Corporate Policies and the Term Structure of Risk*

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Abstract

Asset pricing research indicates that the long and short term do not contribute equally to the market risk premium, and that their relative contribution is time-varying. While having notable implications for firm discount rates, corporate finance models typically abstract from these aspects. In a dynamic model with financing frictions, we show that firms should extend (shorten) their horizon if short-term shocks have a greater (smaller) market price than long-term ones, i.e., if the term structure of risk prices is downward-sloping. Ignoring a downward-sloping term structure leads to underinvestment, excessive payouts, inadequate cash reserves and equity issuances, and excessive liquidations.

Keywords: Horizon of corporate policies; Term structure of risk; Temporary vs. permanent shocks

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1 Introduction

A central question in corporate finance is how managers set discount rates, a tool that lies at the heart of firm decision making. While early research on this topic has relied on qualitative surveys (see Graham and Harvey, 2001), recent works demonstrate quantitatively that managers do understand variations in stock market returns and incorporate them into their cost of equity (Gormsen, 2021; Boutros, Ben-David, Graham, Harvey, and Payne, 2020; Cho and Salarkia, 2020; Kim, 2021). The key takeaway from these works is that expected returns in stock markets influence firm discount rates and, through this channel, bear considerable real effects.[1] This view appears to be taken into consideration by policymakers too, as supported by the documented comovement between stock returns and updates to their growth expectations (see Cieslak and Vissing-Jorgensen, 2020).

Despite the growing interest in the real effects of expected stock returns, their term structure dimension has so far been neglected. This is surprising in light of the burgeoning asset pricing literature on this topic over the past decade. Pioneered by van Binsbergen, Brandt, and Koijen (2012), this line of research has challenged the long-standing view that equity markets mostly remunerate the long term (see, e.g. Campbell and Cochrane, 1999; Bansal and Yaron, 2004) by showing that short-term claims to equity payouts feature a sizable risk premium. Further research in this strand has made asset pricing researchers consistently agree that: (1) short and long term do *not* contribute equally to the market risk premium, and (2) their contribution is time-varying, i.e., either the short or the long term can contribute relatively more at different points of the business cycle.[2]

These findings are clearly relevant for the intertemporal decision making of firms. Indeed, if firms face frictions when raising funds from capital markets and when adjusting their capital stock, corporate managers need to consider the long- and short-term impli-

[1] Among others, see Pastor and Veronesi (2005), Hall (2017), or Haddad, Loualiche, and Plosser (2017).

[2] As we explain in Section 2, the disagreement over the unconditional slope of the term structure or equity risk premia—i.e., on whether long or the short term contribute the most—largely stem from the alternation of the slope over the business cycle.

cations of their investment, financing, and risk management decisions. Hence, accounting for the term structure dimension of risk prices is key to to compute the appropriate discount rates that serve to shape the relevant tradeoffs. Yet, despite its obvious importance, corporate finance studies typically abstract from this dimension.

This paper seeks to fill this gap. We build a dynamic model for a firm operating in an economy with long- and short-term shocks.[3] Long-term shocks have a persistent effect on firm size—they capture, e.g., permanent changes in aggregate output, consumers' tastes, or technology—and affect the firm's present and future cash flows. In turn, short-term shocks—representing, e.g., transitory demand fluctuations—have a temporary effect on cash flows but expose the firm to operating losses. To cover these losses, the firm can use retained earnings or external financing, which yet entails issuance costs. The key novelty of our model is the focus on the relative prices of short- versus long-term shocks—to which we refer as the term structure of risk prices—and its impact on corporate decisions. The term structure of risk prices is downward-sloping (respectively, upward-sloping) if long-term shocks have a lower (higher) market price than short-term ones.[4] As the exposure to and the pricing of aggregate short- and long-term shocks shape the firm cash flow risk and the compensation required by firm investors, investigating their impact on real, financial, and precautionary policies is of obvious interest.

To single out the effect of the term structure of risk prices on corporate policies, we start by analyzing the case in which the firm is symmetrically exposed to short- and long-term aggregate shocks. We show that the term structure affects both the firm's real and financial policies which, in a dynamic world with financing frictions, are interdependent.[5] Specifically, when the term structure of risk prices is downward-sloping, the firm should

[3]See also Décamps, Gryglewicz, Morellec, and Villeneuve (2017), Gryglewicz, Mayer, and Morellec (2020), and Hackbarth, Rivera, and Wong (2021) for theoretical papers accounting for permanent and temporary shocks.

