Compensation Duration, Shareholder Governance, and Managerial Short-Termism

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Abstract

In this paper, I investigate the interaction between the duration of executive compensation and shareholder governance. I show that short-term compensation can elicit shareholder intervention and thus enhance firm value. The central mechanism is that the use of short-term incentives enables informed incumbent shareholders to commit to using their private information to intervene (voice) instead of selling their shares (exit). Without a commitment to voice, incumbent shareholders might find, ex post, that exit is more appealing than voice if they privately observe that a firm’s type is bad. Short-term incentives encourage a good firm to take actions that reveal its type early on. This, in turn, reduces the information advantage of the incumbent shareholders and their ability to profit from exit. Effectively, short-term compensation serves as a commitment device for value-enhancing intervention.

Key Words: Executive Compensation, Corporate Governance, Shareholder Engagement

JEL Classification: G34, M12, M40.

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1 Introduction

Managerial short-termism has attracted much attention in academia and the popular press. The concern is that managers might focus on increasing short-term performance at the expense of long-term value. Large shareholders with short horizons are sometimes blamed for fostering managerial short-termism.\(^1\) Large incumbent shareholders such as venture capitalists and private equity investors have been shown to provide managers with short-term incentives through compensation plans (Cadman and Sunder, 2014).\(^2\) To combat short-termism, many commentators have proposed reforms on executive compensation that intend to extend the duration of managerial compensation (e.g., Bebchuk and Fried, 2010; Posner, 2009).

However, the demand for short-term performance can expose problems early on, which facilitates external corrective intervention to get them fixed.\(^3\) External intervention from large shareholders, otherwise known as voice, plays an important role in creating value, for example, by spurring innovation (Brav et al., 2014) and by shaping capital expenditures (Klein and Zur, 2009; Matanova, 2015). Nonetheless, voice is not the only channel through which large shareholders engage in governance. They can also sell a firm’s shares if it underperforms, otherwise known as exit (Edmans, 2009; Admati and Pfleiderer, 2009).\(^4\)

In this paper, I show that short-term compensation can be optimal when the interaction between the duration of executive compensation and shareholder governance through voice or exit is taken into account. Short-term compensation acts as a substitute for commitment by large incumbent shareholders to voice instead of exit if they privately learn that a firm’s type turns out to be bad. A short-term compensation plan encourages a good firm to take

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\(^1\)On March 31, 2015, Larry Fink, chairman and CEO of BlackRock, sent a letter to S&P 500 CEOs stating, “more and more corporate leaders have responded with actions that can deliver immediate returns to shareholders ... while underinvesting in innovation, skilled workforces or essential capital expenditures necessary to sustain long-term growth.”

\(^2\)According to a survey by PricewaterhouseCoopers (2013), private equity portfolio companies often tie vesting of stock options to short-term metrics such as annual financial targets and exit-based performance.

\(^3\)In a recent article in The Economists titled “The Tyranny of the Long Term: Let’s not Get Carried Away in Bashing Short-Termism”, the author states, “[s]hort-term demands ... can force problems out in the open, the quicker to get them fixed,” and “[long-termism] is a recipe for failure in such businesses as social media, where firms are constantly forced to abandon their plans and ‘pivot’ to a new strategy.”

\(^4\)See Edmans (2014) for a comprehensive review of both the theoretical and empirical literature.
actions that reveal its type early on that in turn reduces incumbent investors’ information advantage. As a result, the trading profit from exit decreases, making voice more appealing ex post, which enhances value. Contrary to the view that short-term incentives imposed by incumbent shareholders hurt the long-term value of the firm, I show that they can enhance value by inducing intervention. From this perspective, regulation and other actions that aim to lengthen compensation duration might distort large incumbent shareholders’ incentives to intervene and, hence, reduce the firm’s value.

To elaborate, my model features a firm initially funded by an incumbent shareholder (e.g., a private equity investor) and managed by a manager. The incumbent shareholder first chooses a managerial compensation scheme and then sells an initial stake to uninformed investors. At a later stage, the incumbent shareholder privately observes the firm’s type and chooses between voice and exit if the firm turns out to be a bad firm without a profitable investment opportunity. Central to my argument is the idea that short-term managerial compensation serves as a commitment device for value-enhancing intervention, allowing the incumbent shareholder to sell the initial stake at a higher price. The price of the initial stake set by the uninformed investors incorporates the impact of the incumbent shareholder’s subsequent choice between voice and exit. The uninformed investors benefit from the enhanced value triggered by voice but suffer trading losses caused by exit. Hence, the price of the initial stake is higher if uninformed investors expect that voice is more likely than exit. This conjecture about the incumbent shareholder’s choice is based on the publicly observed managerial compensation plan. A compensation plan with a larger weight on short-term incentives encourages a good firm (with many profitable investment opportunities) to differentiate itself from a bad firm by cutting intangible investment to boost short-term earnings at the expense of long-term value. The resultant enhanced earnings informativeness about the firm’s type reduces the incumbent shareholder’s information advantage, which

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5 According to a report of PricewaterhouseCoopers (Steve and Aaron, 2012), a partial IPO exit is a common strategy among private equity firms. In a Fortune article on Jan. 25, 2011, Dan Primack states, “[p]rivate equity firms usually sell few of their shares via IPO, instead slowly bleeding out over subsequent months and years (once lock-up provisions expire).”
lowers the trading profit from exit. Consequently, the incumbent shareholder chooses instead to engage in a higher level of value-enhancing intervention. In equilibrium, the correct conjecture about the choice between voice and exit is incorporated into the price of the initial stake. Therefore, the use of short-term incentives allows the incumbent shareholder to commit to intervention and to sell a stake at a higher price ex ante.

Before learning the firm’s type, the incumbent shareholder determines the optimal compensation duration, trading the cost of underinvestment by a good firm for the benefit of a higher level of value-enhancing intervention on a bad firm (which results in a higher price for the initial stake). Thus, the model predicts how compensation duration varies across firms. I find compensation duration to be longer in firms with more growth opportunities, greater R&D intensity, and better recent stock performance. These results are consistent with the empirical evidence in Gopalan et al. (2014) and Edmans et al. (2015). Moreover, I find that compensation duration decreases weakly with the value of intervention in a bad firm. Hence, a shorter compensation duration could imply a higher value of the intervention by an incumbent shareholder instead of a more severe agency problem between an incumbent shareholder and other investors. I also find that compensation duration is non-monotonic in the cost of intervention. When the cost of intervention is low, voice dominates exit, and there is no need to use short-term compensation as a substitute for commitment. When the cost of intervention is high, voice is dominated by exit, and short-term compensation is no longer an effective commitment device. A short-term compensation scheme is effective at an intermediate cost of intervention.

In the base model, I assume the incumbent shareholder is the only informed investor in order to highlight the use of short-term incentives as a commitment device. In the extensions, I first introduce a sophisticated institutional investor (such as a mutual fund) who buys part of the initial shares sold by the incumbent shareholder. The institutional investor competes on exit with the incumbent shareholder. This competition reduces the trading profit from exit, making voice more appealing to the incumbent shareholder. Exit by the institutional investor can (in place of short-term compensation) serve as a substitute for the commitment to a value-
enhancing intervention by the incumbent shareholder. In other words, compensation duration is lengthened because of the presence of the institutional investor, even if the institutional investor has no say on compensation design. This result is consistent with the empirical evidence in Cadman and Sunder (2014), who show that institutional ownership mitigates the use of short-term incentives by a venture capitalist after an initial public offering. The mechanism illustrated here is different from the existing explanation that institutional investors strengthen corporate governance.

In another extension, I consider two groups of shareholders with different investment horizons and different governance mechanisms. Specifically, I modify the model to explain the use of short-term incentives in the presence of hedge fund activists. Institutional investors are sometimes criticized for merely talking publicly about long-term value but being reluctant to push for long-term growth in response to hedge fund activism (Pozen, 2015). I show that short-term compensation can be optimal when long-term investors (such as index funds), who influence managerial compensation through large voting blocs, rely on intervention by a short-term blockholder or large shareholder (such as a hedge fund) to enhance firm value. In other words, the long-term investors design a short-term incentive plan to induce value-enhancing intervention by the short-term blockholder.

Overall, this paper contributes to the literature in three ways. First, it provides a new rationale for the use of short-term incentives in executive compensation. A short-term incentive plan serves as a commitment device for value-enhancing intervention. Second, this paper contributes to the debate on the costs and benefits of shareholder governance. Specifically, the result from the base model reconciles the contradictory roles played by private equity firms and venture capitalists (i.e., value-enhancing monitoring versus

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6Generally, institutional ownership has been shown to increase the use of equity incentives (e.g., Hartzell and Starks 2003; Fernandes et al. 2013), which might induce myopia if combined with short vesting periods. Gopalan et al. (2014) show that managers typically have significant equity vesting in the short term.

7The result is consistent with the evidence that a higher level of shareholder rights is associated with less pronounced lengthening of incentive horizon (intended to address short-termism) (Dikolli et al., 2013).

8As mentioned in a speech by SEC Chair Mary Jo White on March 19, 2015, “an intense debate is taking place in the business, legal and academic communities as to whether activism by hedge funds and others is a positive or negative force for U.S. companies and the economy.”
short-term orientation). The extensions provide new implications for the impact of mutual 
fund trading and hedge fund activism on managerial short-termism. Third, while numerous 
studies have investigated executive compensation and shareholder governance through voice 
and exit independently, little is known about how executive compensation and shareholder 
governance interact with each other. This paper fills the gap.

The rest of the paper proceeds as follows. Section 2 reviews the related literature. Section 
3 presents the model setup and the sequence of events. Section 4 studies two benchmarks. 
Section 5 investigates the optimal compensation duration. Section 6 studies extensions with 
multiple informed investors and Section 7 concludes. All proofs are provided in an appendix.

2 Related Literature

This paper is not the first paper to rationalize the use of short-term incentives in CEO 
compensation. The research studies the problem from the perspective of an optimal 
compensation contract in the presence of moral hazard. Specifically, the optimal 
compensation contract might depend on the short-term market price, because of the following 
scenarios: the additional information content generated in the capital market (Bushman and 
Indjejikian, 1993; Holmström and Tirole, 1993; Dutta and Reichelstein, 2005), the speculative 
motive of the firm’s controlling shareholders (Bolton et al., 2006), market attention inducing 
managers to truthfully disclose soft information (Almazan et al., 2008), improved decisions on 
project abandonment from allowing CEOs to time their stock option exercises (Laux, 2010), 
and more efficient CEO replacement based on early feedback about managerial ability from 
short-term investment (Laux, 2012). In contrast, in this paper, the short-term incentive is 
used as a commitment device for value-enhancing intervention in a bad firm by an incumbent 
shareholder.

The paper is related to the long literature and debate on the costs and benefits of shareholder 
governance. The early theoretical papers that were motivated by the takeover wave in the 1980s 
illustrate some unanticipated costs from shareholder intervention, such as discouraging ex-
Information acquisition by managers (Shleifer and Vishny, 1986) and managerial myopia (Stein, 1988). The finance literature (e.g., Maug 1998; Kahn and Winton 1998; Back et al. 2013) focuses on the influences of liquidity and ownership structure on the effectiveness of shareholder governance and reaches different conclusions by considering different underlying forces behind voice and exit. The literature also debates the governance role of venture capital (VC) and private equity (PE) investors. On one hand, the presence of PE investors can have a value-enhancing effect, for example, by providing financial and managerial support (Barry et al., 1990), enhancing earnings quality (Katz, 2009), and improving corporate governance and investment policies (Krishnan et al., 2011; Matanova, 2015). On the other hand, the literature also criticizes PE investors for having a short-term orientation because of the pressure to obtain fast results from the limited partnerships investors (Arthurs et al., 2008). The short-termism of the VC and PE investors might lead to short-term managerial incentives (Cadman and Sunder, 2014) and less timely bad news disclosure (Ertimur et al., 2014). This paper reconciles this contradictory evidence by showing that the short-term incentives imposed by blockholders such as VC or PE investors can encourage value-enhancing monitoring and intervention. Regarding the literature on exit, Edmans (2009) shows that the exits of blockholders that are driven by self-interest can improve price and investment efficiencies. Admati and Pfleiderer (2009) show that exit can also be effective in overcoming the moral hazard problem. Building on Edmans (2009), Song (2014) investigates the impact of the activists’ reputation concerns on the effectiveness of exit and voice. This paper also builds on Edmans (2009) but focuses instead on the choice of the compensation horizon.

