# Agency Conflicts and Short- versus Long-Termism in Corporate Policies

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- Ph.D. Economics, CentER, Tilburg University, 2008
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## Research Interests

Corporate Finance, Economic Theory

## Publications

- Less Popular but More Effective Toeholds in Corporate Takeovers, 2021
  Journal of Financial and Quantitative Analysis 56, 283-312, with Yun Dai and Han Smit
- Investment Timing and Incentive Costs, 2020
  Review of Financial Studies 33, 309-357, with Barney Hartman-Glaser

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aspects of integrating smart things into the Web, their semantic description, and infrastructures that support human users as well as other machines in finding and interacting with the information and services provided by such devices.

## Publications

- Tailored Controls: Creating Personalized Tangible User Interfaces from Paper.
  Proceedings of the 2019 ACM International Conference on Interactive Surfaces and Spaces.
- Smart Configuration of Smart Environments.
  Transactions on Automation Science and Engineering, July 2016

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## Publications

- Optimal financing with tokens
  Journal of Financial Economics Forthcoming
  with Sebastian Gryglewicz and Simon Mayer
- Short-term debt and incentives for risk-taking
  Journal of Financial Economics 137(1): 179-203, 2020
  with Marco Della Seta and Francesca Zucchi

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# ABSTRACT


- We build a dynamic agency model in which the agent controls both current earnings via short-term investment and firm growth via long-term investment. Under the optimal contract, agency conflicts can induce short- and long-term investment levels beyond first best, leading to short- or long-termism in corporate policies.

- The paper analytically shows how firm characteristics shape the optimal contract and the horizon of corporate policies, thereby generating a number of novel empirical predictions on the optimality of shortversus long-termism.

- It also demonstrates that combining short- and long-term agency conflicts naturally leads to asymmetric pay-for-performance in managerial contracts.

# 1.Introduction

## Background

Should firms target short-term objectives or long-term performance? The question of the optimal horizon of corporate policies has received considerable attention in recent years, with much of the discussion focusing on whether short-termism destroys value.

The worry oftenexpressed in this literature is that short-termism—induced, for example, by stock market pressure—may lead firms to invest too little (see Asker et al., 2015; Bernstein, 2015; Gutierrez and Philippon, 2017, for empirical evidence). Another line of argument recognizes, however, that while firms must invest in their future if they are to have one, they must also produce earnings today to pay for doing so. In line with this view, Giannetti and Yu (2018) find that firms with more short-term institutional investors suffer smaller drops in investment and have better long-term performance than similar firms following shocks that change an industry’s economic environment.

While empirical evidence relating short- or longtermism to firm performance is accumulating at a fast pace, financial theory has made little headway in developing models that characterize the optimal horizon of corporate policies or the relation between firm characteristics and this horizon. In this paper, we attempt to provide an answer to these questions through the lens of agency theory.

## The Main Work

we develop a dynamic agency model in which the agent controls both current earnings and firm growth (i.e., future earnings) through unobservable investment. In this multitasking model, the principal optimally balances the costs and benefits of incentivizing the manager over the short or long term. As shown in the paper, this can lead to optimal short- or long-termism, depending on the severity of agency conflicts and firm characteristics. Additionally, we show that the same firm can find it optimal at times to be short-termist (i.e., favor current earnings) and at other times to be long-termist (i.e., favor growth). Our findings are generally consistent with the views expressed in The Economist1 that "longtermism and short-termism both have their virtues and vices—and these depend on context."

## Contributions

Our theory of short- and long-termism differs from existing contributions in two important respects.

First, while most dynamic agency models focus either on shortor long-term agency conflicts, we consider a multitasking framework with both long- and short-term agency conflicts. We show that agency conflicts over different horizons interact, which can generate short- and long termism in corporate policies.

Second, unlike most models on short-termism, we do not assume that focusing either on the short or the long term is optimal. In our model, the optimal corporate horizon is determined endogenously and reflects both agency conflicts and firm characteristics. These unique features allow us to generate a rich set of testable predictions about firms' optimal investment rates and the horizon of corporate policies.

# Contents

# 2. The model

## 2.1. Assumptions

We consider a principal-agent model in which the risk-neutral owner of a firm (the principal) hires a riskneutral manager (the agent) to operate the firm’ s assets.

In the model, firm performance depends on investment, which can be targeted toward the short- or long-run and entails a monetary cost.

