solutions or assume (41) has a unique solution. For simplicity, we take the second approach, and note if the selection rule picks the solution that is continuous in other variables, the logic below remains valid.

Now consider the manager's effort choice problem

$$\max_e s_M [e + (\Delta - \psi) F(\Gamma)] - c(e) - \theta (1 - I). \tag{42}$$

Unlike (1), the total equity that workers hold is $s_W F(\Gamma)$, hence, the share ownership identity becomes

$$s_W F(\Gamma) + s_M + s_I = 1. \tag{43}$$

Using this identity, it is easy to verify as in our main model, that the manager's objective (42) can be rewritten in the same way as (12) with the same first-order condition as (21). Investors' breakeven condition can also be identically expressed as in (13). Therefore, the only difference in the analysis is that unlike (20), where the sensitivity of workers' compensation on manager's effort is simply workers' share s_W, the fixed-point problem in (41) makes $\frac{\partial \Gamma}{\partial e}$ slightly more complex. Take implicit derivative with respect to e in (41), we have

$$\frac{\partial \Gamma}{\partial e} = s_W \left[1 + (\Delta - \psi) f(\Gamma) \frac{\partial \Gamma}{\partial e} \right],$$

or equivalently,

$$\frac{\partial \Gamma}{\partial e} = \frac{s_W}{1 - s_W (\Delta - \psi) f(\Gamma)}. \tag{44}$$

As in the baseline model, the worker monitoring channel relies on the sign of $\Pi'(\Gamma) \frac{\partial \Gamma}{\partial e} > 0$, which based on (44), is equivalent to $\Pi'(\Gamma) > 0$ (the undercompensation of workers) and $s_W > 0$ (worker equity).[17] Therefore, the key insights from our baseline model, i.e., Propositions 2 and 4, remain valid when workers have different realizations of outside options.

5.5 Imperfectly Informed Workers

In the baseline model, we have assumed for simplicity that workers can observe manager's effort e perfectly before deciding whether to leave for outside option ω. In this subsection, we relax this assumption and allow workers to imperfectly observe manager's effort with noise,

$$\tilde{e} = e + \tilde{\xi},$$

where $\tilde{\xi}$ is a mean-zero noise term with distribution G_ξ. Following the homogeneous worker setting, we assume $\tilde{\xi}$ is common among workers. We also assume workers hold an improper uniform prior, and therefore their posterior expectation of e is simply $\tilde{e}$. Consequently, workers stay if their outside option is below their perceived compensation

$$\omega < s_W (\tilde{e} + (\Delta - \psi)) + \psi,$$

which is equivalent to

$$\omega - s_W \tilde{\xi} < s_W (e + (\Delta - \psi)) + \psi = \Gamma, \tag{45}$$

where Γ is the actual compensation to workers as in (5). It is clear that the noise $\tilde{\xi}$ can be absorbed by the outside option, which can be redefined as

$$\hat{\omega} \equiv \omega - s_W \tilde{\xi},$$

with distribution $\hat{F}$. The problem is isomorphic to the baseline model except that $\hat{F}$ depends on s_W: Worker equity creates a mean-preserving spread on workers' outside option due to the noisy observation of manager effort.

[17] To see that the denominator in (44) is positive, note that when (41) or equivalently, $\Lambda(\Gamma) \equiv \Gamma - [\psi + s_W [e + (\Delta - \psi) F(\Gamma)]] = 0$ has a unique solution $\Gamma^* > 0$, the derivative $\Lambda'(\Gamma^*) = 1 - s_W (\Delta - \psi) f(\Gamma^*) > 0$ must hold. This is because $\Lambda(0) < 0$ and the uniqueness of solution implies that the function must be increasing at the solution Γ^*.

Because the manager's optimal effort problem has the same mathematical formulation as in Proposition 1, our key insight regarding the worker monitoring channel remains robust (Proposition 2). More specifically, workers' compensation must be sensitive to firm's performance ($s_W > 0$) and underpaid relative to monopsony optimal compensation level ($\Pi'(\Gamma) > 0$).

The optimal contract $\{\psi, s_W, s_M, s_I\}$ may change as worker equity s_W affects the endogenous distribution $\hat{F}$ as a mean-preserving spread over the original outside option distribution F. Depending on how such a transformation affects the firm's monopsony profit function $\Pi(\Gamma)$, there is a new channel which may either increase or decrease the optimal level of worker equity relative to the baseline case.

Finally, the case where workers observe manager's effort with idiosyncratic noise $\tilde{\xi}_i$ is essentially the combination of common noise case with heterogeneous outside option in Subsection 5.4. Mathematically, one can absorb the idiosyncratic noise into workers' outside option $\omega - s_W\tilde{\xi}_i$ in ((45)). Therefore, our main insights remain robust and the new force here is that worker equity s_W influences both the degree of mean preserving spread and heterogeneity among workers. We leave more detailed analysis to future research.

6 Relationships to Empirical Work

6.1 Empirical Support for Model Assumptions

The basic inputs into our model are simple: beyond the standard moral-hazard problem facing the manager, we assume that workers have private information about firm outcomes, and that firms charge markdowns in labor markets. Both assumptions are well-supported by a large body of empirical research.

Worker Knowledge. Our assumption that employees observe value-relevant information about the firm is consistent both with how public companies regulate employee trading, and with empirical evidence that worker-generated signals predict fundamentals and returns.