This paper is also related to a small stream of literature that studies the interaction between different governance mechanisms. Cohn and Rajan (2013) find that the internal governance by a board, and the external governance by an activist, can be complementary or substitute for each other depending on the strength of the external governance. In Levit (2014a,b), an active

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9 More recent literature focuses on “low cost” shareholder activism (Ferri, 2012) such as shareholder proposal and voting. Levit and Malenko (2011) find that a strongly biased activist might make the non-binding voting for shareholder proposals more informative. Matsusaka and Ozbas (2014) distinguish the shareholder’s right to propose from the right to vote and find proposal right is more effective but might result in managerial accommodation in favor of a biased activist.
shareholder who has superior information to that of a manager communicates with the manager to change that manager’s action. Levit investigates how exit and ex-post intervention impact the effectiveness of communication accordingly. The focus of my paper is different in that it examines the interaction between executive compensation and shareholder governance through voice and exit.

3 Base Model

The base model adapts the framework in Edmans (2009), Edmans et al. (2013), and Song (2014) to incorporate endogenous compensation duration. There are four players in the model: a manager (referred to as “he”), an incumbent shareholder (referred to as “she”), uninformed investors, and the market maker. All players are assumed to be risk neutral. Figure 1 provides an overview of the event sequence.

At time 0, the firm is initially funded by the incumbent shareholder (e.g., a PE investor) and managed by the manager. The total number of share units is normalized to 1. The incumbent shareholder is endowed with a stake of $1 - \mu$, and the remaining $\mu$ shares are equity incentives to the manager. The incumbent shareholder first chooses a compensation scheme $w$, that determines the structure of the equity incentives (to be specified later). Then, the incumbent shareholder keeps a stake of $\alpha$ and sells a stake of $1 - \alpha - \mu$ to competitive uninformed investors at price $P_0$, where $\alpha \in (0, 1 - \mu)$ is exogenous for liquidity reasons.

At time 1, the manager privately observes the firm type $\theta$ and determines the normalized investment policy $K \in [0, 1]$. The firm has two possible types, $\theta \in \Theta \equiv \{B, G\}$. The prior distribution of $\theta$ is common knowledge in that $\theta = G$ with probability $P_r(\theta = G) = \varphi$. Type $B$ ($G$) corresponds to a bad (good) quality firm. A firm of type $\theta$ is referred to as a “$\theta$-firm,” and its manager is referred to as a “$\theta$-manager.”

At time 2, the firm’s interim signal $s \in \{s_L, s_H\}$, such as an earnings announcement, is realized and publicly disclosed. The interim signal serves as an imperfect but hard (unmanipulable) signal for the firm. I refer to $s = s_H$ as a high signal and $s = s_L$ as a low
At time 3, the incumbent shareholder chooses between voice and exit based on private information on firm type $\theta$. The incumbent shareholder first decides whether to intervene and then decides how many shares to trade. Meanwhile, the uninformed investors suffer a liquidity shock and provide liquidity demand. The market maker clears the market and sets the market price at $P$ as in Kyle (1985).

At time 4, firm value $V$ becomes publicly known, and the payoffs of all players are realized.

Having completed the timeline, I specify more details of the elements in the model as follows:

**Compensation Scheme**: The endogenous incentive structure is the key new feature introduced in this model. The incumbent shareholder designs compensation scheme to balance short-term equity incentives, that is, interim market price $P$, with long-term incentives, that is, realized cash flow or firm value $V$. An incentive structure $w \in W \equiv [\underline{w}, \bar{w}]$, $0 \leq w \leq \bar{w} \leq 1$, allows the manager to sell $w\mu$ shares at time 3 and to hold the remaining $(1 - w)\mu$ shares until time 4. I assume the manager sells his shares once allowed for liquidity.

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10In a discussion about short-termism and executive compensation, Donald A. Norman, a director of economic studies at the Manufacturers Alliance for Productivity and Innovation (MAPI), states that “total shareholder return is not the best measure of performance, especially from a company’s long-term perspective. The pay and performance rule risks incentivizing companies to focus on short-term gains (say, by cutting costs and delaying investments) at the expense of long-term investments which can, in the immediate term, reduce total shareholder return. That is, the rule risks contributing to short-termism.”
reasons, which can also be justified by the empirical evidence in Edmans et al. (2015) who show that equity vesting significantly predicts equity sales. In this paper, I focus on the optimal compensation duration (Cadman and Sunder, 2014) or pay duration (Gopalan et al., 2014) rather than the optimal contracting problem for the manager.\textsuperscript{11} The restriction $[w, \bar{w}]$ reflects other forces for managerial short-termism that are not explicitly modeled, such as a takeover threat (Stein, 1988) or a concern for managerial reputation (Narayanan, 1985). The compensation scheme is publicly disclosed.\textsuperscript{12}

**Investment:** The investment might affect the realization of the long-term value $V$ and the interim signal $s$ depending on firm type $\theta$. In terms of long-term value $V$, the investment unambiguously increases the long-term value for a G-firm. Investment of $K \in [0, 1]$ boosts G-firm’s value to $V_G = X + gK$, where $X$ represents the fundamental value of the asset in place of a good firm, and the parameter $g$ captures the extent to which the investment increases long-term value. The investment does not add value for a B-firm, and a B-firm is worth $V_B = 0$. In terms of the interim signal $s$, a G-firm generates signal $s = s_H$ with probability $\frac{1 - \gamma K^2}{2}$ and signal $s = s_L$ with probability $\frac{1 + \gamma K^2}{2}$, where $0 < \gamma \leq 1$. The primary interpretation is that the investment increases the probability of a good firm delivering low short-term earnings. A B-firm generates signal $s = s_L$ with probability 1. While signal $s$ is public, the firm type $\theta$ and the investment $K$ are observable only to the manager and the incumbent shareholder, but are unobservable to the uninformed investors or market maker.

**Voice:** Intervention in a bad firm is public and value-enhancing so that the value of the bad firm is improved from 0 to $X$ (which is equal to the value of a good firm without intangible investment). The intervention is costly, and the private cost to the incumbent shareholder is $\rho \tau X$ where $\rho > 0$ represents the scale of cost relative to the benefit of intervention $X$, and $\tau$ is a random variable uniformly distributed on $C \equiv [0, 1]$. The distribution of $\tau$ is common

\textsuperscript{11}In Gopalan et al. (2014), “pay duration” is a measure of managerial horizon incentives computed as “the weighted average of the vesting periods of the different components of executive pay.” Cadman and Sunder (2014) concurrently develop a similar measure that they refer to as “compensation duration.”

\textsuperscript{12}To meet the Item 402 disclosure requirements of Regulation S-K, companies planning on going public are required to provide executive compensation disclosure in their registration statement on Form S-1, and public companies are required to provide executive compensation disclosure in the annual proxy statement or 10-K form.
knowledge but $\tau$ is unknown ex ante and learned by the incumbent shareholder at time 3. After learning $\tau$, the incumbent shareholder decides whether to intervene, denoted by $a \in \mathbf{A} \equiv \{0, 1\}$, where $a = 0$ represents not intervening, and $a = 1$ represents intervening.

**Exit**: By the model setup, if $s = s_H$, then the market maker knows the firm is good. If $s = s_L$ and the incumbent shareholder publicly intervenes (i.e., $a = 1$), then the market maker knows the firm is bad, and the firm value improves to $X$. In either case, the incumbent shareholder cannot gain any further profit by trading, so her trading is irrelevant. Hence, I focus on the incumbent shareholder’s trading strategy when $s = s_L$ and there is no intervention (i.e., $a = 0$), which I refer to as exit. The incumbent shareholder might sell a fraction of her shares, $\beta \in [0, \alpha]$, at time 3. I assume $\beta \leq \alpha$ to preclude short selling.

**Market Price**: At time 3, the uninformed investors demand $u$ due to a liquidity shock, where $u$ is a random variable with density function $f(u)$ that is defined as $f(u) = \lambda \exp(-\lambda u)$ if $u > 0$ and $f(u) = 0$ if $u \leq 0$. The market maker observes only the aggregate order $d = u - \beta$ but not the individual orders and sets the market price at $P = E[V|w, a, s, d]$. At time 0, the uninformed investors demand the price of the initial stake $P_0$ to break even, because they anticipates the liquidity shock at time 3.

The manager’s objective function is:

$$U_C = \mu (wP + (1 - w)V). \tag{1}$$

The manager’s objective depends on the short-term market price $P$, which might potentially be affected by the incumbent shareholder’s intervention and trading strategy.

The incumbent shareholder’s objective is to maximize the expected profit. Specifically, the incumbent shareholder’s profit is:

$$U_B = (1 - \alpha - \mu) P_0 + \beta P + (\alpha - \beta) V - a\rho \tau X, \tag{2}$$

where $(1 - \alpha - \mu) P_0$ results from selling the stake of $1 - \alpha - \mu$ to the uninformed investors at
time 0, $\beta P$ is the trading profit from selling $\beta$ shares at time 3, $(\alpha - \beta) V$ is the value of the shares she holds until the end of the game, and $\rho \tau X$ is the intervention cost.

Before the analysis of the equilibrium, I discuss some assumptions on the technology and information structure. First, I assume the investment is unobservable to outsiders. This specification reflects the fact that long-term investment, such as employee training or investment in organizational capital, is often intangible. Thus, the intangible investment is difficult to separate from other corporate expenses. In other words, the investors cannot tell whether high corporate expenses are due to the desired investment (a $G$-firm choosing a high $K$) or bad firm quality (a $B$-firm).\(^{13}\)

Second, the intangible investment increases the probability of the firm delivering low short-term earnings (although the intangible investment increases the long-term value of a $G$-firm). The primary interpretation is that intangible investment is typically expensed and, thus, lowers earnings, but is difficult to distinguish from a loss due to low firm quality.\(^{14}\)

Third, intervention is public and value-enhancing but costly to the incumbent shareholder. I assume the intervention is public to simplify the analysis, which can also be justified by the Regulation Fair Disclosure rule, which mandates that all publicly traded companies must disclose material information to all investors at the same time. The value-enhancing intervention by the incumbent shareholder is consistent with the empirical evidence that finds a positive association between the firm’s performance and the active post-IPO involvement of VC and PE investors (Barry et al., 1990; Katz, 2009; Krishnan et al., 2011; Matanova, 2015). The cost comes from the time and resources the incumbent shareholder devotes to the intervention.

I aim to find a perfect Bayesian equilibrium that is defined formally as followings:

\(^{13}\)Indeed, even if the investment is listed as a separate item in either the income statement (intangible investment such as R&D and advertising) or the cash flow statement (tangible investment such as capital expenditure), it is difficult to distinguish the quality of the investment. The benefit of the investment is uncertain in the long run and can vary enormously from firm to firm. Cohen et al. (2013) find that “the stock market appears unable to distinguish between ‘good’ and ‘bad’ R&D investment.”

\(^{14}\)Alternatively, the investment decision $K$ can be interpreted as a decision of capital allocation (Laux, 2012) or project choice (Gigler et al., 2014) between a short-term project and a long-term project. Compared with a long-term project, a short-term project is more likely to generate high cash flow in the short-term but low cumulative cash flow in the long-term. Hence, a higher investment $K$ on the long-term project instead of the short-term project lowers the cash flow in the short-term.
Definition 1. The incumbent shareholder’s compensation structure strategy \( w \in W \), the G-manager’s investment strategy \( K : W \rightarrow [0,1] \), the incumbent shareholder’s intervention strategy \( a : \Theta \times W \times \{s_L, s_H\} \times C \rightarrow A \) and trading strategy \( \beta : \Theta \times W \times \{s_L, s_H\} \times C \rightarrow [0,\alpha] \), the market maker’s pricing strategy \( P : W \times \mathbb{R} \times A \times \{s_L, s_H\} \rightarrow \mathbb{R} \), the market maker’s belief \( \mu \) about manager’s type \( \theta = G \) without observing intervention, and the market maker’s conjecture about the G-manager’s investment level \( \hat{K} \) constitute a perfect Bayesian equilibrium if and only if:

1. Given \( \mu \) and \( \hat{K} \), \( P \) causes the market maker to break even for any \( w \in W \), \( a \in A \), \( s \in \{s_L, s_H\} \), and \( d \in \mathbb{R} \);

2. Given \( \hat{K} \) and \( P \), \( a \) and \( \beta \) jointly maximize the incumbent shareholder’s expected payoff for any \( \theta \in \Theta \), \( w \in W \), \( s \in \{s_L, s_H\} \), and \( \tau \in C \);

3. Given \( a \), \( \beta \), and \( P \), \( K \) maximizes the G-manager’s expected payoff for any \( w \in W \);

4. Given \( a \), \( \beta \), \( P \), and \( \hat{K} \), \( P_0 \) causes the uninformed investors to break even for any \( w \in W \);

5. Given \( a \), \( \beta \), \( P \), \( \hat{K} \), and \( P_0 \), \( w \) maximizes the incumbent shareholder’s expected payoff;

6. The beliefs are consistent with the equilibrium strategies.

4 Benchmarks

Before analyzing the base model, I study two benchmarks in which the incumbent shareholder can exert governance through either exit or voice only.

