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Board Compensation and Investment Efficiency

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Abstract:
In their role as initiators of new business projects, CEOs have an advantage over access to and control over project-related information. This exacerbates pre-existing agency frictions and may lead to investment inefficiencies. To counteract this challenge, incentive compensation for corporate boards (responsible for approving major projects) emerges as a critical governance tool. Our study demonstrates that the optimal compensation design requires strategically allocating a liability burden between CEOs and boards. When this burden is shifted onto the boards, shareholders reduce management rents, albeit at the expense of residual inefficiency. Our findings thus highlight that shareholders' tolerance for investment inefficiencies may be rooted in optimal compensation. We predict that contracts tolerating excessive investments are optimal under conditions of low labor market value for CEOs, severe CEO empire-building, and attractive outside options for directors. Because of structural changes associated with the reallocation of financial incentives, the non-financial characteristics of CEOs and boards may impact investment efficiency, information quality, project profits, and management rents in a non-monotonic manner.

JEL: D83, D86, G30, G31, G34
Keywords: Board monitoring, director compensation, investment inefficiency

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1 Introduction

Due to their lead role in adopting new business opportunities and projects, Chief Executive Officers (CEOs) have an advantage in accessing project-related information. Thus, CEOs may wield control over the information, exacerbating pre-existing agency frictions (such as empire-building) and giving rise to inefficient investments. One of the governance tools available to counteract this challenge is an optimally designed incentive compensation. In addition to contracting with CEOs, the shareholders also contract with their corporate boards of directors, which are often tasked with project approval (Useem 2006). This study delves into the interplay between executive and board contracts and finds that the optimal compensation structure involves strategically allocating a liability burden between CEOs and boards. That is, financial incentives for CEOs and for boards are substitutes. Our findings underscore that when the liability burden is shifted onto the boards, shareholders reduce management rents. However, this benefit comes at a cost—the shareholders pay the price of residual inefficiency. Essentially, the optimal compensation balances between diminishing management rents and tolerating residual inefficiency. By shedding light on this trade-off, our research provides insights into shareholders' willingness to tolerate investment inefficiency. This tolerance is not merely a byproduct of agency frictions but is, in fact, a consequence of the optimally constructed board compensation that navigates these frictions.

We consider a setting where a board of directors approves or rejects an investment opportunity presented by an empire-building CEO. The CEO tends to overinvest due to private perks (Arikan and Stulz 2016; Décaire and Sosyura 2022) and communicates a strategically constructed but credible signal about the investment project—e.g., an estimate of the probability of project success—to the board. The board has non-financial—e.g., career or reputation—incentives: it incurs a private cost when the approved project destroys company value and earns a private benefit when it enhances the value. The CEO and the board have outside labor market options and are protected by limited liability.

We find that the optimal contracts address overinvestment—arising due to imperfect precision of the CEO's signal and the board's willingness to approve projects with imprecise information—either *directly* or *indirectly*. The direct way is to incentivize the CEO to produce precise information, and the indirect way is to make the board more prudent and willing to approve only if the information is sufficiently precise (Gregor and Michaeli, 2022). With limited liability, both direct and indirect ways address overinvestment by rewarding the status quo through a large base compensation and a financial penalty for project failure (i.e., a concave-like compensation).

The key implication of offering large base compensations is that the incentivized players earn rents (a share of project profits). Additionally, the direct and indirect ways to mitigate investment inefficiency are not used jointly in the optimum: that is, financial incentives for CEOs' production of project information and for directors' project decisions are *substitutes*. The shareholders' core contracting decision then can be presented as a decision on which player deserves financial incentives or, equivalently, which player should bear the burden of penalty for failure. When making this choice, the shareholders compare total project profits and players' rents. A tradeoff arises whereby the shareholders choose between: (i) high project profits (due to higher information precision and associated investment efficiency) and high rents—this outcome is associated with rewards provided only to the CEO while the board receives a fixed pay; and (ii) low project profits (due to lower information precision and associated overinvestment inefficiency) and low rents—this outcome is associated with rewards provided only to the board while the CEO receives a fixed pay. We find that the shareholders sacrifice project profits to pay lower rents (i.e., choose the second option) when the CEO's empire-building is severe, the CEO's outside labor market value is low, the directors' outside options are attractive and their non-financial incentives associated with the investment failure are strong. In these situations, eliminating the CEO's bias directly is too costly to the shareholders and they are willing to tolerate excessive investments instead.

In our model, the shareholders' problem is to allocate incentives across players (i.e., choose between the two options described above). We find that changes in the players' non-financial characteristics leading to a switch from one of the above options to the other often have an opposite effect compared with the effect these changes have when there is no switch. As a result, changes in CEOs' and boards' characteristics may affect information quality, rents and company profits in a non-monotonic manner.

We extend our results by considering a case where the board's characteristics can be modified incrementally, e.g., if the terms of non-executive directors are staggered or when CEOs partially influence board composition. Then, the shareholders—focused on maximizing company value from investment opportunities—optimally *reinforce* the non-financial characteristics that are already dominant among directors. Our analysis thus can be interpreted as shareholders preferring boards with homogenous (unbalanced) non-financial benefits over boards with diverse (balanced) non-financial benefits.

Our paper contributes to the literature on career concerns. A growing stream of empirical work documents that directors' reputation for high-quality monitoring is rewarded with outside directorships (which bring additional compensation, prestige, and experience) and lower regulatory sanctions in case of company fraud (Jiang, Wan, and Zhao 2016). Career concerns are found to be high for young directors, directors with high media exposure, and companies with high market capitalization (Masulis and Mobbs 2014). Early work suggests that career-concerned directors do not receive performance-sensitive compensation as it dilutes the credibility of their reputation (Fama and Jensen 1983). Related, our model predicts that financial compensation and non-financial characteristics are substitutes as they both incentivize more prudent investment decisions. In addition, as the shareholders jointly choose the contracts of CEOs and boards ("say-on-pay"), we also identify a cross-effect of the boards' career concerns on executive compensation due to the substitution of financial incentives of CEOs with those of boards. Notably, in our model this cross-effect may eventually increase the shareholders' willingness to financially compensate directors.

The preceding discussion implies that our paper also speaks to the CEO-director compensation nexus. Most of the empirical literature accounts for firm fixed effects and establishes the link from the residual variation; the observed association therefore includes unobserved time-varying firm effects—such as project nature—that introduce a positive bias. Hence, the CEOs' and the boards' compensation levels are positively correlated. Interestingly, this association is stronger with greater CEOs' control and power, manifested either in the co-optation of the directors by the CEOs (Coles, Daniel and Naveen 2014), the CEO-chairman duality (Fedaseyeu, Linck and Wagner 2018), the low extent of monitoring by institutional investors (Chen, Goergen, Leung and Song 2019), or the excessive use or related-party transactions (Hope, Lu and Saiy 2019). In contrast, our substitution result depends on the assumption that contracts are optimal for the shareholders. Particularly, we show that (i) the optimal contracting view clearly predicts substitution (negative conditional correlation), whereas (ii) the managerial power view clearly predicts complementarity (positive conditional correlation). Therefore, our model provides an empirically clean test of which view—managerial power or optimal contracting—is more relevant in a particular context.

We also contribute to the literature that documents how boards' total compensation reflects directors' characteristics, such as financial expertise, legal and consulting expertise, academic qualifications, management experience, and directors' skill set (e.g., Field and Mkrtchyan 2017; Adams, Akyol and Verwijmeren 2018; Fedaseyeu, Linck, and Wagner 2018; Erel, Stern and Tan 2021). We show that the shareholders find it optimal to allocate financial incentives primarily to directors with high outside options and, thus, more likely to allocate rents to initially valuable non-executive directors. This mechanism reinforces the initial advantages that directors have on the labor market.

Our paper focuses exclusively on how shareholders alleviate overinvestment. Thus, our perspective is orthogonal to multi-tasking (Göx and Hemmer 2021); project implementation with moral hazard (Drymiotes 2007; Drymiotes and Sivaramakrishnan 2012; Jiang and Laux 2024); project selection with moral hazard (Laux and Mittendorf 2011); CEO's earnings manipulation and the separation of board audit and compensation functions (Laux and Laux 2009); effect of executive compensation on the different board roles (Chen, Guay and Lambert 2022); accounting conservatism and CEOs' incentives to innovate (Laux and Ray 2020). Given an exogenous project type, we do not address the role of CEOs' incentives at the project selection stage, e.g., when project selection signals CEOs' quality (Dominguez-Martinez, Swank and Visser 2008) or when CEOs have to search for an investment opportunity (Feng, Luo and Michaeli 2024).

In Baldenius, Meng, and Qiu (2019), boards are offered linear contracts and CEOs can misrepresent their exogenously given information at no cost (cheap talk)—this results in financial and non-financial incentives being complements. In contrast, we find that when contracts can be non-linear and CEOs endogenously collect information, financial and non-financial incentives are typically substitutes; complementarity arises only if it is optimal to reallocate financial incentives between the CEO and the board. Our extension with delegated contracting is related to Drymiotes and Sivaramakrishnan (2012) and Qiu (2019). Drymiotes and Sivaramakrishnan (2012) find that the board's dependence on the CEO has an ambiguous effect on its monitoring and contracting roles. In Qiu (2019), the board pursues a "quiet life" and grants the CEO a large equity stake to reduce the pressure to engage in costly monitoring. Our results on the structure of the CEO's outcome-contingent (concave-like) compensation add to the recently observed adverse role of (convex-like) options provided to management (Laux 2014; Shue and Townsend 2017;

Liu, Masulis and Steinfeld 2021).

Lastly, we provide a novel perspective on the CEO-board interactions that combines persuasion and optimal contracting (Göx and Michaeli 2019). The persuasion perspective on CEO-board interactions is built around the idea that with the proliferation of data analytic techniques and rich underlying data (both internal and external), the management is better off selecting a (credible) signaling technology instead of leaving information transmission to soft communication (Gregor and Michaeli 2022). Therefore, with the increase in analytical technologies, the board's advisory role becomes less important, and the board's monitoring assumes a more central role (Faleye, Hoitash, and Hoitash 2011). In the extreme, the advisory role is fully eliminated by the CEO's unrestricted and costless access to information.

2 Model

The model entails a firm's CEO (referred to as "she"), board of directors, and shareholders. The CEO proposes an investment opportunity ("project") to the board for approval. The project requires an upfront investment normalized to one and can be successfully implemented only if an exogenous event, $\omega \in \{0, 1\}$, is realized (e.g., governmental adoption of subsidy policy, regulatory change, availability of natural resources). In case of success ($\omega = 1$), the project yields a known return of $r > 0$. In case of failure ($\omega = 0$), the firm loses the investment.

Information structure. The players share a common prior belief $\mu := \Pr(\omega = 1) > 0$ about the realization of the exogenous event. The CEO obtains a signal (e.g., seeks expert opinion) about ω. Since the board's decision is binary—approve or reject the project—it is sufficient to consider a binary signal with high and low realizations, $s \in \{h, l\}$.[1] The signal can be characterized either by the probabilities of the realizations,

[1] Any other signal structure yields a weakly lower payoff to the CEO. Proof is available upon request.

(p_l, p_h), where $p_s := \Pr(s)$ or, equivalently, by the induced posterior beliefs, (μ_l, μ_h), where $\mu_s := \Pr(\omega = 1 \mid s)$ and $\mu_l \leq \mu \leq \mu_h$. The two characterizations are linked by the martingale property, which is $p_l\mu_l + p_h\mu_h = \mu$ for a binary state space.[2] Subject to the martingale constraint, the CEO chooses the properties of the signal (e.g., chooses an expert). In line with the setting we have in mind and the Bayesian persuasion literature, the signal properties are observable (e.g., expert qualification is known), and the signal realization is verifiable (e.g., written expert opinion is available within the company and can be requested by the board).[3]

Contracts and financial incentives. In line with recent "say-on-pay" regulations we assume that the shareholders offer contracts to the CEO and the board. In Appendix A, we show that our results do not change if the shareholders contract with the board and the latter contracts with the CEO. As frequently observed in practice, the contracts cannot depend on the properties and realizations of the signal (e.g., the CEO's contract can not specify the expert that she seeks advice from in the future and cannot depend on a future expert opinion) but can depend on the project outcome. In our setting, there are three possible outcomes: the project is rejected (indexed by "$\varnothing$"), the project is approved but fails (indexed by "0" since $\omega = 0$), and the project is approved and succeeds (indexed by "1" since $\omega = 1$). The CEO's outcome-contingent wage is $(x_0, x_\varnothing, x_1)$ and that of the board is $(y_0, y_\varnothing, y_1)$. We refer to $x_\varnothing$ and $y_\varnothing$ as base wages, to $x_\varnothing - x_0$ and $y_\varnothing - y_0$ as penalties for project failure, and to $x_1 - x_\varnothing$ and $y_1 - y_\varnothing$ as bonuses for project success. The wages are monotonic in the outcome, $0 \leq x_0 \leq x_\varnothing \leq x_1$ and $0 \leq y_0 \leq y_\varnothing \leq y_1$. The non-negativity constraint means that the players are protected by limited liability. Appendix B shows that our results qualitatively hold if we allow for non-monotonic wages.