U.S. public firms must disclose whether they maintain insider-trading policies and procedures and file them with the Form 10-K (or explain non-adoption) under Item 408(b) of Regulation S-K, making such policies near-universal in practice among listed firms. These policies typically impose quarterly trading windows or blackouts (e.g., from late quarter-end until after earnings) and allow ad-hoc "special blackouts" around pending material events. While directors and officers face stricter rule-based constraints,[18] firm blackout policies rou-

[18]Under SEC Rule 10b5-1 (as amended in 2022), directors and officers may not trade under a newly

tinely extend beyond executives to broad groups of employees likely to encounter material nonpublic information (MNPI).

There are also a number of empirical papers arguing that workers have private information about firms they work at. In firms with employee stock purchase plans (ESPPs), higher aggregate employee purchases predict future stock returns (Babenko and Sen, 2016). Employees' stock option exercise decisions – distinct from executives' exercise decisions – also predict returns (Huddart and Lang, 2003). Employee-generated signals outside trading also forecast fundamentals and returns. Changes in crowdsourced employer reviews by current employees predict one-quarter-ahead earnings surprises and future stock returns (Green et al., 2019); broader measures of employee satisfaction correlate with long-run abnormal returns (Edmans, 2011) and, across countries, with future profitability and earnings surprises (Edmans et al., 2024).

In our model, employees who are paid in equity, and who believe the firm's future performance will be poor, are more likely to leave. This is consistent with Li et al. (2022), who find that employee turnover is negatively associated with subsequent firm performance. In our model, this could be driven both by selection – workers who receive equity compensation are more likely to leave when firm prospects are poor – and causal effects – worker departures further decrease the firm's output. Relatedly, Tsui and Vance (2023) find that workers' intentions to leave are more strongly correlated with trust in management when workers receive equity compensation. They interpret this as evidence that worker equity improves *sorting*, generating a workforce with greater trust in management. Our theory instead emphasizes *monitoring*: managers work harder when they know that workers with equity stakes will leave if they shirk.

Labor Market Power. We assume that firms have market power in labor markets. This is motivated by a large recent literature that finds evidence for quantitatively meaningful labor market markdowns: wages are set well below workers' marginal revenue product to the firm, consistent with imperfect competition in labor markets (Berger, Herkenhoff and Mongey, 2022; Yeh, Macaluso and Hershbein, 2022; Lamadon, Mogstad and Setzler, 2022; Kroft et al., 2025). Two complementary findings which underpin this interpretation are that firm-specific labor-supply elasticities can be quite low (Dube et al., 2020); and that greater labor-market concentration is associated with lower wages (Azar, Marinescu and Steinbaum,

adopted or modified 10b5-1 plan until a cooling-off period has elapsed: the later of (i) 90 days after adoption/modification or (ii) two business days after the issuer files its next periodic report (Form 10-Q or 10-K), capped at 120 days. Under Sarbanes-Oxley 306, during a "pension plan blackout period" (when plan participants are temporarily restricted from trading issuer equity in an individual account plan), directors and executive officers are prohibited from trading the issuer's equity securities outside the plan; issuers must give advance notice and file a Form 8-K announcing the blackout.

2022).

6.2 Empirical Predictions

Next, we discuss the empirical predictions of our model, where these predictions align with existing evidence, and which new tests they suggest.

Prediction 1. *Broad-based worker equity compensation improves firm governance, and should be more prevalent when workers can credibly threaten to exit, and when worker exits are damaging to firm outcomes.*

Many recent theoretical papers predict that broad-based equity compensation should improve firm outcomes, and a number of empirical papers have found evidence supporting these predictions (Hochberg and Lindsey, 2010; Kim and Ouimet, 2014). Prediction 1 is more specific to our model: we emphasize that the positive effects of equity compensation should work through firm *governance*. This prediction is supported by a number of existing empirical papers. Chen, King and Wen (2020) find that higher employee stock ownership is associated with lower loan spreads and fewer loan covenants, suggesting that credit markets appear to treat worker equity as governance-relevant. Moreover, these effects are stronger at firms with lower employee retention; this is consistent with our prediction to the extent that worker exit is also costly at these firms. Other papers find that employee ownership is associated with lower rates of financial fraud (Wu, Cao and Zhang, 2023) and nonfinancial misconduct (Nguyen, Pham and Xiao, 2024). These relationships can be rationalized using our model, whereas they do not naturally emerge from other theories of broad-based worker equity.

A quantitative sharpening of Prediction 1 is the following: Worker equity compensation can improve firm governance, even when they result in the dilution of managers' equity stake in the firm. Under our mechanism, increasing workers' equity compensation can improve managers' effort incentives – and thus improve governance – even when managers' direct equity stakes are diluted. This prediction could plausibly be tested by constructing measures of managers' and workers' total deltas, and observing whether an increase in workers' deltas, together with a corresponding decrease in managers' deltas, can result in improved governance.

Prediction 2. *Broad-based equity compensation should be more prevalent when workers have less bargaining power.*

Our model predicts that, when workers have high bargaining power, we should see more fixed-wage contracts and less equity contracts. This is due to Claim 4, which builds on Proposition 2.

An observation consistent with our model is that labor unions, which are plausibly associated with higher worker bargaining power, overwhelmingly negotiate the *wages* of employees; it is less common for unions to negotiate *equity* contracts (McCarthy et al., 2011).[19] More broadly, Bova and Yang (2017) obtain a similar prediction using a very different channel: when workers have low bargaining power, firms may negotiate wage-and-equity contracts to lower marginal costs and increase competitiveness in product markets. An interesting direction for future research would be to distinguish these mechanisms empirically, for example by examining whether the relationship between worker bargaining power and equity compensation is stronger among firms where product-market competition is especially important, or among firms where governance concerns are more pronounced.