4.1 Exit Only

First, I look at a benchmark in which the incumbent shareholder cannot exert governance through voice in a bad firm that might be due to either a lack of expertise or the enormous cost of intervention. In such a case, the incumbent shareholder chooses to sell her remaining shares.
after privately observing that a firm is bad. Nonetheless, the option to exit is neither detrimental nor profitable to the incumbent shareholder ex ante because the ex-post trading profit from exit offsets the ex-ante price premium demanded by the uninformed investors. The trading profits from exit come from the trading losses of the uninformed investors. The uninformed investors anticipate the expected trading losses, which are reflected in the price discount of the initial stake. Because exit is irrelevant ex ante, the incumbent shareholder aims to maximize the expected share value $(1 - \mu)V$ when designing the compensation scheme. A compensation plan with more long-term incentives is optimal because it encourages a good manager to invest in long-term growth.

**Lemma 1.** If there is no value-enhancing intervention by the incumbent shareholder, the incumbent shareholder always chooses exit upon negative private information and chooses a long compensation duration with $w^{ExitOnly} = w$.

Here, the exit option is beneficial because it causes prices to reflect fundamental value rather than current earnings. Exit implicitly lengthens the manager’s incentive horizon and encourage a good firm to invest in long-term growth, as suggested in Edmans (2009).

### 4.2 Voice Only

Now, I move to the other benchmark in which the incumbent shareholder cannot exert governance via exit. This scenario might be because of the lock-up period after an initial public offering or a lack of liquidity. In either case, the incumbent shareholder can only exert governance through intervention if she privately observes that a firm is bad. The incumbent shareholder chooses to intervene if and only if the benefit from the increased value of the remaining shares $\alpha X$ is higher than the intervention cost $\rho \tau X$, that is, $\tau < \tau^{VoiceOnly} \equiv \min \left\{ 1, \frac{\alpha}{\rho} \right\}$. The uninformed investors expect the intervention strategy and demand a price for the initial stake accordingly. To maximize the price of the initial stake and the value of the remaining shares, the incumbent shareholder provides the manager with long-term incentives to invest in long-term growth.
Lemma 2. If there is no exit option by the incumbent shareholder, the incumbent shareholder always chooses to intervene if and only if $\tau < \tau^{\text{VoiceOnly}} \equiv \min \left\{ 1, \frac{\alpha}{\rho} \right\}$ and chooses a long compensation duration with $w^{\text{VoiceOnly}} = w$.

A free-rider problem arises here: the incumbent shareholder bears all the cost of intervention but only enjoys a fraction of the benefit. Because the size of remaining shares ($\alpha$) is smaller than that of the initial holdings ($1 - \mu$), it exacerbates the free-rider problem. If the incumbent shareholder is allowed to commit to an intervention strategy ex ante with her initial holdings, there is more intervention. A pre-committed strategy is to intervene if and only if the benefit of her initial holding from intervention ($1 - \mu$) $X$ is higher than the intervention cost $\rho \tau X$, that is, $\tau < \tau^{\text{Commit}} \equiv \min \left\{ 1, \frac{1-\mu}{\rho} \right\}$. I will illustrate how the presence of exit further exacerbates the free-rider problem.

Voice not only improves the value of a bad firm but also encourages a good firm to invest in long-term growth. The prospect of public intervention in a bad firm makes low short-term earnings (due to long-term investment) less detrimental to the CEO’s stock compensation. Specifically, the public intervention reveals a firm that receives intervention is a bad firm. Hence, voice helps to differentiate a good firm with low earnings from a bad firm that always delivers low earnings.

5 Analysis

In this section, I analyze the equilibrium of the game in the base model. I solve the game by backward induction. First, I look at the incumbent shareholder’s intervention and trading strategy. Second, I move to the investment strategy of the manager in a good firm. Third, I turn to the incumbent shareholder’s choice of managerial compensation.

5.1 Intervention and Trading

I first look at the incumbent shareholder’s intervention and trading strategy given the market maker’s conjectures. The market maker’s conjecture on the investment by a good firm is denoted
by $\hat{K}$. I represent the market maker’s conjecture on the incumbent shareholder’s intervention and trading strategy by $\hat{\tau}, \hat{\beta}$, which implies the incumbent shareholder intervenes if and only if $\tau < \hat{\tau}$ and sells $\hat{\beta}$ shares if she privately observes $\theta = B$ but does not intervene.

5.1.1 Trading Strategy

I focus on exit, that is, the incumbent shareholder’s trading strategy when $s = s_L$ and there is no intervention (i.e., $a = 0$). Upon observing signal $s_L$ with no intervention, if the market maker observes a net supply (i.e., $d < 0$), the market maker knows that the incumbent shareholder is selling her shares. It immediately implies that the incumbent shareholder privately observes that the firm is a bad type (i.e., $\theta = B$). The market maker set the market price accordingly, which means $P = 0$ if $d < 0$. Otherwise, if the market maker observes nonnegative net demand (i.e., $d \geq 0$), the firm can be either a good firm with a noise demand being $u = d$ (with probability $\varphi \left( \frac{1+\gamma \hat{K}^2}{2} \right) \exp \left( -\lambda d \right)$), or a bad firm with the incumbent shareholder selling $\hat{\beta}$ shares with a noise demand of $\mu = d + \hat{\beta}$ (with probability $(1 - \varphi) \left( 1 - \hat{\tau} \right) \exp \left( -\lambda \left( d + \hat{\beta} \right) \right)$). In this case, the market maker sets the price according to the posterior belief of the firm being a good firm using the Bayes rule. Defining $\Psi = \frac{\varphi - \varphi \hat{\tau}}{1 - \hat{\tau}}$, I have the following lemma.

**Lemma 3.** Without intervention, after observing signal $s_L$ and net demand $d$, the market maker decides the price by:

$$
\begin{align*}
P &= \pi \hat{V}_G \quad \text{if } d \geq 0, \\
P &= 0 \quad \text{if } d < 0,
\end{align*}
$$

(3)

where $\hat{V}_G$ is the conjectured value of a good firm, and $\pi$ is the posterior of a firm being a $G$-firm given signal $s_L$, nonnegative net demand $d \geq 0$ and no intervention $a = 0$. The $\hat{V}_G$ and $\pi$ are
specified as follows:

\[ \hat{V}_G = X + g\hat{K} \quad (4) \]

\[ \pi \equiv \Pr (\theta = G|s_L, d \geq 0, a = 0) \]

\[ = \frac{\Psi \left( \frac{1+\gamma\hat{K}^2}{2} \right)}{\Psi \left( \frac{1+\gamma\hat{K}^2}{2} \right) + (1 - \hat{\tau}) \exp \left( -\lambda\hat{\beta} \right)}. \quad (5) \]

According to Lemma 3, without intervention, the market price of the firm with low earnings (or signal \(s_L\)) and a nonnegative net demand \(d \geq 0\) is set at \(\pi\hat{V}_G\). That market price \(\pi\hat{V}_G\) increases with the market maker’s conjecture on the investment by a good firm \(\hat{K}\). There are two reasons why a higher investment by a good firm results in a higher market price given a nonnegative net demand \(d \geq 0\). First, the higher the investment made by a good firm, the higher the probability that a good firm will deliver low earnings. Consequently, after observing low earnings and a nonnegative net demand \(d \geq 0\), the market maker is more likely to believe the firm is a good firm. Hence, the posterior of a firm being a \(G\)-firm increases, that is, the posterior \(\pi \equiv \Pr (\theta = G|s_L, d \geq 0, a = 0)\) increases with the investment \(\hat{K}\). Second, the higher the conjectured investment level by a good firm, then the higher the conjectured value of a good firm \(\hat{V}_G\) is.

Anticipating how the market maker determines the market price, the incumbent shareholder who does not intervene decides her exit strategy. Specifically, after observing signal \(s_L\) and privately learning the firm type \(\theta\), the incumbent shareholder chooses how many shares to sell so she can maximize her trading profit. If the incumbent shareholder privately learns the firm is a \(G\)-firm, she does not sell any shares because a good firm with low earnings is underpriced. Otherwise, if the incumbent shareholder privately learns the firm is a \(B\)-firm, she can increase her trading profit of \(\pi\hat{V}_G\) per share if the market maker overprices the bad firm. The overpricing occurs if and only if the market maker observes a nonnegative net demand \(d \geq 0\). The net trading demand is \(d = u - \beta\) when the incumbent shareholder sells \(\beta\) shares. The probability that the market maker observes a nonnegative net demand \(d \geq 0\) and overprices a \(B\)-firm
is \( \Pr (d \geq 0) = \Pr (u \geq \beta) = \exp (-\lambda \beta) \). The incumbent shareholder chooses the amount of shares to sell to maximize her expected trading profit:

\[
\beta^* = \arg \max_{\beta} \beta \exp (-\lambda \beta) \pi \hat{V} G.
\]  

(6)

**Lemma 4.** After privately observing a bad firm (i.e., \( \theta = B \)), if the incumbent shareholder does not intervene, then the incumbent shareholder sells \( \beta^* \) shares, which is determined by:

\[
\beta^* = \min \left\{ \alpha, \frac{1}{\lambda} \right\},
\]

(7)

with trading profit \( \beta^* \exp (-\lambda \beta^*) \pi \hat{V} G \).

The trading profit of the incumbent shareholder increases with the market maker’s conjecture on the investment by a good firm \( \hat{K} \). The trading profit depends on how much the market maker overprice a bad firm when there is a nonnegative net demand \( d \geq 0 \). By Lemma 3, without observing intervention, the higher the conjectured investment by a good firm \( \hat{K} \), then the higher is the market price of a firm with low earnings and a nonnegative net demand \( d \geq 0 \), \( \pi \hat{V} G \) is. The higher market price immediately implies that the trading profit of the incumbent shareholder is also higher.

5.1.2 Intervention Strategy

In time 3, after observing the cost of intervention, \( \rho \tau X \), the incumbent shareholder decides whether to publicly intervene or keep silent. On the one hand, if the incumbent shareholder chooses public intervention (i.e., \( a = 1 \)), then the firm value improves to \( X \). The market price of the firm is set to \( X \). The incumbent shareholder cannot gain any further profit by trading. The net benefit of the incumbent shareholder is calculated by deducting the intervention cost \( \rho \tau X \) from the benefit from the increased value of the remaining shares \( \alpha X \), which is equal to \((\alpha - \rho \tau) X \). On the other hand, if the incumbent shareholder does not intervene (i.e., \( a = 0 \)), the incumbent shareholder chooses the optimal trading strategy to maximize her trading benefit.
The trading profit is $\beta^* \exp (-\lambda \beta^*) \pi \hat{V}_G$ as shown in Lemma 4. Therefore, the incumbent shareholder chooses to intervene if and only if the net benefit of intervention is higher than the trading profit. The higher profit from intervention is true if and only if the cost of intervention is not too large, that is, $\tau$ is small enough. I denote the intervention cutoff as $\tau^*$, which is the indifference point at which the incumbent shareholder switches to public intervention rather than keeping silent and selling her shares. In other words, the incumbent shareholder chooses to intervene if and only if the intervention cost is lower than $\rho \tau^* X$.