[4]Embracing the empirical finding that the slope changes sign over time, our paper studies the impact of both an upward- and downward-sloping term structure.

[5]Conversely, as absent financing frictions financing is irrelevant, the term structure of risk prices has solely an impact on firm's investment—namely, a downward-sloping (upward-sloping) term structure encourages firms to increase (decrease) their investment rate compared to the flat case.

extend the horizon of corporate policies compared to the flat case—not only by investing more, but also by enhancing long-term financial resilience through precautionary policies. Namely, the firm should increase the size of precautionary cash reserves, reduce payouts, be more likely to tap external financing than to shut down operations when running out of funds, and increase the size of equity issuances. Conversely, when the term structure of risk prices is upward-sloping, the firm should shorten the horizon of corporate policies compared to the flat case. Not only the firm should invest less, but also adopt financing policies that are more nearsighted—e.g., it should keep less cash, pay out more, and reduce the likelihood and magnitude of refinancing events.

We then allow the firm to be asymmetrically exposed to these shocks. In this case, a "level" effect adds to the slope effect discussed so far. If the firm is more exposed to long-term shocks, the exposure-weighted level of the term structure is greater (smaller) if upward-sloping (downward-sloping).[6] The level effect compounds the slope effect and, thus, makes the results derived under the assumption of symmetric risk exposure quantitatively stronger—i.e., a decreasing (respectively, increasing) term structure triggers a sharper lengthening (shortening) in corporate horizon. If, instead, a firm is relatively more exposed to short-term shocks, it can exhibit the opposite pattern as the level and slope stir countervailing strengths. First, a decreasing slope spurs a lengthening in corporate horizon, as shown so far. Second, the firm's higher exposure to short-term shocks (which have the largest market price) increases the exposure-weighted level of the term structure and acts as an offsetting strength. This offsetting strength is shown to be more likely to prevail if the firm's profitability is low or if the firm's assets depreciate more quickly. That is, we provide practical guidance for empirical work, which should exploit differential responses in the cross-section of firms based on their exposure to aggregate risks and, for firms that are more exposed to short-term shocks, based on firm characteristics.

Whereas most of our analysis investigates how *market-wide* risk prices affect firm

[6] We refer to "exposure-weighted" as the level of the term structure weighted by the firm specific exposure to short-term and long-term shocks.

policies, we also study how they shape *firm-level* risk premia. In our model, the risk premium has two components compensating for the exposure to long- and short-term shocks, with the long-term (short-term) component being the largest if the term structure of risk prices is increasing (respectively, decreasing). We show that the term structure of risk prices shapes the impact of financing frictions on risk premia, which helps rationalize the available mixed evidence (see Lamont, Polk, and Saá-Requejo, 2001; Whited and Wu, 2006). In fact, whereas the long-term component is always smaller in the presence of financing frictions compared to the frictionless case,[7] the short-term component can be larger or smaller depending on the firm's cash ratio. Thus, the sum of the two components can be higher or lower in the presence of financing friction depending on the firm's cash ratio and the slope of the term structure—specifically, financing frictions inflate a firm risk premium if the term structure is decreasing and the firm's financial position is weak.

Two applications showcase the empirical relevance of our results. First, as corporate horizon is naturally related to cash flow duration, our model can reproduce the negative relation between duration and expected returns observed in the data. Furthermore, our model supports the view that duration spans other pricing factors such as investment, payout, profitability, and value (see Chen and Li, 2018; Gonçalves, 2021a; Gormsen and Lazarus, 2021). Given that, as we show, duration is endogenous and largely shaped by the firm's exposure to short- and long-term systematic risks and their pricing, revisiting the role of duration conditional on the term structure of risk prices would be a fruitful avenue of research. Second, we illustrate that the distortions associated with ignoring the slope (i.e., assuming it flat) are quantitatively notable. Ignoring a downward slope leads firms to put too much emphasis on short-term payouts at the cost of harming growth and financial resilience. I.e., firms underinvest, pursue an overly-generous payout policy, hold inadequate cash reserves, and raise too little external financing. Conversely, ignoring an upward slope leads to overweight the long-term—leading to delayed payouts and excessive