Prediction 3. *Broad-based equity compensation should be more prevalent when workers are more informed about firm outcomes.*

While we are not aware of careful empirical tests of this prediction, anecdotally, it is consistent with the fact that equity makes up a large share of compensation for more seasoned workers at technology companies.[20] Seasoned workers are plausibly more likely to possess private information than junior workers, but are too numerous at large companies for equity compensation to provide strong direct incentives.[21] Further empirical tests of this prediction could correlate equity compensation measures with various measures of workers' private information, like many papers we discussed in Subsection 6.1 above.

Prediction 4. *Broad-based worker equity is less effective at improving governance for distressed firms.*

Prediction 4 is based on Subsection 5.1: when firms are close to default, workers' wages can also be exposed to firm performance, so equity loses its comparative advantage as a governance device. This prediction could be tested by measuring whether the observed positive effects of broad-based equity compensation are weaker for firms closer to default.

[19] Exceptions exist: UAW-represented auto workers have a profit-sharing component of pay, though this is not explicitly an equity stake in the firm. Unions sometimes negotiate for equity when firms are distressed: for example, in the 1994 United Airlines employee buyout, workers accepted equity in exchange for wage concessions, specifically as a means to save the carrier from looming bankruptcy.

[20] For example, as of April 2026, levels.fyi reports that an entry-level E3 engineer at Meta makes around $141,000 in salary and $29,000 in stock per year, whereas a more seasoned E5 engineer makes around $225,000 in salary and $232,000 in stock per year, with similar patterns at other large technology companies.

[21] For example, Google and Meta each employ tens of thousands of software engineers. Public descriptions report that engineers are expected to reach E5 at Meta, so it is likely that there are thousands to tens of thousands of E5-level engineers at Meta; equity grants should thus be quantitatively ineffective at providing direct effort incentives to workers.

Prediction 5. *Workers are more underpaid when the manager's moral hazard problem is more prominent.*

Prediction 5 is based on Subsection 4.4: when the moral hazard problem facing the manager is more important for firm output, the optimal contract distorts worker compensation more in order to provide stronger incentives for the manager. Empirically, there are many potential proxies for the relevance of managerial moral hazard, such as managerial tenure, the degree of entrenchment, and the availability of "hard information" to base the manager's compensation on.

Finally, we discuss a seemingly testable prediction prominently emerging from the model.

Prediction 6. *Workers are solely paid in equity.*

This prediction directly emerges from Proposition 4, and it holds in our model because equity maximizes the strength of workers' monitoring incentives. Taken literally, this prediction is clearly unrealistic; it results from our assumption that workers are risk-neutral, so there are no risk costs of equity compensation. We choose the risk-neutral setting for expositional purpose as it makes the worker monitoring channel salient. With this said, equity does comprise a large fraction of total compensation in a number of high-skill settings, where workers are plausibly informed about firm outcomes: for mid-career software engineers at many large technology companies, around half of workers' total compensation is made in equity.[22] Furthermore, many other compensation forms are based on firms' aggregate performance: for example, year-end bonus pool based on the total profit made by the firm, and the summer support in 9-month academic employment contracts based on universities' budget availability.

7 Conclusion

In this paper, we analyze how workers' private information influences corporate governance and incentive provision for managers. When informed workers are paid partially in equity, they have an incentive to leave the firm if managers shirk. Worker equity compensation thus partially delegates to workers the problem of monitoring the firm: the manager understands that shirking can induce workers to quit, and thus exerts increased effort to influence worker retention. Therefore, even though worker equity crowds out manager's stake in the firm, it can help increase managerial effort incentives. Interestingly, private information also affects

[22]See, for example, levels.fyi.

the level of worker compensation: the worker monitoring channel is only effective when workers are undercompensated relative to the monopsony-optimal level.

Our analysis suggests several directions for future work. Empirically, the most direct tests would examine whether broad-based worker equity improves governance especially in settings where workers are informed and where worker exits are costly to the firm. Theoretically, future work could enrich the contract space by incorporating worker risk aversion, liquidity constraints, vesting schedules, options, bonuses, and dynamic quit decisions. These extensions would help connect the stark equity-only result in our model to the richer mix of wages, equity, deferred compensation, and performance-based pay observed in practice.

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Appendix

A Proofs

A.1 Proof of Proposition 1:

We have:

$$(s_M + s_I)(e + \Delta - \psi) - e$$
$$= (s_M + s_I)(\Delta - \psi) - e(1 - s_M - s_I)$$
$$= (1 - s_W)(\Delta - \psi) - e s_W$$

Now, using the definition of $\Gamma(e, \psi, s_W)$ in (5),

$$\Delta - \Gamma(e, \psi, s_W) = \Delta - (\psi + s_W(e + \Delta - \psi))$$
$$= (\Delta - \psi)(1 - s_W) - e s_W \quad (46)$$

implying that:

$$(s_M + s_I)(e + \Delta - \psi) - e = \Delta - \Gamma(e, \psi, s_W). \quad (47)$$

Rearranging (47) slightly, we have:

$$s_M(e + \Delta - \psi) - \frac{s_M}{s_M + s_I} e = \frac{s_M}{s_M + s_I}(\Delta - \Gamma(e, \psi, s_W)) \quad (48)$$

Substituting (48) into (6), we can write the manager's payoff as:

$$\frac{s_M}{s_M + s_I} e + \frac{s_M}{s_M + s_I} F(\Gamma(e, \psi, s_W))(\Delta - \Gamma(e, \psi, s_W)) - c(e) - \theta(1 - I), \quad (49)$$

which becomes (12), using the definition of the extracted surplus $\Pi(\cdot)$ in (8). Similar substitution of (48) into (7) yields (13).