**Lemma 5.** Given the conjecture on the investment by a good firm $\hat{K}$ and the intervention cutoff $\hat{\tau}$, the incumbent shareholder chooses public intervention, $a = 1$, if and only if the cost is lower than $\rho \tau^* X$, which is equivalent to $\tau < \tau^*$, where $\tau^*$ is determined by:

$$\alpha - \rho \tau^* X = \beta^* \exp (-\lambda \beta^*) \pi \hat{V}_G.$$ (8)

Comparing the result in Lemma 5 with that in Lemma 2, the intervention cutoff $\tau^*$ is lower than that in the benchmark with the voice only, that is, $\tau^* \leq \tau^{\text{VoiceOnly}} = \min \{1, \alpha \rho \}$. The lower intervention cutoff implies that the presence of an exit option exacerbates the free-rider problem.

The intervention cutoff $\tau^*$ decreases with the conjectured investment by a good firm $\hat{K}$. The reason is that the higher the investment by a good firm $\hat{K}$ is, then the higher the trading profit by keeping silent and choosing exit is. A higher trading profit makes keeping silent and exiting more attractive, so the incumbent shareholder is less willing to intervene. Consequently, the incumbent shareholder chooses a lower threshold of intervention cost below which the incumbent shareholder is willing to intervene.

### 5.2 Investment Stage

I now move to the investment strategy of the manager in a good firm. On the one hand, by investing $K$ in intangible assets, the long-term value of the firm increases to $X + gK$. On the other hand, the intangible investment lowers the short-term earnings and, thus, affects
the short-term market price. Specifically, if the earnings are high (with probability $\frac{1-\gamma K^2}{2}$), then the market price is $P = \hat{V}_G$. Otherwise, if the earnings are low (with probability $\frac{1+\gamma K^2}{2}$), then the market price is determined by $P = \pi \hat{V}_G$, which is the market price of a firm without intervention, and with low earnings (i.e., $s = s_L$) and a nonnegative net demand $d \geq 0$. There is a nonnegative net demand $d \geq 0$ for a good firm since the incumbent shareholder does not sell any shares of that type of firm. However, the market maker still cannot differentiate between that firm and a bad firm without intervention, and with low earnings and net demand $d \geq 0$. Hence, the market maker sets the market price for a good firm with low earnings at $P = \pi \hat{V}_G$. Therefore, the manager of a good firm decides the optimal investment level to maximize his expected payoff:

$$\max_K w \left( \left( \frac{1 - \gamma K^2}{2} \right) \hat{V}_G + \frac{1 + \gamma K^2}{2} \pi \hat{V}_G \right) + (1 - w) (X + gK).$$  \hspace{1cm} (9)

The optimal investment level is determined by balancing the trade-off between the benefit of a higher cash flow in the long-term and the cost of a lower market price in the short-term as the investment level increases. Specifically, the marginal benefit of higher investment in the long-term value of a good firm is $g$, and the marginal effect of higher investment in the expected short-term market price is $\gamma K^* (1 - \pi) \hat{V}_G$. I define $\Omega \equiv \frac{w}{1-w}$, which represents the relative weight of the short-term incentives versus the long-term incentives of the manager.

Lemma 6. Given a weight on the short-term incentives $w$, the conjectured investment by a good firm $\hat{K}$ and the conjecture on the intervention cutoff $\hat{\tau}$, the optimal investment level of the G-manager is determined by:

$$\Omega \gamma K^* (1 - \pi) \hat{V}_G = g.$$  \hspace{1cm} (10)

The optimal investment level $K^*$ determined by the manager increases with the conjectured intervention cutoff $\hat{\tau}$. A higher cutoff means a bad firm is more likely to receive public intervention. Consequently, without observing intervention, the market maker believes a firm with low earnings and net demand $d \geq 0$ is more likely a good firm, which increases the
posterior of a firm being a good firm, that is, \( \pi \equiv \Pr (\theta = G|s_L, d \geq 0, a = 0) \) is higher. Hence, the market price of a good firm with low earnings, \( \pi \hat{V}_G \), is also higher, which reduces the gap between the market price of a good firm with low earnings (\( \pi \hat{V}_G \)) and the market price a good firm with high earnings (\( \hat{V}_G \)). The reduced gap lowers the cost of delivering low earnings by a good firm. As a consequence, the marginal cost of the investment because of a higher probability of delivering low earnings decreases. The marginal benefit of the investment on the long-term value does not change. Therefore, intensive public intervention by the incumbent shareholder in a bad firm increases the investment by a good firm.

In equilibrium, the conjecture on the investment by a good firm and the intervention cutoff of the incumbent shareholder should be consistent with the strategy profiles of the good firm and the incumbent shareholder respectively. In other words, the belief should be correct in equilibrium, that is, \( K^* = \hat{K} \) and \( \tau^* = \hat{\tau} \). From Lemma 5 and Lemma 6, I have the following proposition to jointly determine the optimal investment decision of the manager in a good firm and the optimal intervention strategy of the incumbent shareholder, given a public compensation scheme.

**Proposition 1.** Given a compensation structure \( \Omega \equiv \frac{w}{1-w} \), the optimal investment level of \( G \)-manager \( K^*(\Omega) \) and the unique cutoff \( \tau^*(\Omega) \) below which the incumbent shareholder chooses to intervene are jointly determined by:

\[
\alpha - \rho \tau = \beta^* \frac{\Psi (1 + \gamma K^2) (1 + \frac{\Psi}{\lambda} K)}{\exp (\lambda \beta^*) \Psi (1 + \gamma K^2) + 2 (1 - \tau)}
\]

\[
\gamma K = \frac{1}{\Omega X + gK} \frac{\exp (\lambda \beta^*) \Psi (1 + \gamma K^2) + 2 (1 - \tau)}{2 (1 - \tau)},
\]

where \( \Psi \equiv \frac{\varphi}{1-\varphi} \), \( \beta^* = \min \{\frac{1}{\lambda}, \alpha\} \).

The unique pair of equilibrium intervention cutoff of the incumbent shareholder and equilibrium investment by a good firm \((K^*(\Omega), \tau^*(\Omega))\) is determined by the Equations (11) and (12). By Lemma 5, the optimal intervention cutoff \( \tau^* \) decreases in response to an increase in the investment by a \( G \)-firm, \( K \), according to Equation (11). The basic reasoning is that the
higher investment by a $G$-firm increases the trading profit of the incumbent shareholder, which makes exit more attractive. Thus, the incumbent shareholder has a weaker incentive to intervene and reduces the intervention cutoff. By Lemma 6, the optimal investment level $K^*$ increases in response to an increase in the intervention cutoff of the incumbent shareholder, $\tau$, according to Equation (12). The reason is that a higher intervention cutoff implies more intervention by the incumbent shareholder, so a bad firm is more likely to receive an intervention. As a response, the market price is higher for a firm that has low earnings but does not receive an intervention, which decreases the cost of delivering lower earnings that is associated with higher investment by a good firm. Therefore, a unique pair of $(K^*(\Omega), \tau^*(\Omega))$ is determined by the unique crosspoint that satisfies both equations (see Figure 2).

**Corollary 1.** A higher weight on the short-term incentives decreases the investment by a good firm and increases the value-enhancing intervention in bad firms, that is, $\frac{\partial K^*}{\partial \Omega} < 0$ and $\frac{\partial \tau^*}{\partial \Omega} > 0$.

Corollary 1 shows that a compensation structure with more short-term incentives decreases the investment by a good firm and increases the value-enhancing intervention a bad firm receives.
Figure 3: Illustration of how the investment and intervention cutoff changes with the weight on short-term managerial incentives

(see Figure 3). A higher weight on the short-term incentives makes the manager focus more on the short-term market price of the firm. However, in a good firm, a higher intangible investment increases the probability of delivering low short-term earnings, which results in a lower short-term market price. Therefore, in response to a higher weight on short-term incentives, the manager of a good firm reduces the intangible investment to maximize his expected compensation. A lower investment by a good firm in turn decreases the trading benefit of the incumbent shareholder, which makes exit less appealing. Consequently, the incumbent shareholder is more willing to intervene and, thus, increases the intervention cutoff below which the incumbent shareholder is willing to intervene.

5.3 Compensation Structure

I now turn to the choice of the compensation structure, which is the focus of the paper. First, I need to derive how the compensation structure affects the expected payoff of the incumbent shareholder. The incumbent shareholder’s payoff depends on both the price of the initial stake
and the value of the remaining shares with an exit option. The trading profits from exit of the incumbent shareholder come from the trading losses of the uninformed investors. The uninformed investors anticipate the expected trading losses when buying the initial shares. To offset the trading losses, the uninformed investors demand a price discount when buying the initial shares. Therefore, although the incumbent shareholder earns trading profits from exit ex post, the exit option does not improve her ex-ante expected payoff.

Moreover, the exit option prohibits the incumbent shareholder from committing to value-enhancing intervention in a bad firm ex post, which lowers the price of the initial stake. The uninformed investors demand the price of the initial stake to break even, according to their conjecture on the incumbent shareholder’s choice between voice and exit. That conjecture is based on the publicly observed compensation scheme. A longer compensation duration induces higher investment by a good firm, that increases the trading profit from exit. As a result, the incumbent shareholder is more likely to chooses exit over voice. A bad firm is less likely to receive intervention that enhances the firm's value. Hence, a longer compensation duration might not necessarily make the uninformed investors evaluate the initial stake at a higher price. When designing the managerial compensation plan, the incumbent shareholder considers its impact not only on motivating the manager but also on eliciting more voice than exit.

Overall, from the incumbent shareholder’s perspective, the compensation structure should be set up to maximize her ex-ante expected payoff:

$$\max_\Omega (1-\mu) [\varphi(X + gK^*(\Omega)) + (1-\varphi) \tau^*(\Omega) X] - (1-\varphi) \frac{1}{2} \rho (\tau^*(\Omega))^2 X$$

where the first term $(1-\mu) [\varphi(X + gK^*(\Omega)) + (1-\varphi) \tau^*(\Omega) X]$ is the expected value of the initial stake held by the incumbent shareholder, and the second term $(1-\varphi) \frac{1}{2} \rho (\tau^*(\Omega))^2 X$ is the expected intervention cost.

As shown in Corollary 1, a compensation structure with more short-term incentives decreases the investment by a good firm and increases the intervention a bad firm receives. The incumbent shareholder strategically chooses a managerial compensation plan by
balancing its role in encouraging long-term investment and in eliciting more voice than exit from the incumbent shareholder.

**Proposition 2.** If the value of intervention in a bad firm by an incumbent shareholder is significant enough compared with the profitability of the long-term investment by a good firm and the ex-ante probability of the firm being bad is not low, that is, $\frac{X}{g}$ and $\phi$ are not small, then the incumbent shareholder chooses a short compensation duration with $w^* > w$. Otherwise, the incumbent shareholder chooses a long compensation duration with $w^* = w$.

Proposition 2 provides the conditions under which the optimal choice for the incumbent shareholder is a short duration for the managerial compensation. The purpose of using short-term compensation (i.e., placing a higher weight on the short-term incentives, $w$) is as a substitute of commitment for the incumbent shareholder to undertake more value-enhancing intervention in a bad firm. The incumbent shareholder only desires the use of a short-term compensation plan if and only if the value of intervention in a bad firm is significant enough and the probability that a firm is bad and in need of intervention is high.

**Corollary 2.** If the incumbent shareholder chooses $w^* > w$, the expected firm value ex-ante with $w = w^*$ is higher than that with $w = w$.

Corollary 2 states that the expected firm value is higher under the optimal short compensation duration with $w = w^*$ chosen by the incumbent shareholder than under a long compensation duration with $w = w$. A shorter compensation duration elicits more value-enhancing intervention in a bad firm from the incumbent shareholder, which suggests the cost of intervention is higher under a shorter compensation duration. The cost of intervention under the optimal short compensation duration with $w = w^*$ is higher than that under a long compensation duration with $w = w$. Moreover, the optimal short compensation duration with $w = w^*$ maximizes the expected value of the incumbent shareholder’s initial holding after deducting the cost of intervention. Therefore, the expected value of the initial holding under the optimal short compensation duration with $w = w^*$ must be higher than
that under a long compensation duration with \( w = w \). The higher value immediately implies that the expected firm value is higher under the short compensation duration with \( w = w^* \).