[2]One can easily derive the probability that the signal is s conditional on the state ω from (p_l, p_h) and (μ_l, μ_h) using Bayes rule, $\Pr(s \mid \omega) = \frac{\Pr(\omega|s)\Pr(s)}{\Pr(\omega)}$. For instance, $\Pr(s = h \mid \omega = 1) = \frac{\mu_h p_h}{\mu}$.

[3]As in Gregor and Michaeli (2022), allowing the CEO to withhold the signal or misrepresent it does not change the results qualitatively. In our model, the board does not gather information. As in Gregor and Michaeli (2022), if this assumption is relaxed, the CEO adjusts the properties of the signal just enough to discourage the board from learning—thus, our main results remain qualitatively similar.

Non-financial incentives. In addition to their wages, the players have outcome-contingent non-financial incentives. Specifically, the CEO is an empire-builder whose non-financial perks from project approval exceed those from rejection, $c_\varnothing < c_0 \le c_1$. The board receives a non-financial (e.g., reputation) benefit b_1 from a project success and a disutility b_0 from project failure, with $b_0 < b_\varnothing < b_1$. We normalize $(c_\varnothing, b_\varnothing) = (0, 0)$ and adopt two additional assumptions: $\frac{-b_0}{b_1 - b_0} > \mu$ and $b_0 + c_0 < 1$. The former avoids the trivial case where the prior belief is sufficiently optimistic, so the board is willing to approve the project outright. The latter implies that non-financial incentives are smaller than the investment cost.

Payoffs and outside options. Given the financial and non-financial incentives specified above, we can summarize the ex-post payoff of the CEO as

$$u = \begin{cases} u_0 = x_0 + c_0, & \text{if the project is approved and fails;} \\ u_\varnothing = x_\varnothing + c_\varnothing = x_\varnothing, & \text{if the project is rejected;} \\ u_1 = x_1 + c_1, & \text{if the project is approved and succeeds;} \end{cases} \tag{1}$$

and that of the board as

$$v = \begin{cases} v_0 = y_0 + b_0, & \text{if the project is approved and fails;} \\ v_\varnothing = v_\varnothing + b_\varnothing = y_\varnothing, & \text{if the project is rejected;} \\ v_1 = y_1 + b_1, & \text{if the project is approved and succeeds.} \end{cases} \tag{2}$$

The players' expected payoffs are $U = \mathbb{E}[u]$ and $V = \mathbb{E}[v]$, while their reservation utilities (referred to as "outside options" or "labor market values") are $\underline{U}$ and $\underline{V}$, respectively. The outside options are sufficiently attractive, $\underline{U} > (1-\mu)c_0 + \mu c_1$ and $\underline{V} > \mu b_1$, so that, without monetary compensation, the CEO and the board would not accept the contract under any circumstances (i.e., under any signal conveyed to the board). The

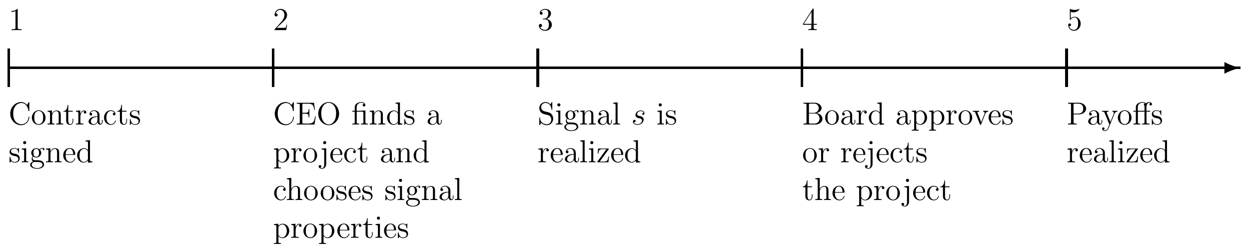


Figure 1: Timeline of the events

expected payoff of the shareholders is denoted S, and the total value for all players is $W = S + U + V$. The shareholders' outside option is normalized to zero.

CEO's types and regimes. Based on her total (financial and non-financial) payoffs, the CEO is either "normal" or "empire-builder." We say that the CEO is normal if $u_1 \geq u_\varnothing \geq u_0 \iff x_1 + c_1 \geq x_\varnothing \geq x_0 + c_0$, i.e., if her ex-post payoff (weakly) increases when the project is approved and succeeds and (weakly) decreases when the project is approved and fails. The CEO is an empire-builder when $u_\varnothing < \min\{u_0, u_1\} \iff x_\varnothing < \min\{x_1 + c_1, x_0 + c_0\}$, i.e., if her ex-post payoff increases when the project is approved, regardless of the success. Board type is defined analogously, but with a monotonic wage, the board is always normal. Throughout the analysis, we therefore differentiate between two *regimes*: under "A-regime" both players are normal (have aligned interests) and under "M-regime" the CEO is an empire-builder and the board is normal (have misaligned interests). Precisely speaking, regimes are sets of feasible pairs of (outcome-contingent) wages that induce players' types as defined above.

Timeline. Figure 1 illustrates the timeline of events. At date 1, the shareholders offer contracts to the CEO and the board. At date 2, the CEO finds a project that yields r with probability μ and chooses the properties of a signal about the project success. At date 3, the CEO's signal is realized and observed by the board. At date 4, the board approves or rejects the project. At date 5, the payoffs are realized. We restrict attention to weakly undominated strategies to avoid miscoordination on a Pareto-dominated equilibrium (which occurs when each player expects that the other player rejects the contract, and therefore both reject the contract).

3 Preliminaries

3.1 Board's Approval

At date 5, after observing the CEO's signal, the board approves the project if and only if its post-signal expected payoff from approval exceeds that from rejection,

$$
\begin{aligned}
& \mu_s \cdot v_1 + (1-\mu_s) \cdot v_0 \geq v_\varnothing \\
\Leftrightarrow \quad & \mu_s \geq \tau := \frac{v_\varnothing - v_0}{v_1 - v_0} = \frac{v_\varnothing - v_0}{(v_\varnothing - v_0) + (v_1 - v_\varnothing)} = \frac{y_\varnothing - (y_0 + b_0)}{y_\varnothing - (y_0 + b_0) + (y_1 + b_1) - y_\varnothing}.
\end{aligned}
$$

That is, the board approves if and only if its posterior (post-signal) belief about project success, μ_s, exceeds a threshold τ that depends on the relative magnitude of the board's (financial and non-financial) loss from approving a failing project, $v_\varnothing - v_0 = y_\varnothing - (y_0 + b_0)$, and the gain from approving a successful project, $v_1 - v_\varnothing = (y_1 + b_1) - y_\varnothing$. It holds that $\tau \in (0, 1)$ because the board is normal, its wage is monotonic, and $b_0 < 0 < b_1$. The threshold can be interpreted as the extent to which the board is prudent when approving the project—thus, we refer to it as the board's "prudence."

3.2 CEO's Signal

We next consider the CEO's choice of signal properties at date 3. Because the CEO's preferences over outcomes are regime-specific (i.e., depend on whether we are under the A-regime or under the M-regime), her choice of signal properties is also regime-specific.

A-regime. Under this regime, the preferences of the CEO and the board are aligned—they both want unprofitable projects to be rejected and profitable ones to be approved. Therefore, in a weakly undominated equilibrium under the A-regime, the CEO chooses a perfectly informative signal structure,

$$(\mu_l^A, \mu_h^A) = (0, 1).$$

The board approves the project after a high signal (with frequency μ) and rejects it after a low signal (with frequency $1 - \mu$).

M-regime. Under this regime, the empire-building CEO seeks to maximize the probability that the project is approved. This happens when the chances for a high signal are maximized, subject to the posterior belief being sufficiently high to warrant board approval (and the signal being Bayes-plausible). The solution to this classic persuasion problem is to send a binary signal that is a lottery over posteriors such that:

$$(\mu_l^M, \mu_h^M) = (0, \tau).$$

Particularly, it is optimal to set the probability for success conditional on low signal, μ_l, at zero, and the probability conditional on high signal, μ_h, precisely at the board's prudence τ. Any $\mu_h < \tau$ would lead to project rejection; any $\mu_h > \tau$ would make the CEO worse off since the chances of board approval are lower. Put differently, the signal properties are such that the posterior belief after a high signal is optimally adjusted to the board's prudence—just high enough for the board to approve the project.[4] The board again approves the project after a high signal (but in contrast to the A-regime with a

[4] Our maintained assumption is that μ is sufficiently low so that the expected values of the project and the board's non-financial benefit are negative. This implies that $\tau > \mu$ and, therefore, the constraint $\mu_h > \mu$ is always satisfied. If any of the two above-mentioned expected values were positive, we might obtain $\tau < \mu$. Then, the constraint $\mu_h \geq \mu$ is binding, and the CEO sends a binary signal with $(0, \max\{\mu, \tau\})$. This flattens the effect of wages on the quality of information but does not change our main results.

higher frequency $\frac{\mu}{\tau} > \mu$) and rejects it after a low signal (now with frequency $1 - \frac{\mu}{\tau}$).

Information quality and board prudence. Under both regimes (A-regime and M-regime), $\mu_l = 0$. Thus, the information quality of the signal is characterized only by μ_h, and we refer to it as the *precision* (quality) of the signal. When interests are misaligned (M-regime), there is a one-to-one mapping between board's prudence and CEO's quality of information. When interests are aligned (A-regime), the board's prudence is irrelevant.

3.3 Maximum Total Value

From the analysis in Section 3.1 and Section 3.2 it follows that the project is undertaken only after a high signal. Taking into account that any financial incentives are simply a transfer between the shareholders and the board or the CEO, the total value boils down to $W = S + U + V = p_h[(1-\mu_h)(b_0 + c_0 - 1) + \mu_h(r + b_1 + c_1)]$. Since $b_0 + c_0 - 1 < 0$, it is straightforward to see that W is increasing in the signal precision so that the maximum achievable total value is at $\mu_h = 1$ and reads $\overline{W} := \mu(r + b_1 + c_1)$. It contains project return and players' non-financial benefits in the event of project success.

3.4 Procedure for Deriving Optimal Contracts

The solution to the shareholders' contracting problem is found in two steps. First, we derive the contracts that are optimal under each regime ("regime-optimal" or "regime-specific" contracts) and then consider the shareholders' preference over the regimes (i.e., preference over outcomes induced by the regime-specific contracts).

Step 1: Regime-optimal contracts. The expected payoffs induced in regime $k \in \{A, M\}$ with regime-optimal contracts are denoted U^k, V^k, S^k and W^k. For any regime and player, we construct the regime-optimal contract by employing another two-step procedure. First, we find the shareholders' payoff-maximizing (least costly) contract that complies with the players' regime-specific incentive constraints (e.g., those related to the player's type) but not necessarily with the players' participation constraints. The players' expected payoffs associated with this contract, $\underline{U}^k$ and $\underline{V}^k$, can be interpreted as the minimum payoffs that ensure regime existence. Second, we consider the participation constraint of each player. If the participation constraint is satisfied with the contract identified in the first step ($\underline{U}^k \geq \underline{U}$, respectively $\underline{V}^k \geq \underline{V}$), the contract is regime-optimal and that player receives a rent ($R_C^k = \underline{U}^k - \underline{U}$, respectively $R_B^k = \underline{V}^k - \underline{V}$). If the participation constraint is not satisfied with that contract ($\underline{U}^k < \underline{U}$, respectively $\underline{V}^k < \underline{V}$), a more attractive contract is offered.[5] In such case, the participation constraint binds and the player earns zero rent. To summarize, under the regime-optimal contracts the players' expected payoffs are

$$(U^k, V^k) = \left(\max\{\underline{U}^k, \underline{U}\}, \max\{\underline{V}^k, \underline{V}\}\right).$$

Step 2: Regime choice. The shareholders' regime choice maximizes

$$S^k = W^k - U^k - V^k = W^k - R_C^k - R_B^k - \underline{U} - \underline{V}$$

over $k \in \{A, M\}$ and depends on how the outcomes generated by the regime-specific contracts compare in two dimensions: the total value W and the players' rents.

