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Time-Inconsistent Manager Incentives and Capital Formation*

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Abstract

The empirical literature emphasizes the importance of protecting shareholder rights by encouraging managers to deliver a high present value of payouts. We show that this alignment is dynamically self-defeating: whenever access to outside equity is possible, even if costly, and commitment is limited, compensation tied to total payouts inadvertently generates *endogenous managerial short-termism* through time inconsistency. Paradoxically, a manager who cannot commit to restrain future equity issuance raises substantial outside funding yet invests too little today. When managers cannot commit ex ante, they rationally discount the marginal benefit of investment at a rate below the subjective discount factor, even though managers and shareholders share the same information and discount factor. The resulting wedge raises the manager's perceived cost of capital and reduces long-run investment. Rewarding the manager for per-share rather than total payouts removes the incentive to dilute incumbent shareholders and restores efficient issuance and investment. Among implementable contracts it maximizes the value accruing to incumbent shareholders and converges to the first-best steady state, so per-share indexing dominates absolute-payout pay for the firm's existing shareholders.

Keywords: Market functioning; Economic models

JEL codes: G32; G34; J33

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1. Introduction

Managers are often compensated to maximize the present value of equity payouts to shareholders. However, as emphasized by Bertrand and Mullainathan (2001) and Bebchuk and Fried (2003), corporate governance safeguards are necessary to prevent managers from influencing their own compensation excessively. Timely equity payouts—dividends and share repurchases[1]—have therefore been stressed as mechanisms to discipline managers and ensure that earnings accrue to shareholders rather than being retained for private benefit or inefficient expansion (Easterbrook, 1984; Jensen, 1986; Zwiebel, 1996; Fluck, 1998; Myers, 1998; La Porta et al., 2000; Denis and Osobov, 2008). Consistent with this view, the empirical literature documents significant managerial incentives to make equity payouts (Michaely et al., 1995; White, 1996; Parrino et al., 2003; Schaeck et al., 2012; Minnick and Rosenthal, 2014; Chen et al., 2019).[2]

This paper shows that such payout-based incentives are dynamically self-defeating. Whenever the manager cannot commit to future payout policy and access to outside equity is possible—even if costly—payout-linked compensation leads the manager to under-invest—an unintended dynamic distortion we call *endogenous short-termism*. The mechanism rests on only three ingredients—payout-linked compensation, limited commitment, and access to outside equity issuance—each a pervasive feature of corporate finance, so the force is general; we isolate it in a deliberately simple model. What is responsible is the manager's inability to commit not to issue equity in the future, not that issuance is costly: the distortion is present even when issuance is frictionless—indeed it is largest then—and disappears only when the firm has no access to outside equity at all. The logic is straightforward: although the manager and shareholders share the same discount factor and are aligned ex ante, the manager cannot commit not to dilute incumbents, so once start-up capital is installed the manager front-loads dividends to the current period through a follow-up equity issuance.

We make three contributions. First, we identify and characterize the mechanism: combining payout-linked compensation, access to outside equity issuance, and limited commitment—each well studied in isolation in the corporate-finance literature—yields endogenous short-termism in closed form, with an effective discount wedge that is independent of the subjective discount factor. Second, we show that the distortion admits a simple and implementable remedy: indexing pay to per-share rather than

[1]We do not distinguish dividends and repurchases in this paper. While dividends and repurchases are not close substitutes in practice (Brav et al., 2005), our model focuses on the life cycle of the firm and does not consider stochastic fluctuations in earnings that are considered to be driving repurchases in practice (Bonaimé and Kahle, 2024). For convenience, we use equity payout and dividend interchangeably.

[2]Equally consistent is the observation that payouts are remarkably persistent: surveyed CFOs report extreme reluctance to cut dividends, and firms routinely maintain payout levels while accessing outside equity (Brav et al., 2005). This co-occurrence of payouts and external finance is the empirical counterpart of the joint determination of dividends and issuance that emerges in the model below.

total payouts realigns the manager with continuing shareholders, and among implementable contracts it maximizes incumbent value and restores the first-best steady state. Third, we draw out the empirical and policy implications, including testable cross-sectional predictions and the warning that making equity issuance cheaper can *worsen* the underinvestment it might be intended to cure.

Methodologically, we characterize the time-consistent Markov-perfect equilibrium through a generalized Euler equation (GEE). The GEE ordinarily involves the derivative of an unknown decision rule (Klein et al., 2008), which makes equilibria difficult to characterize even in steady state. In our setting, the manager's objective is linear in dividends, which collapses that derivative to a constant, so the GEE yields a *closed-form* solution. The manager's effective discount factor on the marginal benefit of investment is $\widehat{\beta} = \beta(1 - \alpha\psi/(1+\psi))$, strictly below the common subjective β, where ψ is the compensation sensitivity to payouts and α is the efficiency of equity issuance. The wedge between $\widehat{\beta}$ and β depends only on ψ and α—and, importantly, is independent of β; production curvature enters later, amplifying the wedge's effect on the capital stock through the exponent $1/(1-\nu)$. This β-invariance distinguishes the mechanism from existing accounts of dynamic inconsistency based on quasi-hyperbolic discounting (Strotz, 1956; Phelps and Pollak, 1968; Laibson, 1997) or on heterogeneity in discount factors across agents (Jackson and Yariv, 2015).

We first illustrate the mechanism in a simple two-period model. Under commitment, investment equates the marginal product of capital to its discounted cost. Without commitment, dilution creates a wedge in the Euler condition and investment falls below the efficient level. We then extend the analysis to an infinite-horizon setting and solve for the Markov Perfect Equilibrium. The underinvestment distortion persists in steady state whenever the firm can raise outside equity and compensation is tied to payout levels.

The steady-state distortion admits a simple closed-form expression. If α measures issuance efficiency and ψ captures payout sensitivity in compensation, the effective investment wedge is $\frac{\alpha\psi}{1+\psi}$, amplified by the factor $1/(1-\nu)$. The wedge is increasing in α, so the distortion is largest precisely when external equity markets function well—efficient issuance is what lets the manager front-load payouts. At an issuance efficiency in the range implied by the flotation-cost estimates of Hennessy and Whited (2007), $\alpha \in [0.9, 0.95]$, even a compensation sensitivity as small as $\psi = 0.01$—under which payout-linked pay is about one percent of firm value—leaves steady-state capital some 9% below the commitment benchmark (with $\beta = 0.9$ and $\nu = 0.9$; see Appendix F). The distortion does not require that issuance be costly. The wedge is strictly positive and *largest* in the frictionless limit $\alpha \to 1$ (a 9.5% shortfall at $\psi = 0.01$), so what drives underinvestment is positive payout sensitivity together with limited commitment, not the issuance cost itself; the inefficiency matters more, the smaller those costs are, and disappears only in the opposite limit $\alpha \to 0$, when the firm cannot raise outside equity at all.

This is the counterintuitive heart of the mechanism: better-functioning equity markets *deepen* the friction, because efficient issuance is precisely what lets the manager front-load payouts at the expense of incumbents.

While explicit compensation contracts indexed directly to dividend payments are uncommon, managerial incentives are often closely tied to payout policies through bonuses tied to free cash flow, repurchase-linked performance metrics, perks indexed to dividend distributions, and deferred-equity vesting on payout milestones. These instruments arise as second-best responses to information and monitoring frictions, and private benefits represent a further channel through which payout policies affect managerial utility.

Our mechanism differs from existing accounts of managerial short-termism. Much of the literature focuses on earnings manipulation, either real or accrual-based (Brav et al., 2005; Zang, 2012; Terry et al., 2023), or on stock-price manipulation induced by short-term equity incentives (Bolton et al., 2006; Brisker et al., 2014; Bergstresser and Philippon, 2006; Gopalan et al., 2014). That literature emphasizes voluntary disclosure and the regulation of financial reporting; such frameworks constrain misreporting but do not eliminate incentives to influence prices through real decisions (Einhorn, 2007; Cohen et al., 2008; Gigler et al., 2014; Schroth, 2018). In contrast, our distortion arises even under full information, common discounting, and risk neutrality. It does not rely on misreporting, belief differences, or managerial impatience. Our analysis abstracts from optimal contracting: short-termism arises endogenously even when managers and shareholders share the same information. Rather than relying on misreporting, the mechanism turns on the manager's inability to commit to future equity issuance. A manager who cannot commit not to excessively raise equity funding in the future will, paradoxically, pursue inefficiently low investment today—so the firm raises substantial outside funding and yet invests too little.

The paper is also related to the literature on compensation design and financing constraints (Atkeson, 1991; Holmstrom and Tirole, 1997; Atkeson and Cole, 2005). We treat the compensation sensitivity ψ as exogenous and abstract from optimal contracting considerations. A natural question is why $\psi > 0$ would arise in equilibrium if it generates the wedge described above; our contribution is not to characterize the optimal level of ψ but to isolate a dynamic distortion that any positive ψ generates when payout-based incentives interact with access to outside equity and commitment is limited. Because managers and shareholders share the same discount factor and value payouts proportionally, this cost reflects a dynamic inefficiency rather than a redistribution across claimants. In this respect, the analysis complements the dividend-discipline view of Jensen (1986) by identifying a dynamic cost of payout-linked governance mechanisms.

Our results also shed light on the prevalence of earnings-per-share-based incentives (Bens et al., 2002, 2003; Young and Yang, 2011; Huang et al., 2014; Kim and Ng, 2018): conditioning compensation on per-share rather than total payouts eliminates the dilution channel, so the time-consistent policy implements the same first-best investment path as under full commitment (Sections 4.2–4.3). More broadly, even long-term equity incentives—intended to align the manager with shareholders—can create a self-control problem when the manager cannot commit to future payout policies.

Overall, the analysis suggests that compensation structures designed to protect shareholder value may reduce firm value whenever the firm can raise outside equity and commitment is limited. A policy typically used to discourage managers from over-investing—incentives to pay out equity—ends up creating the exact opposite problem, precisely because managers cannot commit to future equity-payout plans. The interaction between payout-based incentives and financing frictions can therefore generate persistent underinvestment even in the absence of traditional agency conflicts.

The remainder of the paper is organized as follows. Section 2 introduces the mechanism in a two-period model. Section 3 develops the infinite-horizon model and characterizes the Markov-perfect equilibrium through the generalized Euler equation. Section 4 draws out the economic implications—endogenous short-termism, the per-share remedy, and the comparison of compensation designs. Section 5 develops the empirical implications, and Section 6 concludes.

2. A Simple Two-Period Model

We begin with a two-period version of the model to isolate the mechanism generating time inconsistency and underinvestment. The infinite-horizon extension follows in Section 3.