The optimal compensation duration is determined by trading the cost of decreased long-term intangible investment by a good firm for the benefit of increased value-enhancing intervention in a bad firm. Thus, the model predicts how the compensation duration varies across firms. Because \( \Omega \) is the ratio of the weight on short-term market price to the weight on long-term cash flow, I interpret \( \frac{1}{\Omega} \) as a measure of compensation duration. Proposition 3 gives the global comparative statics.

**Proposition 3.** *(Comparative statics):*

1. Both investment \( K^* \) and compensation duration \( \frac{1}{\Omega^*} \) weakly increase with the profitability of investment \( g \).

2. Both investment \( K^* \) and compensation duration \( \frac{1}{\Omega^*} \) are weakly increase with the probability of the firm’s type being good \( \varphi \).

3. Both investment \( K^* \) and compensation duration \( \frac{1}{\Omega^*} \) weakly increase with the value of intervention on a bad firm by an incumbent shareholder \( X \).

4. Both investment \( K^* \) and compensation duration \( \frac{1}{\Omega^*} \) first weakly decrease and then weakly increase with the scale of intervention cost \( \rho \).

5. In equilibrium, the compensation duration \( \frac{1}{\Omega^*} \) and the investment \( K^* \) are positively associated with each other.

Proposition 3 implies that compensation duration is longer in firms with more growth opportunities (a higher profitability of investment \( g \)), greater R&D intensity (higher investment \( K^* \)), and better recent stock performance (a higher probability of the firm’s type being good \( \varphi \)). These results are consistent with the empirical evidence in Gopalan et al. (2014) and Edmans et al. (2015).

I also find that the compensation duration weakly decreases with the value of intervention in a bad firm by an incumbent shareholder. This finding implies that a shorter compensation
duration imposed by the incumbent shareholder might indicate a higher value from the intervention instead of the typical criticism that the incumbent shareholder is more short-term oriented.

In addition, I find the compensation duration is non-monotonic on the cost of intervention. When the cost of intervention is small, intervention dominates exit, and there is no need to use short-term compensation as a substitute for commitment. When the cost of intervention is large, intervention is dominated by exit, and short-term compensation is no longer an effective commitment device. For intermediate intervention cost, a short-term incentive plan is an effective commitment device and, thus, desirable.

6 Extensions

In the main model, I assume the incumbent shareholder is the only informed investor. In the extensions, I consider multiple informed investors and investigate the interaction between them. In the first extension, I introduce a sophisticated (informed) institutional investor who buys part of the initial shares offered by the incumbent shareholder. In the second extension, I consider two groups of shareholders with different investment horizons and different governance mechanisms.

6.1 The Presence of Sophisticated Institutional Investor

In the base model, I assumed all investors who buy shares from the incumbent shareholder are uninformed. Now I relax the assumption and assume that there is a sophisticated institutional investor (such as a mutual fund) who can also privately observe the firm type. Specifically, I assume the institutional investor buys $\alpha_{new}$ initial shares at $t = 0$ and chooses to sell $\beta_{new}$ shares at $t = 3$. In this setting, I denote the optimal weight on the short-term incentives determined by the incumbent shareholder as $w^{*I}$.

**Proposition 4.** *The optimal managerial compensation for the incumbent shareholder comprises (weakly) fewer short-term incentives in the presence of an informed institutional investor, that*
Proposition 5 implies that the compensation duration is lengthened in the presence of the informed institutional investor. This result is consistent with the empirical evidence in Cadman and Sunder (2014) who find that institutional ownership mitigates the use of short-term incentives by a venture capitalist after an initial public offering. Indeed, informed trading of the institutional investor reduces the trading profit of the incumbent shareholder when the firm turns out to be a bad firm. This reduction implies that in the presence of the institutional investor, compared with exit, the intervention becomes more attractive for the incumbent shareholder, which mitigate the limited commitment problem of the incumbent shareholder. Hence, the incumbent shareholder does not have to design the compensation scheme to have as much weight on short-term incentives, because there is less need for a commitment to intervene in a bad firm. The institutional investor (in place of short-term compensation) serves as the substitute for commitment to more value enhancing intervention. In other words, the compensation duration is lengthened in the presence of the institutional investor. The lengthened compensation duration is not due to the direct demand of the institutional investor but is an indirect consequence of the speculative trading by the institutional investor.

6.2 Multiple Shareholders with Different Governance Mechanisms

Now, I modify the base model to address whether short-term compensation is also desirable when there are multiple shareholders with different governance mechanisms. Specifically, I consider a setting in which passive long-term shareholders (such as index funds) who influence the managerial compensation through large voting blocs rely on the intervention by an active investor (such as a hedge fund) to enhance value. The passive shareholders exert influences on the design of the managerial compensation through “say on pay” or shareholder proposals. The value-enhancing intervention by an active investor is consistent with the empirical evidence that finds a positive association between firm performance and the entrepreneurial shareholder
activism (Brav et al., 2008, 2014; Klein and Zur, 2009).

In the modified model, the key difference is that the passive shareholders set the managerial compensation scheme instead of the informed incumbent shareholder, and there is no initial trading stage at time 0. The active investor who holds $\alpha$ shares privately observes the firm’s type and plays a similar role to the informed incumbent shareholder in choosing exit versus voice at time 3. A group of liquidity traders provides the liquidity supply $\mu$, which has the same distribution as the liquidity supply of the uninformed investors in the base model. The analysis of the trading stage, the intervention strategy, and the investment stage is the same as the base model. Now, I study the optimal compensation design strategy of the passive investors. I denote the optimal weight on the short-term incentives determined by the passive investors as $w^{*,II}$. The objective of the passive investors is to maximize the expected value of the firm. In this case, the optimal compensation horizon $\Omega$ is determined by:

$$\max_\Omega [\varphi (X + gK) + (1 - \varphi) \tau X] \quad (14)$$

s.t. $\alpha - \rho \tau = \beta \frac{\Psi (1 + \gamma K^2) (1 + \frac{\varphi}{X} K)}{\exp (\lambda \beta) \Psi (1 + \gamma K^2) + 2 (1 - \tau)} \quad (15)$

$$\gamma K = \frac{1}{\Omega} \frac{\frac{\varphi}{X} \exp (\lambda \beta) \Psi (1 + \gamma K^2) + 2 (1 - \tau)}{2 (1 - \tau)} \quad (16)$$

**Proposition 5.** The optimal managerial compensation scheme for the institutional investors comprises (weakly) more short-term incentives, that is, $w^{*,II} \geq w$, where the inequality is strict if $\frac{X}{g}$ and $\varphi$ is large enough, that is, the fundamental value is important enough compared with the return on the intangible investment and the ex-ante probability that the firm is bad is high enough.

Proposition 5 provides the conditions under which the passive institutional investors choose a short duration of managerial compensation in equilibrium. The resultant short compensation duration appears to exacerbate managerial myopia, which lowers the long-term investment by a good firm. A lower investment lowers the probability of a good firm delivering low earnings. The lower investment by a good firm improves the informativeness of low earnings on firm
type and, thus, reduces the active investor’s information advantage. Trading profits from exit decrease for the active investor, making exit less attractive than voice. Consequently, the active shareholder is more likely to intervene in the operations of a bad firm. The passive institutional shareholders trade off the cost of lower investment by a good firm with the benefit of more value-enhancing intervention in a bad firm by the active shareholder. The benefit from more intervention dominates the cost of lower investment if and only if the firm is likely to be bad (i.e., $\varphi$ is large enough), and the value of intervention (i.e., $X$) is high enough. When those conditions hold, it is optimal to choose a short compensation duration.

The result of Proposition 5 explains the use of short-term incentives in the presence of hedge fund activism. Short-term compensation can be optimal when long-term institutional investors who influence managerial compensation through large voting blocs rely on intervention by a short-term blockholder such as a hedge fund to enhance firm value.

7 Conclusion

In this paper, I investigate the interaction between compensation duration and shareholder governance. The paper proposes that a short managerial compensation duration can serve as a substitute of commitment for an incumbent shareholder to undertake value-enhancing intervention instead of exit. The short-term managerial compensation induces a good firm to reveal its type early on. This in turn reduces information asymmetry between the informed incumbent shareholder and the uninformed outside investors. Thus, the trading profit from exit is lower for the incumbent shareholder. Consequently, voice becomes more appealing to the incumbent shareholder, and a bad firm is more likely to receive value-enhancing intervention. Contrary to the view that short-term incentives imposed by incumbent shareholders reduce firm value, I show that they can improve firm value by inducing intervention. From this perspective, regulation and other actions aiming to extend compensation duration might distort incumbent shareholders’ incentives to pursue value-enhancing activities.

This paper has abstracted from some interesting issues. In the initial stake’s selling stage,
I assume complete information and an exogenous ownership structure so I can focus on the compensation duration. An investigation on how the incumbent shareholder jointly determines share retention and the executive compensation structure, in the presence of information asymmetry before selling the initial stake might be an interesting extension of this paper. Both share retention and the compensation scheme can be used as tools to signal the firm’s quality and to commit to future value-enhancing involvement. The extension could provide more implications for the PE-backed initial public offering. Another possible extension is to consider an alternative means of voice. While this paper focuses on direct intervention, investigating soft communication as studied in Levit (2014b) also might be interesting.

Future research could explore a related issue of the interaction between the managerial incentives and the board’s incentives, instead of the interaction between managerial incentives and the shareholder governance studied in this paper. The managerial decisions that need the approval of the board of directors are often long-term decisions such as new business strategies or major asset purchases. Can the board use short-term managerial incentives to get early feedback about the long-term decision made by the board?
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APPENDIX

A  Proof

Proof of Lemma 1: The proof is omitted.

Proof of Lemma 2: The incumbent shareholder chooses public intervention if and only if the net profit from voice is positive:

\[(\alpha - \rho \tau) X > 0 \iff \tau < \tau^{VoiceOnly} \equiv \min \left\{ 1, \frac{\alpha}{\rho} \right\}. \] (A.1)

Proof of Lemma 3: If the incumbent shareholder does not intervene and chooses to sell \(\beta\) shares, the net trading demand is

\[d = u - \beta, u \sim Exp(\lambda).\] (A.2)

The probability that there is net demand, i.e., \(d > 0\) is:

\[\Pr(d > 0) = \Pr(u > \beta) = \exp(-\lambda \beta).\] (A.3)

Given the market maker’s conjecture on the investment by the good firm, \(\hat{K}\), the intervention cutoff for the incumbent shareholder, \(\hat{\tau}\), and the trading amount of the incumbent shareholder \(\hat{\beta}\) by Bayesian rule, the posterior belief that a firm is good given no intervention, low earnings and net demand \(d \geq 0\), which is denoted by \(\pi\), is determined by:

\[\pi = \frac{\varphi \left(1 + \gamma \hat{K}^2\right)^2}{\varphi \left(1 + \gamma \hat{K}^2\right)^2 + (1 - \varphi)(1 - \hat{\tau}) \exp\left(-\lambda \hat{\beta}\right)},\] (A.4)

and the value of a good firm is given by \(\hat{V}_G = X + g\hat{K}\). Therefore, the market maker sets the market price according to:

\[
\begin{cases} 
    P = \pi \hat{V}_G & \text{if } d \geq 0 \\
    P = 0 & \text{if } d < 0
\end{cases}
\] (A.5)

Proof of Lemma 4: The incumbent shareholder’s trading strategy is determined by:

\[\beta^* = \arg \max_{\beta \in [0, \alpha]} \beta \exp(-\lambda \beta) \pi \hat{V}_G.\] (A.6)

From the first order condition, I obtain

\[(1 - \lambda \beta) \exp(-\lambda \beta) \pi \hat{V}_G = 0,\] (A.7)
which has a unique solution $\beta = \frac{1}{\lambda}$. However, because the no short selling constraint requires $\beta \in [0, \alpha]$, $\frac{1}{\lambda}$ might not be achieved if $\frac{1}{\lambda} > \alpha$. In that case, the optimal choice of $\beta$ is $\beta = \alpha$, because the marginal profit of selling an additional share (which is the LHS in the above equation) is positive for any $\beta \in \left(0, \frac{1}{\lambda}\right)$. Overall, the optimal number of shares is given by:

$$\beta^* = \min\left\{\alpha, \frac{1}{\lambda}\right\}.$$  \hspace{1cm} (A.8)