A.2 Proof of Proposition 3

For convenience in this proof, denote

$$k \equiv \frac{s_M}{s_M + s_I}.$$

Suppose a contract induces $\Gamma = \Gamma^*_{FW}$ as the outcome. Since $\Pi'(\Gamma^*) = 0$, the manager's effort level is determined by:

$$c'(e^*) = k\left(1 + \Pi'(\Gamma^*)\, s_W\right) = k, \tag{50}$$

which is independent of the workers' compensation contract $\{\psi, s_W\}$. Since k, e^*, and Γ^*_{FW} are fixed, it is easy to see that both the investors' payoff (13) and the manager's payoff in (14) are independent of the worker's compensation, proving the desired result.

A.3 Proof of Claim 1

If $s^*_M = 0$, condition (22) implies that manager's optimal effort $e^* = 0$. The payoff in ((14)) is therefore bounded by $\theta \max_\Gamma \Pi(\Gamma)$. This is implemented by granting the worker a fixed wage, and is therefore dominated by the optimal contract (19) in this case. Hence, $s^*_M > 0$ and $e^* > 0$.

Define $\kappa \equiv \frac{s_I}{s_M} \in [0, \infty)$. Condition (22) becomes

$$\frac{1}{1+\kappa}\left[1 + \Pi'\left(\Gamma\left(e^*, \psi, s_W\right)\right) s_W\right] = c'(e^*) \tag{51}$$

and the ex-ante contract design problem ((14)) can be written as

$$\max_{s_W, \psi, \kappa} \left(\frac{1-\theta}{1+\kappa} + \theta\right)\left[e^* + \Pi\left(\Gamma\left(e^*, \psi, s_W\right)\right)\right] - c(e^*). \tag{52}$$

We therefore need to show the optimal $\kappa^* > 0$.

Calculate the impact of κ on e^*, and totally differentiate (51) with respect to κ:

$$c''(e^*)\frac{\partial e^*}{\partial \kappa} = -\frac{1}{(1+\kappa)^2}\left[1 + \Pi'\left(\Gamma\left(e^*, \psi, s_W\right)\right) s_W\right] + \frac{1}{1+\kappa}\Pi''(\Gamma) s_W^2 \frac{\partial e^*}{\partial \kappa}.$$

Hence,

$$\frac{\partial e^*}{\partial \kappa} = \frac{-\frac{1}{(1+k)^2}\left[1 + \Pi'\left(\Gamma\left(e^*, \psi, s_W\right)\right) s_W\right]}{c''(e^*) - \frac{1}{1+\kappa}\Pi''(\Gamma) s_W^2} < 0.$$

At $\kappa = 0$,

$$\left|\frac{\partial e^*}{\partial \kappa}|_{\kappa=0}\right| = \frac{1 + \Pi'\left(\Gamma\left(e^*, \psi, s_W\right)\right) s_W}{c''(e^*) - \Pi''(\Gamma) s_W^2} \leq \frac{1 + \Pi'\left(\Gamma\left(e^*, \psi, s_W\right)\right)}{c''(e^*)},$$

which is bounded since $c''(e)$ is bounded away from 0 for any e.

Next, consider the impact of κ on the manager's design objective around a neighbourhood of $\kappa = 0$. Totally differentiate (52) with respect to κ:

$$-\frac{1-\theta}{(1+\kappa)^2}\left[e^* + \Pi\left(\Gamma\left(e^*, \psi, s_W\right)\right)\right] + \left[\left(\frac{1-\theta}{1+\kappa} + \theta\right)\left[1 + \Pi'\left(\Gamma\right) s_W\right] - c'\left(e^*\right)\right]\frac{\partial e^*}{\partial \kappa}.$$

Using (51) to plug in the expression for $c'(e^*)$, the total derivative becomes

$$-\frac{1-\theta}{(1+\kappa)^2}\left[e^* + \Pi\left(\Gamma\left(e^*, \psi, s_W\right)\right)\right] + \frac{\theta\kappa}{1+\kappa}\left[1 + \Pi'\left(\Gamma\right) s_W\right]\frac{\partial e^*}{\partial \kappa}.$$

Evaluating around $\kappa = 0$, the total derivative is

$$\frac{\theta-1}{(1+\kappa)^2}\left[e^* + \Pi\left(\Gamma\left(e^*, \psi, s_W\right)\right)\right] > 0.$$

Hence, a marginal increase in κ over 0 strictly improves the manager's payoff and therefore $\kappa^* > 0$.

A.4 Proof of Claim 2

A.4.1 There exists an equity-only contract $\tilde{s}_W$ which implements Γ^*_{FW}

Define $\tilde{e}$ as the unique solution to (50) in the proof of Proposition 3, which is the optimal managerial effort when workers receive Γ^*_{FW}.