4 Optimal Contracts

4.1 A-Regime Contracts

Our preliminary analysis in Section 3.2 illustrated that the A-regime is associated with perfect information quality, $(\mu_h, \mu_l) = (1, 0)$, and thereby generates the maximum total value $\overline{W}$ defined in Section 3.3. As a result, the shareholders' contracting problem boils

[5] Given that wage is not restricted from above, this is always possible without violating incentive constraints.

down to minimizing the players' rents.

Proposition 1 (Optimal A-regime)**.** *The optimal A-regime contract with the CEO involves liability for project failure and zero bonus for project success,*

$$x_0^A = 0 < x_\varnothing^A = x_1^A = c_0 + \max\{0, \underline{U} - \underline{U}^A\},$$

where $\underline{U}^A = c_0 + \mu c_1$ *is the minimum CEO's payoff out of all feasible contracts that ensure CEO's normality. The optimal A-regime contract with the board involves zero liability for project failure and zero bonus for project success,*

$$y_0^A = y_\varnothing^A = y_1^A = \underline{V} - \mu b_1.$$

The CEO's expected payoff is $U^A = \max\{\underline{U}^A, \underline{U}\}$ *and that of the board is* $V^A = \underline{V}$*.*

To summarize, under the A-regime it is optimal to offer a concave-like compensation (financial liability but no bonus) to the CEO and a fixed wage to the board. The board earns no rents, the CEO earns a rent $R_C^A = \max\{0, c_0 + \mu c_1 - \underline{U}\}$, and the shareholders' payoff is $S^A = \overline{W} - \underline{U} - \underline{V} - R_C^A$. The shareholders fail to extract the maximum project surplus under the A-regime only when incentivizing the CEO's alignment generates a positive CEO's rent.

4.2 M-Regime Contracts

The signal precision under the M-regime, represented by the properties $(\mu_l, \mu_h) = (0, \tau)$, is imperfect. We proceed in two steps. First, we fix the board's prudence τ (this is equivalent to fixing the information precision at τ) and seek contracts that minimize rents conditional on τ. We call these contracts τ-*specific* M-regime contracts. Second, we choose the τ-specific M-regime contracts that yield the highest shareholder value; these contracts are regime-optimal.

To find τ-specific M-regime contracts, we employ the procedure outlined in Section 3.4: we first derive the least costly contracts that satisfy all—but participation—constraints of the players and obtain the minimized payoffs $\underline{U}_\tau^M$ and $\underline{V}_\tau^M$. Then we check whether the participation constraints are satisfied and offer more attractive contracts if necessary. The resulting payoffs are U_τ^M and V_τ^M.

Lemma 1 (τ-specific M-regime)**.** *The M-regime contract with the CEO for a fixed τ involves zero liability for project failure and zero bonus for project success,*

$$x_{\tau,0}^M = x_{\tau,\varnothing}^M = x_{\tau,1}^M = \underline{U} - \underline{U}_\tau^M,$$

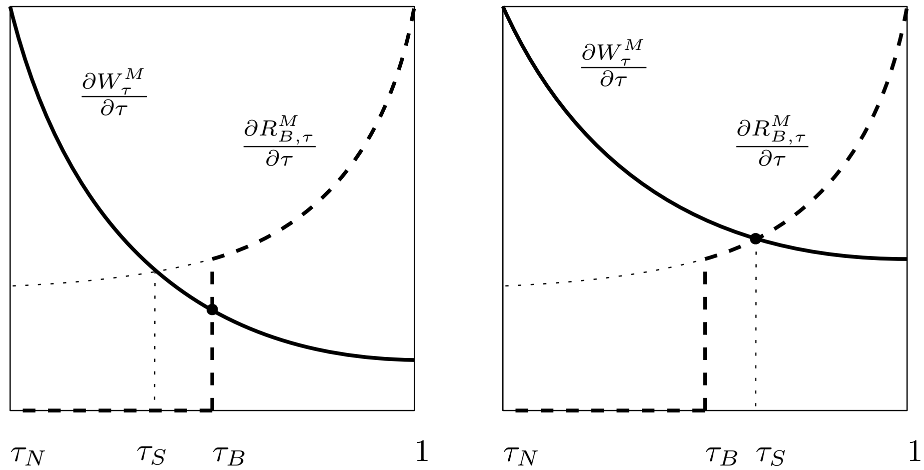
where $\underline{U}_\tau^M = \mu\frac{1-\tau}{\tau}c_0 + \mu c_1$ is the CEO's expected non-financial benefit when signal precision is τ. The τ-specific M-regime contract with the board involves positive liability for project failure and zero bonus for project success,

$$y_{\tau,0}^M = \max\{0, \underline{V} - \underline{V}_\tau^M\} < y_{\tau,\varnothing}^M = y_{\tau,1}^M = \max\{\underline{V}_\tau^M, \underline{V}\},$$

where $\underline{V}_\tau^M = b_0 + \frac{\tau}{1-\tau}b_1$ is the minimum board's payoff out of all feasible contracts that achieve a board's prudence τ. The CEO's expected payoff is $U_\tau^M = \underline{U}$, and the board's expected payoff is $V_\tau^M = \max\{\underline{V}_\tau^M, \underline{V}\}$.

To summarize, under τ-specific M-regime contracts, it is optimal to offer a fixed wage to the CEO and concave-like compensation (financial liability but no bonus) to the board. The CEO earns no rents and the board earns $R_B^M = \max\{0, b_0 + \frac{\tau}{1-\tau}b_1 - \underline{V}\}$.

Once τ-specific M-regime contracts (and values induced by these contracts) are known, we can proceed with the identification of the optimal prudence (equivalently, precision) from shareholders' perspective under the M-regime, denoted τ_M. With an increase in board's prudence (and a corresponding increase in signal precision), there are two effects on the shareholders' payoff $S_\tau^M = W_\tau^M - \underline{U} - \underline{V} - R_{B,\tau}^M$: (i) a positive effect due to increase



(a) Corner optimum ($\tau_M = \tau_B$) (b) Interior optimum ($\tau_M = \tau_S$)

Figure 2: Optimal prudence (and precision) under the M-regime
Here, τ_N is the prudence under zero board's wage. In the Proof of Lemma 1, we show that it is sufficient to study only $\tau \geq \tau_N$.

in the total value, and (ii) a weakly negative effect due to increase in the board's rent.

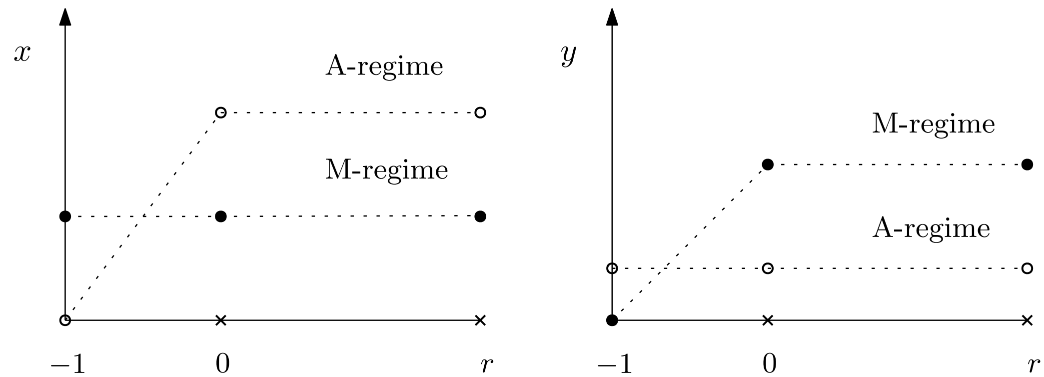
The marginal effect on the total value, $\frac{\partial W_\tau^M}{\partial \tau}$, is continuous, whereas the marginal effect on the board's rent, $\frac{\partial R_{B,\tau}^M}{\partial \tau}$, is potentially *discontinuous* due to a kink in the rent function. This gives rise to two possible types of optima: Corner optimum τ_B is located at the kink of the rent function $R_{B,\tau}^M$ and interior optimum τ_S is located where the two marginal effects cancel out, $\frac{\partial W_\tau^M}{\partial \tau} = \frac{\partial R_{B,\tau}^M}{\partial \tau}$. Figure 2 illustrates these optima.

Lemma 2 (Optimal prudence under the M-regime)**.** *The optimal board's prudence (and resulting signal precision) under the M-regime is* $\tau_M = \max\{\tau_B, \tau_S\} < 1$, *where*

$$(\tau_B, \tau_S) := \left(\frac{\underline{V} - b_0}{\underline{V} - b_0 + b_1}, \sqrt{\frac{1 - c_0 - b_0}{1 - c_0 - b_0 + \frac{b_1}{\mu}}} \right).$$

The optimal M-regime contracts easily follow from the results of Lemma 1 and Lemma 2:

Proposition 2 (Optimal M-regime)**.** *The optimal M-regime contracts with the CEO and the board are the contracts in Lemma 1 for* $\tau = \tau_M = \max\{\tau_B, \tau_S\}$, *where* τ_B *and* τ_S *are given in Lemma 2. In the optimum, the board's rent is positive if and only if* $\tau_S > \tau_B$.



(a) CEO's contract (b) Board's contract

Figure 3: Regime-optimal contracts

4.3 Regime Choice

Before proceeding, it is useful to summarize the key properties of the optimal regime-specific contracts as reflected in Proposition 1 and Proposition 2. First, bonuses are never offered. Intuitively, bonuses for success (convex-like compensation) encourage the approval of risky projects, but because the key distortion is overinvestment, generating this risk-taking incentive is either undesirable or irrelevant. Second, the optimal regime-specific contracts impose liability for failure (concave-like compensation) *only on one of the players*, making this player "central" for alleviating overinvestment. The CEO is central under the A-regime, and the board is central under the M-regime. Figure 3 graphically illustrates these properties of the regime-specific contracts.

We next analyze the shareholders' regime choice. The margin from selecting the optimal A-regime contracts instead of the optimal M-regime contracts is

$$S^A - S^M = W^A - W^M - R_C^A + R_B^M = \mu\tfrac{1-\tau_M}{\tau_M}(1 - c_0 - b_0) - R_C^A + R_B^M,$$

where $R_C^A = \max\{c_0 + \mu c_1 - \underline{U}, 0\}$ and $R_B^M = \max\{b_0 + \frac{\tau_M}{1-\tau_M} b_1 - \underline{V}, 0\}$. In the parametrical subspace for which the regime choice between the optimal A-regime and the optimal M-regime is relevant, the CEO earns rent, $R_C^A > 0$,[6] whereas the board may or may not earn rent, $R_B^M \geq 0$.

Proposition 3 (Regime choice)**.** *The shareholders implement the optimal M-regime if and only if* $\mu\frac{1-\tau_M}{\tau_M}(1-c_0-b_0) - \max\{c_0+\mu c_1-\underline{U}, 0\} + \max\{b_0+\frac{\tau_M}{1-\tau_M}b_1-\underline{V}, 0\} < 0$, *where* $\tau_M = \max\left\{\frac{\underline{V}-b_0}{\underline{V}-b_0+b_1}, \sqrt{\frac{1-c_0-b_0}{1-c_0-b_0+\frac{b_1}{\mu}}}\right\}$. *Allowing misalignment of the CEO (implementing the M-regime) is weakly more attractive to the shareholders if* $\underline{U}$, b_0 *or* b_1 *are low, and if* $\underline{V}$, c_0 *or* c_1 *are high.*

Two stylized implications arise: (i) Low CEO's labor market value and high CEO's empire-building concerns motivate the shareholders to allow CEO's objective to be misaligned with the company and the board (in the equilibrium, this leads to lower information precision and a subsequent overinvestment). (ii) High directors' labor market value and high incentives to avoid project failures motivate the shareholders to reallocate financial incentives from the CEO to the board. This, again, reduces the alignment between the CEO and the board.

Our results imply that financial incentives (and consequently also rents) are allocated either to the CEO or to the board. Put differently, when designing optimal contracts, the shareholders seek the less costly way to fix the agency problem of excessive investments. To that end, they select a central player to whom financial incentives (and possibly also rents) are offered. When choosing the central player, the shareholders consider two dimensions. The first dimension is the players' non-financial incentives: a player with less disruptive or otherwise more valuable non-financial incentives is more likely to become central (i.e., a CEO with a lower empire-building bias or directors with a higher interest in avoiding project failure). The second dimension is labor market value: a player with a higher labor market value is more likely to become central.[7] Our results can be

[6] To see why, suppose this is not the case, i.e., $R_C^A = 0$. Then, using $\tau_M < 1$ and $W^M < \overline{W}$, we see that $S^A = \overline{W} - \underline{U} - \underline{V} > W^M - \underline{U} - \underline{V} \geq S^M$. The shareholders prefer the A-regime unambiguously.