[7] Because financing frictions provide firms with incentives to keep safe assets such as cash, the composition of cash and (risky) productive assets reduces the required compensation for long-term risk

investment, cash accumulation, and equity issuances. By exploiting variations in firm value as the term structure slope varies over time, our paper proposes a roadmap for empirical tests to assess whether firms indeed account (or not) for the term structure of risk prices in ways consistent with our theory.[8]

Finally, we account for the dynamic nature of the term structure of risk prices. As empirically documented, we assume that the level of risk prices is countercyclical and study the effect of time variation in the slope. When accounting for a procyclical slope, we show that time variation in level and in slope have countervailing effects on the firm's optimal investment. In fact, firms have greater (lower) incentives to invest when risk prices are relatively low (high) in expansion (recession), but the increasing slope moderates this effect. I.e., a procyclical slope mildens the impact of business-cycle fluctuations in the level of risk prices on investment, then enabling firms to maintain a steadier growth rate. Conversely, if the slope is countercyclical, time variation in level and in slope have the same directional effect on the firm's optimal investment, then making a firm's growth rate more volatile over the business cycle. By analyzing both cases, we remain agnostic regarding the empirical discussion concerning the slope cyclicality. Yet, as we show that the procyclicality and countercyclicality have very different implications for optimal firm policies, our analysis urges the empirical asset pricing literature to resolve this debate.

Related literature Our paper is motivated by the asset pricing literature studying the pricing and timing of risk (see, e.g., Bansal, Dittmar, and Lundblad, 2005; Lettau and Wachter, 2007; Hansen, Heaton, and Li, 2008; Da, 2009; van Binsbergen, Brandt, and Koijen, 2012). Recent works stress the need to account for multiple sources of risk—featuring heterogeneous market prices—to rationalize the dynamics of the term structure of equity risk premia.[9] Whereas this line of research has groundbreaking implications

[8]We discuss the roadmap to empirical testing in Section 5.4.

[9]See, e.g., Gormsen (2020), Croce, Lettau, and Ludvigson (2015), and Breugem, Colonnello, Marfè, and Zucchi (2021). Heterogeneous and horizon-dependent market prices of risk can also be understood through dynamically-inconsistent risk preferences (e.g., Andries, Eisenbach, and Schmalz, 2019; Lazarus,

for the discount rates used by firms, to the best of our knowledge there is no corporate finance work that explicitly studies the ensuing impact on corporate policies.

More generally, our paper relates to the literature that analyzes the corporate implications of the properties and fluctuations of aggregate discount rates, e.g., Chen (2010), Haddad, Loualiche, and Plosser (2017), Hall (2017), Dou, Ji, and Wu (2020), Chen, Dou, Guo, and Ji (2020), or Bustamante and Zucchi (2021), among many others. Notably, Kim and Routledge (2021) show quantitatively that ignoring the dynamics of the equity premium leads to suboptimal investment and substantial value losses. Our paper takes a novel perspective and shows that ignoring the horizon dimension of market risk prices leads to considerable distortions in corporate policies. Our paper is then related to Giglio, Maggiori, Rao, Stroebel, and Weber (2021), who tap the housing market to gather information about the appropriate discount rate to value long-term investments in climate change abatement, to account for their maturity and risk properties.

Our paper also contributes to the corporate finance literature that studies the horizon of corporate policies. Early contributions (Stein, 1988, 1989; Aghion and Stein, 2008) emphasize that stock market pressure leads managers to boost short-term earnings at the expense of long-term performance.[10] More recent studies, in turn, have focused on identifying the conditions under which short-termism can be efficient through the lens of agency conflicts, see Hackbarth, Rivera, and Wong (2021) and Gryglewicz, Mayer, and Morellec (2020). Whereas previous theoretical and empirical works have studied corporate horizon through firms' investment appetite, our contribution is novel in at least two dimensions. First, instead of focusing on managerial incentives/beliefs or stock market pressure due to quarterly reporting as drivers of corporate horizon,[11] our paper provides an explanation based on risk pricing. Second, instead of just focusing on investment, we

2019).