**Proof of Lemma 5:** The net profit of the incumbent shareholder from intervention is $(\alpha - \rho \tau)X$. The trading profit from exit is $\beta^* \exp(-\lambda \beta^*) \pi \hat{V}_G$. Therefore, the incumbent shareholder chooses public intervention if and only if the net profit from voice is higher than the trading profit from exit. The net profit from voice is higher when the intervention cost is lower than $\rho \tau^*X$, in which $\tau^*$ is determined by:

$$(\alpha - \rho \tau^*)X = \beta^* \exp(-\lambda \beta^*) \frac{\varphi \left(1 + \gamma \hat{K}^2\right) \left(X + g\hat{K}\right)}{\varphi \left(1 + \gamma \hat{K}^2\right) + 2 (1 - \varphi) (1 - \hat{\tau}) \exp \left(-\lambda \hat{\beta}\right)}$$

$$= \beta^* \exp(-\lambda \beta^*) \pi \hat{V}_G.$$ \hspace{1cm} (A.9)

**Proof of Lemma 6:** The CEO of a good firm decides the optimal investment level that maximizes his expected payoff:

$$K^* = \arg \max_K \left(\frac{1 - \gamma K^2}{2} \hat{V}_G + \frac{1 + \gamma K^2}{2} \pi \hat{V}_G\right) + (1 - w)(X + gK).$$ \hspace{1cm} (A.10)

From the first order condition, I get:

$$w \left(-\gamma K \hat{V}_G + \gamma K \pi \hat{V}_G\right) + (1 - w)g = 0$$

$$w \gamma K (1 - \pi) \hat{V}_G = (1 - w)g.$$ \hspace{1cm} (A.11)

Let $\Omega = \frac{w}{1 - w}$, so the equation above can be rewritten as:

$$\Omega \gamma K^* (1 - \pi) \hat{V}_G = g.$$ \hspace{1cm} (A.12)

**Proof of Proposition 1:** In equilibrium, $\hat{\tau} = \tau^*$, $\hat{\beta} = \beta^*$, $\hat{K} = K^*$, plugging $\hat{V}_G = X + g\hat{K}$ and $\pi = \frac{\psi \left(1 + \gamma K^2\right)}{\psi \left(1 + \gamma K^2\right) + (1 - \hat{\tau}) \exp(-\lambda \hat{\beta})}$ into the equations in Lemma 5 and 6, the equilibrium investment by a good firm $K^* (\Omega)$ and the equilibrium intervention cutoff of the incumbent shareholder $\tau^* (\Omega)$ given a compensation scheme $\Omega$ are jointly determined by:

$$\alpha - \rho \tau = \beta^* \frac{\psi \left(1 + \gamma K^2\right) \left(1 + \frac{q}{X} K\right)}{\exp(\lambda \beta^*) \psi \left(1 + \gamma K^2\right) + 2 (1 - \tau)}.$$ \hspace{1cm} (A.13)

$$\gamma K = \frac{1}{\Omega} \frac{\frac{q}{X} \exp(\lambda \beta^*) \psi \left(1 + \gamma K^2\right) + 2 (1 - \tau)}{2 (1 - \tau)}.$$ \hspace{1cm} (A.14)
Equation (A.14) can be rewritten as:

\[
\begin{align*}
\Omega \left( K + \frac{X}{g} \right) & \gamma K - \frac{\exp(\lambda \beta) \Psi}{2(1-\tau)} (1 + \gamma K^2) - 1 = 0 \\
\left( \Omega - \frac{\exp(\lambda \beta) \Psi}{2(1-\tau)} \right) & \gamma K^2 + \Omega \frac{X}{g} \gamma K - 1 - \frac{\exp(\lambda \beta) \Psi}{2(1-\tau)} = 0.
\end{align*}
\] (A.15)

Therefore, I obtain the investment by a good firm as a function of \( \Omega \) and \( \tau \):

\[
K^*(\tau; \Omega) = \frac{-\Omega \frac{X}{g} \gamma + \sqrt{\left( \frac{\Omega}{2} \gamma \right)^2 + 4 \left( \Omega - \frac{\exp(\lambda \beta) \Psi}{2(1-\tau)} \right) \gamma \left( 1 + \frac{\exp(\lambda \beta) \Psi}{2(1-\tau)} \right)}}{2 \gamma \left( \Omega - \frac{\exp(\lambda \beta) \Psi}{2(1-\tau)} \right) \gamma \left( 1 + \frac{\exp(\lambda \beta) \Psi}{2(1-\tau)} \right)}.
\] (A.16)

Consequently, \( \frac{\partial K^*}{\partial \Gamma} < 0 \), which implies that a heavier weight on the short-term market price reduces the intangible investment.

Let \( \Gamma = \frac{\exp(\lambda \beta \tau) \Psi}{2(1-\tau)} \), and \( K^*(\tau; \Omega) \) in Equation (A.16) can be written as a function of \( \Gamma \):

\[
K = \frac{2 (1+\Gamma)}{\Omega \frac{X}{g} \gamma + \sqrt{\left( \frac{\Omega}{2} \gamma \right)^2 + 4 \left( \Omega - \Gamma \right) \gamma (1+\Gamma)}},
\] (A.17)

and I also obtain:

\[
\frac{\partial K}{\partial \Gamma} = \frac{2 \gamma^2 + 4(\Omega - \Gamma) \gamma (1+\Gamma)}{\gamma^2 \left( \Omega \frac{X}{g} \gamma + \sqrt{\left( \frac{\Omega}{2} \gamma \right)^2 + 4 \left( \Omega - \Gamma \right) \gamma (1+\Gamma)} \right)^2}.
\] (A.18)
Thus, $\frac{\partial \tau}{\partial \tau} > 0$, so I have $\frac{\partial K^*(\tau; \Omega)}{\partial \tau} = \frac{\partial K}{\partial \tau} \frac{\partial \tau}{\partial \tau} > 0$, which implies that more intervention in bad firms increases the intangible investment of good firms.

Equation (A.13) can be rewritten as:

$$
\left(1 + \frac{g}{X} K\right) = \frac{\alpha - \rho \tau}{\beta^*} \left(\exp(\lambda \beta^*) + \frac{2 (1 - \tau)}{\Psi (1 + \gamma K^2)}\right). \tag{A.19}
$$

I denote the cutoff determined by the above equation with $\tau^* (K)$. Because the LHS increases with $K$, and the RHS decreases with both $K$ and $\tau$, I have $\frac{\partial \tau^*(K)}{\partial K} < 0$, which implies that more intangible investment by the good firms rules out the value-enhancing intervention in bad firms. More precisely, I define $T (\tau, K)$ as below:

$$
T (\tau, K) = 1 + \frac{g}{X} K - \frac{\alpha - \rho \tau}{\beta^*} \left(\exp(\lambda \beta^*) + \frac{2 (1 - \tau)}{\Psi (1 + \gamma K^2)}\right). \tag{A.20}
$$

Equation (A.13) is equivalent to $T (\tau, K) = 0$. As long as the interior solution exist, the conditions that $\alpha - \rho \tau > 0$ and $\tau \leq 1$ should be valid. Therefore, I can obtain

$$
\frac{\partial T (\tau, K)}{\partial K} = \frac{g}{X} + \frac{(\alpha - \rho \tau) (1 - \tau)}{\beta^*} \frac{4K}{\Psi (1 + \gamma K^2)^2} > 0, \tag{A.21}
$$

$$
\frac{\partial T (\tau, K)}{\partial \tau} = \frac{\rho}{\beta^*} \exp(\lambda \beta^*) + \frac{\alpha - \rho \tau + \rho (1 - \tau)}{\beta^*} \frac{2}{\Psi (1 + \gamma K^2)} > 0. \tag{A.22}
$$

Thus, I have

$$
\frac{d \tau^* (K)}{dK} = -\frac{\partial T (\tau, K)}{\partial K} \frac{\partial \tau^* (K)}{\partial \tau} < 0, \tag{A.23}
$$

which implies a higher investment by a good firm decreases the intervention cutoff of the incumbent shareholder.

Now, I prove that there is a unique pair of $(K^*, \tau^*)$ that satisfies the above equation system given $\Omega$. I have proved that the function of $\tau^* (K)$ that is determined by the Equation (A.13) decreases with $K$. I also have proved that the function of $K^* (\tau; \Omega)$ that is determined by the Equation (A.14) increases with $\tau$ and decreases with $\Omega$. Therefore, there is a unique pair of $(K^* (\Omega), \tau^* (\Omega))$ that satisfies the above equation system given $\Omega$.

**Proof of Corollary 1:** In the proof of Proposition 1, I show that the function of $\tau^* (K)$ that is determined by the Equation (A.13) decreases with $K$. I also have proved that the function of $K^* (\tau; \Omega)$ that is determined by the Equation (A.14) increases with $\tau$ and decreases with $\Omega$. Therefore, if $\Omega$ increases, then $K^* (\Omega)$ decreases and $\tau^* (\Omega)$ increases. This corollary can also be proved by showing a contradiction. Assuming $K^* (\Omega)$ increases, because $\tau^* (K)$ that is determined by the Equation (A.13) decreases with $K$, the resultant equilibrium $\tau^* (\Omega)$ should decrease. Then, because $\Omega$ increases and $K^* (\tau; \Omega)$ increases with $\tau$ and decreases with $\Omega$, these conditions imply that $K^* (\Omega)$ decreases and does not increase.
Proof of Proposition 2: The incumbent shareholder’s problem of determining the optimal \( w \) or, equivalently, the optimal \( \Omega \) is given by:

\[
\max_{\Omega} (1 - \mu) [\varphi (X + gK^* (\Omega)) + (1 - \varphi) \tau^* (\Omega) X] - (1 - \varphi) \frac{1}{2} \rho (\tau^* (\Omega))^2 X,
\]

which is equivalent to:

\[
\max_{\Omega} \Psi \left( 1 + \frac{g}{X} K \right) + \tau - \frac{\rho}{2 (1 - \mu)} \tau^2 \tag{A.24}\]

s.t. \( \alpha - \rho \tau = \frac{\beta}{\Omega} - \frac{\Psi (1 + \gamma K^2) \left( 1 + \frac{g}{X} K \right)}{\exp (\lambda \beta)} \left( 1 + \gamma K^2 \right) + 2 (1 - \tau) \tag{A.25} \)

\[
\gamma K = \frac{1}{\Omega} \frac{g}{X} \frac{\exp (\lambda \beta)}{2 (1 - \tau)} \tag{A.26}\]

The unique pair \((K, \tau)\) is determined by \(\Omega\). Observing that \(\Omega\) only appears in Equation (A.26), it is equivalent to find a \((K, \tau)\) that satisfies Equation (A.25) and maximizes the objective function (A.24). Because \(\tau^* (K)\) is a function that is defined by Equation (A.25), the equivalent optimization problem is as follows:

\[
\max_{K} \Psi \left( 1 + \frac{g}{X} K \right) + \tau^* (K) - \frac{\rho}{2 (1 - \mu)} (\tau^* (K))^2. \tag{A.27}\]

Based on the objective function A.24, the marginal benefit of increasing the investment of a good firm \(K\) is \(\Psi \frac{g}{X}\), and the marginal cost of increasing the investment of a good firm \(K\) is \(\left( 1 - \frac{\rho}{1 - \mu} \tau^* (K) \right) \frac{d\tau^* (K)}{dK} < 0\) from Lemma 5. The marginal effect of \(K\) on the marginal cost is:

\[
\frac{\partial \left[ - \left( 1 - \frac{\rho}{1 - \mu} \tau^* (K) \right) \frac{d\tau^* (K)}{dK} \right]}{\partial K} = \frac{\rho}{1 - \mu} \left( \frac{d\tau^* (K)}{dK} \right)^2 - \left( 1 - \frac{\rho}{1 - \mu} \tau^* (K) \right) \frac{d^2 \tau^* (K)}{dK^2}, \tag{A.28}\]

which is positive if I can show \(\frac{d^2 \tau^* (K)}{dK^2} < 0\) (Note that \(1 - \frac{\rho}{1 - \mu} \tau^* (K) > 0\) because \(\alpha - \rho \tau^* (K) > 0\) and \(1 - \mu > \alpha\)). Equation (A.25) is equivalent to:

\[
\Psi \left( 1 + \frac{g}{X} \right) K \left[ 1 + \frac{g}{X} K - \frac{\alpha - \rho \tau}{\beta^*} \exp (\lambda \beta^*) \right] - \frac{\alpha - \rho \tau}{\beta^*} (1 - \tau) = 0. \tag{A.29}\]