2.1. Environment

There are two dates, $t = 0, 1$. Given k_0, output is generated through the decreasing-returns-to-scale production function

$$f(k_t) = k_t^{\nu}, \qquad \nu \in (0, 1),$$

and capital fully depreciates after production. In $t = 0$, the manager chooses next-period capital k_1, dividends $z_0 \geq 0$, and equity issuance $m_0 \geq 0$. Issuance is costly: only a fraction $\alpha \in (0, 1)$ becomes usable resources. The period-0 resource constraint is

$$(1 + \psi)z_0 + k_1 = k_0^{\nu} + \alpha m_0, \tag{1}$$

where ψz_0 is managerial compensation. In $t = 1$, the firm liquidates and distributes all output:

$$(1+\psi)z_1 = k_1^{\nu}. \tag{2}$$

The manager's compensation is proportionate to the present value of total dividend payouts to shareholders:

$$V = \psi(z_0 + \beta z_1). \tag{3}$$

2.2. Equity Pricing and Dilution

Let e_0 denote the ownership share allocated to new shareholders. Competitive pricing requires that issued equity equals the present value of dividends paid to shareholders purchasing the equity, i.e.,

$$m_0 = \beta e_0 z_1. \tag{4}$$

We impose a dilution constraint, which requires that the ownership share of new equity holders does not exceed the fraction of new equity relative to total firm resources:

$$e_0 \leq \frac{m_0}{m_0 + k_0^{\nu} - (1+\psi)z_0}. \tag{5}$$

The right-hand side of (5) is the ratio of new cash contributed by outside investors, m_0, to total firm resources after issuance, $m_0 + k_0^{\nu} - (1+\psi)z_0$. Thus, the constraint requires that new shareholders cannot receive an ownership share exceeding their pro-rata contribution to firm resources. We interpret (5) as a reduced-form representation of the legal and institutional protections that limit dilution of existing shareholders—including pre-emptive rights, board fiduciary duties toward existing equity holders, supermajority listing-rule requirements for large issuances, and litigation risk when issuances are priced below book value. Competitive pricing alone, as in (4), does not impose this restriction on e_0; absent (5), the manager could dilute existing shareholders excessively while still satisfying fair-value pricing.[3]

[3] A simple sub-game rationalizes (5) as an equilibrium outcome. After the manager proposes an issuance plan (m_0, e_0), existing shareholders observe the proposal and may block it through a vote, board action, or post-issuance suit. Suppose existing shareholders block any proposal in which the new shareholders' ownership share exceeds their pro-rata contribution, that is, any (m_0, e_0) with $e_0 > m_0/(m_0 + k_0^{\nu} - (1+\psi)z_0)$. This blocking rule is the simplest expression of the protections cited above and is incentive-compatible for existing shareholders, since any violation transfers value from them to new shareholders. Anticipating the blocking rule, the manager chooses (m_0, e_0) within the constraint, so (5) emerges as the operative upper bound on e_0. Throughout the paper we work with the constraint directly rather than embedding the sub-game.

2.3. Commitment Benchmark

If the manager can commit to not dilute existing ownership shares ($e_0 = 0$), all dividends will be paid out to existing shareholders. As a result, the ex-ante shareholder value at the beginning of $t = 0$ is

$$\Omega_0 = z_0 + \beta(1 - e_0)z_1 = z_0 + \beta z_1. \tag{6}$$

The manager's objective, (3), is aligned with the shareholder value, (6), which implies that the latter is maximized under commitment prior to $t = 0$. Importantly, by committing to not dilute the shares ex-post, the firm attracts sufficiently large capital k_0 through equity issuance, which is crucial for production.

In $t = 0$, the manager effectively maximizes total surplus given k_0 and $e_0 = 0$, which equals

$$k_0^\nu - k_1 + \beta k_1^\nu.$$

Taking the first-order condition, the optimal k_1 satisfies the efficiency condition

$$1 = \beta\nu k_1^{\nu-1}. \tag{7}$$

That is, k_1 achieves the efficient level of capital

$$k^* = (\beta\nu)^{1/(1-\nu)}. \tag{8}$$

As a result, dividend payouts are

$$z_0^* = \frac{1}{1+\psi}\left(k_0^\nu - k^*\right), \tag{9}$$

$$z_1^* = \frac{1}{1+\psi}(k^*)^\nu. \tag{10}$$

2.4. No Commitment

With no commitment to shareholders' value, the manager has an incentive to deviate from the commitment solution. Once k_0 is installed, the manager reneges on the commitment to not dilute the shares and reoptimizes the initial decisions. In particular, the firm issues more equity up to the point where the dilution constraint (5) binds, as the manager gains access to more resources to reward himself by paying out more dividends. Substituting (1), (2), (4) and (5) into (3) and taking the first-order condition with respect to k_1 yield

$$1 = \beta\nu k_1^{\nu-1}\left(1 - \frac{\alpha\psi}{1+\psi}\right). \tag{11}$$

Thus, equilibrium investment is

$$\hat{k}_1 = \left[\beta\nu\left(1 - \frac{\alpha\psi}{1+\psi}\right)\right]^{1/(1-\nu)}. \tag{12}$$

Lemma 1 (Underinvestment)**.** *Underinvestment occurs in equilibrium if the manager cannot commit to future actions.*

$$\hat{k}_1 < k^*.$$

As a corollary to Lemma 1, we obtain tilted dividend payouts relative to the commitment solution:

$$\widehat{z}_0 = \frac{1}{1+\psi}\left(k_0^\nu - \widehat{k}_1 + \alpha\beta\widehat{e}_0\widehat{z}_1\right) > z_0^*, \tag{13}$$

$$\widehat{z}_1 = \frac{1}{1+\psi}\widehat{k}_1^\nu < z_1^*. \tag{14}$$

The distortion in investment arises because dividend-linked compensation induces the manager to front-load payouts ($\widehat{z}_0 > z_0^*$ and $\widehat{z}_1 < z_1^*$), a pattern made possible through new equity issuance that deviates from the commitment solution. Although the manager's value for a given k_0 exceeds that under commitment, initial shareholders are worse off because their claim is diluted relative to the maximum $\Omega_0^* = z_0^* + \beta z_1^*$.

3. Infinite-Horizon Model

We now extend the analysis to an infinite-horizon setting and examine the long-run implications of time-inconsistency by comparing steady states under commitment and time-consistent equilibrium.

The manager's objective function is the present value of lifetime compensation

$$\sum_{t=0}^{\infty}\beta^t\psi z_t, \tag{15}$$

where $z_t \geq 0$ denotes dividends. In every period, the manager faces the budget constraint

$$(1+\psi)z_t + k_{t+1} = k_t^{\nu} + \alpha m_t, \tag{16}$$

and the dilution constraint

$$e_t \leq \frac{m_t}{m_t + k_t^{\nu} - (1+\psi)z_t}, \tag{17}$$

where $k_t \geq 0$ is capital, $m_t \geq 0$ denotes equity issuance, and $e_t \in (0, 1]$ is the ownership share allocated to new equity holders in period t whenever $m_t > 0$. If no equity is issued, then $m_t = e_t = 0$, and the dilution constraint is irrelevant.

3.1. Commitment Benchmark

In addition to (16) and (17), the manager must satisfy the following commitment constraint for shareholder value Ω_t:

$$\Omega_t = z_t + \beta(1 - e_t)\Omega_{t+1}. \tag{18}$$

Moreover, new equity issuance must be consistent with the following pricing equation:

$$m_t = \beta e_t \Omega_{t+1}. \tag{19}$$

Combining (17) and (19), positive equity issuance must satisfy

$$\begin{cases} m_t + k_t^{\nu} - (1+\psi)z_t \leq \beta\Omega_{t+1} & \text{(20a)} \\ m_t \leq \beta\Omega_{t+1} & \text{(20b)} \end{cases}$$

Condition (20a) corresponds to the case in which (17) is operative without the hard upper bound on e_t binding separately. When (20a) binds, it yields an interior solution for $e_t \in (0, 1)$, except at the boundary where the implied value $e_t = 1$ just reaches the corner as the manager pays out all the output of existing capital as dividends, that is, $k_t^{\nu} = (1+\psi)z_t$. Equality in (20b) corresponds to the true corner case in which the hard upper bound $e_t = 1$ binds and (20a) is slack. In this case, all new investment, as well as the portion of dividend payouts in excess of the output of existing capital, $(1+\psi)z_t - k_t^{\nu}$, is financed by new equity. Existing shareholders receive the entire committed shareholder value through current dividends, so that $z_t = \Omega_t$. Similarly, substituting (19) into (18) yields

$$\Omega_t = z_t + \beta\Omega_{t+1} - m_t. \tag{21}$$

The commitment allocation $\{z_t, k_{t+1}, \Omega_t, m_t\}_{t=0}^{\infty}$ maximizes (15) subject to (16), (20), and (21), given k_0. The manager chooses Ω_0 so that (21) holds after all other period-0 variables are optimally selected. By contrast, for $t \geq 1$, Ω_t represents a binding promise to shareholders in future periods. Consequently, in period 0, the manager can raise as much equity as permitted by (20) without being disciplined by (21). In later periods, however, any additional equity issuance would worsen the terms of the initial equity issuance through the recursion in (21). (19). The following proposition establishes the manager's equity issuance decision under commitment.

Proposition 1. *Under commitment, the manager always issues equity in period* 0*, may also do so in period* 1*, but never thereafter.*

The proof of Proposition 1 is provided in Appendix A. The intuition for the proposition is as follows. The manager chooses to incur the cost of equity issuance in the initial period, when the incentive to raise dividend payouts is strongest. Any later issuance is wasteful because of issuance costs and dilution, and can instead be reduced to improve the terms of the initial equity issuances. The resulting gain can then be used both to increase the capital stock so as to offset the reduction in resources associated with lower future equity issuance and to raise current dividend payouts. Although this is the baseline pattern, the manager may issue additional equity in period 1. This occurs when the manager's desired equity issuance in period 0 is constrained by the hard bound $e_0 = 1$. When e_0 is already at this bound, the manager raises shareholder value Ω_1 by temporarily accumulating additional capital and paying it out as dividends in period 1, thereby offsetting the dilution effect of period-1 equity issuance. This further increases period-0 equity issuance and dividends, raising total dividends over the first two periods. Appendix A shows that continuing $e_t = 1$ for more than one period leads to suboptimal accumulation of capital, which can be reduced to increase dividend payouts in earlier periods.

Proposition 1 has three important implications. First, under the commitment policy, the manager's incentive is perfectly aligned with shareholders purchasing new equities in the initial periods. Since the manager never issues equity again, (21) implies that $\Omega_{s+1} = \sum_{t=s+1}^{\infty} \beta^{t-s-1} z_t$, where s is the last period of equity issuance. The manager's value after period s is proportionate to Ω_{s+1}.

Second, the absence of equity issuance after the initial periods implies $e_{ss} = m_{ss} = 0$ in the steady state. Moreover, the optimal steady-state condition for investment is

$$1 = \beta \nu k_{ss}^{\nu - 1}. \tag{22}$$

It follows that k_{ss} attains the efficient capital stock, k^*, which allows the manager to pay a positive dividend

$$z^* = \frac{k^{*\nu} - k^*}{1 + \psi}. \tag{23}$$

Given this, the commitment constraint (21) implies

$$\Omega^* = \frac{k^{*\nu} - k^*}{(1 + \psi)(1 - \beta)} \tag{24}$$

for shareholders.

Third, despite these favorable features, the proposition highlights the time inconsistency of commitment. Although the manager announces *ex ante* an intention to align with the interests of shareholders who purchase equity in the initial periods, this commitment is not credible. The reason is that, *ex post*, the manager faces the same incentive to issue equity as in period 0, thereby reneging on the promise not to dilute existing shareholders after the initial issuances. The incentive arises because the manager is compensated for dividend payouts and therefore seeks to extract firm value through payouts. Under the commitment policy, this is promised to occur only in the initial periods but not thereafter.

3.2. Markov Perfect Equilibrium and Generalized Euler Equation

The time-inconsistency problem implies that the commitment allocation cannot be implemented as an outcome of the manager's problem. A standard approach is to formulate a game in which managers play against their future selves and to study its Markov perfect equilibrium (MPE), which yields a time-consistent strategy. Specifically, we follow (Klein et al., 2008) and examine its properties.