[10] Asker, Farre-Mensa, and Ljungqvist (2015), Edmans, Fang, and Lewellen (2017), and Terry, Whited, and Zakolyukina (2020) investigate the consequences of stock market pressure on corporate investment.

[11] See, e.g., Hackbarth, Rivera, and Wong (2021), Gryglewicz, Mayer, and Morellec (2020), Asker, Farre-Mensa, and Ljungqvist (2015), or Ladika and Sautner (2019). Barrero (2021) studies the impact of managerial overconfidence and overextrapolation on firm performance and the macroeconomy.

also investigate financial policies, showing that equity issuances, cash retention, payouts, and liquidation decisions respond to the slope of the term structure of risk prices, which tilts the focus between long-term financial resilience through precautionary policies and fallback financing policies that may harm long-term profitability (such as asset sales).

Finally, our paper relates to studies accounting for temporary and permanent shocks to understand firm choices, e.g., Gorbenko and Strebulaev (2010), Décamps et al. (2017), or Byun, Polkovnichenko, and Rebello (2019). As shown by Gryglewicz, Mancini, Morellec, Schroth, and Valta (2021), the majority of firms' operating cash flows are subject to both types of shock, and the exposure to these shocks importantly shapes firm's financial and cash management policies. We advance this strand by studying the impact of the relative pricing of these shocks on the intertwined nature of investment, financing, and cash management policies.

The paper is organized as follows. Section 2 presents some motivating facts. Section 3 presents our model. Section 4 derives the model solution, and Section 5 analyzes its implications. Section 6 studies the impact of time variation in the term structure of risk prices. Section 7 concludes. Technical developments and proofs are in the Appendix.

2 Motivating facts

Corporate finance textbooks teach that the risk premium of the aggregate equity market is a key component of corporate discount rates. They also teach that discount rates should reflect the relevant horizon and risk of the investment under valuation. Yet, corporate finance studies typically abstract from the term structure dimension of equity market risk—i.e., whether different horizons contribute equally to the equity risk premium or if either the short- or long-term contribute proportionally more. This is surprising in light of: (1) the burgeoning asset pricing literature studying the term structure of equity in the past decade, which informs about horizon-specific equity risk premia, and (2) the growing corporate finance studies on the importance of short- and long-term shocks in analyzing firm decision making. Below we describe the facts that motivate our model.

Fact 1: Long and short term do not contribute equally to the market risk premium.

This fact is long established in the literature. Leading asset pricing models such as Campbell and Cochrane (1999) and Bansal and Yaron (2004) suggest that equity markets mostly remunerate the long term—then implying that the unconditional term structure of equity risk premia is upward-sloping. In contrast, the literature on the term structure of equity initiated by van Binsbergen, Brandt, and Koijen (2012) illustrates that short-term claims to equity indexes feature a sizable risk premium and that the term structure is downward-sloping. Thus, the literature universally agrees that different horizons do *not* contribute equally to the equity risk premium. By informing about discount rates of risky cash flows at different horizons, this should clearly matter for corporate decision making. However, to the best of our knowledge, there is no corporate finance paper trying to model this aspect.

Fact 2: The relative contribution of the long and short term to the market risk premium is time-varying.

The aforementioned disagreement regarding which horizon contributes the most to the equity risk premium—equivalently, regarding the sign of the *unconditional* slope of the term structure of equity risk premia—has been largely caused by its time variation. That is, short samples may lead to biased estimates of the unconditional slope by not properly capturing the alternation of good and bad economic conditions and the associated short- and long-term premia. Indeed, the empirical asset pricing literature agrees that the slope of the term structure is time-varying.[12] Thus, it is important to study the impact of

[12]Namely, the term structure of equity yields has been shown to be increasing in expansions and decreasing in recessions (see, e.g., Bansal, Miller, Song, and Yaron, 2021). At the same time, as shown by Gormsen (2020) and Breugem et al. (2021), the term structure of equity risk premia has been shown to be decreasing in expansions and increasing in recessions.

both an upward- and downward-sloping term structure on corporate policies as well as its dynamics.

Fact 3: Long-term (persistent) and short-term (transitory) shocks have a prime impact in determining the compensation required by equity investors across the horizon.