[7] The labor market value of a player refers to the market rate for the pool of players of specific type,

interpreted as firms implementing either of two governance forms:

(a) *Executive form* (when A-regime contracts are offered): CEOs are the central players, and their primary benefits are *financial*, whereas boards' primary benefits are *non-financial*. The executive form is prevalent when CEOs have large market value and low empire-building incentives (e.g., late-career CEOs), and non-executive directors have low market values and are concerned mostly about project success (e.g., concerned about being "part of a success story").

(b) *Collegial form* (when M-regime contracts are offered): Boards are the central player. Thus, CEOs' information acquisition about investment opportunities is not shaped by their financial incentives but rather by those of the directors. The collegial form is prevalent when CEOs have low market value and high empire-building incentives, and directors are concerned about project failures.

There are also implications for labor markets. We observe that financial incentives (and consequently also rents) are allocated only to the central player. To become the central player (and potentially receive rents), the outside option for that player must be relatively high. This means that the optimal allocation of financial incentives (and rents) mirrors the pre-existing differences in the market values of the players.

4.4 Information and Investment Efficiency

Under the A-regime, the CEO chooses perfect information precision, leading to efficient investments. Under the M-regime, however, the CEO chooses a signal structure with imperfect precision. In this case, since the optimal choice is $\mu_l = 0$, there are no Type-I errors (i.e., rejections of profitable projects). But since $\mu_h = \tau_M < 1$, there are Type-II

not to an individual labor market value within the pool. For instance, a CEO is more likely the central player if the market rate for CEOs in general increases, not when the individual CEO's rate increases above the market rate for executives. An increase in the individual rate above the market rate means that the specific CEO is too expensive for the company and is replaced by a cheaper CEO.

errors (i.e., approvals of some unprofitable projects). The preceding discussion implies that the shareholders' regime choice affects the equilibrium information and, thereby, the investment efficiency. To ensure investment efficiency, the shareholders must eliminate the root of the agency problem by aligning the CEO with the company (implement the A-regime). Alternatively, the shareholders can allow residual inefficiency by not aligning the CEO but rather incentivizing the board to be more prudent (implement the M-regime). Put differently, (in)tolerance for CEO's misalignment is equivalent to (in)tolerance for investment inefficiency. The result in Proposition 3 establishes that, under certain circumstances, the shareholders are willing to tolerate investment inefficiency, as long as they are able to keep a larger share of the surplus.

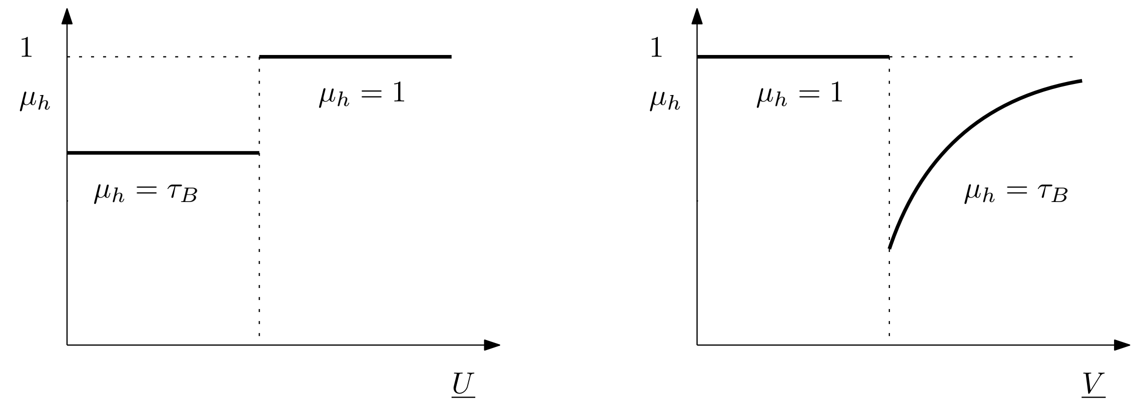
How does a parametrical change affect the information precision (and, thereby, the level of investment inefficiency) in equilibrium? It occurs in either of three ways:[8] (i) through the effect within the M-regime, (ii) through the effect associated with a switch from the M-regime to the A-regime, and (iii) through the effect associated with a switch from the A-regime to the M-regime.

Table 1: **Effects on the equilibrium quality of information μ_h**

		$\underline{U}$	$\underline{V}$	c_0	c_1	b_0	b_1
Corner optimum in M-regime ($\tau_M = \tau_B$)							
(i)	Effect within M-regime	0	+	0	0	–	–
(ii)	Switch from M to A-regime	jump				jump	jump
(iii)	Switch from A to M-regime		drop	drop	drop		
Interior optimum in M-regime ($\tau_M = \tau_S$)							
(i)	Effect within M-regime	0	0	–	0	–	–
(ii)	Switch from M to A-regime	jump				jump	jump
(iii)	Switch from A to M-regime		drop	drop	drop		

Effects (i)-(iii) are summarized in Table 1 while distinguishing between the two M-

[8] In addition, there is an effect within the A-regime. But as the quality of information under the A-regime is perfect, the effect is zero for any parameter change.



(a) Step increase in CEO's labor value (b) Non-monotonicity in board's labor value

Figure 4: The effect of parameter increase on investment efficiency

regime optima (corner with $\tau_M = \tau_B$ and interior with $\tau_M = \tau_S$). When the effect within the M-regime and the effect when the regime switches go in opposite directions (e.g., an increase in a parameter—like $\underline{V}$ for example—improves the quality of information within the M-regime, but a preceding switch from the A-regime to the M-regime is associated with a discontinuous decrease/drop), the quality of information is *non-monotonic* at the point of regime switch.[9] Otherwise, the quality is monotonic with a discontinuous jump or drop (e.g., an increase in a parameter—like $\underline{U}$ for example—does not affect the quality of information within the M-regime, and a preceding switch from the A-regime to the M-regime is associated with a discontinuous increase/jump).

In particular, when we have an interior optimum, $\tau_M = \tau_S$, the precision is either a *non-monotonic function with structural break* at the point of regime switch (for parameters b_0, b_1), a *strictly increasing function* (for parameter c_0), or a *step function* (for all other parameters). For the corner optimum, $\tau_M = \tau_B$, the precision is either a *non-monotonic function* (for parameters $\underline{V}, b_0, b_1$) or a *step function* (for all other parameters). Figure 4 panel (a) illustrates monotonicity (with discontinuous jump) in the CEO's labor market value, $\underline{U}$, and panel (b) illustrates non-monotonicity (with discontinuous drop) in the

[9]Note that non-monotonicity is not associated with a switch between interior and corner optima within the M-regime, because $\tau_M = \max\{\tau_B, \tau_S\}$ is monotonic in all parameters.

board's labor market value, $\underline{V}$; both for corner optimum $\tau_M = \tau_B$. The following forces drive the non-monotonicity in panel (b): When the board's labor value, $\underline{V}$, is low, the shareholders prefer the A-regime, where financial incentives are offered only to the CEO and she collects information with perfect precision, $\mu_h = 1$. A marginal increase in the board's labor value does not impact information precision, given it is already perfect. A further increase in the board's labor value shifts shareholder preference towards the M-regime, leading to a discrete decrease in precision (from perfect with $\mu_h = 1$ to imperfect with $\mu_h = \tau_M < 1$). Any subsequent increases in the board's labor value compel the CEO to enhance information precision to ensure project approval.

4.5 Preferred Board's Characteristics

In the main part of the paper, the board's non-financial incentives (i.e., the board's "characteristics") are fixed, and the shareholders only optimize over the financial incentives. We now analyze situations where these characteristics can be modified *incrementally*, which may happen when the terms of non-executive directors are staggered or when CEOs partially influence board composition leaving the shareholders only with partial control over director appointments. Such marginal change in the board's characteristics does not affect the optimal regime (unless the shareholders are indifferent over regimes), and therefore, the shareholders' preferences over them are regime-specific.

Proposition 4 (Preferred boards' characteristics)**.** *When the A-regime is optimal, in the process of incrementally modifying the board's characteristics, the shareholders prefer to increase b_1 and are indifferent over b_0. When the M-regime is optimal, the shareholders prefer to decrease both b_1 and b_0.*

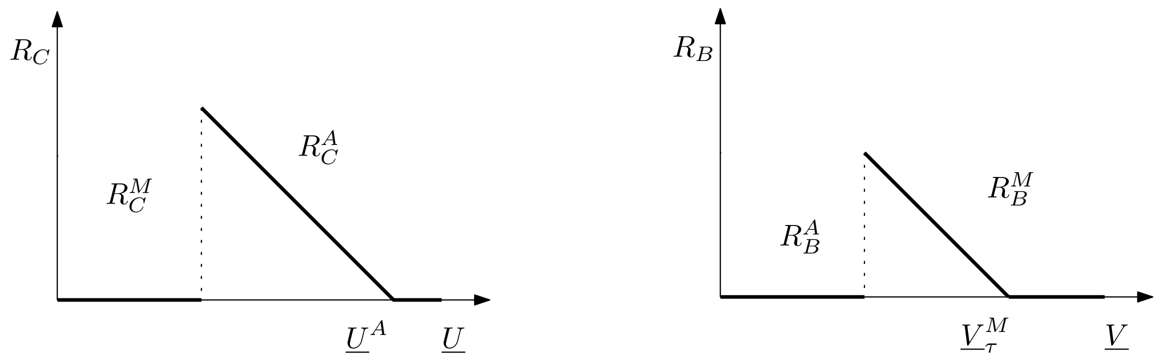
The shareholders optimally *reinforce* the non-financial characteristics that are already dominant. If the current board strongly benefits (non-financially) from approving a successful project, the shareholders implement the A-regime and prefer to further increase this characteristic—directors with high non-financial benefits from success demand a lower financial compensation and are thus cheaper for the company. In contrast, if the board strongly suffers (non-financially) from a failed project, the shareholders implement the M-regime and prefer to strengthen this characteristic even further. Our analysis can be interpreted as shareholders preferring boards with homogenous (unbalanced) non-financial benefits over boards with diverse (balanced) non-financial benefits.

Overall, we identify a force that contributes to the segmentation of companies into two distinct types: In companies with executive form of governance, the shareholders financially incentivize the CEO (e.g., via large bonuses) and prefer that directors strongly (and non-financially) benefit from project success (e.g., entrepreneurs) as this substitutes for financial compensation. The optimal board in the executive form puts a great emphasis on launching and executing projects. In companies with collegial form of governance, the shareholders do not emphasize variable financial incentives but rather appoint directors who are motivated to avoid project failures (e.g., CPAs and lawyers). The optimal board in the collegial form emphasizes careful assessment of risks and downsides before making the project decision. Thus, our work complements prior studies on why corporate governance is endogenous (e.g., Levit and Malenko 2016). Here, the mutually strengthening governance features are contracting schemes and board characteristics.

5 Players' Rents and Empirical Implications

Our model links excess compensation (rents) of boards and managers to empirically observable characteristics.[10] In our setting, rents may be received either by the CEO (under the A-regime) or by the board (under the M-regime):

[10]The empirical literature defines excess compensation as the difference between observed and expected compensation levels after controlling for firm characteristics (investment opportunities, firm complexity, need for monitoring, and firm performance/risk). The abnormal compensations are then explained by governance variables or other proxies for CEO-director reciprocity (Dah and Frye 2017; Chen, Georgen, Leung and Song 2019; Hope, Lu and Saiy 2019).



(a) Non-monotonicity in CEO's labor value (b) Non-monotonicity in board's labor value

Figure 5: Effect of increase in players' labor values on their rents

(a) The CEO's rent under the A-regime, $R_C^A = \max\{0, c_0 + \mu c_1 - \underline{U}\}$, is associated with low $\underline{U}$ and with high c_0 and c_1. Given that the CEO does not earn rents under the M-regime, $R_C^M = 0$, her rents are also associated with the shareholders' choice of the A-regime, which we predict in Proposition 3 is more likely when $\underline{U}$, b_0 and b_1 are high, and when $\underline{V}$, c_0 and c_1 are low. Thus, the CEO's rents are overall weakly increasing in the directors' non-financial incentives (b_0 and b_1) and are weakly decreasing in their labor market value ($\underline{V}$). However, the preceding discussion implies that the CEO's rent is non-monotonic in the CEO's empire-building incentives (c_0 and c_1) and her labor market value ($\underline{U}$) around the point at which a switch between regimes occurs. Panel (a) of Figure 5 graphically illustrates such non-monotonicity of the CEO's rent in her outside labor value.