With no commitment, the manager does not respect existing shareholder values and takes the equilibrium equity value as given. The manager's time-consistent decisions can then be characterized by policy functions that depend only on the current state k. Writing the problem recursively, we supress time subscripts and denote next-period variables with a prime. The market value of the firm, denoted by $\Omega(k)$, is a function of state variable k and equals the present value of equilibrium payouts to existing shareholders starting from capital k:

$$\Omega(k) = g^z(k) + \beta(1 - g^e(k))\Omega(g^k(k)), \tag{25}$$

where $g^z(k)$, $g^e(k)$ and $g^k(k)$ denote MPE policy functions for dividends, the new ownership share, and next-period capital, respectively. The manager's problem is

$$\max_{z\geq 0,\ k'\geq 0,\ e\in[0,1]} \left\{\psi z + \beta V(k')\right\}, \tag{26}$$

subject to the budget constraint

$$(1+\psi)z + k' = k^\nu + \alpha\beta e\Omega(k') \tag{27}$$

and the dilution constraint

$$e \leq \frac{\beta e\Omega(k')}{\beta e\Omega(k') + k^\nu - (1+\psi)z}, \tag{28}$$

where $\Omega(k)$ is given by (25) and $V(k)$ must be consistent with

$$V(k) = \psi g^z(k) + \beta V(g^k(k)). \tag{29}$$

Note that managers and shareholders share the same discount factor β and there is no information asymmetry between them.

We focus on the interior solution to the problem. Substituting (27) into (26), the objective function simplifies to

$$\frac{\psi}{1+\psi}\left(k^\nu - k' + \alpha\beta e\Omega(k')\right) + \beta V(k').$$

In contrast to the commitment allocation, the MPE is not constrained by the current shareholder value associated with k. Thus, the manager chooses e up to the point at which (28) binds. In this case, dividend payout is given by

$$z = \frac{(1-\alpha)k^\nu - k' + \alpha\beta\Omega(k')}{(1+\psi)(1-\alpha)}. \tag{30}$$

Moreover, when (28) binds, the equilibrium shareholder value in (25) implies that

$$\Omega(k) = k^\nu - \psi g^z(k). \tag{31}$$

Substituting (30) and (31) into the Bellman problem yields:

$$V(k) = \max_{k' \geq 0} \left\{ \frac{\psi}{(1+\psi)(1-\alpha)} \left[(1-\alpha)k^{\nu} - k' + \alpha\beta\,(k')^{\nu} - \alpha\beta\psi\, g^{z}(k') \right] + \beta V(k') \right\}. \tag{32}$$

The first-order condition with respect to k' yields the following generalized Euler equation (GEE):

$$1 = \beta\nu\,(k')^{\nu-1} \left[1 - \alpha\psi \frac{g_k^z(k')}{\nu\,(k')^{\nu-1}} \right], \tag{33}$$

where g_k^z is the derivative of g^z with respect to k. The term $g_k^z(k')$ captures the manager's incentive to pay out more dividends when capital is installed due to the absence of commitment. In general, the derivative of the unknown decision rule, g_k^z, makes the equilibrium difficult to characterize, even in the steady state (Klein et al., 2008). However, Proposition 2 shows that the linearity of the manager's objective in dividends collapses $g_k^z(k')$ to a constant, so (33) simplifies to a closed-form expression for the MPE policies.

Proposition 2. *The time-consistent investment policy under MPE is given by*

$$\widehat{k} = \left(\widehat{\beta}\nu \right)^{1/(1-\nu)}, \tag{34}$$

where

$$\widehat{\beta} = \beta \left(1 - \frac{\alpha\psi}{1+\psi} \right). \tag{35}$$

Proof. See Appendix B. □

Substituting (34) and (31) into (30) yields

$$g^{z}(k) = \frac{(1-\alpha)k^{\nu} - \widehat{k} + \alpha\beta\widehat{k}^{\nu} - \alpha\beta\psi\, g^{z}(\widehat{k})}{(1+\psi)(1-\alpha)}.$$

Therefore, denoting the steady-state dividends under MPE by $\widehat{z}$, it is given by

$$\widehat{z} = g^{z}(\widehat{k}) = \frac{(1-\alpha+\alpha\beta)\widehat{k}^{\nu} - \widehat{k}}{(1+\psi)(1-\alpha) + \alpha\beta\psi}. \tag{36}$$

Moreover, (31), (34) and (36) yield the steady-state shareholder value under MPE, $\widehat{\Omega}$:

$$\widehat{\Omega} = \Omega\big(\widehat{k}\big) = \widehat{k}^{\nu} - \psi\widehat{z} = \frac{(1-\alpha)\widehat{k}^{\nu} + \psi\widehat{k}}{(1+\psi)(1-\alpha) + \alpha\beta\psi}.$$

Since (28) binds in equilibrium, the steady-state equity issuance and ownership share are, respectively,

$$\widehat{m} = \frac{\beta\widehat{k}^{\nu} - [1+(1-\beta)\psi]\widehat{k}}{(1+\psi)(1-\alpha) + \alpha\beta\psi},$$
$$\widehat{e} = \frac{\beta\widehat{k}^{\nu} - [1+(1-\beta)\psi]\widehat{k}}{\beta(1-\alpha)\widehat{k}^{\nu} + \beta\psi\widehat{k}}.$$

4. Economic Implications and Interpretation

4.1. Endogenous Short-Termism

The distortion in (34) operates through *endogenous* short-termism, reflected in the effective discount factor $\widehat{\beta}$ in (35), which is lower than the common subjective discount factor β. In the time-consistent equilibrium, the current manager and shareholders rationally anticipate that future managerial selves will face the same incentive to use equity issuance to support payouts. As a result, part of the return to investment is expected to be distributed prematurely, so the manager discounts the marginal benefit of investment at the lower rate $\widehat{\beta}$. The size of the wedge between β and $\widehat{\beta}$ is determined by the compensation structure, ψ, and the technology of equity issuance, α: if $\psi = 0$, dividends do not affect compensation and the distortion vanishes; if $\alpha = 0$, equity issuance cannot support payouts and the distortion likewise disappears. Higher ψ and higher α strengthen the distortion by increasing, respectively, the incentive and the ability to front-load dividend payouts.

The endogenous short-termism is the paper's central substantive result. Unlike standard sources of time inconsistency, such as present-biased preferences arising from exogenously-determined myopia (Strotz, 1956; Phelps and Pollak, 1968; Laibson, 1997) and heterogeneity in discount factors across agents (Jackson and Yariv, 2015), the wedge derived here arises even though the manager and shareholders share the same β. Moreover, the magnitude of the distortion is independent of β.

The steady-state implications of the short-termism generated by (35) are as follows.

Corollary 1. *First, the time-consistent capital stock is lower than the efficient level supported by* *commitment by a factor of*

$$\frac{\widehat{k}}{k^*} = \left(1 - \frac{\alpha\psi}{1+\psi}\right)^{1/(1-\nu)}. \tag{37}$$

Second, the dividend-output ratio is higher under the time-consistent equilibrium than under commitment, that is, $\widehat{z}/\widehat{k}^{\nu} > z^*/k^{*\nu}$. Third, the shareholder value is lower under the time-consistent equilibrium than under commitment, that is, $\Omega^* > \widehat{\Omega}$.

Proof. See Appendix C. □

The first result shows that the wedge in the manager's effective discount factor drives the gap between MPE and commitment capital, while production curvature magnifies the resulting distortion through the exponent $1/(1-\nu)$. Despite the lower capital level, the second result shows that the manager distributes a larger share of output as dividends under MPE than under commitment, consistent with the manager's incentive to front-load dividend payouts. The third result shows that the distortion in MPE lowers shareholder value relative to commitment. Appendix F tabulates the percentage capital shortfall $1 - \widehat{k}/k^*$ implied by (37) for a range of (α, ψ, ν) values, illustrating that the distortion is economically meaningful at standard parameter values. Our results thus show that, paradoxically, higher-powered incentives for the manager lead to non-trivial distortions in investment that lower the firm's size and profits.

4.2. Per-Share Compensation

The distortion arises because, under total-dividend compensation, the manager's *ex post* incentive is misaligned with shareholders. Indexing pay to dividends *per share* removes this misalignment. Let N_t be the number of shares outstanding, with $N_0 = 1$ and $N_{t+1} = N_t/(1-e_t)$; the manager's objective is then $W_0 = \psi \sum_{t=0}^{\infty} \beta^t z_t/N_t$, which the next claim rewrites to make its anti-dilution property transparent.

Claim 1. *The present value of per-share dividend compensation can be expressed as*

$$W_0 = \psi \sum_{t=0}^{\infty} \beta^t \left(z_t - m_t\right). \tag{38}$$

Proof. Since $1/N_t = \prod_{s=0}^{t-1}(1-e_s)$, we have $\sum_{t=0}^{\infty} \beta^t z_t/N_t = z_0 + \beta(1-e_0)\Omega_1$ by the definition of Ω_1. The pricing condition $m_0 = \beta e_0 \Omega_1$ makes this $z_0 - m_0 + \beta\Omega_1$; iterating forward yields (38). □

Because shareholder value is itself $\Omega_0 = \sum_{t=0}^{\infty} \beta^t (z_t - m_t)$, the manager's objective is *proportional to shareholder value at every date* — the alignment is global, not merely in steady state. The dilution gain that drives issuance under total-dividend pay therefore disappears, as the next two results make precise.

Proposition 3. *Under dividend-per-share compensation, the manager never issues equity and pays dividends simultaneously:* $z_t m_t = 0$ *for all* $t \geq 0$.

Proof. See Appendix D. □

Building on this, the next proposition characterizes the manager's equity-issuance policy.

Proposition 4. *Under dividend-per-share compensation, the manager may issue equity once in the initial period and never thereafter. If* k_0 *is sufficiently small, this initial issuance supports investment to attain*

$$k_1 = \left[\frac{\alpha \beta^s \nu^s}{1+\psi}\right]^{1/(1-\nu^s)}, \tag{39}$$

where $s \geq 1$ *is the earliest period for which* $k_1^{\nu^s} \geq k^*$ *and dividend payouts begin. Further equity issuance is not optimal once capital reaches this level.*

Proof. See Appendix E. □

Together these results make the commitment policy time-consistent and efficient.

Corollary 2. *The commitment policy under dividend-per-share compensation is time-consistent and achieves* k^*, z^*, *and* Ω^* *in the steady state.*

Proof. The capital level k_1 in (39) is the most the manager will ever support through issuance: any further issuance dilutes per-share payouts without a sufficient offsetting gain, so in period 1 the manager has no incentive to issue again, and additional capital is financed from retained earnings. The commitment policy is therefore time-consistent, and its long-run condition $1 = \beta \nu k_{t+1}^{\nu-1}$ delivers the efficient benchmark (k^*, z^*, Ω^*). □

The mechanism is intuitive: each unit of new equity dilutes the manager's per-share pay by exactly the factor by which it dilutes incumbent shareholders, so the dilution gain that drives issuance under total-dividend pay vanishes and long-run issuance is zero.[4] The only remaining cost is that a firm

[4] This efficiency result is specific to the channel we model, in which the manager's per-share objective is exactly proportional to incumbent value. In richer environments, per-share (earnings-per-share) targets can themselves distort real decisions in the opposite direction: Almeida et al. (2016) find that EPS-motivated share repurchases are associated with reductions in investment and employment, as managers cut real spending to meet analyst EPS forecasts. Our model abstracts from the analyst-target and repurchase-timing frictions behind those effects; incorporating them would temper

starting with little capital must accumulate largely from retained earnings, approaching k^* gradually. As the next subsection shows, that gradual path is not a cost borne by incumbent shareholders but the optimal response to costly issuance.

4.3. Which Design Maximizes Shareholder Value?

The two implementable designs studied above—total-payout pay, which yields the distorted Markov perfect equilibrium, and per-share pay, which is time-consistent—can be ranked by the value they deliver to the firm's initial shareholders. Let $\Omega_0 = \sum_{t=0}^{\infty} \beta^t (z_t - m_t)$ denote that value, which by the law of motion (21) is well defined along any feasible allocation. The next result shows that per-share pay is not merely one way to remove the wedge: among implementable designs, it maximizes initial-shareholder value.

Proposition 5. *For any initial capital k_0, the date-0 value to initial shareholders under per-share compensation, $\Omega_0^s(k_0)$, is at least as large as under total-payout compensation, $\widehat{\Omega}_0(k_0)$:*

$$\Omega_0^s(k_0) \geq \widehat{\Omega}_0(k_0), \tag{40}$$

with strict inequality whenever the total-payout equilibrium involves positive equity issuance.