We consider that the firm’ s capital stock (firm size) $\{K\} = \{K_t\}_t \geq 0$ evolves according to the controlled geometric Brownian motion process:

$$dK_t = (\ell_t \mu - \delta) K_t dt + \sigma_K K_t dZ_t^K, \tag{1}$$

where $\mu > 0$ is a constant, $\delta > 0$ is the rate of depreciation, $\sigma_K > 0$ is a constant volatility parameter. $\{Z^K\} = \{Z_t^K\}_{t \geq 0}$ is a standard Brownian motion, and $\ell_t$ is the firm’s long-term investment choice. For the problem to be well defined, we consider that $\ell_t \in [0, \ell_{\max}]$ with $\ell_{\max} < \frac{r+\delta}{\mu}$ where $r \geq 0$ is the constant discount rate of the firm owner.

Cash flows $dX_t$ are proportional to $K_t$ but uncertain and governed by

$$dX_t = K_t dA_t = K_t\left(s_t \alpha\, dt + \sigma_X dZ_t^X\right), \tag{2}$$

where α and σ X are strictly positive constants, st ∈ [0, smax] is the firm’s short-term investment choice

$$\mathbb{E}[dZ_t^K dZ_t^X] = \rho\, dt,\ \text{ with } \rho \in (-1, 1). \tag{3}$$

We have that $\mathcal{I}(K_t, s_t, \ell_t) \equiv K_t C(s_t, \ell_t)$, where C is increasing and convex in its arguments. Unless otherwise mentioned, we consider quadratic costs of investment

$$C(s_t, \ell_t) = \frac{1}{2}\left(\lambda_s s_t^2 \alpha + \lambda_\ell \ell_t^2 \mu\right), \tag{4}$$

The manager can change recommended short-run (respectively long-run) investment by any amount  and keep the difference between actual investment cost and allocated funds

$$K_t\left[\mathcal{C}(s_t, \ell_t) - \mathcal{C}(s_t - \varepsilon^s, \ell_t - \varepsilon^\ell)\right]$$

Because { X } and { K } are subject to Brownian shocks — as long as $\sigma_X > 0$ and $\sigma_K > 0$ — there is moral hazard over short- and long-term investment decision. For simplicity, we assume that diversion does not entail efficiency losses.

## 2.2. The contracting problem

We let $\Pi \equiv (\{C\}, \{s\}, \{\ell\}, \tau)$ represent the contract, where all elements are progressively measurable with respect to $\mathbb{F}$.

With the agent' s actual investment choice $\{\hat{s}\}, \{\hat{\ell}\}$, ve call a contract incentive compatible. We denote the set of these contracts by $\mathbb{IC}$.

The principal receives the firm cash flows net of in- vestment cost and pays the compensation to the manager. As a result, given the contract $\Pi$, the principal' s expected payoff can be written as

$$\hat{P}(W, K) \equiv \mathbb{E}\left[\int_0^{\tau} e^{-rt}(dX_t - K_t C(s_t, \ell_t)dt - dC_t) + e^{-r\tau} RK_\tau \middle| W_0 = W, K_0 = K\right]. \quad (5)$$

We make the usual assumption that the principal possesses full bargaining power. Denote the set of incentive compatible contracts by $\mathbb{IC}$.

The investor’ s optimization problem reads

$$P(W,K) \equiv \max_{\Pi \in \mathbb{IC}} \hat{P}(W,K) \text{ s.t. } W_t \geq 0 \text{ and } dC_t \geq 0 \text{ for all } t \geq 0. \quad (6)$$

## 2.3. First-best short- and long-term investment

the first-best (FB) outcome

$$P^{FB}(K) = \max_{(s,\ell)\in[0,s_{\max}]\times[0,\ell_{\max}]} \frac{K}{r+\delta-\mu\ell} \times \left[\alpha s - \frac{1}{2}\left(\lambda_s \alpha s^2 + \lambda_\ell \mu \ell^2\right)\right] \equiv K p^{FB},$$

*Proposition 1* (First-best firm value and investment choices). *Assume the bounds $i_{\max}$ for $i \in \{s, \ell\}$ are such that the first-best solution is interior. Then the following holds:*

(i) *First-best short-term investment satisfies:* $s^{FB} = \frac{1}{\lambda_s}$.

(ii) *First-best long-term investment satisfies:* $\ell^{FB} = \frac{1}{\mu}\left[r+\delta-\sqrt{(r+\delta)^2-\frac{\mu\alpha}{\lambda_s\lambda_\ell}}\right] = \frac{p^{FB}}{\lambda_\ell}$.