To reproduce the dynamics of the term structure of equity, the literature has highlighted the need to account for multiple sources of risk (see, e.g., Gormsen, 2020). In particular, two obvious candidates are long-term (persistent) and short-term (transitory) shocks, see, e.g., Croce, Lettau, and Ludvigson (2015), Marfè (2017), and Breugem et al. (2021). The stylized model in Appendix A.1 captures this intuition. Specifically, long-term, persistent shocks introduce a stochastic trend and accumulate over time. As a result, long-term shocks make the equity risk premium increasing with the horizon. At the same time, short-term, temporary shocks produce stationary fluctuations. As a result, short-term shocks induce a downward-sloping strength. The relative magnitude of the risk prices associated with short-term and long-term shocks is then key to pin down the slope of the term structure of equity compensation.

Fact 4: Long-term (persistent) and short-term (transitory) shocks have a pivotal impact on corporate policies.

Starting with Gorbenko and Strebulaev (2010), the corporate finance literature has growingly acknowledged the importance of accounting for the firm's exposure to temporary and permanent shocks when analyzing corporate decision making. Supporting this view, Gryglewicz et al. (2021) show that the bulk of firm's operating cash flows are subject to both permanent and transitory shocks, and that the exposure to permanent and transitory shocks has strong implications for corporate liquidity and financing choices. Yet, this literature has so far abstracted from the prices associated to such risks. This is surprising, as the market prices and the firm's exposure to short-term and long-term risks are essential to correctly shape the intertemporal tradeoffs at the heart of optimal investment, financing, and cash management decisions. The model presented in the next section seeks to fill this gap. We focus not only on investment but also on financing and cash management, as cash flow risk (driven by long- and short-term shocks) determines all these decisions in a world with frictions, as boldly reminded by the covid crisis.

3 The model

The economic environment Time is continuous, and the horizon is infinite. There is a constant risk-free rate denoted by r. We consider an economy characterized by two sources of aggregate, undiversifiable risk: long-term shocks and short-term shocks. Long-term shocks affect the economy permanently—i.e., they can be interpreted as persistent changes in the composition of aggregate output, technology, or consumers' tastes—and are driven by a standard Brownian motion denoted by $d\tilde{W}_t$ under the physical probability measure. Short-term shocks affect the economy only temporarily—i.e., they can be interpreted as shocks capturing transitory risks in the economy, like seasonal fluctuations in demand, political uncertainty, or geopolitical tensions—and are driven by a standard Brownian motion denoted by $d\tilde{B}_t$ under the physical measure. We assume that the two shocks are independent. Investors are risk-averse, so we need to distinguish between physical and risk-neutral measures.

The stochastic discount factor reflects the two sources of aggregate risks in the economy, which are therefore priced. The dynamics of the stochastic discount factor, denoted by ξ_t, follow a geometric Brownian motion:[13]

$$\frac{d\xi_t}{\xi_t} = -rdt - \eta_L d\tilde{W}_t - \eta_S d\tilde{B}_t. \tag{1}$$

[13]The stochastic discount factor can be generated by a consumption-based asset pricing model. We follow Bolton, Chen, and Wang (2013) and take it as given, to focus on corporate policies.

The parameters η_L and η_S are the prices of risk associated with long- and short-term aggregate risks, respectively—i.e., they describe the market's remuneration for undiversifiable risks that have long- or short-term impact. We refer to the relative magnitude of η_L versus η_S by defining the slope of the term structure of risk prices. Specifically, we refer to the case in which the market price of long-term shocks is larger than the market price of short-term shocks (i.e., $\eta_L > \eta_S$) as characterized by an increasing term structure of risk prices. Conversely, we refer to the case in which the market price of short-term shocks is higher than that of long-term shocks (i.e., $\eta_L < \eta_S$) as characterized by a decreasing term structure of risk prices. Finally, we refer to the case in which short-term and long-term shocks have the same market price (i.e., $\eta_L = \eta_S$) as having a flat term structure. As discussed in Section 2 and illustrated in Appendix A.1, the relative prices of short-term and long-term risks shape the slope of the term structure of equity risk premia.