Proof. By Claim 1, under per-share compensation the manager's objective is $W_0 = \psi \sum_{t=0}^{\infty} \beta^t (z_t - m_t) = \psi \Omega_0$. The per-share policy therefore maximizes Ω_0 over all allocations satisfying the budget constraint (16) and the dilution constraint (20). The total-payout equilibrium allocation satisfies these same constraints and is hence feasible in that problem, so it cannot attain a higher value of Ω_0. Strictness follows because positive issuance under total-payout pay both dissipates resources through the issuance wedge and dilutes existing claims, neither of which occurs at the per-share optimum. □

Proposition 5 resolves the design question cleanly: *there is no region of the parameter space in which tying the manager's pay to total payouts raises date-0 firm value*. The intuition is that per-share pay makes the manager's objective coincide with the present value accruing to incumbent shareholders, so the time-consistent per-share policy is exactly the one those shareholders would choose. A numerical sweep over $\beta \in \{0.85, 0.9, 0.95\}$, $\nu \in \{0.36, 0.5, 0.7, 0.9\}$, $\psi \in \{0.005, 0.01, 0.02, 0.05, 0.1, 0.2\}$, and $\alpha \in \{0.3, 0.5, 0.8, 0.95\}$ confirms that the inequality in (40) never reverses.

Panel (a) of Figure 1 shows the magnitude. For the baseline $(\beta, \nu, \psi) = (0.9, 0.9, 0.01)$ and the realistic issuance efficiency $\alpha = 0.9$, per-share pay delivers roughly twice the date-0 value of total-payout pay

the unqualified case for per-share pay.

even when initial capital is ample; as k_0 falls the ratio rises without bound, because aggressive front-loading under total-payout pay leaves initial shareholders with almost nothing.

This advantage does not come from faster capital accumulation. Panel (b) traces the capital path from a low k_0. Total-payout pay front-loads investment by issuing equity aggressively and reaches its steady state $\widehat{k}$ in a single period; but because $\widehat{k} < k^*$, the firm remains permanently underinvested. Per-share pay issues at most once and then relies on retained earnings, so it accumulates slightly more slowly at first, yet it converges to the efficient level k^* within a few periods. Panel (c) shows the difference in financing behavior directly: under total-payout pay the firm issues new equity *every period*—the recurring dilution that drives the distortion—whereas under per-share pay it issues once, if at all, and never again. At empirically relevant issuance efficiency the early-growth sacrifice is small; it becomes pronounced only when issuance is very costly (low α)—which is also the regime in which the distortion being cured is itself small.

The result is straightforward: rewarding the manager for per-share rather than total payouts removes the incentive to dilute incumbents and so achieves efficient equity issuance and investment. Per-share pay therefore dominates absolute-payout pay for existing shareholders, delivering both higher incumbent value and the efficient allocation with no offsetting cost within the model. The only qualification concerns the speed of capital accumulation: relying on retained earnings rather than dilutive issuance, a firm starting with little capital approaches k^* gradually—but that path is itself the optimal response to costly issuance, and is appreciable only when external equity is very costly, precisely where the distortion being cured is smallest. A genuine trade-off would arise only under a blunter remedy, such as prohibiting equity issuance outright, which would pit short-run against long-run investment; per-share indexing attains the efficient allocation without imposing any such restriction.

5. Empirical Implications

Although this paper is theoretical and we undertake no empirical analysis ourselves, the mechanism delivers sharp, testable implications for empirical work, which we set out here. The model's comparative statics map directly into observable cross-sectional variation. The wedge $1 - \alpha\psi/(1+\psi)$ depends on two firm-specific primitives: the issuance efficiency α, which varies with a firm's reliance on outside equity, and the compensation sensitivity ψ, which varies with the structure of CEO pay. The capital elasticity ν varies across industries and amplifies the wedge as in (37). Three predictions follow.

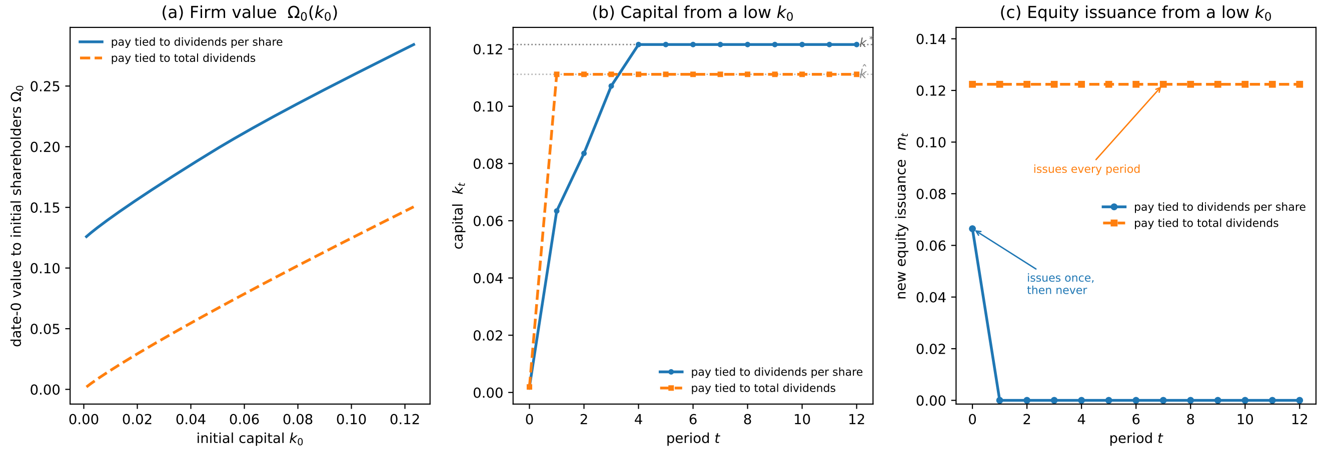

Figure 1: Comparison of compensation designs at $\beta = \nu = 0.9$, $\psi = 0.01$, and issuance efficiency $\alpha = 0.9$ (in the Hennessy–Whited range). In every panel the solid line is pay tied to dividends *per share* and the dashed line is pay tied to *total* dividends. **(a)** Date-0 value to initial shareholders Ω_0 against initial capital k_0: per-share pay dominates at every k_0. **(b)** Capital path from a low k_0: total-payout pay reaches its underinvested steady state $\widehat{k} < k^*$ in one period, whereas per-share pay converges to the efficient level k^* within a few periods. **(c)** New-equity issuance m_t: total-payout pay issues every period—the recurring dilution behind the distortion—while per-share pay issues at most once.

Prediction 1: Issuance activity.

Firms that frequently raise outside equity — and for which the dilution channel is therefore active — should exhibit a stronger negative relationship between dividend-sensitivity of CEO compensation and investment than firms that self-finance. The mechanism predicts a negative interaction between a measure of payout-linked pay (analog of ψ) and a measure of issuance reliance (analog of α) in cross-sectional regressions of investment or capital growth. This prediction is grounded in the comparative static $\partial\widehat{k}/\partial\alpha < 0$, which itself requires $\psi > 0$. Standard measures of payout-linked compensation can be constructed from data sources used by Minnick and Rosenthal (2014) and Chen et al. (2019).

Prediction 2: Firm maturity.

Mature firms that fund investment from retained earnings should display a weaker — or absent — wedge between observed and counterfactual commitment investment, because for these firms α is effectively zero in equilibrium. By contrast, growth firms with active SEO programs should display the full wedge. This prediction is consistent with traditional dividend-discipline arguments (Jensen, 1986), but with the opposite normative implication: the dividend channel that disciplines free cash flow in mature firms is the same channel that distorts investment in growth firms.

Prediction 3: Per-share-indexed compensation.

By Corollary 2, firms whose CEO compensation is indexed to per-share dividends or to earnings per share should display no investment distortion from payout sensitivity, while firms with absolute-payout-indexed pay should display the full wedge. This prediction admits a triple-difference test: investment as a function of (payout sensitivity) $\times$ (per-share-indexed pay dummy) $\times$ (issuance-active dummy), with the prediction that the per-share dummy fully absorbs the interaction. The rising prevalence of EPS-linked incentives (Bens et al., 2002, 2003; Young and Yang, 2011; Huang et al., 2014; Kim and Ng, 2018) provides cross-sectional and time-series variation suitable for this test.

The three predictions jointly distinguish the dilution mechanism from leading alternative accounts. Earnings-manipulation theories (Brav et al., 2005; Terry et al., 2023) do not yield Prediction 3, because conditioning compensation on per-share metrics does not, by itself, eliminate manipulation incentives — it eliminates only the dilution channel identified here. Short-term stock-price-management theories (Bolton et al., 2006) do not yield Prediction 1, because the incentive to manipulate prices through real decisions is largely orthogonal to whether the firm raises outside equity. Discount-factor-mismatch theories do not yield Prediction 2, because a discount-factor wedge applies uniformly across firms regardless of their reliance on equity issuance, and is in any case inconsistent with the β-invariance of the wedge in (37). The combination of all three predictions is therefore a falsifiable empirical signature of the mechanism developed in this paper.

6. Conclusion

Rewarding managers for the payouts they deliver is meant to align their interests with those of shareholders. We show that this alignment is dynamically self-defeating: whenever a manager cannot commit to future payout policy and access to outside equity is possible—even if costly—payout-linked pay leads the manager to under-invest—an *endogenous managerial short-termism*. The mechanism is general, resting on only three pervasive ingredients—payout-linked compensation, limited commitment, and access to outside equity issuance—and we isolate it in a deliberately simple model in which it admits a closed-form characterization. Faced with the temptation to raise current dividends beyond what shareholders had expected, the manager cannot sustain the first-best investment path implied by the commitment solution. With limited commitment, the manager instead chooses inefficiently low investment, rationally anticipating that larger investment would induce future selves to increase payouts further, thereby eroding both net firm resources and shareholder value relative to what had been expected *ex ante*. This distortion is an unintended consequence of an incentive scheme designed to protect shareholder interests, and it differs fundamentally from other forms of short-termism emphasized in the literature, such as managerial impatience or short-horizon incentive contracts.

The analysis also identifies a feasible remedy. When compensation is tied to dividends per share rather than total payouts, the manager's objective is aligned with shareholder value along the entire equilibrium path, so the time-consistent policy coincides with the shareholder-optimal commitment policy. In fact, among implementable designs per-share pay maximizes the value accruing to incumbent shareholders and converges to the first-best steady-state capital. When initial capital is low it approaches that level only gradually, but this is the optimal response to costly issuance rather than an inefficiency, so at empirically relevant issuance costs the remedy carries little real cost.

More broadly, the model yields a clean prescription rather than a trade-off: indexing managerial pay to per-share rather than absolute payouts removes the dynamic distortion, maximizes the value of the firm to its existing shareholders, and restores the efficient allocation, curbing only the value-destroying equity issuance that drives the distortion. The analysis isolates one force—the dynamic cost of absolute-payout incentives—and takes as given the disciplining role that such incentives are conventionally thought to play (Jensen, 1986). Weighing that disciplining benefit against the cost identified here is a natural next step toward a theory of optimal payout-linked compensation.

The mechanism also carries a policy lesson, and one that is easy to miss because the distortion hides in plain sight: a firm that invests too little is, surprisingly, one that raises *too much* outside equity rather than too little. A natural response to weak corporate investment is to make equity issuance cheaper or more efficient—a recurring theme in policy debates over access to equity finance. Our analysis shows that such measures can backfire: a lower issuance cost (higher α) *amplifies* the manager's commitment problem and widens the investment wedge. The effective remedy is not to improve the issuance technology but to design managerial incentives—indexing pay to per-share payouts—so that initiatives meant to ease equity finance do not deepen the very underinvestment they are intended to cure.