## 2.4. Model solution

We can use the martingale representation theorem to show that the continuation payoff of the agent solves

$$dW_t = \gamma W_t dt - dC_t + \beta_t^s (dX_t - \alpha s_t K_t dt) + \beta_t^\ell (dK_t - (\mu \ell_t - \delta) K_t dt). \quad (7)$$

In addition, compensation must be sufficiently sensitive to firm performance, as captured by the processes $\beta_t^s = dW_t/dX_t$ and $\beta_t^\ell = dW_t/dK_t$, to maintain incentive compatibility.

The optimal contract sets $dc \equiv \frac{dC}{K}$ o zero for low values of w and only stipulates payments to the manager once the firm has accumulated sufficient slack. That is, there exists a threshold $\overline{w}$ with

$$p'(\overline{w}) = -1 \text{ and } dc = \max\{0, w - \overline{w}\}, \quad (8)$$

Where the optimal payout boundary is determined by the super-contact condition:

$$p''(\overline{w}) = 0. \quad (9)$$

When w falls to zero, the contract is terminated and the firm is liquidated so that

$$p(0) = R. \quad (10)$$

When w $\in$ [0, $\overline{w}$], the agent's compensation is deferred and dc = 0. The HJB equation for the principal's problem is then given by

$$\begin{aligned}&(r+\delta)p(w)\\&= \max_{s,\ell,\beta^s,\beta^\ell}\Big\{\alpha s - C(s,\ell) + p'(w)w(\gamma+\delta-\mu\ell) + \mu\ell p(w)\\&\quad + \frac{p''(w)}{2}\big[(\beta^s\sigma_X)^2 + \sigma_K^2(\beta^\ell - w)^2\\&\quad + 2\rho\sigma_X\sigma_K\beta^s(\beta^\ell - w)\big]\Big\}, \quad (11)\end{aligned}$$

$P(W, K_0) = p(w) K_0$ , The investor's maximization problem at $t = 0$ can now be rewritten as

$$\max_{w_0 \in [0, \overline{w}]} p(w_0) K_0,$$

with unique solution $w_0 = w^*$ satisfying

$$p'(w^*) = 0. \tag{12}$$

As a consequence, the principal initially promises the agent utility $w^* K_0$ and expects a payoff $P(K_0 w^*, K_0) = p(w^*) K_0$. For convenience, we normalize $K_0$ to unity in the following and refer to $p(w^*)$ as expected payoff instead of scaled expected payoff.

*Proposition 2* (Firm value and optimal compensation under agency). *Let* $\Pi = (\{C\}, \{s\}, \{\ell\}, \tau)$ *denote the optimal contract solving problem (6). The following holds true:*

1. *There exist* $\mathbb{F}$*-progressive processes* $\{\beta^{\ell}\}$ *and* $\{\beta^{s}\}$ *such that the agent's continuation utility* $W_t$ *evolves according to (7). The optimal contract is incentive compatible in that* $\beta^{s} = \lambda_s s$ *and* $\beta^{\ell} = \lambda_{\ell} \ell$, *where* $\{s\}$, $\{\ell\}$ *are the firm's optimal investment decisions.*
2. *Firm value is proportional to firm size in that* $P(W, K) = Kp(w)$. *The scaled firm value* $p(w)$ *is the unique solution to Eq. (11) subject to (8), (9), and (10) on* $[0, \overline{w}]$. *For* $w > \overline{w}$, *the scaled value function satisfies* $p(w) = p(\overline{w}) - (w - \overline{w})$. *Scaled cash payments* $dc = \frac{dC}{K}$ *reflect* $w$ *back to* $\overline{w}$.
3. *The function* $p(w)$ *is strictly concave on* $[0, \overline{w})$.

Note also that overall value, $P(W, K) + W$, is split between the principal and the manager, where the manager obtains a fraction,

$$\mathcal{S}(w) = \frac{W}{P(W, K) + W} = \frac{w}{p(w) + w},$$

of overall value. Because of $\mathcal{S}'(w) > 0$ for all $w \in (0, \overline{w})$, the scaled continuation value w corresponds (monotonically) to the fraction of overall firm value that goes to the manager. Therefore, we also refer to w as the agent's or manager's stake in the firm. When the manager's stake w falls down to zero, she has no more incentives to stay and accordingly leaves the firm. In this case, deadweight losses are incurred due to contract termination.