By definition, $\Gamma^*_{FW} \leq \Delta$, otherwise $\Pi\left(\Gamma^*_{FW}\right) < \Pi\left(\Delta\right) = 0$, which is clearly suboptimal. Therefore, we can construct the workers' equity contract as

$$\tilde{s}_W \equiv \frac{\Gamma^*_{FW}}{\tilde{e} + \Delta} < 1 \tag{53}$$

From (5), since the fix wage is zero, total compensation for workers is

$$\Gamma = \tilde{s}_W\left(\tilde{e} + \Delta\right) = \Gamma^*_{FW}.$$

Therefore, the constructed $\tilde{s}_W$ implements Γ^*_{FW}.

A.4.2 A small deviation from $\tilde{s}_W$ to $\tilde{s}_W - \delta$ increases $\tilde{e}$

Consider a marginal reduction of $\tilde{s}_W$ in a full-equity contract. Using the definition of Γ in (5), we can rewrite the manager's effort FOC (22) in this case as:

$$c'(e) = k\left(1 + \Pi'\left(s_W\left(e + \Delta\right)\right)s_W\right) \tag{54}$$

We want to show that the solution e as a function of s_W satisfies

$$\frac{\partial e}{\partial s_W}\ |_{s_W = \tilde{s}_W} < 0.$$

To do this, we apply the implicit function theorem to (54) at the contract $\tilde{s}_W$. Defining:

$$\Lambda \equiv c'(e) - k\left(1 + \Pi'\left(s_W\left(e + \Delta\right)\right)s_W\right)$$

$$\frac{\partial \Lambda}{\partial e} = c''(e) - k s_W^2 \Pi''\left(s_W\left(e + \Delta\right)\right)$$

$$\frac{\partial \Lambda}{\partial s_W} = -\left[k\left(\Pi'\left(\tilde{s}_W\left(\tilde{e} + \Delta\right)\right) + \tilde{s}_W\left(\tilde{e} + \Delta\right)\Pi''\left(\tilde{s}_W\left(\tilde{e} + \Delta\right)\right)\right)\right]$$

where $\tilde{e}$ is defined in (50). Now, we have by assumption:

$$\Pi'\left(\tilde{s}_W\left(\tilde{e} + \Delta\right)\right) = \Pi'\left(\Gamma^*_{FW}\right) = 0$$

Thus, we have:

$$\frac{\partial e}{\partial s_W}\ |_{s_W = \tilde{s}_W} = \frac{k\tilde{s}_W\left(\tilde{e} + \Delta\right)\Pi''\left(\tilde{s}_W\left(e + \Delta\right)\right)}{c''(e) - k\tilde{s}_W^2\Pi''\left(\tilde{s}_W\left(e + \Delta\right)\right)} \tag{55}$$

Now, we assumed Π'' is everywhere negative and c'' is everywhere positive, and k, $\tilde{s}_W$ and $\tilde{e} + \Delta$ are everywhere positive, so we have shown that $\frac{\partial e}{\partial s_W}\ |_{s_W = \tilde{s}_W} < 0$.

A.4.3 A small deviation from $\tilde{s}_W$ to $\tilde{s}_W - \delta$ increases $\mathcal{M}$

Differentiating (14) with respect to s_W, we have:

$$\frac{d\mathcal{M}}{ds_W} : \left[\frac{s_M + \theta s_I}{s_M + s_I} - c'(\tilde{e})\right]\frac{\partial e}{\partial s_W} + \frac{s_M + \theta s_I}{s_M + s_I}\Pi'\left(\Gamma\left(\tilde{s}_W\right)\right)\frac{\partial \Gamma}{\partial s_W}\ |_{\Gamma = \Gamma^*_{FW}} \tag{56}$$

But, since $\Gamma\left(\tilde{s}_W\right) = \Gamma^*_{FW}$ by definition of $\tilde{s}_W$, we have $\Pi'\left(\Gamma\left(\tilde{s}_W\right)\right) = 0$, hence the second term vanishes.

In contrast, a small downwards deviation from $\tilde{s}_W$ unambiguously increases the manager surplus component of $\mathcal{M}$, because effort is always too low due to the manager's commitment problem. To see that, substituting the manager's FOC at $\tilde{s}_W$, (50), into (56), and using that $\Pi'(\Gamma(\tilde{s}_W)) = 0$, we have:

$$\frac{d\mathcal{M}}{ds_W}|_{s_W=\tilde{s}_W} = \left[\frac{s_M+\theta s_I}{s_M+s_I} - \frac{s_M}{s_M+s_I}\right]\frac{\partial e}{\partial s_W}|_{s_W=\tilde{s}_W} = \left[\frac{\theta s_I}{s_M+s_I}\right]\frac{\partial e}{\partial s_W}|_{s_W=\tilde{s}_W}$$

Clearly, $\frac{\theta s_I}{s_M+s_I} > 0$. Moreover, we showed in Appendix A.4.2 above that $\frac{\partial e}{\partial s_W}|_{s_W=\tilde{s}_W} < 0$: marginally decreasing s_W increases manager effort. Thus, we have shown that

$$\frac{d\mathcal{M}}{ds_W}|_{s_W=\tilde{s}_W} < 0$$

and that a small deviation from $\tilde{s}_W$ to $\tilde{s}_W - \delta$ increases $\mathcal{M}$.

A.5 Proof of Proposition 4

First, it is clear that the optimal $s_W^* < 1$. Otherwise, $s_W^* = 1$ implies that $s_M^* = s_I^* = 0$, contradicting Claim 1.