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Appendix

A. Proof of Proposition 1

In period 0, the manager chooses z_0, k_1, e_0, m_0 and commits to a future plan. Since the value promised to existing shareholders does not affect the terms of equity issuance in period 0, the manager issues equity up to the point at which either (20a) or (20b) binds.

Roadmap. The proof treats the two cases separately. **Case A.1** (Section A.1) covers the interior dilution case in which (20a) binds in period 0 with $e_0 \in (0,1)$. We first establish that no candidate optimum over-accumulates capital (Claim 2), then rule out $m_1 > 0$ by a one-period perturbation, and conclude $m_t = 0$ for all $t \geq 1$ by induction. **Case A.2** (Section A.2) covers the corner case in which $e_0 = 1$ binds in period 0. We solve in closed form for $k_1 = \theta k^* > k^*$, show that the manager issues equity in period 1 up to a binding interior dilution constraint (Claim 5), and conclude $m_t = 0$ for $t \geq 2$ by an analogous induction. Together these establish that under commitment the manager issues equity only in period 0, and possibly period 1, and never thereafter.

A.1. Case where (20a) binds in period 0

In this case, (16) and (20a) imply

$$(1+\psi)z_0 + k_1 = k_0^\nu + \alpha m_0, \tag{41}$$

$$m_0 = \frac{1}{1-\alpha}\left(\beta\Omega_1 - k_1\right). \tag{42}$$

Claim 2 (No over-accumulation of capital, period 1)**.** *Any candidate optimum satisfies $k_1 < k^*$. Equivalently, $\beta\nu k_1^{\nu-1} > 1$.*

Proof. Suppose $k_1 \geq k^*$, so that $\beta\nu k_1^{\nu-1} \leq 1$. Consider a marginal reduction $\Delta k_1 = -\delta$ with $\delta > 0$. In period 1, lower capital reduces output, so the budget constraint implies $\Delta z_1 = -\nu k_1^{\nu-1}\delta/(1+\psi)$. Through (44), this lowers continuation value by $\Delta\Omega_1 = \Delta z_1$ since m_1 and Ω_2 are held fixed. In period 0, however, the reduction in k_1 relaxes the resource constraint directly. In addition, the lower Ω_1 reduces m_0 through (42). Combining (41) and (42), the induced change in z_0 is $\Delta z_0 = [1 - \alpha\beta\nu k_1^{\nu-1}/(1+\psi)]\,\delta/[(1+\psi)(1-\alpha)]$. Therefore, the net change in the manager's payoff is

$$\Delta z_0 + \beta\Delta z_1 = \frac{1 - \big(1 - \alpha\psi/(1+\psi)\big)\beta\nu k_1^{\nu-1}}{(1+\psi)(1-\alpha)}\,\delta.$$

This expression is strictly positive because $\beta\nu k_1^{\nu-1} \leq 1$ and $1-\alpha\psi/(1+\psi) < 1$. Hence, any optimum must satisfy $k_1 < k^*$, equivalently $\beta\nu k_1^{\nu-1} > 1$. □

We first show that $m_1 = 0$ in period 1. Suppose, to the contrary, that $m_1 > 0$. Then, the period-1 budget, commitment and dilution constraints are, respectively,

$$(1+\psi)z_1 + k_2 = k_1^\nu + \alpha m_1, \tag{43}$$

$$\Omega_1 = z_1 + \beta\Omega_2 - m_1, \tag{44}$$

$$m_1 + k_1^\nu - (1+\psi)z_1 \leq \beta\Omega_2, \text{ and } m_1 \leq \beta\Omega_2. \tag{45}$$

To show that $m_1 > 0$ is suboptimal, consider a perturbation that reduces equity issuance to

$$\widetilde{m}_1 = m_1 - \frac{\epsilon}{\alpha},$$

where ϵ is an arbitrarily small positive number. To keep z_1 and k_2 unchanged in the budget constraint, increase k_1 to

$$\widetilde{k}_1 = (k_1^\nu + \epsilon)^{1/\nu}. \tag{46}$$

We verify below that this perturbation is feasible. Holding z_1, k_2 and Ω_2 fixed, the perturbed allocation continues to satisfy (45) and raises $\widetilde{\Omega}_1$ to $\widetilde{\Omega}_1 = \Omega_1 + \epsilon/\alpha$ through (44). By (42), $\widetilde{m}_0$ adjusts to the increases in $\widetilde{\Omega}_1$ and $\widetilde{k}_1$: constraint by $\beta\epsilon$.

$$\widetilde{m}_0 = \frac{1}{1-\alpha}\left[\beta\left(\Omega_1 + \frac{\epsilon}{\alpha}\right) - (k_1^\nu + \epsilon)^{1/\nu}\right] = m_0 + \frac{\beta}{1-\alpha}\left(\frac{1}{\alpha} - \frac{1}{\beta\nu k_1^{\nu-1}}\right)\epsilon + O(\epsilon^2), \tag{47}$$

where we applied a first-order Taylor expansion around $\epsilon = 0$. By Claim 2, $k_1 < k^*$, so $\beta\nu k_1^{\nu-1} > 1$. Hence, (47) implies that $\widetilde{m}_0 > m_0$ for sufficiently small $\epsilon > 0$. Substituting (46) and (47) into (41) yields

$$\widetilde{z}_0 = z_0 + \frac{\beta}{(1+\psi)(1-\alpha)}\left(1 - \frac{1}{\beta\nu k_1^{\nu-1}}\right)\epsilon + O(\epsilon^2) > z_0, \tag{48}$$

since $\beta\nu k_1^{\nu-1} > 1$. Hence, the perturbed allocation $(\widetilde{m}_1, \widetilde{k}_1)$ is feasible and leaves additional resources available for dividends in period 0. Therefore, any allocation with $m_1 > 0$ cannot be optimal, and the commitment allocation must satisfy $m_1 = 0$.

We next show by induction that $m_t = 0$ for all $t \geq 1$. Suppose that $m_1 = \cdots = m_{s-1} = 0$ and, contrary to the claim, that $m_s > 0$.

Claim 3 (No over-accumulation of capital, period s)**.** *Under the inductive hypothesis $m_1 = \cdots = m_{s-1} = 0$, any candidate optimum satisfies $\prod_{t=1}^{s} \beta\nu k_t^{\nu-1} > 1$.*

Proof. Suppose $k_s > k^*$ and consider a marginal reduction $\Delta k_s = -\delta$ with $\delta > 0$. Holding k_{s+1} and m_s fixed, the period-$(s-1)$ and period-s budget constraints imply $\Delta z_{s-1} = \delta/(1+\psi)$ and $\Delta z_s = -\nu k_s^{\nu-1}\delta/(1+\psi)$. Hence,

$$\Delta z_{s-1} + \beta\Delta z_s = \frac{\delta}{1+\psi}\left(1 - \beta\nu k_s^{\nu-1}\right) > 0,$$

since $k_s > k^*$ implies $\beta\nu k_s^{\nu-1} < 1$. Moreover, holding m_s and Ω_{s+1} fixed, $\Delta\Omega_{s-1} = \Delta z_{s-1} + \beta\Delta z_s > 0$. Because $m_t = 0$ for $t = 1, \ldots, s-1$, the commitment recursion gives $\Omega_t = z_t + \beta\Omega_{t+1}$ for $t = 1, \ldots, s-1$. Therefore, the gain in Ω_{s-1} propagates backward and yields $\Delta\Omega_1 > 0$, holding dividends for $t = 2, \ldots, s-2$ fixed. Through (41) and (42), this implies $\Delta z_0 > 0$. Since $\Delta z_0 + \beta^{s-1}\Delta z_{s-1} + \beta^s\Delta z_s > 0$, the perturbation raises the manager's payoff, contradicting optimality. Hence, $k_s \leq k^*$, equivalently $\beta\nu k_s^{\nu-1} \geq 1$, in any optimum. The same argument applies to any $t = 2, \ldots, s-1$, so $\beta\nu k_t^{\nu-1} \geq 1$ for all $t = 2, \ldots, s$. Combined with the strict inequality $\beta\nu k_1^{\nu-1} > 1$ from Claim 2, this yields $\prod_{t=1}^{s} \beta\nu k_t^{\nu-1} > 1$. $\square$

Consider a perturbation that lowers equity issuance in period s to

$$\widetilde{m}_s = m_s - \frac{\epsilon}{\alpha},$$

for sufficiently small $\epsilon > 0$. To offset the reduction in resources in period s while keeping z_s and k_{s+1} unchanged, set $\widetilde{k}_s = (k_s^\nu + \epsilon)^{1/\nu}$ is feasible in the $t = s$ budget constraint:

$$\widetilde{k}_s = (k_s^\nu + \epsilon)^{1/\nu}.$$

We then verify that this perturbation is feasible. First, this allocation satisfies the period-s budget constraint

$$(1+\psi)z_s + k_{s+1} = \widetilde{k}_s^\nu + \alpha\widetilde{m}_s.$$

The perturbed allocation also satisfies the dilution limit since $\widetilde{m}_s + \widetilde{k}_s^\nu - (1+\psi)z_s < m_s + k_s^\nu - (1+\psi)z_s \leq$

$\beta\Omega_{s+1}$. In addition, reducing m_s raises shareholder value in period s:

$$\widetilde{\Omega}_s = z_s + \beta\Omega_{s+1} - \widetilde{m}_s = \Omega_s + \frac{\epsilon}{\alpha}.$$

By iterating the commitment constraints backward for periods $1, \dots, s-1$, this increase propagates to commitment constraints, $\Omega_t = z_t + \beta\Omega_{t+1}$, for $t = 1, \dots, s-1$, this translates into $\widetilde{\Omega}_1 = \Omega_1 + \beta^{s-1}\epsilon/\alpha$.

$$\widetilde{\Omega}_1 = \Omega_1 + \beta^{s-1}\frac{\epsilon}{\alpha}. \tag{49}$$

Moreover, since $m_t = 0$ for $t = 1, \dots, s-1$, $\{\widetilde{k}_t\}_{t=1}^{s-1}$ must satisfy $\{\widehat{k}_t(\epsilon)\}_{t=1}^{s}$ is

$$\begin{aligned} \widetilde{k}_1 &= \left[\widetilde{k}_2 + (1+\psi)z_1\right]^{1/\nu}, \\ &\vdots \\ \widetilde{k}_{s-1} &= \left[\widetilde{k}_s + (1+\psi)z_{s-1}\right]^{1/\nu}. \end{aligned}$$

Using a first-order Taylor expansion around $\epsilon = 0$, $\widetilde{k}_1$ can be expressed as

$$\widetilde{k}_1 = k_1 + \frac{\beta^s\epsilon}{\prod_{t=1}^{s}\beta\nu k_t^{\nu-1}} + O(\epsilon^2), \tag{50}$$

where $\prod_{t=1}^{s}\beta\nu k_t^{\nu-1} > 1$ by Claim 3. Substituting (49) and (50) into (42) yields

$$\widetilde{m}_0 = m_0 + \frac{\beta^s}{1-\alpha}\left(\frac{1}{\alpha} - \frac{1}{\prod_{t=1}^{s}\beta\nu k_t^{\nu-1}}\right)\epsilon + O(\epsilon^2). \tag{51}$$

As a result, period-0 dividends increase to

$$\widetilde{z}_0 = z_0 + \frac{\beta^s}{(1+\psi)(1-\alpha)}\left(1 - \frac{1}{\prod_{t=1}^{s}\beta\nu k_t^{\nu-1}}\right)\epsilon + O(\epsilon^2) > z_0. \tag{52}$$

Therefore, the perturbed allocation is feasible and frees additional resources for dividends in period 0. This contradicts the optimality of any allocation with $m_s > 0$. Hence, $m_t = 0$ for all $t \geq 1$.