# 3. Short- versus long-run incentives

## 3.1. Short-term investment and incentives

Optimal short-term investment s = s(w) is obtained by taking the first-order condition in Eq. (11) after using the incentive compatibility condition $\beta^s = \lambda_s s.$ This yields the following result:

*Proposition* 3 (Optimal short-term investment). *Optimal short-term investment is given by*

$$s(w) = \frac{\overbrace{\alpha}^{\substack{\text{Direct benefit}\\ \text{of investment}}}}{\underbrace{\lambda_s \alpha}_{\substack{\text{Direct cost}\\ \text{of investment}}} \underbrace{-p''(w)(\lambda_s \sigma_X)^2}_{\substack{\text{Agency cost}\\ \text{of investment}}}}. \tag{13}$$

## 3.2. Long-term incentives and investment

We characterize the firm’ s optimal long-term investment $\ell$ and the agent’ s long-term incentives $\beta^{\ell}$. Jsing the HJB Eq. (11) and the incentive compatibility condition $\beta^{\ell} = \lambda_{\ell}\ell,$ we get the following result:

*Proposition 4* (Optimal long-term investment). *Optimal long-term investment is given by*

$$\ell(w) = \frac{\overbrace{\mu(p(w) - p'(w)w)}^{\substack{\text{Direct benefit} \\ \text{of investment}}} \quad \overbrace{-p''(w)w\lambda_{\ell}\sigma_K^2}^{\text{Reducing dilution risk}}}{\underbrace{\lambda_{\ell}\mu}_{\substack{\text{Direct cost} \\ \text{of investment}}} \quad \underbrace{-p''(w)(\lambda_{\ell}\sigma_K)^2}_{\substack{\text{Agency cost} \\ \text{of investment}}}}. \quad (14)$$

Consider the costs and benefits from marginally increasing long-term investment :

$$\frac{\partial p(w)}{\partial \ell} \propto \underbrace{\mu(p(w) - p'(w)w)}_{\text{Direct benefit}} \underbrace{-\lambda_\ell \mu \ell}_{\substack{\text{Direct}\\ \text{cost}}} + \underbrace{p''(w)\ell(\lambda_\ell \sigma_K)^2}_{\text{Agency cost}}$$

$$\underbrace{-p''(w)w\lambda_\ell \sigma_K^2}_{\substack{\text{Reducing dilution}\\ \text{risk}}}. \qquad (15)$$

Consider next the benefits of raising long-term investment.

The first difference between optimal shortand long-term investment is that the direct benefit of long-term investment is time varying and given by $p(w) - p'(w)w$.

A second difference is that investment in $\ell(w)$ offers an additional benefit compared to investment in s(w): it mitigates the dilution of the agent’ s stake w.

By Ito’ s lemma, the dynamics of the agent’ s stake are given by

$$dw = (\gamma + \delta - \mu\ell)wdt + \beta^s\sigma_X dZ^X + (\beta^\ell - w)\sigma_K dZ^K, \tag{16}$$

so the instantaneous variance of dw satisfies

$$\Sigma(w) \equiv \frac{\mathbb{V}(dw)}{dt} = (\beta^s\sigma_X)^2 + (\beta^\ell - w)^2\sigma_K^2. \tag{17}$$

We refer to the reduction of the agent’ s stake upon a positive shock $dZ^K > 0$ as dilution and the volatility generated by this effect (i.e., $-w\sigma_K$), as dilution risk.

$$dw/dZ^K = (\beta^\ell - w)\sigma_K$$

As long as $\beta^{\ell} < w$, raising $\beta^{\ell}$ lowers the volatility and instantaneous variance $\Sigma(w)$ of w, and therefore the risk of liquidation, so that the effective (marginal) agency cost of long-run investment is pinned down by the net change in risk, that is, by

$$\underbrace{-p''(w)\ell(\lambda_{\ell}\sigma_K)^2}_{\text{Agency cost }(>0)}+\underbrace{p''(w)w\lambda_{\ell}\sigma_K^2}_{\substack{\text{Reducing dilution}\\ \text{risk }(<0)}}=\underbrace{-p''(w)\sigma_K^2\lambda_{\ell}(\lambda_{\ell}\ell-w)}_{\text{Effective agency cost }(\lesseqgtr 0)}. \tag{18}$$

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# 4. Short- and long-termism in corporate policies

Because the manager's ability to divert funds decreases the benefits of investment, each moral hazard problem working in isolation leads to underinvestment relative to the first-best levels. The novel insight of our model is that a simultaneous moral hazard problem over both the short and long run can generate overinvestment. We call overinvestment for the long run, longtermism and overinvestment for short-run, short-termism. Below we analyze and contrast the circumstances that lead to long-termism and short-termism. We find that long-termism can arise irrespective of whether the different sources of cash flow risk are correlated, while short-termism requires $\rho \neq 0$.