Second, we show $s_W^* > 0$. Otherwise, if $s_W^* = 0$, then the worker is on fixed wage contract. The optimal contract in this case is given by $\psi = \Gamma_{FW}^*$. Proposition 3 implies that this contract generates identical outcomes to the pure equity contract $\tilde{s}_W$ in Claim 2, which we showed is suboptimal. Hence, $s_W^* \in (0, 1)$.

Third, we show $\Gamma^* < \Gamma_{FW}^*$. By the same logic as above, all contracts generating $\Gamma^* = \Gamma_{FW}^*$ have identical outcomes. We next show that all contracts generating $\Gamma > \Gamma_{FW}^*$ are strictly dominated by the fixed-wage contract of $\hat{\psi} = \Gamma_{FW}^*$ and $\hat{s}_W = 0$. Consider a contract s_M, s_W, ψ that induces some $\tilde{\Gamma} > \Gamma_{FW}^*$. From (11), we know $\Pi'\left(\tilde{\Gamma}\right) < 0$.

From (14), the manager's payoff can be written as:

$$\mathcal{M} = \underbrace{\frac{s_M+\theta s_I}{s_M+s_I}e^* - c(e^*)}_{Manager\ Surplus} + \frac{s_M+\theta s_I}{s_M+s_I}\Pi(\Gamma(e^*, \psi, s_W)) \tag{57}$$

where we suppress the arguments in $e^*(s_M, s_W, \psi)$ and $\Gamma(e^*, \psi, s_W)$ for notational simplicity.

From (22) of Proposition 2, the manager's effort $\tilde{e}$ under the contract we are considering satisfies:

$$c'(\tilde{e}) = \frac{s_M}{s_M+s_I}\left(1+\Pi'\left(\tilde{\Gamma}\right)s_W\right) < \frac{s_M}{s_M+s_I} < \frac{s_M+\theta s_I}{s_M+s_I} \tag{58}$$

Now, consider $\hat{\psi} = \Gamma_{FW}^*$. Since $\Pi'(\Gamma_{FW}^*) = 0$, the manager's effort $\hat{e}$ under the new fixed-wage contract is determined by:

$$c'(\hat{e}) = \frac{s_M}{s_M + s_I} < \frac{s_M + \theta s_I}{s_M + s_I} \tag{59}$$

Comparing (58) and (59), clearly $\tilde{e} < \hat{e}$, and furthermore both are below the value of e which maximizes the manager surplus term in (57), which satisfies:

$$c'(e^*) = \frac{s_M + \theta s_I}{s_M + s_I}$$

Thus, concavity of the manager surplus term implies that the manager surplus term in (57) is higher under $\hat{e}$ than $\tilde{e}$, that is:

$$\frac{s_M + \theta s_I}{s_M + s_I}\hat{e} - c(\hat{e}) > \frac{s_M + \theta s_I}{s_M + s_I}\tilde{e} - c(\tilde{e})$$

By definition, the last term in (57) is also clearly higher under the new contract:

$$\Pi(\Gamma^*_{FW}) > \Pi\left(\tilde{\Gamma}\right)$$

Thus, both terms of (57) are higher under the new contract, and the manager strictly prefers the new contract. This completes the proof of $\Gamma^* < \Gamma^*_{FW}$ and therefore $\Pi'(\Gamma^*) > 0$.

Finally, we show $\psi^* = 0$. Suppose otherwise that $\psi^* > 0$. We shall construct another contract with $\psi^\dagger = \psi^* - \epsilon$ that generates higher payoff to the manager. In fact, we show that this contract is a Pareto improvement for both the manager and workers. As a notational convention, we denote by variables with $*$ the ones under the conjectured optimal contract and those with $\dagger$ the ones under the newly constructed contract. Define $s_W^\dagger$ such that

$$\Gamma\left(e^*, \psi^\dagger, s_W^\dagger\right) = s_W^\dagger(e^* + \Delta - \psi^* + \epsilon) + \psi^* - \epsilon = s_W^*(e^* + \Delta - \psi^*) + \psi^* = \Gamma(e^*, \psi^*, s_W^*).$$

Hence

$$s_W^\dagger = \frac{s_W^*(e^* + \Delta - \psi^*) + \epsilon}{(e^* + \Delta - \psi^* + \epsilon)} = s_W^* + \frac{(1 - s_W^*)\epsilon}{(e^* + \Delta - \psi^* + \epsilon)} > s_W^*.$$

It is possible to choose a small ϵ such that $\psi^\dagger > 0$ and $s_W^\dagger < 1$ hold. Define

$$s_M^\dagger = s_M^* \frac{1 - s_W^\dagger}{1 - s_W^*} \text{ and } s_I^\dagger = s_I^* \frac{1 - s_W^\dagger}{1 - s_W^*}$$

that maintain the equity ratio between the manager and the investor: $s_M^\dagger / s_I^\dagger = s_M^* / s_I^*$. Using the fact that $\Pi'(\Gamma(e^*, \psi^*, s_W^*)) > 0$, we have

$$\frac{s_M^\dagger}{s_M^\dagger + s_I^\dagger}\left[1 + \Pi'\left(\Gamma\left(e^*, \psi^\dagger, s_W^\dagger\right)\right) s_W^\dagger\right] = \frac{s_M^*}{s_M^* + s_I^*}\left[1 + \Pi'\left(\Gamma\left(e^*, \psi^*, s_W^*\right)\right) s_W^\dagger\right] > \frac{s_M^*}{s_M^* + s_I^*}\left[1 + \Pi'\left(\Gamma^*\right) s_W^*\right] = c'\left(e^*\right).$$