The firm We consider the optimization problem of a firm operating in this economy. The firm is exposed to both of the economy's aggregate shocks. To model the firm's exposure to both types of shock, we assume that cash flows satisfy:

$$dX_t = A_t dY_t. \tag{2}$$

In this equation, A_t represents the firm's assets. Shocks to A_t change the future prospects of the firm and influence cash flows persistently. We assume that these shocks are correlated with the long-term source of aggregate risk. In turn, shocks associated with dY_t are short-lived and, thus, do not affect the firm's future prospects. We assume that these shocks are correlated with the short-term source of aggregate risk.

Specifically, our cash flow specification implies that shocks to the firm assets A_t affect the firm's present and future cash flows. For instance, a positive shock of this type—e.g., an improvement in the technology utilized by the firm—expands the size of the firm's operations, and can make the firm wealthier both in the short and in the long term. We describe the firm's long-term shocks through a standard Brownian motion $\hat{W}_t$ under the physical measure, which is correlated with the aggregate permanent shock $\tilde{W}_t$ by a factor $\rho_A \geq 0$. Namely, the dynamics of A_t satisfy:

$$\begin{aligned} dA_t =&(\mu A_t + L_t)dt + \sigma_A A_t d\hat{W}_t \\ =&(\mu + l_t)A_t dt + \sigma_A A_t \left(\rho_A d\tilde{W}_t + \sqrt{1-\rho_A^2} d\tilde{W}_t^A\right) \end{aligned} \tag{3}$$

where the standard Brownian motion $\tilde{W}_t^A$ is independent of $\tilde{W}_t$—i.e., it represents the idiosyncratic portion of the firm's long-term shock. In this equation, μ and $\sigma_A > 0$ are constant parameters. We do not impose restrictions on the sign of the parameter μ—if negative, it represents the depreciation rate of the firm's capital. Furthermore, $l_t = L_t/A_t$ represents the firm's investment rate, which expands firm size and is set endogenously. We assume that the price of assets is normalized to one, and that investment also entails a quadratic adjustment cost given by:

$$G(L, A) = g(l)A = \frac{\kappa l^2}{2} A, \tag{4}$$

where κ is a positive constant.

In turn, transitory shocks do not affect the firm's long-term prospects. Namely, the transitory component of cash flows dY_t follows an arithmetic Brownian motion with dynamics:

$$dY_t = \alpha dt + \sigma_Y d\hat{B}_t = \alpha dt + \sigma_Y \left(\rho_Y d\tilde{B}_t + \sqrt{1-\rho_Y^2} d\tilde{B}_t^Y\right). \tag{5}$$

In this equation, $\alpha > 0$ and $\sigma_Y > 0$ are positive constants denoting the associated drift and volatility, respectively. Moreover, the firm's short-term shocks, denoted by $d\hat{B}_t$ under the physical measure, are correlated with the aggregate shock $d\tilde{B}_t$ by a factor $\rho_Y \geq 0$. In the above equation, $\tilde{B}_t^Y$ is independent of $\tilde{B}_t$ and, thus, it represents the portion of the cash flow shock that is not priced. We assume that the Brownian motions $\hat{W}_t$ and $\hat{B}_t$ are orthogonal. In the Appendix, we show that allowing the firm to engage in short-term investment affecting the cash flow drift α does not change the main predictions of the model on the role of the term structure of risk prices on the horizon of corporate policies.[14]

Our definition of cash flows and the way permanent and transitory shocks affect the firm's prospects are similar to Décamps et al. (2017), Gryglewicz, Mayer, and Morellec (2020), and Hackbarth, Rivera, and Wong (2021).[15] As in these works, we want to allow for negative cash flows, consistent with real-world observation. To see how shocks to A_t have a long-term impact, consider a Modigliani-Miller setup with costless access to external financing. For the sake of illustration, assume that the firm invests at a constant rate l. In this environment, the firm is infinitely-lived and its value is simply the expected present value of all future cash flows

$$E_A^Q\left[\int_0^\infty e^{-rt}dX_t\right] = E_A^Q\left[\int_0^\infty e^{-rt}A_t dY_t\right] = \frac{\alpha A}{r + \sigma_A\rho_A\eta_L - \mu - l}. \tag{6}$$

This expression illustrates that shocks to A_t are permanent as they affect future cash flows too. In turn, shocks coming from dY_t are short-lived and, thus, do not affect the firm's future prospects. Notably, the greater the price of long-term shocks, the lower the present value of future cash flows.