(b) The comparative statics of the board's rent is even more nuanced. The board's rent under the M-regime, $R_B^M = \max\{b_0 + \frac{\tau_M}{1-\tau_M} b_1 - \underline{V}, 0\}$ is associated with low $\underline{V}$ and with high b_0, b_1 and τ_M. In turn, τ_M is associated with high $\underline{V}$ and with low c_0, b_0 and b_1. Given that directors do not earn rents under the optimal A-regime, $R_B^A = 0$, we also predict that their rents are associated with the shareholders' choice of the M-regime, which we predict in Proposition 3 is more likely when $\underline{U}$, b_0 and b_1 are low, and when $\underline{V}$, c_0 and c_1 are high. Summarizing these observations, the board's rents are weakly decreasing in the CEO's outside market labor value ($\underline{U}$) and her benefit from successful projects (c_1). However, the effect of all other parameters is ambigious and may be non-monotonic around the point at which a switch between regimes occurs. Panel (b) of Figure 5 graphically illustrates such non-monotonicity in the board's rent in the directors' outside labor value.

The preceding discussion implies that testing our predictions about how board and managerial excess compensation varies with empirically observable characteristics requires controlling for the governance form. The main identification challenge is that the governance form may be observed mainly through compensation which is endogenous.

Our model differentiates between various directors' non-financial concerns: those about reputation in case of failure are different from those about success. The concerns can be proxied by job type, education and work history.[11] We predict that concerns about failure and concerns about success have *opposite* effects on the quality of information and on the preference for the executive (vs. collegial) form of governance. We also predict that boards with stronger career concerns (e.g., those with high number of independent directors and high media exposure as documented in Jiang, Wan and Zhao 2016) may have a non-monotonic effect on company value: High career concerns make the board more prudent which improves the quality of CEO's information and all else equal has a positive effect on company value. This is consistent with findings in Sila, Gonzalez and Hagendorf (2017). However, high career concerns also imply that the M-regime generates less frictions and is more likely optimal—then, if there is a regime switch, company value drops, leading to non-monotonicity.

[11]Established board platforms, such as BoardProspects.com, allow to separate the history of approving value-enhancing investments (governance, strategy, development, and execution experience; experience with operational and strategic issues; global or international business experience; founding and running a successful startup) from the history of avoiding value-reducing investments (regulatory or legal experience; high-level work for the government).

6 Conclusion

Why do shareholders offer contracts that do not fully alleviate investment distortions? In this paper, we show that it may be due to contracting costs. In particular, incentivizing management can be achieved by payment of rents, i.e., shareholders share the surplus with management. We find that under certain conditions, to appropriate a larger share of the surplus, the shareholders sacrifice investment efficiency (even though this reduces the total amount of surplus available for sharing).

We study a setting where an empire-building CEO persuades a reputation-concerned board to approve an investment project via strategic information acquisition. Investment efficiency is determined by the quality of information, which in turn depends on the incentive compensation. The shareholders can influence the information precision (and thereby investment efficiency) either directly or indirectly. A *direct* way is to motivate the CEO to acquire more precise information; an *indirect* way is to motivate the board to be persuaded into investment approval only by sufficiently precise information. The former generates an executive form of governance and the latter generates a collegial form. Under either form, only one player is central and is motivated via a financial *penalty for project failure* but receives no bonus for project success (that is, receives a concave-like compensation). The other (non-central) player is offered a fixed pay. Because both CEOs and boards are often protected by limited liability and cannot be penalized too severely for project failures, the only way to motivate them is to increase the reward for the status quo (i.e., by a large base compensation), which ultimately means increasing rents (share of company profits). The optimal contracts that we identify represent an optimal choice between the direct and indirect ways to improve information through financial incentives.

The rise in risks (e.g., from geopolitical tensions, supply chain disruptions, changes in the workforce, or litigation) has emphasized the boards' role in corporations. Our model speaks to the optimal allocation of real authority to non-executive directors (Aghion and

Tirole 1997). We predict that a collegial form of governance—where boards are central players endowed with not only nominal but also real authority—is more likely optimal when CEOs' empire-building interests and labor market values are high and/or when directors' non-financial incentives and labor market value are low. Furthermore, we find that the quality of information, the magnitude of investment deviations, and the rent paid to the central player can be non-monotonic.

Appendix

A Supplemental Analysis: Delegated Contracting

In this extension, we show that by delegating the power to set the CEO's contract to the board, the shareholders do not lose the ability to (uniquely) implement the players' wages that are optimal in the absence of delegation. In particular, through appropriately constructed board contract, the shareholders can achieve identical information, project decisions, and shareholders' payoff. Consequently, there is no difference between delegated and non-delegated contracting and all comparative statics results from non-delegated contracting extend also to delegated contracting.

A.1 Changes to the Setup

Contracting. Let $(\pi_0, \pi_\varnothing, \pi_1) := (-1, 0, r)$ be the (outcome-contingent) project profit. Date 1 is now split into two sub-dates. At date 1A, the shareholders offer a contract to the board. At date 1B, the board offers a contract to the CEO. CEO's contracting space is defined by the three project outcomes $(\pi_0, \pi_\varnothing, \pi_1)$: the contractual variable (CEO's performance measure) is π. The board's contracting space is defined by the project outcome as well as the CEO's compensation: the contractual variables (board's performance measures) are (π, x). Thus, a CEO's contract is a triplet $(x_0, x_\varnothing, x_1)$, and a board's contract is a function $Y(\pi, x)$. While the CEO's wage is given directly by the proposed CEO's contract, the board's wage is given by both board's and CEO's contracts,

$$(y_0, y_\varnothing, y_1) = (Y(\pi_0, x_0), Y(\pi_\varnothing, x_\varnothing), Y(\pi_1, x_1)).$$

Monotonicity. As in the main analysis, we assume that each player's contract is monotone (weakly increasing) in each of the performance measures. Precisely, for the CEO, x is weakly increasing in π, $0 \leq x_0 \leq x_\varnothing \leq x_1$. For the board, (i) Y is weakly increasing in π, $Y(\pi_0, x) \leq Y(\pi_\varnothing, x) \leq Y(\pi_1, x)$ for any x, and (ii) Y is weakly decreasing in x, $Y(\pi, x') \geq Y(\pi, x'')$ for any $x' \leq x''$ and any π. In addition, as in the main analysis, we preserve that the board's wage is monotonic, $0 \leq y_0 \leq y_\varnothing \leq y_1$, or equivalently, $0 \leq Y(\pi_0, x_0) \leq Y(\pi_\varnothing, x_\varnothing) \leq Y(\pi_1, x_1)$.

We note that even if the board's wage is set indirectly (by board's and CEO's contracts), the set of feasible pairs of wages does not change with delegation; this is due to high flexibility of the board's contract function Y. Precisely, for any pair $(x_0, x_\varnothing, x_1)$ and $(y_0, y_\varnothing, y_1)$ that is feasible in the absence of delegation, it is possible to generate an identical pair of wages by proposing an appropriate board contract function Y. In particular, consider a board function that is independent on the CEO's compensation, i.e., $(Y(\pi_0, x), Y(\pi_\varnothing, x), Y(\pi_1, x)) = (y_0, y_\varnothing, y_1)$ for any x. This contract function is feasible in the presence of delegation as it satisfies monotonicity in both arguments as well as limited liability, and consequently also the pair $(x_0, x_\varnothing, x_1)$ and $(y_0, y_\varnothing, y_1)$ is feasible in the presence of delegation.

A.2 Irrelevance of Delegation

In the absence of delegation, the shareholders' optimal contracting problem is to select the optimal pair of players' wages from the set of feasible wages. In the presence of delegation, the shareholders' optimal contracting problem is to select the optimal board contract from the set of feasible board contracts. This problem can be also formulated as the selection of the optimal pair of players' wages from a *subset* of the set of pairs of wages that are feasible in the absence of delegation and additionally incentive-compatible in the presence of delegation.

To see why, recall that delegation does not affect the feasibility of pairs of wages. What it changes is that the shareholders cannot implement any board's wage that is feasible. The board, when proposing the CEO's wage, must find it optimal to set the CEO's wage and consequently, also the board wage that the shareholders seek to implement (incentive compatibility). The shareholders' optimal contracting problem therefore involves an *extra incentive compatibility constraint* that the board must not deviate to any other pair of wages. The shareholders' optimal contracting problem under delegation is thus a *constrained version* of their optimal contracting problem in the absence of delegation.

The key question is whether the extra compatibility constraint is binding in the optimum or not. In what follows, we demonstrate that it is not binding; the shareholders can implement the pair of wages and consequently the corresponding profile of payoffs that is optimal in the absence of the constraint. Intuitively, the extra constraint is not binding because the shareholders can flexibly shape the board contract function Y and consequently can greatly limit to which alternative pairs of wages the board can deviate.

A.2.1 Optimal A-regime

We begin with the case (in terms of parameter values) where the optimal A-regime is preferred over the optimal M-regime in the absence of delegation, $S^A \geq S^M$. Implementation involves only a single performance measure (the CEO's wage). The board is paid a fixed high wage unless the CEO receives an excessive wage; otherwise, the board receives a low (zero) wage. Conditional on the CEO's wage being small, the board expects a fixed wage and due to its non-financial incentives maximizes precision by aligning the CEO. The financial penalty in the form of the zero wage serves only as an incentive for the board to offer the CEO the lowest wage out of all wages that align the CEO.

Lemma 3 (Implementing A-regime)**.** *Consider a board's contract*

$$Y(\pi, x) = \begin{cases} y^A_\varnothing & \text{if } x \leq x^A_\varnothing, \\ 0 & \text{otherwise.} \end{cases}$$

Given this contract, it is uniquely optimal for the board to propose a CEO's contract $(x^A_0, x^A_\varnothing, x^A_1)$*. Then, A-regime is implemented and board's wage is* $(y^A_0, y^A_\varnothing, y^A_1)$*. The shareholders' payoff is* S^A*.*

A.2.2 Optimal M-regime

We proceed with the case (in terms of parameter values) where the optimal M-regime is preferred over the optimal A-regime in the absence of delegation, $S^M > S^A$. Implementation now involves both performance measures (project profits and the CEO's wage). The shareholders promise to pay a high wage to the board only if two complementary conditions are met: (i) the project does not fail and (ii) the CEO's wage is not excessive. If any of these conditions is not satisfied, the board receives a low wage. The level of tolerable CEO's compensation makes it impossible to fully align the CEO without facing a penalty; this penalty discourages the A-regime. At the same time, the specific values of compensation offered to the board implement the target value of board's prudence τ_M.

Lemma 4 (Implementing M-regime)**.** *Consider a board's contract*

$$Y(\pi, x) = \begin{cases} y_{\tau_M,\varnothing} & \text{if } \pi \geq 0 \text{ and } x \leq x_{\tau_M,\varnothing}, \\ y_{\tau_M,0} & \text{otherwise.} \end{cases}$$

Given this contract, it is uniquely optimal for the board to propose a CEO's contract $(x_{\tau_M,0}; x_{\tau_M,\varnothing}; x_{\tau_M,1})$*. Then, M-regime is implemented with precision* τ_M *and board wage is* $(y_{\tau_M,0}; y_{\tau_M,\varnothing}; y_{\tau_M,1})$*. The shareholders' payoff is* S^M*.*

B Supplemental Analysis: Non-Monotonic Contracts

In this extension, we allow non-monotone contracts but preserve limited liability (non-negative wages). The contracting set is a superset of the contracting set in the main part of the paper and thus gives greater flexibility to shareholders. To preserve the shareholders' flexibility, we assume that the CEO can not burn profits. We demonstrate that all main results hold. To that end, we will replicate the structure of Section 4. For convenience, we will preserve the notation of the regime-specific contracts.

To begin with, notice that with non-monotone contracts, the board is not necessarily normal. Therefore, in addition to the A-regime and M-regime, new regimes exist, and the regime choice is richer. However, it is clearly suboptimal to artificially misalign board's and shareholders' project preferences, and therefore the regime choice reduces to the well-known choice from the A-regime and M-regime.[12]

B.1 Non-Monotonic A-regime Contracts

As in the main analysis, the shareholders' contracting problem under the A-regime reduces to minimization of total rents.

[12] In particular, if the board prefers to reject the project always, it is cheaper to dissolve the company. If the board is empire-builder or has opposite preferences than the shareholders (benefitting from project failure and losing from project success), it is cheaper to fire the board and delegate powers to the CEO.

Lemma 5 (Non-monotonic contracts: optimal A-regime)**.** *The optimal non-monotonic CEO's A-regime contract involves maximum liability for project failure and negative bonus for project success,*

$$(x_0^A, x_\varnothing^A, x_1^A) = \left(0, c_0 + \max\{\underline{U} - \underline{U}^A, 0\}, \max\{\underline{U} - \underline{U}^A, 0\}\right),$$

where $\underline{U}^A = (1-\mu)c_0 + \mu c_1$ *is the minimum CEO's payoff out of all feasible contracts that align the CEO. The optimal non-monotonic board's A-regime contract involves zero liability and zero bonus,*

$$y_0^A = y_\varnothing^A = y_1^A = \underline{V} - \mu b_1.$$

The CEO's expected payoff is $U^A = \max\{\underline{U}^A, \underline{U}\}$ *and that of the board is* $V^A = \underline{V}$*.*

Higher contracting flexibility—specifically the ability to give negative bonus—decreases $\underline{U}^A$ from $c_0 + \mu c_1$ to $(1-\mu)c_0 + \mu c_1$. This (weakly) decreases the CEO's rent and (weakly) increases the shareholders' payoff, $S^A = \overline{W} - \underline{U} - \underline{V} - R_C^A$.