Based on the Implicit Function Theorem, I get:

\[
\Psi \left( 1 + \frac{g}{X} \right) K \left( \frac{g}{X} + \frac{\rho \tau'}{\beta^*} \exp (\lambda \beta^*) \right) + \Psi \gamma K \left( 1 + \frac{g}{X} K - \frac{\alpha - \rho \tau}{\beta^*} \exp (\lambda \beta^*) \right) + \frac{\rho \tau'}{\beta^*} (1 - \tau) + \frac{\alpha - \rho \tau}{\beta^*} \tau' = 0. \tag{A.30}\]
and
\[
\psi \gamma \left( 1 + \frac{g}{X} K - \frac{\alpha - \rho \tau}{\beta^*} \exp (\lambda \beta^*) \right) + 2 \psi \gamma K \left( \frac{g}{X} + \frac{\rho \tau'}{\beta^*} \exp (\lambda \beta^*) \right) + \frac{\psi (1 + \gamma K^2)}{2} \frac{\rho \tau''}{\beta^*} \exp (\lambda \beta^*) + \frac{\rho \tau''}{\beta^*} (1 - \tau) - 2 \frac{\rho \tau'}{\beta^*} \tau' + \frac{\alpha - \rho \tau}{\beta^*} \tau'' = 0. \tag{A.31}
\]

Hence, I obtain:
\[
\tau' = - \frac{\psi \gamma \left( 1 + \frac{g}{X} K - \frac{\alpha - \rho \tau}{\beta^*} \exp (\lambda \beta^*) \right)}{\frac{\rho}{\beta^*} \left( \psi \gamma \left( \frac{1 + \gamma K^2}{2} \right) \exp (\lambda \beta^*) + (1 - \tau) \right) + \frac{\alpha - \rho \tau}{\beta^*}} \tag{A.32}
\]
\[
\tau'' = - \frac{\psi \gamma \left( 1 + \frac{g}{X} K - \frac{\alpha - \rho \tau}{\beta^*} \exp (\lambda \beta^*) \right) + 2 \psi \gamma K \left( \frac{g}{X} + \frac{\rho \tau'}{\beta^*} \exp (\lambda \beta^*) \right) - 2 \frac{\rho \tau'}{\beta^*} \tau'}{\frac{\psi \gamma \left( 1 + \gamma K^2 \right)}{2} \frac{\rho}{\beta^*} \exp (\lambda \beta^*) + \frac{\rho}{\beta^*} (1 - \tau) + \frac{\alpha - \rho \tau}{\beta^*}}. \tag{A.33}
\]

In order to prove \( \tau'' < 0 \), it is equivalent to prove:
\[
\psi \gamma \left( 1 + \frac{g}{X} K - \frac{\alpha - \rho \tau}{\beta^*} \exp (\lambda \beta^*) \right) + 2 \psi \gamma K \left( \frac{g}{X} + \frac{\rho \tau'}{\beta^*} \exp (\lambda \beta^*) \right) - 2 \frac{\rho \tau'}{\beta^*} \tau' > 0 \tag{A.34}
\]
\[
\gamma \left( 1 + \frac{g}{X} K - \frac{\alpha - \rho \tau}{\beta^*} \exp (\lambda \beta^*) \right) + 2 \gamma K \frac{g}{X} + 2 \frac{\rho \tau'}{\beta^*} \left( \gamma K \exp (\lambda \beta^*) - \frac{\tau'}{\psi} \right) > 0, \tag{A.35}
\]

Observing that:
\[
\lim_{\psi \to 0} \frac{\tau'}{(\gamma K \exp (\lambda \beta^*)) - \frac{\tau'}{\psi}) = 0, \tag{A.36}
\]

and \( \gamma \left( 1 + \frac{g}{X} K - \frac{\alpha - \rho \tau}{\beta^*} \exp (\lambda \beta^*) \right) + 2 \gamma K \frac{g}{X} > 0 \) which does not depend on \( \psi \), I conclude that \( \tau'' < 0 \) if \( \Psi \) is not too large.

Let \( \Omega = \frac{w}{w^*} \). Because \( \partial \left[ -\left(1 - \frac{\rho}{\mu} \tau^*(K) \right) \frac{d\tau^*(K)}{dK} \right]_{\Omega=\Omega} > 0 \), I conclude that if
\[
-\left(1 - \frac{\rho}{\mu} \tau^*(K) \right) \frac{d\tau^*(K)}{dK} \bigg|_{\Omega=\Omega} > \psi \frac{g}{X}, \tag{A.37}
\]
the optimal choice for the incumbent shareholder is the short-term compensation scheme with \( w^* > w \) or equivalently \( \Omega^* > \Omega \). Plugging in Equation (A.32), the inequality
\[
-\left(1 - \frac{\rho}{\mu} \tau^*(K) \right) \frac{d\tau^*(K)}{dK} \bigg|_{\Omega=\Omega} > \psi \frac{g}{X}
\]
can be rewritten as:
\[
\left(1 - \frac{\rho}{1 - \mu} \tau^*(K) \right) \frac{\frac{1 + \gamma K^2}{2} + \gamma K \left( \frac{1 - \frac{\alpha - \rho \tau^*(K) \exp (\lambda \beta^*)}{\frac{g}{X}} + K \right) \frac{\rho}{\beta^*} \left( \frac{\psi (1 + \gamma K^2)}{2} \exp (\lambda \beta^*) + (1 - \tau^*(K)) \right)}{\frac{\alpha - \rho \tau^*(K)}{\beta^*}} \bigg|_{\Omega=\Omega} > 1 \tag{A.37}
\]
which is true if \( \frac{g}{X} \) and \( \Psi \) are not too large.

**Proof of Corollary 2:** When choosing the compensation duration, the equivalent objective of the incumbent shareholder is:
\[
\max_{\Omega} (1 - \mu) [\varphi (X + gK^* (\Omega)) + (1 - \varphi) \tau^* (\Omega) X] - (1 - \varphi) \frac{1}{2} \rho (\tau^* (\Omega))^2 X, \tag{A.38}
\]
which is the expected value of \((1 - \mu)\) shares deducted by the intervention cost. Because \(\Omega = \Omega^*\) maximizes the incumbent shareholder’s objective, I obtain:

\[
(1 - \mu) [\varphi (X + gK^*(\Omega^*)) + (1 - \varphi) \tau^*(\Omega^*) X] - (1 - \varphi) \frac{1}{2} \rho (\tau^*(\Omega^*))^2 X \\
> (1 - \mu) [\varphi (X + gK^*(\Omega)) + (1 - \varphi) \tau^*(\Omega) X] - (1 - \varphi) \frac{1}{2} \rho (\tau^*(\Omega))^2 X.
\] (A.39)

Moreover, because \(\Omega^* > \Omega\) and \(\tau^*(\Omega)\) increases with \(\Omega\), \(\tau^*(\Omega^*) > \tau^*(\Omega)\). Therefore, I get:

\[
\varphi (X + gK^*(\Omega^*)) + (1 - \varphi) \tau^*(\Omega^*) X > \varphi (X + gK^*(\Omega)) + (1 - \varphi) \tau^*(\Omega) X,
\] (A.40)

which implies that the expected firm value under the compensation duration with \(\Omega = \Omega^*\) is higher than that under the long compensation duration with \(\Omega = \Omega\).

**Proof of Proposition 3:** The unique pair of \((K, \tau)\) is determined by \(\Omega\). Observing that \(\Omega\) only appears in Equation (A.26), it is equivalent to find a \((K, \tau)\) that satisfies Equation (A.25) and maximizes the objective function (A.24). From the first order condition, I have

\[
\frac{\psi g}{X} - \left(1 - \frac{\rho}{1 - \mu} \tau^*(K)\right) \frac{d\tau^*(K)}{dK} = 0,
\] (A.41)

which can be rewritten as:

\[
\left(1 - \frac{\rho}{1 - \mu} \tau^*(K)\right) \frac{(1 + \gamma K^2)^2}{2} + \gamma K \left(1 - \frac{\alpha - \rho \tau^*(K)}{\beta^*} \exp(\lambda \beta^*) + K\right) \frac{\rho}{\beta^*} \frac{\psi (1 + \gamma K^2)^2}{2} \exp(\lambda \beta^*) + (1 - \tau^*(K)) + \frac{\alpha - \rho \tau^*(K)}{\beta^*} = 1.
\] (A.42)

Let \(\mathcal{L}^* = \left(1 - \frac{\rho}{1 - \mu} \tau^*(K)\right) \frac{(1 + \gamma K^2)^2}{2} + \gamma K \left(1 - \frac{\alpha - \rho \tau^*(K)}{\beta^*} \exp(\lambda \beta^*) + K\right) \frac{\rho}{\beta^*} \frac{\psi (1 + \gamma K^2)^2}{2} \exp(\lambda \beta^*) + (1 - \tau^*(K)) + \frac{\alpha - \rho \tau^*(K)}{\beta^*}\). Based on the proof of Proposition 2, I already have \(\frac{\partial \mathcal{L}^*}{\partial K} > 0\) if \(\psi\) is not too large.
Let \( \mathcal{L} = \left( 1 - \frac{\rho}{1 - \mu} \tau \right) \frac{1 + \gamma K^2}{2} + \gamma K \left( \frac{1 - \frac{\alpha - \rho \tau}{\beta} \exp(\lambda \beta^*)}{X} + K_0 \right) \), I obtain

\[
\frac{\partial \mathcal{L}}{\partial \tau} = \left( 1 - \frac{\rho}{1 - \mu} \tau \right) \frac{\rho}{\beta^*} \frac{\exp(\lambda \beta^*) \gamma K}{2} \left( \frac{\Psi(1 + \gamma K^2)}{2} \exp(\lambda \beta^*) + (1 - \tau) \right) + \frac{\alpha - \rho \tau}{\beta^*},
\]

(A.43)

which is positive if

\[
\left( 1 - \frac{\rho}{1 - \mu} \tau \right) \frac{\rho}{\beta^*} \frac{\exp(\lambda \beta^*) \gamma K}{2} \left( \frac{\Psi(1 + \gamma K^2)}{2} \exp(\lambda \beta^*) + (1 - \tau) \right) + \frac{\alpha - \rho \tau}{\beta^*} > 0.
\]

(A.44)

The above inequality is true if \( \frac{\rho}{X} \) is not too large and \( 1 - \mu > 2\alpha \).