## 4.1. Long-termism

$$\ell(w) = \frac{\overbrace{\mu(p(w) - p'(w)w)}^{\substack{\text{Direct benefit} \\ \text{of investment}}} \overbrace{-p''(w)w\lambda_\ell\sigma_K^2}^{\text{Reducing dilution risk}}}{\underbrace{\lambda_\ell\mu}_{\substack{\text{Direct cost} \\ \text{of investment}}} \underbrace{-p''(w)(\lambda_\ell\sigma_K)^2}_{\substack{\text{Agency cost} \\ \text{of investment}}}}. \tag{14}$$

*Proposition 5* (Long-termism). *The following holds true:*

(i) *Long-termism (i.e., $\ell(w) > \ell^{FB}$) arises only if $\sigma_X > 0$ and $\sigma_K > 0$.*

(ii) *Assume $\sigma_X > 0$ and $\sigma_K > 0$. Then, there exist $w^L$ and $w^H$ with $0 < w^L < w^H < \overline{w}$ such that $\ell(w) > \ell^{FB}$ for $w \in (w^L, w^H)$, provided that $\mu$ and $\gamma - r$ are sufficiently low.*
*The firm underinvests (i.e., $\ell(w) < \ell^{FB}$) when $w < w^L$ or $w > w^H$ (i.e., when $w$ is close to zero or close to $\overline{w}$).*

(iii) *Higher volatility $\sigma_X > 0$ or $\sigma_K > 0$ favors long-termism: if $\mu$ is sufficiently low and parameters are such that $\sup\{\ell(w) : 0 \le w \le \overline{w}\} = \ell^{FB}$, then there exists $\varepsilon > 0$ such that $\sup\{\ell(w) : 0 \le w \le \overline{w}\} > \ell^{FB}$ if $\sigma_X$ or $\sigma_K$ increases by $\varepsilon$.*

Fig. 1 presents a quantitative example illustrating long-termism.

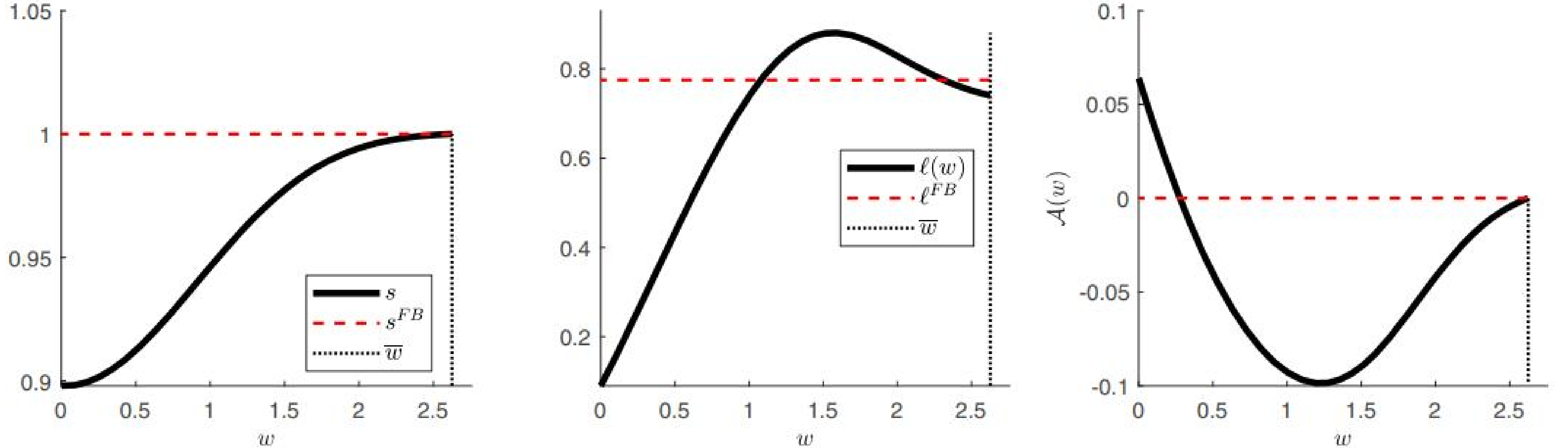


**Fig. 1.** Numerical example of long-termism. The first two panels depict optimal investment as functions of $w$. The third panel at the right displays effective agency cost $\mathcal{A}(w) = -p''(w)(\lambda_\ell \ell(w) - w)$. The parameters are $\alpha = 0.25$, $\sigma_K = 0.25$, $\sigma_X = 0.2$, $\rho = 0$, $\mu = 0.025$, $r = 0.046$, $\gamma = 0.048$, $\delta = 0.125$, $\lambda_s = \lambda_\ell = 1$, and $R = 0.2$.

The left plot shows that the firm underinvests in the short run for all w.

The middle plot shows that the firm overinvests in the long run for intermediate values of w.