Hence, the managerial effort under † contract is higher: $e^\dagger \geq e^*$. From (22) and $\Pi' > 0$, we have

$$\frac{s_M^* + \theta s_I^*}{s_M^* + s_I^*}\left[1 + \Pi'(\Gamma^*) s_W\right] > \frac{s_M^*}{s_M^* + s_I^*}\left[1 + \Pi'(\Gamma^*) s_W\right] = c'\left(e^*\right).$$

Comparing the managerial payoff under the two contracts and using the fact that $e^\dagger > e^*$, we have

$$\frac{s_M^\dagger + \theta s_I^\dagger}{s_M^\dagger + s_I^\dagger}\left[e^\dagger + \Pi\left(\Gamma\left(e^\dagger, \psi^\dagger, s_W^\dagger\right)\right)\right] - c\left(e^\dagger\right) > \frac{s_M^* + \theta s_I^*}{s_M^* + s_I^*}\left[e^* + \Pi\left(\Gamma\left(e^*, \psi^\dagger, s_W^\dagger\right)\right)\right] - c\left(e^*\right) = \frac{s_M^* + \theta s_I^*}{s_M^* + s_I^*}\left[e^* + \Pi\left(\Gamma^*\right)\right] - c\left(e^*\right),$$

where the last equality follows from the construction of the † contract. The contradiction with optimality of the $*$ contract implies that $\psi^* = 0$.

Finally, again since $e^\dagger > e^*$, workers' payoffs also strictly increase under the † contract:

$$\Gamma\left(e^\dagger, \psi^\dagger, s_W^\dagger\right) > \Gamma\left(e^*, \psi^\dagger, s_W^\dagger\right) = \Gamma\left(e^*, \psi^*, s_W^*\right).$$

A.6 Proof of Proposition 5

First, note that, with $k \equiv \frac{s_M}{s_M + s_I}$, we have:

$$\frac{s_M + \theta s_I}{s_M + s_I} = \theta + (1 - \theta)\, k \tag{60}$$

We differentiate manager surplus $\mathcal{M}$ in (14) with respect to s_W and set to zero, holding the ratio $\frac{s_M}{s_M + s_I}$ fixed:

$$\frac{\partial}{\partial s_W} : \ \left[(\theta + (1 - \theta)\, k) - c'\left(e^*\left(k, s_W\right)\right)\right] \frac{de^*}{ds_W} + (\theta + (1 - \theta)\, k)\, \Pi'\left(\Gamma\left(e^*\left(k, s_W\right), s_W\right)\right) \frac{d\Gamma}{ds_W}$$

where, with slight abuse of notation, we use $\frac{d\Gamma}{ds_W}$ to denote:

$$\frac{d\Gamma}{ds_W} \equiv \frac{d}{ds_W}\Gamma\left(e^*\left(k, s_W\right), s_W\right)$$

This is (24). Now, using (5), note that for full-equity contracts, $\psi = 0$, we have:

$$\Gamma\left(e, s_W\right) = s_W\left(e + \Delta\right) \tag{61}$$

which implies:

$$\frac{d}{ds_W}\Gamma = \frac{d}{ds_W}\left(s_W\left(e^*\left(k, s_W\right) + \Delta\right)\right) = e^*\left(k, s_W\right) + \Delta + s_W\frac{de^*}{ds_W}$$

This is (25). Finally, we can calculate $\frac{de^*}{ds_W}$ by applying the implicit function theorem to the manager's effort FOC. Using (61), we can write (22) as:

$$\Lambda = c'\left(e\right) - \frac{s_M}{s_M + s_I}\left(1 + \Pi'\left(s_W\left(e + \Delta\right)\right)s_W\right) = 0 \tag{62}$$

We then have:

$$\frac{\partial\Lambda}{\partial e} = c''\left(e\right) - \frac{s_M}{s_M + s_I}\Pi''\left(s_W\left(e + \Delta\right)\right)s_W^2$$

$$\frac{\partial\Lambda}{\partial s_W} = -\left[k\left(\Pi'\left(s_W\left(e + \Delta\right)\right) + s_W\left(e + \Delta\right)\Pi''\left(s_W\left(e + \Delta\right)\right)\right)\right]$$

From which we get:

$$\frac{de^*}{ds_W} = \frac{k\left(\Pi'\left(s_W\left(e^*\left(k, s_W\right) + \Delta\right)\right) + s_W\left(e^*\left(k, s_W\right) + \Delta\right)\Pi''\left(s_W\left(e^*\left(k, s_W\right) + \Delta\right)\right)\right)}{c''\left(e\right) - k\Pi''\left(s_W\left(e + \Delta\right)\right)s_W^2}$$

this is (26).