Therefore,

\[
\frac{\partial \mathcal{L}}{\partial g} < 0, \quad \frac{\partial \mathcal{L}}{\partial \hat{X}} > 0, \quad \frac{\partial \mathcal{L}}{\partial \hat{\Psi}} < 0.
\]

(A.45)

(A.46)

(A.47)

Similar to the proof of Proposition 1, I derive that:

\[
\frac{\partial T(\tau, K)}{\partial g} = \frac{K}{X} > 0,
\]

(A.48)

\[
\frac{\partial T(\tau, K)}{\partial \hat{X}} = -\frac{g K}{X^2} < 0,
\]

(A.49)

\[
\frac{\partial T(\tau, K)}{\partial \hat{\Psi}} = \frac{\alpha - \rho \tau}{\beta} \frac{2 (1 - \tau)}{\Psi^2 (1 + \gamma K^2)} > 0,
\]

(A.50)

\[
\frac{\partial T(\tau, K)}{\partial \rho} = \frac{\tau}{\beta} \left( \exp(\lambda \beta) + \frac{(1 - \tau)}{\Pi(K)} \right) > 0.
\]

(A.51)
Hence, I obtain:

\[
\frac{d\tau^*(K)}{dg} = -\frac{\partial T(\tau,K)}{\partial g} < 0, \quad (A.52)
\]

\[
\frac{d\tau^*(K)}{dX} = -\frac{\partial T(\tau,K)}{\partial X} > 0, \quad (A.53)
\]

\[
\frac{d\tau^*(K)}{d\Psi} = -\frac{\partial T(\tau,K)}{\partial \Psi} < 0, \quad (A.54)
\]

\[
\frac{d\tau^*(K)}{d\rho} = -\frac{\partial T(\tau,K)}{\partial \rho} < 0. \quad (A.55)
\]

Therefore, I obtain:

\[
\frac{\partial \mathcal{L}^*}{\partial g} = \frac{\partial \mathcal{L}}{\partial \tau} \frac{\partial \tau}{\partial g} + \frac{\partial \mathcal{L}}{\partial g} < 0, \quad (A.56)
\]

\[
\frac{\partial \mathcal{L}^*}{\partial X} = \frac{\partial \mathcal{L}}{\partial \tau} \frac{\partial \tau}{\partial X} + \frac{\partial \mathcal{L}}{\partial X} > 0, \quad (A.57)
\]

\[
\frac{\partial \mathcal{L}^*}{\partial \Psi} = \frac{\partial \mathcal{L}}{\partial \tau} \frac{\partial \tau}{\partial \Psi} + \frac{\partial \mathcal{L}}{\partial \Psi} < 0. \quad (A.58)
\]

Because \( K^* \) is determined by \( \mathcal{L}^* = 1 \), I get:

\[
\frac{\partial K^*}{\partial g} > 0, \quad (A.59)
\]

\[
\frac{\partial K^*}{\partial X} < 0, \quad (A.60)
\]

\[
\frac{\partial K^*}{\partial \Psi} > 0. \quad (A.61)
\]

Moreover, I have

\[
\Omega = \frac{\frac{\beta}{X}}{1 + \frac{\beta}{X}K} \frac{\exp(\lambda\beta)\Psi(1 + \gamma K^2) + 2(1 - \tau)}{2(1 - \tau)\gamma K} = \frac{\frac{\beta}{X}}{\alpha - \rho \tau} \frac{\exp(\lambda\beta)\Psi(1 + \gamma K^2) + 2(1 - \tau)}{2(1 - \tau)\gamma K}. \quad (A.62)
\]
Plugging \(1 + \frac{g}{X}K = \frac{\alpha - \rho \tau}{\beta^*} \left( \exp(\lambda \beta^*) + \frac{2(1 - \tau)}{\Psi(1 + \gamma K^2)} \right)\), the above equation can be rewritten as:

\[
\Omega = \frac{\frac{g}{X}}{\alpha - \rho \tau} \frac{\exp(\lambda \beta) \Psi(1 + \gamma K^2) + 2(1 - \tau)}{2(1 - \tau) \gamma K}
\]

Moreover, the above equation can be rewritten as:

\[
\Omega = \frac{\frac{g}{X}}{\alpha - \rho \tau} \frac{\beta^* \Psi(1 + \gamma K^2)}{2(1 - \tau) \gamma K}.
\]

(A.63)

Moreover, from the first order condition, I have:

\[
\left(1 - \frac{\rho}{1 - \mu} \tau^*(K)\right) \frac{(1 + \gamma K^2)}{2} + \gamma K \left(\frac{1 - \frac{\alpha - \rho \tau^*(K)}{\beta^*} \exp(\lambda \beta^*)}{\frac{g}{X}} + K\right) = 1
\]

\[
\left(1 - \frac{\rho}{1 - \mu} \tau^*(K)\right) \frac{(1 + \gamma K^2)}{2} + \gamma K \left(\frac{\alpha - \rho \tau^2(K)}{\beta^*} \frac{\Psi(1 + \gamma K^2)}{2} \exp(\lambda \beta^*) + (1 - \tau^*(K))\right) + \frac{\alpha - \rho \tau^*(K)}{\beta^*} = 1,
\]

(A.64)

so the formula of \(\Omega\) can be rewritten as:

\[
\Omega = \frac{1}{\left(\frac{\rho}{1 - \mu} \tau^*(K) \exp(\lambda \beta^*) - 1\right) \frac{(1 + \gamma K^2)}{2} + \frac{\alpha - \rho \tau + \rho(1 - \tau)}{\beta^*(1 - \frac{\rho}{1 - \mu} \tau)}}
\]

(A.65)

which decreases with \(K\). Therefore, I obtain:

\[
\frac{\partial \Omega^*}{\partial g} < 0,
\]

(A.66)

\[
\frac{\partial \Omega^*}{\partial X} > 0,
\]

(A.67)

\[
\frac{\partial \Omega^*}{\partial \Psi} < 0.
\]

(A.68)

Moreover, I have

\[
\frac{\partial \mathcal{L}}{\partial \rho} = \frac{\rho}{\beta^*} \left(\frac{\Psi(1 + \gamma K^2)}{2} \exp(\lambda \beta^*) + (1 - \tau)\right) + \frac{\alpha - \rho \tau}{\beta^*}
\]

\[
- \left(1 - \frac{\rho}{1 - \mu} \tau\right) \left(\frac{(1 + \gamma K^2)}{2} + \gamma K \left(\frac{1 - \frac{\alpha - \rho \tau}{\beta^*} \exp(\lambda \beta^*)}{\frac{g}{X}} + K\right)\right) \left(\frac{1}{\beta} \exp(\lambda \beta) \Psi(1 + \gamma K^2) + \frac{\Psi(1 + \gamma K^2)}{2} \exp(\lambda \beta^*) + (1 - \tau)\right) + \frac{\alpha - \rho \tau}{\beta^*}
\]

\[
- \frac{1}{1 - \mu} \frac{\rho}{\beta^*} \left(\frac{(1 + \gamma K^2)}{2} + \gamma K \left(\frac{1 - \frac{\alpha - \rho \tau}{\beta^*} \exp(\lambda \beta^*)}{\frac{g}{X}} + K\right)\right)
\]

(A.69)
which is negative if $\tau$ is small ($\rho$ is large), and positive if $\tau$ is large ($\rho$ is small). Therefore, I obtain:

$$\frac{\partial L^*}{\partial \rho} = \frac{\partial L^*}{\partial \tau} + \frac{\partial L^*}{\partial \rho} \begin{cases} < 0 & \text{if } \rho \text{ is large} \\ > 0 & \text{if } \rho \text{ is small} \end{cases}$$  \hfill (A.70)

and, thus, I have:

$$\frac{\partial K^*}{\partial \rho} \begin{cases} > 0 & \text{if } \rho \text{ is large} \\ < 0 & \text{if } \rho \text{ is small} \end{cases}$$  \hfill (A.71)

and

$$\frac{\partial \Omega^*}{\partial \rho} \begin{cases} < 0 & \text{if } \rho \text{ is large} \\ > 0 & \text{if } \rho \text{ is small} \end{cases}$$  \hfill (A.72)

**Proof of Proposition 4:** By Bayesian rule, the posterior belief that a firm is good given no intervention, low earnings, and nonnegative net demand $d \geq 0$, which is denoted as $\pi$, is determined by:

$$\pi = \frac{\varphi \left( \frac{1 + \gamma K^2}{2} \right)}{\varphi \left( \frac{1 + \gamma K^2}{2} \right) + (1 - \varphi) (1 - \tau) \exp \left( -\lambda \left( \hat{\beta} + \hat{\beta}_{new} \right) \right)}.$$  \hfill (A.73)

The trading strategy is determined by:

$$\beta^* = \arg \max_{\beta \in [0, \alpha]} \beta \exp \left( -\lambda (\beta + \beta_{new}) \right) \pi \hat{V}_G,$$  \hfill (A.74)

$$\beta_{new}^* = \arg \max_{\beta \in [0, \alpha_{new}]} \beta \exp \left( -\lambda (\beta + \beta_{new}) \right) \pi \hat{V}_G.$$  \hfill (A.75)

From the first order condition, I obtain

$$(1 - \lambda \beta) \exp \left( -\lambda (\beta + \beta_{new}) \right) \pi \hat{V}_G = 0,$$  \hfill (A.76)

$$(1 - \lambda \beta_{new}) \exp \left( -\lambda (\beta + \beta_{new}) \right) \pi \hat{V}_G = 0,$$  \hfill (A.77)

which has a unique pair of solutions with $\beta = \frac{1}{\lambda}$ and $\beta_{new} = \frac{1}{\lambda}$. However, because of the no short selling constraint, $\frac{1}{\lambda}$ might not be achieved. The optimal solutions are $\beta^* = \min \left\{ \alpha, \frac{1}{\lambda} \right\}$ and $\beta_{new}^* = \min \left\{ \alpha_{new}, \frac{1}{\lambda} \right\}$. Therefore, the incumbent shareholder’s trading profit from exit is $\beta^* \exp \left( -\lambda (\beta^* + \beta_{new}^*) \right) \pi \hat{V}_G$. In equilibrium, $\hat{\beta} = \beta^*$ and $\hat{\beta}_{new} = \beta_{new}^*$, so the trading profit is:

$$\beta^* \exp \left( -\lambda (\beta^* + \beta_{new}^*) \right) \pi \hat{V}_G = \beta^* \frac{\Psi \left( 1 + \gamma K^2 \right) \left( 1 + \frac{Q}{K} \right)}{\exp \left( \lambda (\beta^* + \beta_{new}^*) \right) \Psi \left( 1 + \gamma K^2 \right) + 2 (1 - \tau)}$$  \hfill (A.78)

which implies the trading of the institutional investor reduces the trading profit of the incumbent shareholder.

The net profit of the incumbent shareholder by intervention is $(\alpha - \rho \tau) X$. Therefore,
the incumbent shareholder chooses public intervention if and only if $\tau < \tau^*$, in which $\tau^*$ is determined by:

\[
(\alpha - \rho \tau^*) X = \beta^* \exp (-\lambda (\beta^* + \beta_{new}^*)) \frac{\varphi \left( 1 + \gamma \hat{K}^2 \right) \left( X + g \hat{K} \right)}{\varphi \left( 1 + \gamma \hat{K}^2 \right) + 2 \left( 1 - \varphi \right) \left( 1 - \hat{\tau} \right) \exp \left( \frac{-\lambda \left( \beta^* + \hat{\beta}_{new} \right)}{2} \right)} \frac{\Psi \left( 1 + \gamma K^2 \right) \left( 1 + \frac{\varrho}{X} K \right)}{\exp \left( \lambda (\beta^* + \beta_{new}^*) \right) \Psi \left( 1 + \gamma K^2 \right) + 2 \left( 1 - \hat{\tau} \right)}.
\]

Equation (A.79)

Because the trading profit decreases, the intervention cutoff increases, which implies a higher level of intervention by the incumbent shareholder. The informed trading by the institutional investor mitigates the limited commitment problem of the incumbent shareholder. Hence, the incumbent shareholder does not have to provide many short-term managerial incentives to commit to value-enhancing intervention in a bad firm, i.e., $w^*_{II} \leq w^*$.

**Proof of Proposition 5:** From the perspective of passive investors, the marginal benefit of increasing the investment by a good firm $K$ is $\Psi \frac{\varphi}{X}$, and the marginal cost of increasing the investment by a good firm $K$ is $-\frac{d\tau^*(K)}{dK}$ where $\frac{d\tau^*(K)}{dK} < 0$ from Lemma 5. From the proof of Proposition 2, I have shown $\tau'' < 0$ if $\Psi$ is not too large. I can conclude that if $-\frac{d\tau^*(K)}{dK}|_{\Omega=\Omega} > \Psi \frac{\varphi}{X}$, the optimal choice for the incumbent shareholder is the short-term compensation scheme with $w^*_{II} > w$ or equivalently $\Omega^* > \Omega$. Plugging in Equation (A.32), the inequality $-\frac{d\tau^*(K)}{dK}|_{\Omega=\Omega} > \Psi \frac{\varphi}{X}$ can be rewritten as:

\[
\frac{\left( \frac{1+\gamma K^2}{2} + \gamma K \left( \frac{1-\frac{\alpha-\varphi}{\beta^*} \exp (\lambda \beta^*)}{\Psi} + K \right) \right)}{\frac{\varrho}{\beta^*} \left( \frac{(1+\gamma K^2)}{2} \exp (\lambda \beta^*) + (1 - \tau) \right) + \frac{\alpha-\varphi}{\beta^*}}|_{\Omega=\Omega} > 1,
\]

Equation (A.80)

which is true if $\frac{\varphi}{X}$ and $\Psi$ are not too large.