A.2. Case where (20b) binds in period 0

We proceed in three steps. First, we solve for k_1. Second, we show that $m_2 = 0$ is optimal. Third, we extend the same argument to all $t \geq 3$ by induction.

Step 1. Solve for k_1

Since $e_0 = 1$, the period-0 budget constraint and the equity-pricing condition imply

$$(1+\psi)z_0 + k_1 = k_0^{\nu} + \alpha m_0, \tag{53}$$

$$m_0 = \beta\Omega_1. \tag{54}$$

$$k_0^{\nu} - (1+\psi)z_0 < 0. \tag{55}$$

Condition (55) implies $z_0 > 0$. Then, Claim 5 below shows that the manager's optimal policy in period 1 is to issue equity again up to the point where (20a) binds. Hence, period 1 is characterized by a binding dilution constraint, so the period-1 variables satisfy

$$(1+\psi)z_1 + k_2 = k_1^{\nu} + \alpha m_1, \tag{56}$$

$$m_1 = \frac{1}{1-\alpha}\left(\beta\Omega_2 - k_2\right), \tag{57}$$

$$\Omega_1 = k_1^{\nu} - \psi z_1. \tag{58}$$

To solve for k_1, we assume that $z_1 > 0$ and then verify that this assumption is consistent with the resulting allocation. The first-order condition implied by (53)-(58) yields

$$k_1 = \theta k^*, \tag{59}$$

where $\theta \equiv [1+\alpha/(1+\psi)]^{1/(1-\nu)} > 1$. With $e_0 = 1$, (54) implies that the manager can influence period-0 equity issuance only through Ω_1. Accordingly, the manager deliberately accumulates k_1 above k^* in period 0 in order to raise Ω_1 and offset the dilution effect of period-1 equity issuance.

Step 2. Show that $m_2 = 0$ is optimal

For $t \geq 2$, the constraints are given by

$$(1+\psi)z_t + k_{t+1} = k_t^{\nu} + \alpha m_t, \tag{60}$$

$$\Omega_t = z_t + \beta\Omega_{t+1} - m_t, \tag{61}$$

$$m_t + k_t^{\nu} - (1+\psi)z_t \leq \beta\Omega_{t+1},\ \ m_t \leq \beta\Omega_{t+1} \text{ if } m_t > 0. \tag{62}$$

Claim 4 (No over-accumulation, case A.2)**.** *At any candidate optimum in case A.2, $k_2 < k^*$. Given the inductive hypothesis that $m_r = 0$ for $r = 2, \dots, t-1$, also $k_t < k^*$ for $t \geq 3$.*

Proof. We prove the claim for $t = 2$; the extension to $t \geq 3$ follows by propagating $\Delta\Omega_2, \Delta\Omega_3, \dots$ back to Ω_1 through the same recursion. Suppose $k_2 \geq k^*$ and consider $\Delta k_2 = -\delta$ for $\delta > 0$, holding k_1, m_2, k_3, Ω_3, and $\{z_r\}_{r\geq 3}$ fixed. By (60)-(61), $\Delta z_2 = -\nu k_2^{\nu-1}\delta/(1+\psi)$ and $\Delta\Omega_2 = \Delta z_2$. The period-1 binding-dilution structure (56)-(57) implies $z_1 = k_1^\nu/(1+\psi) + (\alpha\beta\Omega_2 - k_2)/[(1+\psi)(1-\alpha)]$, hence

$$\Delta z_1 \;=\; \frac{-\Delta k_2 + \alpha\beta\Delta\Omega_2}{(1+\psi)(1-\alpha)} \;=\; \frac{\delta\,[1-\alpha\beta\nu k_2^{\nu-1}/(1+\psi)]}{(1+\psi)(1-\alpha)} \;>\; 0$$

for $k_2 \geq k^*$ since $\alpha\beta\nu k_2^{\nu-1}/(1+\psi) \leq \alpha/(1+\psi) < 1$. Through (58), $\Delta\Omega_1 = -\psi\Delta z_1$; through (54) and (53), $\Delta z_0 = \alpha\beta\Delta\Omega_1/(1+\psi) = -\alpha\psi\beta\Delta z_1/(1+\psi)$. Combining,

$$\Delta z_0 + \beta\Delta z_1 + \beta^2\Delta z_2 \;=\; \frac{\beta\delta(1+\psi(1-\alpha))(1-\alpha\beta\nu k_2^{\nu-1}/(1+\psi))}{(1+\psi)^2(1-\alpha)} \;-\; \frac{\beta^2\nu k_2^{\nu-1}\delta}{1+\psi}.$$

This expression is linear in $\beta\nu k_2^{\nu-1}$ with negative slope, evaluates to $\beta\delta\alpha^2\psi/[(1+\psi)^3(1-\alpha)] > 0$ at $\beta\nu k_2^{\nu-1} = 1$ (i.e., $k_2 = k^*$), and is therefore strictly positive for every $\beta\nu k_2^{\nu-1} \leq 1$ (i.e., every $k_2 \geq k^*$). The candidate with $k_2 \geq k^*$ is dominated, so $k_2 < k^*$ in any optimum. □

Suppose, contrary to the claim, that $m_2 > 0$ is optimal. Consider the perturbation $\widetilde{m}_2 = m_2 - \epsilon/\alpha$ together with $\widetilde{k}_2 = (k_2^\nu + \epsilon)^{1/\nu}$, holding k_1 and $\{z_t, k_{t+1}, \Omega_{t+1}\}_{t=2}^\infty$ fixed. The argument follows the same logic as in Section A.1. Here, however, the perturbation affects not only z_1 but also z_0, because the change in z_1 induces further changes in Ω_1 and m_0.

First, the perturbation remains feasible in period 2 because it satisfies (62).[5] Second, reducing m_2 raises Ω_2 by ϵ/α through (61), holding z_2 and Ω_3 fixed. Third, holding k_1 fixed, (56) and (57) imply that the induced changes in Ω_2 and k_2 raise m_1 and z_1 for $k_2 < k^*$.[6] However, through (58), this reduces Ω_1, which, in turn, decreases m_0 via (54) and then z_0 via (53).[7] The net change is an increase in $z_0 + \beta z_1$ by $[1-\alpha\psi/(1+\psi)]\beta^2\epsilon[1-1/(\beta\nu k_2^{\nu-1})]/[(1+\psi)(1-\alpha)] > 0$ for $k_2 < k^*$.

To verify that $k_2 < k^*$ is consistent with $m_2 = 0$, set $m_2 = 0$ in the period-2 budget and commitment constraints:

$$(1+\psi)z_2 + k_3 = k_2^\nu, \tag{63}$$
$$\Omega_2 = z_2 + \beta\Omega_3. \tag{64}$$

[5] In (62), $\widetilde{m}_2 + \widetilde{k}_2^\nu$ declines by $\epsilon(1/\alpha - 1) > 0$ while all other variables are held fixed.

[6] Up to first order, the adjustments in $\widetilde{\Omega}_2$ and $\widetilde{k}_2$ increase $\widetilde{m}_1$ and $\widetilde{z}_1$ by $\beta\epsilon[1/\alpha - 1/(\beta\nu k_2^{\nu-1})]/(1-\alpha) > 0$ and $\beta\epsilon[1-1/(\beta\nu k_2^{\nu-1})]/[(1+\psi)(1-\alpha)] > 0$, respectively, for $k_2 < k^*$.

[7] The induced reduction in $\widetilde{\Omega}_1$ through (58) is $\psi\beta\epsilon[1-1/(\beta\nu k_2^{\nu-1})]/[(1+\psi)(1-\alpha)]$. As a result, $\widetilde{z}_0$ declines by $\alpha\psi\beta^2\epsilon[1-1/(\beta\nu k_2^{\nu-1})]/[(1+\psi)^2(1-\alpha)]$ through (53).

Using (56)-(57) and (63)-(64), the first-order condition with respect to k_2 yields

$$k_2 = \left[\left(1 - \frac{\alpha\psi}{1+\psi} \right) \beta\nu \right]^{1/(1-\nu)} = \widehat{k} < k^*. \tag{65}$$

Furthermore, since $k_2 < k^* < k_1^\nu$ in (56), the manager can choose $z_1 > 0$, verifying that the assumption $z_1 > 0$ in Step 1 is internally consistent. Therefore, $m_2 = 0$ is optimal. As a result, the manager chooses $k_3 = k^*$ and $z_2 = \left(\widehat{k}^\nu - k^*\right)/(1+\psi)$ if $\widehat{k}^\nu \geq k^*$, and chooses $k_3 = \widehat{k}^\nu$ and $z_2 = 0$ otherwise.

Step 3. Extend to all $t \geq 3$ by induction

We now prove by induction that $m_t = 0$ for $t \geq 3$. Suppose that $m_t = 0$ is optimal for $t = 2, ..., s-1$ and consider a candidate optimum with $m_s > 0$. Introduce the perturbation $\widetilde{m}_s = m_s - \epsilon/\alpha$ and $\widetilde{k}_s = (k_s^\nu + \epsilon)^{1/\nu}$, holding k_1, $\{z_t\}_{t=2}^\infty$, and $\{k_{t+1}, \Omega_{t+1}\}_{t=s}^\infty$ fixed.

As in period 2, the perturbation is feasible in period s and raises $\widetilde{\Omega}_s$ by ϵ/α. This increase then propagates backward: first to period 2 through (60) and (61),[8] and then to period 1 through (56)-(62).[9] After collecting the induced changes in $\widetilde{m}_1$, $\widetilde{z}_1$, $\widetilde{\Omega}_1$, $\widetilde{m}_0$, and $\widetilde{z}_0$, one obtains a positive net increase in $\widetilde{z}_0 + \beta\widetilde{z}_1$.[10] Therefore, the original allocation with $m_s > 0$ cannot be optimal.

Hence, $m_t = 0$ for $t \geq 2$ once equity has been issued in periods 0 and 1.

Claim 5. *If the manager chooses $z_0 > 0$ and $e_0 = 1$ in period 0, then it is optimal to issue equity in period 1 up to the point where (20a) binds.*

Proof. First, we show that for any allocation with feasible $e_1 \in [0, 1)$, the manager can do strictly better by increasing equity issuance up to the point where (20a) binds. Next, we show that $e_1 = 1$ cannot be optimal except when (20a) is just binding.

Step 1: the manager chooses the highest feasible equity issuance up to (20a)

For arbitrary feasible $e_1 \in [0, 1)$, consider a perturbation with $\widetilde{m}_1 = m_1 + \epsilon$ and $\widetilde{z}_1 = z_1 + \alpha\epsilon/(1+\psi)$, which keeps k_2 unchanged in the period-1 budget constraint:

$$(1+\psi)\widetilde{z}_1 + k_2 = k_1^\nu + \alpha\widetilde{m}_1. \tag{66}$$

[8] Holding $\{z_t\}_{t=2}^{s-1}$ fixed, $\widetilde{\Omega}_2$ increases by $\beta^{s-2}\epsilon/\alpha$, and $\widetilde{k}_2$ must also increase to satisfy the budget constraints $\widetilde{k}_{t-1} = [\widetilde{k}_t + (1+\psi)z_{t-1}]^{1/\nu}$ for $t = 3, \ldots, s$.

[9] In period 1, $\widetilde{m}_1$ and $\widetilde{z}_1$ increase by $[1/\alpha - 1/\prod_{t=2}^s \beta\nu k_t^{\nu-1}]\beta^{s-1}\epsilon/(1-\alpha) > 0$ and $[1 - 1/\prod_{t=2}^s \beta\nu k_t^{\nu-1}]\beta^{s-1}\epsilon/[(1+\psi)(1-\alpha)] > 0$, respectively, since $k_2 < k^*$ and $k_t \leq k^*$ for $t \geq 3$.