The right plot also shows that long-termism is related to a negative effective agency cost

## 4.2. Correlated cash flow shocks and short-termism

To start with, note that when shocks are correlated, optimal short- and long-term investment are given by

$$s(w) = \frac{\alpha + \overbrace{p''(w)\rho\sigma_X\sigma_K\lambda_s(\lambda_\ell \ell(w) - w)}^{\text{Externality}}}{\lambda_s\alpha - p''(w)(\lambda_s\sigma_X)^2} \tag{19}$$

and

$$\ell(w) = \frac{\mu\left(p(w) - p'(w)w\right) + \overbrace{p''(w)\rho\sigma_X\sigma_K\lambda_\ell\lambda_s s(w)}^{\text{Externality}} - p''(w)w\lambda_\ell\sigma_K^2}{\lambda_\ell\mu - p''(w)(\lambda_\ell\sigma_K)^2}. \tag{20}$$

The externality effect in the numerator of s(w) in Eq. (19) has two separate components:

$$p''(w)\rho\sigma_X\sigma_K\lambda_s\big(\lambda_\ell\ell(w)-w\big)$$
$$=\underbrace{p''(w)\rho\sigma_X\sigma_K\lambda_s\lambda_\ell\ell(w)}_{\text{Agency cost}}\underbrace{-p''(w)\rho\sigma_X\sigma_K\lambda_s w}_{\text{Reducing dilution risk}}. \tag{21}$$

*Proposition 6 (Short-termism under distress with. $\rho<0$) The following holds true:*

(i) *Short-termism arises only if $\sigma_X>0$, $\sigma_K>0$, and $\rho\neq 0$. Conversely, if either $\sigma_X=0$, $\sigma_K=0$, or $\rho=0$, short-termism cannot arise and $s(w)\leq s^{FB}$ for all w.*

(ii) *Assume $\sigma_X>0$, $\sigma_K>0$, and $\rho<0$. Then, there exist $w^L<w^H$ with $s(w)>s^{FB}$ for $w\in(w^L,w^H)$, provided $\sigma_X$ is sufficiently small. When, in addition, $\lambda_\ell$ and $\gamma-r$ are sufficiently small, the set $\{w\in[0,\overline{w}]:s(w)>s^{FB}\}$ is convex and contains zero and s(w) decreases on this set.*

Fig. 2 provides an example of short-termism when the correlation between long- and short-term shocks is negative.

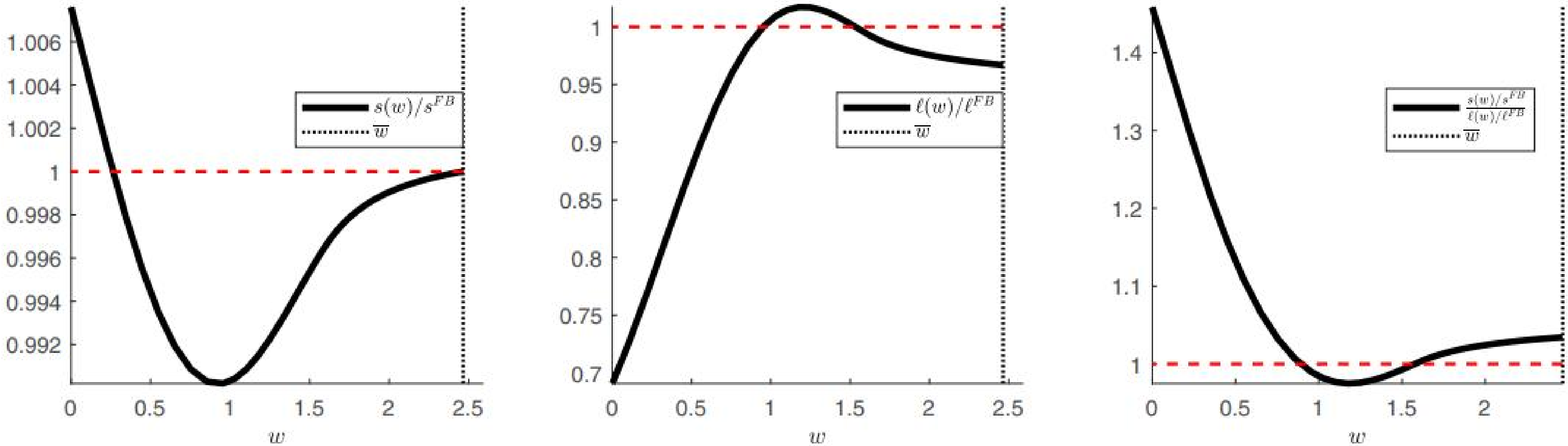


**Fig. 2.** Numerical example of short-termism. The parameters are $\alpha = 0.25$, $\sigma_X = 0.15$, $\sigma_K = 0.5$, $\rho = -0.75$ $\mu = 0.025$, $r = 0.046$, $\gamma = 0.047$, $\delta = 0.125$, $\lambda_s = 1.15$, $\lambda_\ell = 0.25$, and $R = 0.75$.