B.2 Non-Monotonic M-regime Contracts

As in the main analysis, we first seek contracts that minimize rents conditional on τ (τ-specific M-regime contracts) according to the procedure outlined in Section 3.4.

Lemma 6 (Non-monotonic τ-specific M-regime)**.** *The CEO's τ-specific non-monotonic M-regime contract involves zero liability and zero bonus,*

$$x_{\tau,0}^M = x_{\tau,\varnothing}^M = x_{\tau,1}^M = \underline{U} - \underline{U}_\tau^M,$$

where $\underline{U}_\tau^M = \mu\frac{1-\tau}{\tau}c_0 + \mu c_1$ *is the CEO's expected non-financial benefit when signal precision is τ. The board's τ-specific non-monotonic M-regime contract involves positive liability for project failure and negative bonus for project success,*

$$y_{\tau,0}^M = y_{\tau,1}^M = \max\{\underline{V}_\tau^M - \underline{V}, 0\}; y_{\tau,\varnothing}^M = \max\{\underline{V}_\tau^M, \underline{V}\},$$

where $\underline{V}_\tau^M = \max\{(1-\tau)b_0 + \tau b_1, 0\}$ *is the minimum board's payoff out of all feasible contracts that achieve board's prudence τ. The CEO's expected payoff is* $U_\tau^M = \underline{U}$ *and the board's expected payoff is* $V_\tau^M = \max\{\underline{V}_\tau^M, \underline{V}\}$*.*

Now, higher contracting flexibility decreases $\underline{V}_\tau^M$ due to the ability to give a negative bonus. We proceed with identification of the optimal τ_M. As in the main analysis, an increase in board's prudence (and a corresponding increase in signal precision) generates two effects on the shareholders' payoff $S_\tau^M = W_\tau^M - \underline{U} - \underline{V} - R_{B,\tau}^M$: (i) a positive effect due to an increase in the project surplus, and (ii) a weakly negative effect due to an increase in the board's rent.

The marginal effect on the project surplus is continuous, whereas the marginal effect on board's rent is potentially discontinuous due to kink in the rent function. As in the main analysis, this gives rise to two types of optima. A corner optimum is in the kink of the board rent function τ_B, and an interior optimum is located at the level τ_S where the two marginal effects cancel out.

However, in contrast to the main analysis, the board's rent at perfect precision is no longer prohibitively large, which implies that perfect precision may also be optimal. This is intuitive. With non-monotonic contracts, the shareholders have higher contracting flexibility. This makes board's regime-specific contracts less costly. As a consequence, the board's rent function decreases and the kink of the board's rent function (where the shareholders begin to consider that M-regime generates rent) increases. As a result, the optimal precision under the M-regime also increases.

Lemma 7 (Non-monotonic contracts: optimal M-regime)**.** *The optimal board's prudence (and resulting signal precision) in M-regime is $\tau_M = \max\{\tau_B, \tau_S\}$ if $\max\{\tau_B, \tau_S\} < 1$, and $\tau_M = 1$ otherwise, where*

$$(\tau_B, \tau_S) := \left(\frac{\underline{V} - b_0}{b_1 - b_0}, \sqrt{\mu \frac{1 - c_0 - b_0}{b_1 - b_0}},\right).$$

In the optimum, the board's rent is positive if and only if $\tau_M > \tau_B$.

B.3 Regime Choice

The shareholders' margin $S^A - S^M$ is defined as in the main analysis,

$$S^A - S^M = W^A - W^M - R_C^A + R_B^M = \mu \frac{1 - \tau_M}{\tau_M}(1 - c_0 - b_0) - R_C^A + R_B^M.$$

The differences are in the CEO rent function, $R_C^A = \max\{(1-\mu)c_0 + \mu c_1 - \underline{U}, 0\}$, and the board rent function, $R_B^M = \max\{b_0 + \tau_M(b_1 - b_0) - \underline{V}, 0\}$. In the parametrical subspace for which the regime choice between A-regime and the imperfect M-regime is relevant, we again have $R_C^A > 0$. The effects of changes in parameters on the regime choice are identical to the main analysis.

Proposition 5 (Non-monotonic contracts: Regime choice)**.** *The shareholders implement the optimal M-regime if and only if $\mu \frac{1-\tau_M}{\tau_M}(1 - c_0 - b_0) - \max\{(1-\mu)c_0 + \mu c_1 - \underline{U}, 0\} + \max\{b_0 + \tau_M(b_1 - b_0) - \underline{V}, 0\} < 0$ where $\tau_M = \min\left\{1, \max\left\{\frac{\underline{V} - b_0}{b_1 - b_0}, \sqrt{\mu \frac{1 - c_0 - b_0}{b_1 - b_0}}\right\}\right\}$. Allowing misalignment of the CEO (implementing M-regime) is weakly more attractive to the shareholders if $\underline{U}$, b_0 or b_1 are low and $\underline{V}$, c_0 or c_1 are high.*

B.4 Non-Monotonic Quality of Information

As in the main analysis, we show how a change in players' characteristics affect the equilibrium quality of information (i) through the effect within the M-regime, (ii) through the effect associated with a switch from the M-regime to the A-regime, and (iii) through the effect associated with a switch from the A-regime to the M-regime. Effects (i)-(iii) are summarized in Table 2 while distinguishing between the three M-regime optima (corner with $\tau_M = 1$, corner with $\tau_M = \tau_B$, and interior with $\tau_M = \tau_S$).

Table 2: **Effects on equilibrium quality of information μ_h**

		$\underline{U}$	$\underline{V}$	c_0	c_1	b_0	b_1
Corner optimum ($\tau_M = 1$)							
(ii)	Effect within M-regime	0	0	0	0	0	0
(iii)	Switch from M to A-regime	jump					jump
(iv)	Switch from A to M-regime		drop	drop	drop		
Corner optimum ($\tau_M = \tau_B$)							
(ii)	Effect within M-regime	0	+	0	0	−	−
(iii)	Switch from M to A-regime	jump				jump	jump
(iv)	Switch from A to M-regime		drop	drop	drop		
Interior optimum ($\tau_M = \tau_S$)							
(ii)	Effect within M-regime	0	0	−	0	+	−
(iii)	Switch from M to A-regime	jump				jump	jump
(iv)	Switch from A to M-regime		drop	drop	drop		

In four cases, the sign of the effect with the M-regime is *opposite* to the sign associated with a switch between the regimes. As a consequence, in these case, the quality of information is *non-monotonic* at the point of the regime switch.

C Proofs

C.1 Proofs: Main Analysis

Proof of Proposition 1: Part 1 (*CEO's contract*). The CEO's rent, $R_C = \max\{0, U - \underline{U}\}$, is minimized when the CEO's (expected) payoff U is minimized subject to her incentive constraints (normality, i.e., monotone ex post payoffs) and her participation constraint ($U \geq \underline{U}$). As stated in Section 3.4, we proceed in two steps. First, we derive a contract that minimizes the CEO's payoff (the least costly CEO's contract) and satisfies her incentive constraint (but not necessarily her participation constraint):

$$(x_0, x_\varnothing, x_1) = (0, c_0, c_0)\,.$$

This illustrates that the CEO must be financially incentivized to not support value-destroying projects. The corresponding CEO's total (financial and non-financial) expected payoff is $\underline{U}^A := c_0 + \mu c_1$. Next, we add the participation constraint. (i) If $\underline{U}^A > \underline{U}$, then the constraint is already met and the optimal contract does not change, and also the payoff does not change, $U^A = \underline{U}$. The CEO receives a positive rent $U^A - \underline{U} = \underline{U}^A - \underline{U} > 0$. (ii) If $\underline{U}^A \leq \underline{U}$, then the shareholders need to increase the CEO's payoff by $\underline{U} - \underline{U}^A$ to meet her participation constraint. There are several (for the shareholders equivalent) ways to accommodate the transfer in the CEO's contract without distorting her incentive constraints; the simplest one is to increase $x_\varnothing$ (basic wage) by the amount $\underline{U} - \underline{U}^A$ and keep bonus at zero. To generalize cases (i) and (ii), an optimal A-regime CEO's contract is

$$(x_0^A, x_\varnothing^A, x_1^A) = \left(0, c_0 + \max\{\underline{U} - \underline{U}^A, 0\}, c_0 + \max\{\underline{U} - \underline{U}^A, 0\}\right).$$

and the CEO's expected payoff is $U^A = \max\{\underline{U}, \underline{U}^A\}$.

Part 2 (*Board's contract*). Analogically, the board's rent, $R_B = \max\{0, V - \underline{V}\}$, is minimized when the board's (expected) payoff V is minimized subject to board's incentive constraint (normality) and board's participation constraint ($V \geq \underline{V}$). Again, we first derive a contract that minimizes board's payoff and satisfies its incentive constraint (but not necessarily its participation constraint). This contract offers zero wage:

$$(y_0, y_\varnothing, y_1) = (0, 0, 0).$$

The corresponding board's expected payoff is $\underline{V}^A := \mu b_1$. Since $\underline{V} \geq \mu b_1$ by assumption, the shareholders always need to increase board's payoff by $\underline{V} - \underline{V}^A \geq 0$ to meet the participation constraint. There are many (for shareholders equivalent) ways how to provide the transfer without distorting incentive constraints; the simplest one is to offer a fixed wage $\underline{V} - \underline{V}^A$. An optimal A-regime board's contract is then

$$(y_0^A, y_\varnothing^A, y_1^A) = (\underline{V} - \underline{V}^A, \underline{V} - \underline{V}^A, \underline{V} - \underline{V}^A),$$

and the board's expected payoff is $V^A = \max\{\underline{V}, \underline{V}^A\} = \underline{V}$.

Proof of Lemma 1: Part 1 (*Board's contract*). Deriving τ-specific board's contract is straightforward: In the equilibrium of the persuasion game, board's prudence is defined as a belief τ at which the board is *indifferent* between approval and rejection, $y_\varnothing = (1-\tau)(y_0 + b_0) + \tau(y_1 + b_1)$.[13] Given this indifference, the board's expected payoff is simply the board's payoff under rejection,

$$V_\tau^M = \left(1 - \tfrac{\mu}{\tau}\right) y_\varnothing + \tfrac{\mu}{\tau}\left[(1-\tau)(y_0 + b_0) + \tau(y_1 + b_1)\right] = \left(1 - \tfrac{\mu}{\tau}\right) y_\varnothing + \tfrac{\mu}{\tau} y_\varnothing = y_\varnothing.$$

As outlined in Section 3.4, we begin with the incentive constraints only. When the shareholders minimize board's expected payoff (conditional on achieving τ), their objective is actually to *minimize* $y_\varnothing$ subject to (i) board's normality constraints, $y_0 + b_0 \leq y_\varnothing \leq y_1 + b_1$, (ii) board's indifference at τ, $y_\varnothing = (1-\tau)(y_0 + b_0) + \tau(y_1 + b_1)$, and also (iii) contracting constraints, $0 \leq y_0 \leq y_\varnothing \leq y_1$.

First, we show that it is sufficient to study only $\tau \geq \tau_N$, where $\tau_N := \frac{-b_0}{b_1 - b_0}$ is the prudence under zero wage for the board, $y_\varnothing = y_0 = y_1 = 0$. Consider a costless (zero wage) board contract. This contract achieves zero board payoff, $V_\tau^M = y_\varnothing = 0$, and prudence $\tau = \tau_N$. If the shareholders want to achieve a lower prudence, they optimally increase y_1 as this decreases τ without affecting zero board payoff. Since $y_\varnothing$ is constant, any decrease in prudence has zero effect on board rent. However, with lower precision, the

[13] When $y_0 + b_0 < y_1 + b_1$, the belief is unique. We will proceed with this case and thus disregard the knife-edge case where a normal board is indifferent over project approval for any belief.

total value W^M decreases. Also, the CEO's payoff increases (as the CEO's expected non-financial benefit is decreasing in signal precision τ) which weakly increases R_C^M. Taken these three effects together, shareholders strictly prefer the zero wage board contract that implements $\tau = \tau_N$ to any optimal M-regime contract that implements $\tau < \tau_N$.