[10] Since $\widetilde{\Omega}_1$ decreases by ψ times the increase in z_1, in period 0, m_0 decreases by $[1 - 1/\prod_{t=2}^s \beta\nu k_t^{\nu-1}]\psi\beta^s\epsilon/[(1+\psi)(1-\alpha)]$, which, in turn, lowers z_0 by $[1 - 1/\prod_{t=2}^s \beta\nu k_t^{\nu-1}]\alpha\psi\beta^s\epsilon/[(1+\psi)^2(1-\alpha)]$. In the end, the perturbation creates a net change in $z_0 + \beta z_1$ of $[1 - \alpha\psi/(1+\psi)][1 - 1/\prod_{t=2}^s \beta\nu k_t^{\nu-1}]\beta^s\epsilon/[(1+\psi)(1-\alpha)] > 0$.

The perturbation induces a change in $\widetilde{\Omega}_1$ through the commitment constraint:

$$\widetilde{\Omega}_1 = \widetilde{z}_1 + \beta\Omega_2 - \widetilde{m}_1. \tag{67}$$

Since Ω_2 is held fixed, $\widetilde{\Omega}_1$ falls by $[1-\alpha/(1+\psi)]\epsilon$. Through (53)-(54), this lowers $\widetilde{m}_0$ and $\widetilde{z}_0$ by $\beta[1-\alpha/(1+\psi)]\epsilon$ and $\alpha\beta[1-\alpha/(1+\psi)]\epsilon/(1+\psi)$, respectively. However, the gain in $\widetilde{z}_1$ dominates, increasing $z_0+\beta z_1$ by $\alpha^2\beta\epsilon/(1+\psi)^2>0$. This argument holds as long as the dilution constraint is slack because $m_1+k_1^\nu-(1+\psi)z_1<\beta\Omega_2$ implies that

$$\widetilde{m}_1 + k_1^\nu - (1+\psi)\widetilde{z}_1 = m_1 + k_1^\nu - (1+\psi)z_1 + (1-\alpha)\epsilon < \beta\Omega_2 \tag{68}$$

for sufficiently small $\epsilon>0$. Therefore, the manager can do strictly better by expanding period-1 equity issuance up to the point at which the dilution constraint binds. If an allocation in period 1 is derived from binding (20a), including the case of $e_1=1$, further increase in equity issuance is not feasible.

Step 2: $e_1=1$ with binding (20b) cannot be optimal

If a candidate allocation involves $e_1=1$ with (20a) being slack, then $k_1^\nu-(1+\psi)z_1<0$ must hold. In period 1, this allocation satisfies

$$(1+\psi)z_1 + k_2 = k_1^\nu + \alpha m_1, \tag{69}$$

$$m_1 = \beta\Omega_2, \tag{70}$$

$$\Omega_1 = z_1. \tag{71}$$

In period 2, the allocation satisfies constraints (60)-(62). Regardless of which constraint binds in (62), we can express Ω_2 as

$$\Omega_2 = \frac{k_2^\nu}{1+\psi} + \text{ other terms that depend on } z_2,\ m_2, \text{ and } k_3. \tag{72}$$

Given (60)-(62), (69)-(70), and (72), the first-order condition with respect to k_2 yields

$$k_2 = \theta k^* > k^*. \tag{73}$$

Moreover, given (73), the manager chooses $z_2>0$ regardless of the amount of equity issuance in period 2.[11] Now, consider a perturbation with $\widetilde{k}_2=(k_2^\nu-\epsilon)^{1/\nu}$ and $\widetilde{z}_2=z_2-\epsilon/(1+\psi)$, holding m_2, k_3

[11] If $m_2=0$, the optimal policy is $k_3=k^*$ and $z_2=(\theta^\nu k^{*\nu}-k^*)/(1+\psi)>0$. If m_2 is bound by the dilution constraint, the manager chooses $k_3<k^*$. Because $(\theta^\nu k^{*\nu}-k_3)/(1+\psi)>(\theta^\nu k^{*\nu}-k^*)/(1+\psi)>0$, the manager pays positive dividends. If m_2 is bound by $e_2=1$, then $k_2^\nu-(1+\psi)z_2<0$ must hold. Since $k_2>0$, z_2 must be positive.

and Ω_3 fixed. The perturbation satisfies the period-2 constraints, (60) and (62), while lowering $\widetilde{\Omega}_2$ by $\epsilon/(1+\psi)$ through (61). In period 1, this reduces $\widetilde{m}_1$ by $\beta\epsilon/(1+\psi)$, but because $\widetilde{k}_2 < k_2$, the induced change in $\widetilde{z}_1$ is positive. This can be shown as follows: $[\alpha\beta(\widetilde{\Omega}_2 - \Omega_2) - (\widetilde{k}_2 - k_2)]/(1+\psi)$.

$$
\begin{aligned}
\widetilde{z}_1 &= z_1 + \frac{\alpha\beta(\widetilde{\Omega}_2 - \Omega_2) - (\widetilde{k}_2 - k_2)}{1+\psi} \\
&= z_1 + \frac{\beta\epsilon}{1+\psi}\left(\frac{1}{\beta\nu k_2^{\nu-1}} - \frac{\alpha}{1+\psi}\right) + O(\epsilon^2) \\
&= z_1 + \frac{\beta\epsilon}{1+\psi} + O(\epsilon^2),
\end{aligned} \tag{74}
$$

where (73) is substituted into the second line of (74). The increase in period-1 dividends raises $\widetilde{\Omega}_1$ through (71), which then increases $\widetilde{m}_0$ by $\beta^2\epsilon/(1+\psi)$ through (54). As a result, $\widetilde{z}_0$ increases by $\alpha\beta^2\epsilon/(1+\psi)^2$ through (53). The total welfare change due to the perturbation is positive since

$$
\widetilde{z}_0 - z_0 + \beta(\widetilde{z}_1 - z_1) + \beta^2(\widetilde{z}_2 - z_2) = \frac{\alpha\beta^2\epsilon}{(1+\psi)^2} + \frac{\beta^2\epsilon}{1+\psi} - \frac{\beta^2\epsilon}{1+\psi} = \frac{\alpha\beta^2\epsilon}{(1+\psi)^2} > 0.
$$

Hence, the allocation with $e_1 = 1$ is dominated and cannot be optimal. Combined with Step 1, this implies that the optimum in period 1 must involve positive equity issuance with the dilution constraint binding.

□

B. Proof of Proposition 2

We proceed by guess and verification. Guess that $g^z(k) = (k^\nu + C)/(1+\psi)$, where C is a constant. Then, $g_k^z(k) = 1/(1+\psi)\nu k^{\nu-1}$. Substituting this derivative into (33) yields (34). Since $\widehat{k}$ is a constant,

$$
\begin{aligned}
g^z(k) &= \frac{1}{1+\psi}k^\nu + \frac{1}{(1+\psi)(1-\alpha)}\left[-\widehat{k} + \alpha\beta\widehat{k}^\nu - \alpha\beta\psi\, g^z\left(\widehat{k}\right)\right] \\
&= \frac{1}{1+\psi}\left[k^\nu - \frac{(1+\psi)\widehat{k} - \alpha\beta\widehat{k}^\nu}{(1+\psi)(1-\alpha) + \alpha\beta\psi}\right].
\end{aligned} \tag{75}
$$

Therefore,

$$
C = -\frac{(1+\psi)\widehat{k} - \alpha\beta\widehat{k}^\nu}{(1+\psi)(1-\alpha) + \alpha\beta\psi}, \tag{76}
$$

which confirms that the conjectured constant C is indeed independent of k.

C. Proof of Corollary 1

Dividing (34) by (8) yields the expression for $\widehat{k}/k^*$. To establish the second result, dividend-output ratios under commitment and MPE are

$$\frac{z^*}{k^{*\nu}} = \frac{1-k^{*1-\nu}}{1+\psi} = \frac{1-\beta\nu}{1+\psi},$$
$$\frac{\widehat{z}}{\widehat{k}^{\nu}} = \frac{1-\alpha+\alpha\beta-\widehat{k}^{1-\nu}}{(1+\psi)(1-\alpha)+\alpha\beta\psi} = \frac{1-\alpha+\alpha\beta-[1-\alpha\psi/(1+\psi)]\,\beta\nu}{(1+\psi)(1-\alpha)+\alpha\beta\psi}.$$

Taking the difference between the two ratios and simplifying yields

$$\frac{\widehat{z}}{\widehat{k}^{\nu}} - \frac{z^*}{k^{*\nu}} = \frac{\alpha\beta(1-\nu+\beta\psi\nu)}{[(1+\psi)(1-\alpha)+\alpha\beta\psi]\,(1+\psi)},$$

where the numerator simplification uses

$$(1+\psi)\Big\{1-\alpha+\alpha\beta-\beta\nu[1-\alpha\psi/(1+\psi)]\Big\}$$
$$-\big\{(1+\psi)(1-\alpha)+\alpha\beta\psi\big\}(1-\beta\nu) = \alpha\beta(1-\nu+\beta\psi\nu).$$

Given $\alpha, \beta, \nu \in (0,1)$ and $\psi > 0$, both the numerator and the denominator are strictly positive. Hence, $\widehat{z}/\widehat{k}^{\nu} > z^*/k^{*\nu}$.

To establish the third result, it suffices to show that any allocation with positive equity issuance yields lower shareholder value than the commitment solution. Shareholder value can be written as

$$\Omega_\tau = \sum_{t=\tau}^{\infty} \beta^{t-\tau}(z_t - m_t).$$

Under commitment, Ω^* is attained with $z_t = z^*$, $k_t = k^*$, and $m_t = 0$ for all t. Suppose instead that $m_t > 0$ for some t, so equity issuance is used to raise either current dividends or next-period capital relative to the commitment allocation. If equity issuance raises current dividends above z^*, the budget constraint implies

$$(1+\psi)z_t = k^{*\nu} - k^* + \alpha m_t.$$

If equity issuance instead raises next-period capital above k^*, the budget constraint implies

$$(1+\psi)z^* = k^{*\nu} - k_{t+1} + \alpha m_t.$$

In either case, consider an alternative allocation with $\widetilde{m}_t = m_t - \epsilon$ and $\widetilde{z}_t = z_t - \alpha\epsilon/(1+\psi)$ for sufficiently small $\epsilon > 0$. Such an allocation is feasible and leaves the allocation unchanged before and after period t. Moreover,

$$(\widetilde{z}_t - \widetilde{m}_t) - (z_t - m_t) = \left(1 - \frac{\alpha}{1+\psi}\right)\epsilon > 0.$$

Hence, any deviation from Ω^* involving $m_t > 0$ cannot increase shareholder value. It remains to characterize the optimum among allocations with $m_t = 0$ for all t. In that case, shareholder value is maximized by choosing k_{t+1} to satisfy $\beta\nu k_{t+1}^{\nu-1} = 1$, which implies $k_{t+1} = k^*$. Therefore, Ω^* attains the maximum steady-state shareholder value, so $\Omega^* > \widehat{\Omega}$.

D. Proof of Proposition 3

Suppose, to the contrary, that $z_t > 0$ and $m_t > 0$ for some t. Consider a perturbation with $\widetilde{m}_t = m_t - \epsilon$ and $\widetilde{z}_t = z_t - \alpha\epsilon/(1+\psi)$ for sufficiently small $\epsilon > 0$. The perturbed allocation satisfies (16) and (20), holding k_t, k_{t+1}, and Ω_{t+1} fixed. Moreover, $\widetilde{z}_t - \widetilde{m}_t - (z_t - m_t) = [1 - \alpha/(1+\psi)]\epsilon > 0$. This implies that period-t compensation increases by $\psi[1 - \alpha/(1+\psi)]\epsilon$, and therefore raises the objective by $\beta^t\psi[1-\alpha/(1+\psi)]\epsilon$. It also raises Ω_t, so it does not decrease dividends prior to period t. Therefore, the assumed allocation cannot be optimal, and either $z_t = 0$ or $m_t = 0$ must hold in any period.