A.7 Proof of Proposition 6

We differentiate manager surplus $\mathcal{M}$ in (14) with respect to k, to get:

$$\frac{\partial \mathcal{M}}{\partial k} = \underbrace{(1-\theta)\left[e^*(k, s_W) + \Pi\left(\Gamma\left(e^*(k, s_W), s_W\right)\right)\right]}_{Financing} + \underbrace{\frac{\partial e^*}{\partial k}\left[\left(\theta + (1-\theta)k\right) - c'\left(e^*(k, s_W)\right)\right]}_{Manager\ Effort} + \underbrace{\left(\theta + (1-\theta)k\right)\Pi'\left(\Gamma\left(e^*(k, s_W), s_W\right)\right)\frac{\partial \Gamma}{\partial e^*}\frac{\partial e^*}{\partial k}}_{Worker\ Profit} \tag{63}$$

where we used (60) in Appendix A.6 to express $\frac{s_M + \theta s_I}{s_M + s_I}$ in terms of k. Intuitively, (63) has 3 terms: shifting k impacts financing I, manager effort through e^*, and worker profit through Π. We can simplify slightly further by nothing that $\frac{\partial \Gamma}{\partial e^*} = s_W$, implying that the worker profit term can be written as:

$$\left(\theta + (1-\theta)k\right)\Pi'\left(\Gamma\left(e^*(k, s_W), s_W\right)\right)s_W\frac{\partial e^*}{\partial k} \tag{64}$$

We can eliminate the worker profit term in (63), intuitively, by shifting s_W together with k to hold Π fixed. Technically, this involves substituting the s_W FOC, (24) of Proposition (5), into the k FOC in (63). First, we apply the implicit function theorem to the manager's effort FOC, (62) in Appendix A.6, to calculate $\frac{de^*}{dk}$:

$$\frac{\partial \Lambda}{\partial e} = c''(e) - \frac{s_M}{s_M + s_I}\Pi''\left(s_W(e + \Delta)\right)s_W^2$$

$$\frac{\partial \Lambda}{\partial k} = 1 + \Pi'\left(s_W(e + \Delta)\right)s_W$$

Hence we have:

$$\frac{\partial e^*}{\partial k} = \frac{\frac{\partial \Lambda}{\partial k}}{\frac{\partial \Lambda}{\partial e}} = \frac{1 + \Pi'\left(s_W(e + \Delta)\right)s_W}{c''(e) - k\Pi''\left(s_W(e + \Delta)\right)s_W^2} \tag{65}$$

This gives (28). Now, note that we can write (24) of Proposition 5 as:

$$\left[\left(\theta + (1-\theta)k\right) - c'\left(e^*(k, s_W)\right)\right]\frac{\partial e^*}{\partial s_W} = - \left(\theta + (1-\theta)k\right)\Pi'\left(\Gamma\left(e^*(k, s_W), s_W\right)\right)\left(e^*(k, s_W) + \Delta + s_W\frac{\partial e^*}{\partial s_W}\right)$$

We can multiply both sides by:

$$\frac{s_W \frac{\partial e^*}{\partial k}}{e^*(k, s_W) + \Delta + s_W \frac{\partial e^*}{\partial s_W}}$$

To get:

$$\begin{aligned}(\theta + (1-\theta) k)\, \Pi' (\Gamma (e^* (k, s_W), s_W))\, s_W \frac{\partial e^*}{\partial k} = \\ - [(\theta + (1-\theta) k) - c' (e^* (k, s_W))] \frac{\partial e^*}{\partial s_W} \frac{s_W \frac{\partial e^*}{dk}}{e^*(k, s_W) + \Delta + s_W \frac{\partial e^*}{\partial s_W}}\end{aligned} \quad (66)$$

Now, the LHS of (66) is identical to the worker profit term (64) of the manager's FOC with respect to k. We can thus substitute (66) in to (63), getting:

$$\begin{aligned}\frac{\partial \mathcal{M}}{\partial k} : (1-\theta) [e^*(k, s_W) + \Pi (\Gamma (e^* (k, s_W), s_W))] + \\ \frac{\partial e^*}{\partial k} [(\theta + (1-\theta) k) - c' (e^* (k, s_W))] - \\ [(\theta + (1-\theta) k) - c' (e^* (k, s_W))] \frac{\partial e^*}{\partial s_W} \frac{s_W \frac{\partial e^*}{\partial k}}{e^*(k, s_W) + \Delta + s_W \frac{de^*}{ds_W}}\end{aligned}$$

This allows us to group the last two terms, into:

$$\begin{aligned}\frac{\partial \mathcal{M}}{\partial k} : (1-\theta) [e^*(k, s_W) + \Pi (\Gamma (e^* (k, s_W), s_W))] + \\ [(\theta + (1-\theta) k) - c' (e^* (k, s_W))] \left[\frac{\partial e^*}{\partial k} - \frac{\partial e^*}{\partial s_W} \frac{s_W \frac{\partial e^*}{\partial k}}{e^*(k, s_W) + \Delta + s_W \frac{de^*}{ds_W}} \right]\end{aligned}$$

This gives (27).

A.8 Proof of Claim 5

The optimal effort is given by (39) is straightforwardly calculated from the first order condition

$$e_i^* = s_i.$$

Therefore the design objective (38) becomes

$$\max_{s_i} s_0 + \frac{\sum_{i=1}^N s_i}{N} - \frac{1}{2} (s_0)^2 - \frac{1}{2N} \sum_{i=1}^N s_i^2.$$

subject to (40). Denote by $\frac{\lambda}{N}$ the Lagrangian multiplier on this constraint. First order conditions with respect to s_i are as follows:

$$N - Ns_0^* - \lambda = 0$$

and

$$1 - s_i^* - \lambda = 0.$$

Hence, $s_i^* = 1 - \lambda$ and $s_0^* = 1 - \frac{\lambda}{N}$. Plugging into the constraint (40) yields

$$N - N\lambda + 1 - \frac{\lambda}{N} = 1.$$

Solve for λ:

$$\lambda = \frac{N}{N + \frac{1}{N}}.$$

Hence, $s_0^* = 1 - \frac{1}{N+\frac{1}{N}}$ and $s_i^* = \frac{\frac{1}{N}}{N+\frac{1}{N}}$.