For $\tau \geq \tau_N$, the shareholders need to increase $y_\varnothing$ and y_1 to make board indifferent at τ. Increasing the two wages by the same amount gives the least costly contract:

$$(y_0, y_\varnothing, y_1) = \left(0, b_0 + \tfrac{\tau}{1-\tau} b_1, b_0 + \tfrac{\tau}{1-\tau} b_1\right).$$

Intuitively, to increase prudence above the level which is given only by non-financial incentives, $\tau > \tau_N$, shareholders have to increase board liability. Given limited liability constraint, this however increases board's expected payoff, $\underline{V}_\tau^M = y_\varnothing = b_0 + \frac{\tau}{1-\tau} b_1$.

To satisfy the board's participation constraint, it is then sufficient to add a transfer $\max\{\underline{V} - \underline{V}_\tau^M, 0\}$ to each of the three outcomes. This fixed transfer will not affect either board's normality or board's prudence:

$$y_{\tau,0}^M = \max\{\underline{V} - \underline{V}_\tau^M, 0\}, y_{\tau,\varnothing}^M = y_{\tau,1}^M = y_{\tau,0}^M + b_0 + \tfrac{\tau}{1-\tau} b_1.$$

Consequently, the board's expected payoff is $V_\tau^M = \max\{\underline{V}, \underline{V}_\tau^M\}$ and the board's rent is $R_{B,\tau}^M = \max\{0, \underline{V}_\tau^M - \underline{V}\}$.

Part 2 (*CEO's contract*). Providing zero wage preserves CEO's empire-building type, and thus satisfies the M-regime. Thus, the minimized CEO's payoff that complies with the CEO's incentive compatibility constraints (without necessarily satisfying the CEO's participation constraint) is purely non-financially based, $\underline{U}_\tau^M = p_h[(1-\tau)c_0 + \tau c_1] = \mu\frac{1-\tau}{\tau}c_0 + \mu c_1$. To satisfy also the CEO's participation constraint, it is then sufficient to add a transfer $\max\{\underline{U} - \underline{U}_\tau^M, 0\}$ to each of the three outcomes; this fixed transfer will not affect the CEO's empire-building type. The transfer is positive. To see why, observe that $\tau \geq \tau_N > \mu$ implies $\frac{1-\tau}{\tau} < \frac{1-\mu}{\mu}$ and consequently $\mu\frac{1-\tau}{\tau}c_0 + \mu c_1 < (1-\mu)c_0 + \mu c_1$. Using that the CEO's outside option is sufficiently attractive, $\underline{U} > (1-\mu)c_0 + \mu c_1 > \mu\frac{1-\tau}{\tau}c_0 + \mu c_1 = \underline{U}_\tau^M$. The τ-specific M-regime CEO's contract is

$$x_{\tau,0}^M = x_{\tau,\varnothing}^M = x_{\tau,1}^M = \underline{U} - \underline{U}_\tau^M.$$

Consequently, the CEO's expected payoff is $U_\tau^M = \max\{\underline{U}_\tau^M, \underline{U}\} = \underline{U}$ and the CEO's rent is zero.

Proof of Lemma 2: We evaluate the marginal effects of an increase in τ on the shareholders' payoff S_τ^M:

- Total value (positive effect): Total value of the project is $W_\tau^M = \mu(1 + r + b_1 - b_0 + c_1 - c_0) - \frac{\mu}{\tau}(1 - c_0 - b_0)$. The marginal effect of an increase in τ is $\frac{\mu}{\tau^2}(1 - c_0 - b_0) > 0$. As τ approaches one, the marginal effect decreases to $\mu(1 - c_0 - b_0) > 0$.

- Board's rent (weakly negative effect): The board's minimized payoff consistent with the board's incentive constraints only is $\underline{V}_\tau^M = b_0 + \frac{\tau}{1-\tau} b_1$ and the board's rent is

$R^M_{B,\tau} = \max\{\underline{V}^M_\tau - \underline{V}, 0\}$. Using that $\underline{V}^M_\tau$ is increasing in τ, the marginal effect of an increase in τ on board's rent is zero when $\tau < \tau_B$, where τ_B is the level of precision at which $\underline{V}^M_\tau = \underline{V}$:

$$\tau_B = \frac{\underline{V} - b_0}{\underline{V} - b_0 + b_1}$$

When $\tau > \tau_B$, the marginal effect on rent is $\frac{b_1}{(1-\tau)^2} > 0$ and approaches infinity when τ approaches one. As the rent enters the shareholders' payoff S^M_τ negatively, we speak of a weakly negative effect through a weakly higher board rent.

As the positive effect on the total value is decreasing in τ and the non-positive effect on the rent is weakly increasing in τ, there is a *unique* precision level τ_M at which the shareholder's payoff is maximized. To find it, first abstract away from the kink in the board rent function $R^M_{B,\tau}$ and derive the level of precision at which the two marginal effects are equal, $\frac{\mu}{\tau^2}(1 - c_0 - b_0) = \frac{b_1}{(1-\tau)^2}$:

$$\tau_S = \sqrt{\frac{1 - c_0 - b_0}{1 - c_0 - b_0 + \frac{b_1}{\mu}}}$$

Next, it is clear that $\tau_M \geq \tau_B$; for lower precision levels, the board's rent effect is zero and the overall effect of an increase in τ is positive.

- When $\tau_S \leq \tau_B$, the positive value effect at $\tau = \tau_B$ is less or equal than the negative board effect. The negative difference pronounces with τ. Consequently, $\tau_M = \tau_B$ (a corner optimum).
- When $\tau_S > \tau_B$, the positive value effect at $\tau = \tau_B$ exceeds the negative board effect. The difference shrinks with τ up to τ_S where the effects are exactly equal. Consequently, $\tau_M = \tau_S$ (an interior optimum).

To generalize, $\tau_M = \max\{\tau_B, \tau_S\}$. Figure 2 compares the levels of the positive effect (solid line) and the weakly negative effect (dashed line) and illustrates the two optima.

Proof of Proposition 2: By Lemma 1, the τ_M-specific M-regime contracts are optimal for the shareholders out of the sets of contracts for which $\tau = \tau_M$. By Lemma 2, the contracts are also preferred by the shareholders over other τ-specific M-regime contracts, where $\tau \neq \tau_M$. Consequently, they are preferred also over any other contracts which lead to precision $\tau \neq \tau_M$.

At $\tau_M = \tau_B \geq \tau_S$, the board earns zero rent, since τ_B is defined such that $\underline{V}^M_\tau = \underline{V}$. For $\tau_M = \tau_S > \tau_B$, we use that $\underline{V}^M_\tau$ is increasing in τ, and therefore $R^M_B = \underline{V}^M_\tau - \underline{V} > 0$.

Proof of Proposition 3: We evaluate $S^A - S^M \gtreqless 0$. To find the sign of the derivative of the margin $S^A - S^M$, we distinguish between the types of the optimum in M-regime.

- *Corner optimum in M-regime*, $\tau_M = \tau_B$: Here, board rent is zero. By entering $\tau_M = \tau_B$, the shareholders' margin is $S^A - S^M = \mu(1 - b_0 - c_0)\frac{b_1}{\underline{V} - b_0} - \max\{0, c_0 + \mu c_1 - \underline{U}\}$. When evaluating the effects of parameters on the margin, the only ambiguous effect is with respect to b_0; here we however use that c_0 is negligible relative to the investment level 1 and also to $1 - \underline{V}$, which implies that the ratio $\frac{1-c_0-b_0}{\underline{V}-b_0}$ is increasing in b_0.

- *Interior optimum in M-regime*, $\tau_M = \tau_S$: Here, board rent is positive and the shareholders margin is $S^A - S^M = \mu(1 - b_0 - c_0)\frac{1-\tau_S}{\tau_S} - \max\{0, c_0 + \mu c_1 - \underline{U}\} + b_0 + \frac{\tau_S}{1-\tau_S}b_1 - \underline{V}$. In the absence of kinks, an effect of a change of a generic parameter (denoted z) consists of a direct and indirect effect,

$$\frac{dS^A - S^M}{dz} = \underbrace{\frac{\partial S^A - S^M}{\partial z}}_{\text{direct}} - \underbrace{\frac{\partial S^M}{\partial \tau_M}\frac{\partial \tau_M}{\partial z}}_{\text{indirect}}.$$

  By the Envelope Theorem, the indirect effect is zero and the overall effect is given by the direct effect (where τ is fixed). This simplifies the analysis. To find the positive effect with respect to b_0, see that the positive effect is if and only if $\frac{\tau_S}{1-\tau_S} > \mu$. To prove that this is true, see that in the interior optimum, board rent is positive, and thus $b_0 + \frac{\tau_S}{1-\tau_S}b_1 > \underline{V}$, where we know $\underline{V} > \mu b_1 > b_0 + \mu b_1$ (recall $b_0 < 0$). As a consequence, $b_0 + \frac{\tau_S}{1-\tau_S}b_1 > b_0 + \mu b_1$, which implies $\frac{\tau_S}{1-\tau_S} > \mu$.

Table 3 lists the signs of the marginal effects.

Table 3: Regime choice for monotonic contracts (in favor of A-regime)

M-regime optimum	$\underline{U}$	$\underline{V}$	c_0	c_1	b_0	b_1
$\tau_M = \tau_B$	+/0	−	−	−/0	+	+
$\tau_M = \tau_S$	+/0	−	−	−	+	+

Proof of Proposition 4: Part 1 (*A-regime*): The shareholders' payoff $S^A = \mu(r + b_1 + c_1) - \max\{c_0 + \mu c_1 - \underline{U}, 0\} - \underline{U} - \underline{V}$ is clearly constant in b_0 and increasing in b_1.

Part 2 (*M-regime*): We distinguish between the types of the optimum in M-regime.

- *Corner optimum*, $\tau_M = \tau_B$: Here, $S^M = \mu(r + b_1 + c_1) - \mu(1 - b_0 - c_0)\frac{b_1}{\underline{V}-b_0} - \underline{U} - \underline{V}$. For the effect with respect to b_0, we again (as in Proof to Proposition 3) use that the ratio $\frac{1-c_0-b_0}{\underline{V}-b_0}$ is increasing in b_0 and therefore the effect is negative. The same condition also implies that S^M is decreasing with respect to b_1.

- *Interior optimum*, $\tau_M = \tau_S$: Here, $S^M = \mu(r + b_1 + c_1) - \mu(1 - b_0 - c_0)\frac{1-\tau_S}{\tau_S} - \underline{U} - b_0 - \frac{\tau_S}{1-\tau_S}b_1$. We use the Envelope Theorem again, by which the indirect effect through a change in τ_S is zero, and consequently we only evaluate the partial derivative of S^M

(the direct effect) with τ_M being constant. For both the effect with respect to b_0 and b_1, we again use that for $\tau_M = \tau_S$, the condition $\frac{\tau}{1-\tau} > \mu$ holds. The negative effects follow immediately.

C.2 Proofs: Delegated Contracting

Proof of Lemma 3: With a CEO's contract $(x_0^A, x_\varnothing^A, x_1^A)$ and the proposed board contract function $Y(\pi, x)$, the board's wage is fixed, $(y_0^A, y_\varnothing^A, y_1^A) = (y_\varnothing^A, y_\varnothing^A, y_\varnothing^A)$. This generates the optimal A-regime with the shareholders' payoff S^A. We show that the board is worse off with any other CEO's contract. To begin with, see that the board's expected value V contains a financial and non-financial component. The financial component cannot be improved over the fixed payment $y_\varnothing^A$ because $y_\varnothing^A$ is the maximum wage offered by the contract function. The non-financial component is maximized when precision is maximum. Therefore, the board's optimum is to implement the A-regime. Second, the CEO's contract is implemented by board uniquely. Any other CEO's contract that makes the CEO normal and satisfies the CEO's participation constraint violates either $x_\varnothing \le x_\varnothing^A$ or $x_1 \le x_\varnothing^A$ (or both) and thus decreases the financial component of the board's expected value.

Proof of Lemma 4: Denote the two implementable (low and high) levels of the board wage as $(y_L, y_H) := (y_{\tau_M,0}; y_{\tau_M,\varnothing})$. With a CEO's contract $(x_{\tau_M,0}; x_{\tau_M,\varnothing}; x_{\tau_M,1})$, the board's wage is (y_L, y_H, y_H). This generates the optimal M-regime with precision τ_M and the shareholders' payoff S^M. We show that the board is worse off with any other CEO's contract.