E. Proof of Proposition 4

We proceed in three steps. First, we show that equity issuance never occurs up to the point at which (20) binds. Second, we show that, if equity issuance occurs, it can occur only in period 0. Third, we characterize the optimal initial issuance.

Claim 6. *In any period, the manager never issues equity up to the point at which (20) binds.*

Proof. Suppose $m_t > 0$. First, the manager never chooses $e_t = 1$. If so, then all existing shares are fully diluted in period t, so continuing compensation is worth zero in per-share terms. Moreover, Proposition 3 implies $z_t = 0$ whenever $m_t > 0$. Hence, the manager's period-t compensation is zero. By contrast, the manager can attain strictly positive compensation by setting $m_t = 0$ and retaining resources within the firm. Therefore, $e_t = 1$ cannot be optimal.

Next, suppose that (20a) binds. Since Proposition 3 implies $z_t = 0$ when $m_t > 0$, the binding condition yields

$$k_t^\nu = -m_t + \beta\Omega_{t+1} = \Omega_t.$$

Thus, current shareholder value is pinned down at k_t^ν. However, because the manager's objective under per-share compensation is aligned with shareholder value, the manager can attain a strictly higher value by avoiding issuance and financing investment through retained earnings whenever profitable. Hence, issuing equity up to the point at which (20a) binds cannot be optimal.

Therefore, any equity issuance that occurs must be strictly below the limit implied by (20a). □

Claim 7. *If equity issuance is used, it may occur only in period* 0*. No equity issuance occurs in any later period.*

Proof. Suppose that the manager issues equity in periods 0 and 1. By Proposition 3, this requires $z_0 = z_1 = 0$. By Claim 6, the only binding constraints in periods 0 and 1 are the budget constraints:

$$k_1 = k_0^\nu + \alpha m_0, \tag{77}$$

$$k_2 = k_1^\nu + \alpha m_1. \tag{78}$$

We first show that $k_1 < k^{*\,1/\nu}$. If instead $k_1 \geq k^{*\,1/\nu}$, then in period 1 the manager can set $k_2 = k^*$, $z_1 = (k_1^\nu - k^*)/(1+\psi) > 0$, and $m_1 = 0$, which strictly dominates any allocation with $m_1 > 0$ and $z_1 = 0$. Hence $k_1 < k^{*\,1/\nu}$, which implies $\beta\nu k_1^{\nu-1} > 1$.

Now, consider a perturbation that reduces period-1 equity issuance and raises period-0 issuance: $\widetilde{m}_1 = m_1 - \epsilon/\alpha$ and $\widetilde{k}_1 = (k_1^\nu + \epsilon)^{1/\nu}$ for sufficiently small $\epsilon > 0$. This perturbation preserves (78) and leaves k_2 and all later variables unchanged.

To support $\widetilde{k}_1$, period-0 issuance must increase to

$$\widetilde{m}_0 = \frac{\widetilde{k}_1 - k_0^\nu}{\alpha} = m_0 + \frac{\epsilon}{\alpha\nu k_1^{\nu-1}} + O(\epsilon^2),$$

applying a first-order Taylor expansion around $\epsilon = 0$. Hence, the change in the manager's objective is

$$\psi\big(-\widetilde{m}_0 - \beta\widetilde{m}_1\big) - \psi\big(-m_0 - \beta m_1\big) = \frac{\psi\beta\epsilon}{\alpha}\left(1 - \frac{1}{\beta\nu k_1^{\nu-1}}\right) + O(\epsilon^2).$$

Since $\beta\nu k_1^{\nu-1} > 1$, the bracketed term is strictly positive for sufficiently small $\epsilon > 0$. Therefore, the original allocation with $m_1 > 0$ cannot be optimal, so $m_1 = 0$.

We next prove by induction that $m_t = 0$ for all $t \geq 2$. Suppose that an allocation satisfies $m_0 > 0$, $m_1 = \cdots = m_{t-1} = 0$, and $m_t > 0$ for some $t \geq 2$. As in the period-1 case, if $k_t \geq k^{*\,1/\nu}$, the manager can set $m_t = 0$, attain $k_{t+1} = k^*$, and pay positive dividends in period t, which strictly dominates issuing equity with zero dividends. Hence $k_t < k^{*1/\nu}$, so $\beta\nu k_t^{\nu-1} > 1$. Because $m_1 = \cdots = m_{t-1} = 0$, optimality also requires $z_1 = \cdots = z_{t-1} = 0$ along the transition to period t. Thus, $\beta\nu k_s^{\nu-1} > 1$ for $s = 1, \dots, t$.

The budget constraints are (77) and

$$\begin{aligned} k_2 &= k_1^\nu, \\ &\vdots \\ k_t &= k_{t-1}^\nu, \\ k_{t+1} &= k_t^\nu + \alpha m_t. \end{aligned} \tag{79}$$

Now, consider a perturbation $\widetilde{m}_t = m_t - \epsilon/\alpha$ and $\widetilde{k}_t = (k_t^\nu + \epsilon)^{1/\nu}$ for sufficiently small $\epsilon > 0$. This preserves (79) and leaves k_{t+1} and all later variables unchanged. Propagating this perturbation backward through the retained-earnings constraints implies that period-0 issuance must rise to

$$\widetilde{m}_0 = \frac{\widetilde{k}_1 - k_0^\nu}{\alpha} = m_0 + \frac{\beta^t \epsilon}{\alpha \beta^t \nu^t k_t^{\nu^t - 1}} + O(\epsilon^2) = m_0 + \frac{\beta^t \epsilon}{\alpha \prod_{s=1}^t \beta\nu k_s^{\nu-1}} + O(\epsilon^2).$$

Therefore,

$$\widetilde{W}_0 - W_0 = \psi\big(-\widetilde{m}_0 - \beta^t \widetilde{m}_t\big) - \psi\big(-m_0 - \beta^t m_t\big) = \frac{\psi\beta^t\epsilon}{\alpha}\left(1 - \frac{1}{\prod_{s=1}^t \beta\nu k_s^{\nu-1}}\right) + O(\epsilon^2).$$

Since $\beta\nu k_s^{\nu-1} > 1$ for all $s = 1, \dots, t$, the product exceeds one, so $\widetilde{W}_0 > W_0$ for sufficiently small ϵ. Hence, the original allocation with $m_t > 0$ cannot be optimal, so $m_t = 0$ for all $t \geq 1$.

The same logic covers the case in which $m_0 = 0$ in the original allocation: if $m_t > 0$ for some $t \geq 1$, one can raise period-0 issuance from zero and lower m_t to increase the manager's objective. Thus, equity issuance never occurs after period 0. □

It remains to characterize the optimal initial issuance. Suppose the manager issues equity in period 0, accumulates capital through retained earnings, and begins paying dividends in period $s \geq 1$. Then the manager's objective is

$$\psi\left[-\left(\frac{k_1 - k_0^\nu}{\alpha}\right) + \beta^s\left(\frac{k_1^{\nu^s} - k^*}{1+\psi} + \beta\Omega_{s+1}\right)\right],$$

where we used $k_s = k_1^{\nu^{s-1}}$ from the chain $k_{t+1} = k_t^\nu$ for $t = 1, \dots, s-1$, and set $k_{s+1} = k^*$ as the long-run optimum from period $s+1$ onward. Taking the first-order condition with respect to k_1 yields

$$\frac{1}{\alpha} = \frac{\beta^s \nu^s k_1^{\nu^s - 1}}{1+\psi}.$$

Hence, the optimal level of capital supported by initial equity issuance is

$$k_1 = \left[\frac{\alpha \beta^s \nu^s}{1+\psi}\right]^{1/(1-\nu^s)}. \tag{80}$$

The corresponding period-0 equity issuance is

$$m_0 = \frac{\left[\alpha \beta^s \nu^s/(1+\psi)\right]^{1/(1-\nu^s)} - k_0^{\nu}}{\alpha}.$$

Thus, equity issuance occurs in period 0 if and only if the capital level implied by (80) strictly exceeds k_0^{ν}.

F. Quantitative Illustration

This appendix illustrates the magnitude of the steady-state distortion for the paper's baseline parameters. From (37), the ratio of time-consistent to commitment capital is

$$\frac{\widehat{k}}{k^*} = \left(1 - \frac{\alpha\psi}{1+\psi}\right)^{1/(1-\nu)}.$$

Table 1 reports the percentage capital shortfall $1 - \widehat{k}/k^*$ for a range of issuance efficiency (α) and compensation sensitivity (ψ) values, with $\beta = 0.9$ and $\nu = 0.9$.

	$\alpha = 0.80$	$\alpha = 0.90$	$\alpha = 0.95$
$\psi = 0.005$	3.9	4.4	4.6
$\psi = 0.01$	7.6	8.6	9.0
$\psi = 0.02$	14.6	16.3	17.1

Table 1: Steady-state capital shortfall $1 - \widehat{k}/k^*$ (percent)

The distortion is sizable because the exponent $1/(1-\nu) = 10$ amplifies the wedge $\alpha\psi/(1+\psi)$. At the issuance efficiency implied by the estimates discussed below ($\alpha \approx 0.9$–0.95), even a compensation sensitivity as small as $\psi = 0.01$—under which the manager's payout-linked component is just under one percent of firm value, $\psi/(1+\psi) \approx 0.99\%$—generates a capital shortfall of roughly 9 percent, and at $\psi = 0.02$ the shortfall reaches 16–17 percent. Even at the lower efficiency $\alpha = 0.80$—a

20% issuance cost—the shortfall is still 7.6 percent at $\psi = 0.01$. These magnitudes suggest that the interaction between payout-linked compensation and equity issuance can generate economically significant underinvestment even when the manager's stake in payouts is small.

Choice of α.

In the model, a fraction $1 - \alpha$ of equity-issuance proceeds is dissipated, so $1 - \alpha$ is the proportional cost of raising outside equity. The structural estimates of Hennessy and Whited (2007) provide a direct empirical counterpart: they estimate marginal equity flotation costs of 5.0 percent for large firms and 10.7 percent for small firms. Mapping the proportional component to $1 - \alpha$ implies α between 0.89 and 0.95, at the upper end of the range in Table 1. Because the wedge $\alpha\psi/(1 + \psi)$ is increasing in α, an empirically disciplined issuance technology makes the distortion *larger*, not smaller: at the large-firm value $\alpha = 0.95$ the capital shortfall reaches 9.0 percent even at the small sensitivity $\psi = 0.01$. The lower-α column is retained only as a comparative static.

Choice of ν.

The model has a single productive input *k* that stands for the firm's overall productive scale, with labor and other inputs implicit. At the firm level, the relevant elasticity is therefore the combined returns-to-scale parameter rather than the capital share in an aggregate Cobb–Douglas specification. Empirical estimates of firm-level returns to scale typically lie in the range 0.85–0.95 once labor and intermediate inputs are included, motivating our baseline $\nu = 0.9$.

Sensitivity to ν.

Because the exponent $1/(1 - \nu)$ amplifies the wedge nonlinearly, the magnitudes in Table 1 depend on this choice. At standard aggregate values ($\nu = 0.36$, exponent 1.56), the wedge survives but with substantially smaller magnitude: at the baseline $(\alpha, \psi) = (0.80, 0.01)$ the capital shortfall is 1.2 percent rather than 7.6 percent, and at $(0.95, 0.02)$ it is 2.9 percent rather than 17.1 percent. At an intermediate value ($\nu = 0.5$, exponent 2) the same two cells become 1.6 and 3.7 percent. The qualitative result — that payout-linked compensation interacts with equity issuance to generate persistent underinvestment — holds across this range. The amplification at $\nu = 0.9$ is what makes the distortion economically dramatic at the firm level; at lower ν the distortion is more modest but still material.