For completeness, we also investigate optimal investment when the correlation between cash flow shocks is positive. In this case, the firm can overinvest in both shortand long-term investment at the same time.

*Proposition 7 (Short-termism with. $\rho > 0$) Assume $\sigma_X > 0$, $\sigma_K > 0$ and $\rho > 0$. Then, there exist $w^L < w^H$ with $s(w) > s^{FB}$ for $w \in (w^L, w^H)$, provided $\sigma_X > 0$ and $\gamma - r$ is sufficiently small. When in addition $\mu$ is sufficiently small, the set $\{w \in [0, \overline{w}] : s(w) > s^{FB}\}$ is convex with $\inf\{w \in [0, \overline{w}] : s(w) > s^{FB}\} > 0$ and $\sup\{w \in [0, \overline{w}] : s(w) > s^{FB}\} = \overline{w}$.*

## 5. Incentive contracts contingent on stock prices

We start with writing the dynamics of earnings and stock prices. The firm' s (instantaneous) earnings net of investment cost are given by

$$dE_t = (\alpha s_t - C(s_t, \ell_t))K_t dt + K_t \sigma_X dZ_t^X,$$

while the stock price (which, with full equity financing and the total share supply normalized to one, is equivalent to firm value) evolves according to

$$\frac{dP_t}{P_t} = \mu_t^P dt + \Sigma_t^X dZ_t^X + \Sigma_t^K dZ_t^K,$$

The principal provides the incentives to the manager by choosing the manager' s exposures to earnings and stock price changes, respectively, defined by

$$\beta_t^E = \frac{dW_t}{dE_t} \text{ and } \beta_t^P = \frac{dW_t}{dP_t}$$

Expressions for the exposures implied by the optimal contract

$$\beta_t^P = \lambda_\ell \ell_t \left( \frac{1}{p(w_t) + p'(w_t)(\lambda_\ell \ell_t - w_t)} \right)$$

and

$$\beta_t^E = \lambda_s s_t \left( \frac{p(w_t) - p'(w_t) w_t}{p(w_t) + p'(w_t)(\lambda_\ell \ell_t - w_t)} \right).$$

We analyze how the manager' s exposure to the firm' s stock price relative to her exposure to earnings changes over time. To do so, we analyze the ratio:

$$\frac{\beta^P}{\beta^E} = \frac{\lambda_\ell \ell}{\lambda_s s} \times \frac{1}{p(w) - wp'(w)}.$$

Fig. 3 depicts a typical pattern of $\beta^P/\beta^E$ and $\ell/s$ as functions of w.