- **Weak CEO's incentives**: Suppose the board proposes a CEO's contract which preserves that the CEO is an empire-builder, $x_0 + c_0 > x_\varnothing$. Given that the board's wage is binary, only three types of board's wages may arise: (i) As we know, (y_L, y_H, y_H) represents the optimal M-regime with board's expected payoff $V^M = y_H$. (ii) Board wage (y_L, y_L, y_L) represents an alternative M-regime for which board's expected payoff is only $V = y_L < y_H$. (Here we again use that in any M-regime, the CEO sets the information precision such that the board is exactly indifferent between project acceptance and rejection, and consequently the board's expected payoff is simply $V = y_\varnothing$.) (iii) Board wage (y_L, y_L, y_H) cannot be implemented because it requires $x_1 \le x_{\tau_M,\varnothing} < x_\varnothing$ which violates monotonicity of the CEO's contract, $x_\varnothing \le x_1$. (iv) The last case (y_L, y_H, y_L) involves a non-monotonic board wage which is not feasible in this specific setting.

- **Strong CEO's incentives**: Suppose the board proposes a CEO's contract which makes the CEO normal, $x_0 + c_0 \le x_\varnothing$. This generates A-regime. Since $x_0 \ge 0$, it must be that $x_\varnothing \ge c_0$, and by monotonicity, also $x_1 \ge c_0$. This contract gives the board a low wage for any project outcome, i.e., board wage (y_L, y_L, y_L). To see why, notice that $x_{\tau_M,\varnothing} = \underline{U} - \underline{U}_\tau^M = \underline{U} - \mu c_1 - \mu \frac{1-\tau_M}{\tau_M} c_0 < \underline{U} - \mu c_1 < c_0$. (Here we use that the optimal M-regime is more attractive to the shareholders in the absence of delegation only if the optimal A-regime involves the CEO's rent. The CEO's rent is generated only if $\underline{U} < \underline{U}^A = c_0 + \mu c_1$, which is equivalent to $\underline{U} - \mu c_1 < c_0$.)

As A-regime is generated, the CEO prepares a perfectly precise signal and board's expected payoff is $V = y_L + \mu b_1$. Now, we will show that this makes the board worse off, $V = y_L + \mu b_1 < y_H = V^M$. To that end, see that $y_H = y_L + \underline{V}_\tau^M$ and that $\underline{V}_\tau^M \geq \underline{V} > \mu b_1$. (The second inequality is the requirement that the board does not work for free. The first inequality follows from the fact that in the optimal M-regime, we always have $\underline{V}_\tau^M \geq \underline{V}$; any M-regime with $\underline{V}_\tau^M < \underline{V}$ would imply that $\tau < \tau_B$, but we know that $\tau_M \geq \tau_B$.)

C.3 Proofs: Non-Monotonic Contracting

Proof of Lemma 5: Part 1 (*CEO's contract*). The CEO's rent, $R_C = \max\{0, U - \underline{U}\}$, is minimized when the CEO's (expected) payoff U is minimized subject to her incentive constraints (normality) and her participation constraint ($U \geq \underline{U}$). As stated in Section 3.4, we proceed in two steps. First, we derive a contract that minimizes the CEO's payoff and satisfies her incentive constraint (but not necessarily her participation constraint):

$$(x_0, x_\varnothing, x_1) = (0, c_0, 0)\,.$$

The corresponding CEO's total (financial and non-financial) payoff is $\underline{U}^A := (1-\mu)c_0 + \mu c_1$. Next, we add the participation constraint. (i) If $\underline{U}^A > \underline{U}$, then the optimal contract does not change and also the payoff does not change, $\underline{U}^A = \underline{U}$. The CEO receives a positive rent $U^A - \underline{U} = \underline{U}^A - \underline{U}$. (ii) If $\underline{U}^A \leq \underline{U}$, then the shareholders need to increase the CEO's payoff by $\underline{U} - \underline{U}^A$ to meet her participation constraint. To accommodate the transfer in the contract without distorting incentive constraints, one can, as in the case of monotonic contracting, increase both base wage and wage in the event of project success by the amount $\underline{U} - \underline{U}^A$. To generalize cases (i) and (ii), an optimal A-regime CEO's contract is

$$(x_0^A, x_\varnothing^A, x_1^A) = (0, c_0 + \max\{\underline{U} - (1-\mu)c_0 - \mu c_1, 0\}, \max\{\underline{U} - (1-\mu)c_0 - \mu c_1, 0\})\,.$$

and the CEO's expected payoff is $U^A = \max\{\underline{U}, \underline{U}^A\}$.

Part 2 (*Board's contract*). Analogically, the board's rent, $R_B = \max\{0, V - \underline{V}\}$, is minimized when the board's (expected) payoff V is minimized subject to board's incentive constraint (normality) and board's participation constraint ($V \geq \underline{V}$). Again, we first derive a contract that minimizes board's payoff and satisfies its incentive constraint (but not necessarily its participation constraint). This contract offers zero payoffs:

$$(y_0, y_\varnothing, y_1) = (0, 0, 0).$$

The corresponding board's payoff is $\underline{V}^A := \mu b_1$. Since $\underline{V} \geq \mu b_1$ by assumption, the shareholders always need to increase board's payoff by $\underline{V} - \underline{V}^A \geq 0$ to meet the participation constraint. To provide the transfer without distorting incentive constraints, one can, as in the case of monotonic contracting, simply increase the fixed wage. An optimal A-regime board's contract is then

$$(y_0^A, y_\varnothing^A, y_1^A) = (\underline{V} - \mu b_1, \underline{V} - \mu b_1, \underline{V} - \mu b_1),$$

and the board's expected payoff is $V^A = \max\{\underline{V}, \underline{V}^A\} = \underline{V}$.

Proof of Lemma 6: Part 1 (*Board's contract*). Deriving τ-specific board's contract is straightforward. As in the main analysis, we use that in the equilibrium of the persuasion game, board's prudence is defined as a belief τ at which the board is *indifferent* between approval and rejection, $y_\varnothing = (1-\tau)(y_0 + b_0) + \tau(y_1 + b_1)$. (This belief is unique if $y_0 + b_0 < y_1 + b_1$.) Given this indifference, the board's expected payoff is simply the board's payoff under rejection, $V_\tau^M = y_\varnothing$.

As outlined in Section 3.4, we begin with the incentive constraints only. When the shareholders minimize board's expected payoff conditional on board's prudence τ, their objective is actually to *minimize* $y_\varnothing$ subject to (i) board's normality constraints, $y_0 + b_0 \leq y_\varnothing \leq y_1 + b_1$, (ii) board's indifference at τ, $y_\varnothing = (1-\tau)(y_0 + b_0) + \tau(y_1 + b_1)$, and (iii) limited liability constraints, $(y_0, y_\varnothing, y_1) \in \mathbb{R}_+^3$.

The argument in Proof of Lemma 1 that it is sufficient to study only $\tau \geq \tau_N$ applies here as well. For $\tau \geq \tau_N$, the shareholders need to increase $y_\varnothing$ by $(1-\tau)b_0 + \tau b_1$ to make board indifferent at τ.[14] In contrast to monotonic contracting, it is not necessary to increase y_1. Precisely:

$$(y_0, y_\varnothing, y_1) = (0, (1-\tau)b_0 + \tau b_1, 0).$$

The board's expected payoff is $\underline{V}_\tau^M = y_\varnothing = (1-\tau)b_0 + \tau b_1$. Notice we can also write this non-monotonic contract as $(y_0, y_\varnothing, y_1) = (0, \underline{V}_\tau^M, 0)$.

We proceed to the second step. To satisfy the board's participation constraint, it is sufficient to add a transfer $\max\{\underline{V} - \underline{V}_\tau^M, 0\}$ to each of the three outcomes; this fixed transfer will not affect either board's normality or prudence:

$$y_{\tau,0}^M = y_{\tau,1}^M = \max\{\underline{V}_\tau^M - \underline{V}, 0\}; y_{\tau,\varnothing}^M = \max\{\underline{V}_\tau^M, \underline{V}\}.$$

Consequently, the board's expected payoff is $V_\tau^M = \max\{\underline{V}, \underline{V}_\tau^M\}$.

Part 2 (*CEO's contract*). This part replicates Part 2 in Proof of Lemma 1. The τ-specific M-regime CEO's contract is $x_{\tau,0}^M = x_{\tau,\varnothing}^M = x_{\tau,1}^M = \underline{U} - \underline{U}_\tau^M = \underline{U} - \mu\frac{1-\tau}{\tau}c_0 - \mu c_1 < 0$. Consequently, the CEO's expected payoff is $U_\tau^M = \max\{\underline{U}, \underline{U}_\tau^M\} = \underline{U}$ and the CEO's rent is zero.

Proof of Lemma 7: We evaluate the marginal effects of an increase in τ on the shareholders' payoff S_τ^M:

- Total value (positive effect): As in the main analysis, the marginal effect of an increase in τ is $\frac{\mu}{\tau^2}(1 - c_0 - b_0) > 0$. As τ approaches one, the marginal effect

[14]See that a required increase in $y_\varnothing$ will not violate board's normality.

decreases to $\mu(1-c_0-b_0)>0$.

- Board's rent (weakly negative effect): The board's minimized payoff consistent with the board's incentive constraints only is $\underline{V}_{\tau}^{M}=(1-\tau)b_0+\tau b_1$ and the board's rent is $R_{B,\tau}^{M}=\max\{\underline{V}_{\tau}^{M}-\underline{V},0\}$. Using that $\underline{V}_{\tau}^{M}$ is increasing in τ, the marginal effect of an increase in τ on board's rent is zero when $\tau<\tau_B$, where $\tau_B:=\frac{\underline{V}-b_0}{b_1-b_0}$ is the level of precision at which $\underline{V}_{\tau}^{M}=\underline{V}$. (In contrast to the main analysis, we now may have $\tau_B\geq 1$.) When $\tau>\tau_B$, the marginal effect is $b_1-b_0>0$. As the rent enters the shareholder's payoff S_{τ}^{M} negatively, we speak of a weakly negative effect through a weakly higher board rent.

As in the main analysis, first abstract away from the kink in the board rent function and derive the level of precision at which the two marginal effects are equal, $\frac{\mu}{\tau^2}(1-c_0-b_0)=b_1-b_0$:

$$\tau_S:=\sqrt{\mu\frac{1-c_0-b_0}{b_1-b_0}}.$$

- Suppose $\max\{\tau_B,\tau_S\}<1$. It is clearly optimal to increase τ up to $\max\{\tau_B,\tau_S\}$ (total value effect dominates board rent effect). It is also clearly optimal to decrease τ down to $\max\{\tau_B,\tau_S\}$ (board rent effect dominates total value effect). The optimum is $\tau_M=\max\{\tau_B,\tau_S\}$.

- Suppose $\max\{\tau_B,\tau_S\}\geq 1$. Again, it is clearly optimal to increase τ up to $\max\{\tau_B,\tau_S\}$ (total value effect dominates board rent effect). Given that $\tau\leq 1$, the optimum is $\tau_M=1$.

Proof of Proposition 5: As in the main analysis, we will derive the overall effect of a parametrical change on the shareholders margin by observing the direct and indirect effects. We also use that the indirect effect is zero when $\tau_M=1$ (a fixed precision) and when $\tau_M=\tau_S$ (due to the Envelope Theorem). Table 4 lists direct, indirect and the overall effect of each parametrical change. When analyzing the direct effect, we exploit the following properties: (i) If $\tau_M=\tau_B$, then $R_B^M=0$. (ii) If $\tau_M=\tau_S$, then $R_B^M>0$.

The only inconsistency between the direct and indirect effect is with respect to the effect of b_0 when $\tau_M=\tau_B$. By inserting $\tau_M=\tau_B$ into the margin, we however observe that the positive indirect effect is dominating over the negative direct effect if $\underline{V}$ is sufficiently small, $\underline{V}<1-c_0$, which is true.

Table 4: Regime choice for non-monotonic contracts (in favor of A-regime)

Effect	M-regime optimum	$\underline{U}$	$\underline{V}$	c_0	c_1	b_0	b_1
direct	$\tau_M = 1$	$+/0$	$-/0$	$-/0$	$-/0$	0	$+/0$
	$\tau_M = \tau_B$	$+/0$	0	$-$	$-/0$	$-$	0
	$\tau_M = \tau_S$	$+$	$-$	$-$	$-$	$+$	$+$
indirect	$\tau_M = 1$	0	0	0	0	0	0
	$\tau_M = \tau_B$	0	$-$	0	0	$+$	$+$
	$\tau_M = \tau_S$	0	0	0	0	0	0
overall	$\tau_M = 1$	$+/0$	$-/0$	$-/0$	$-/0$	0	$+/0$
	$\tau_M = \tau_B$	$+/0$	$-$	$-$	$-/0$	$+$	$+$
	$\tau_M = \tau_S$	$+$	$-$	$-$	$-$	$+$	$+$
overall, robust	$\tau_M \leq 1$	$+/0$	$-/0$	$-/0$	$-/0$	$+/0$	$+/0$

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