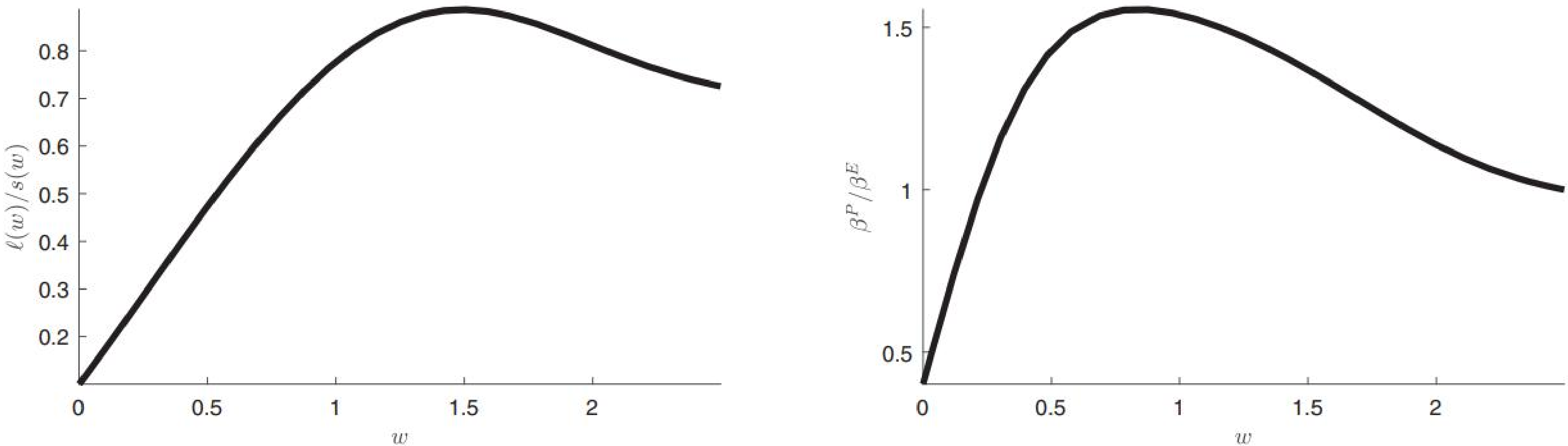


**Fig. 3.** Numerical illustration of the dynamics of $\beta^P/\beta^E$ and $\ell/s$. The parameters are $\alpha = 0.25$, $\sigma_K = 0.25$, $\sigma_X = 0.2$, $\rho = 0$, $\mu = 0.025$, $r = 0.046$, $\gamma = 0.048$, $\delta = 0.125$, $\lambda_s = \lambda_\ell = 1$, and $R = 0.2$.

$$\frac{\beta^P}{\beta^E} = \frac{\lambda_\ell \ell}{\lambda_s s} \times \frac{1}{p(w) - wp'(w)}.$$

# 6. Asymmetric pay in executive compensation

We now turn to analyze the dynamics of incentive provision and show that the optimal contract induces asymmetric pay. We assume throughout the section that the correlation ρ between short- and long-run shocks is zero. For clarity of exposition, we focus on a specification in which the investment cost $\mathcal{C}$ is linear:

$$\mathcal{C}(s, \ell) = \alpha\lambda_s s + \mu\lambda_\ell \ell. \tag{22}$$

When the investment cost is linear, incentive compatibility requires

$$\beta^s \geq \lambda_s \text{ and } \beta^\ell \geq \lambda_\ell.$$

Minimizing risk exposure amounts to minimizing the instantaneous variance of the scaled promised payments:

$$\Sigma(w) = (\beta^s\sigma_X)^2 + (\beta^\ell - w)^2\sigma_K^2 \text{ subject to } \beta^s \geq \lambda_s \text{ and } \beta^\ell \geq \lambda_\ell.$$

*Proposition 8* (Asymmetric pay in executive compensation). *When investment costs are linear and full investment is optimal (i.e., $s = s_{\max}$ and $\ell = \ell_{\max}$), we have that*

(i) *Incentives are given by $\beta^s = \lambda_s$ and $\beta^\ell = \lambda_\ell + \max\{0, w - \lambda_\ell\}$.*

(ii) *$\beta^\ell(w) > \lambda_\ell$ arises only if $\sigma_X > 0$ and $\sigma_K > 0$.*

(iii) *Assume $\sigma_X > 0$ and $\sigma_K > 0$. If $\gamma - r$, $\ell_{\max}$ or $\lambda_\ell$ is sufficiently low, $\overline{w} > \lambda_\ell$ and $\beta^\ell(w) > \lambda_\ell$ for $w \in (\lambda_\ell, \overline{w}]$.*

# 7. Robustness and extensions

## 7.1. Agent's limited wealth

The Online Appendix solves the model under the assumption that the agent has limited wealth and shows that our findings remain qualitatively unchanged in this alternative setting.

## 7.2. Private investment cost

In the model, we assume that the principal bears the investment cost C while the agent can divert funds for her private consumption.Alternatively, we could also assume tha t the effort (investment) cost C is private to the manager. In this alternative setting, incentivizing investment $s$, $\ell$ requires compensating this private cost to the manager by increasing the growth rate of the agent' s scaled continuation value w.

This beneficial private cost effect may lead to overinvestment. For completeness, we solve our model with private investment cost in the Appendix and demonstrate that short- and long-termism can arise in this model as well.

## 8. Conclusion

- The model predicts that the nature of the risks facing firms is key in determining the corporate horizon.In particular, firms should become more short-termist after bad performance.
- This generates the distinct prediction that extra pay-forperformance is introduced and the manager’ s wealth is fully exposed to permanent shocks only when her stake in the firm is large enough. Notably, when her stake is low, the extra pay-for-performance effect is shut down and the incentive compatibility constraint is binding.Our model therefore provides a rationale for the asymmetry of pay-for-performance observed in the executive compensation data.
- In our model, the outcome of long-term investment realizes instantaneously. It would be interesting to study a setup in which the impact of the manager’ s long-term investment decisions gradually realizes over time, giving rise to more involved incentive structures.

THANK YOU!