Absent short-term shocks, the firm's cash flows would always be positive (i.e., given by $\alpha A_t dt$) because so is A_t. In turn, short-term shocks can give rise to operating losses, which can be covered by raising external financing or by using retained earnings. We allow management to save earnings inside the firm and denote by M_t the firm's cash

[14]In this extended setup, we show that the firm optimally tilts its focus towards long- or short-term investment in ways consistent with an extension or contraction of the firm's optimal horizon, as predicted by our baseline model with just one type of investment.

[15]These works merge two theoretical frameworks. In the first, cash flows are governed by a geometric Brownian motion, so shocks are permanent in nature, as in the models following Leland (1994). In the second, cash flows are driven by an arithmetic Brownian motion, so shocks are transitory, see Décamps, Mariotti, Rochet, and Villeneuve (2011), Bolton, Chen, and Wang (2011), Della Seta, Morellec, and Zucchi (2020), and Zucchi (2021).

reserves at any time $t > 0$. Cash reserves earn a rate of return $r - \lambda$ inside the firm, where λ represents the opportunity cost of cash. The firm can increase its cash reserves by raising external financing. Raising external funds is costly and entails a proportional cost p as well as fixed cost fA_t. Following Bolton, Chen, and Wang (2011, henceforth BCW) and Décamps et al. (2017), the fixed cost scales with firm size, to ensure that the firm does not grow out of its fixed cost of equity issuance. Cash reserves satisfy the following dynamics:

$$dM_t = (r - \lambda)M_t dt + A_t dY_t - (l_t + g(l))\, A_t dt + dH_t - d\Phi_t - dU_t \tag{7}$$

where H_t, Φ_t, and U_t are non-decreasing processes that represent the cumulative gross equity financing, the cumulative issuance costs, and the cumulative payout to shareholders. This equation illustrates that cash reserves increase with the interest on cash (the first term on the right-hand side), with the firm's earnings (the second term), and external financing (the fourth term), whereas it decreases with investment-related costs (the third term), issuance costs (the fifth term), and payouts to shareholders (the last term).

The firm can be forced into default if its cash reserves reach zero following a series of negative shocks and it is not possible/optimal to raise fresh funds. As BCW (2011), we assume that the liquidation value of risky assets, denoted by ℓ_τ, is a fraction of A_t. That is, $\ell_\tau \equiv \phi A_\tau$, where $\phi \in [0, 1)$ represents the firm's recovery rate (equivalently, $1 - \phi$ represents a haircut related to default costs) and τ denotes the firm's time of default.

Management chooses the firm's payout (U_t), financing (H_t), investment (l_t), and default (τ) policies to maximize shareholder value. That is, management solves

$$V(A, M) = \sup_{U,H,l,\tau} E^Q \left[\int_0^\tau e^{-rt} \left(dU_t - dH_t \right) + e^{-r\tau} \ell_\tau \right],$$

subject to equation (7), where the expectation is taken under the risk-neutral probability measure. In this equation, the first term in the square brackets represents the flow of dividends accruing to incumbent shareholders, net of the claim of new shareholders. The second term represents the present value of the cash flow to shareholders in default.

4 Model solution

Using the stochastic discount factor in equation (1), we pin down the dynamics of the relevant stochastic processes under the risk-neutral probability measure (see Appendix A.2). Using these dynamics, we start by solving the model under the assumption that the firm does not face financing frictions, in which case the Modigliani-Miller theorem holds and financial policies are irrelevant. We then analyze the case with financing frictions in Section 4.2, in which the firm's investment, cash retention, payout, and financing policies are intertwined and jointly determined.

4.1 The case with no financing frictions

Absent financing frictions, the firm has no incentives to keep cash reserves because any funding need can be covered by raising new equity at no cost nor delay. Thus, it is optimal for the firm to pay out any cash flow exceeding its operating needs to shareholders. That is, financing is irrelevant. In this environment, we show that the term structure of risk prices has solely an impact on the firm's optimal investment policy.

In this environment, firm value is denoted by $V^*(a)$, being a function of its size (or capital stock). We conjecture that $V^*(a) = av^*$, where v^* represents firm value scaled by size. Using standard arguments, we show that the scaled firm value satisfies the HJB equation (28) reported in Appendix A.2. Maximizing this equation with respect to l^* gives the firm's optimal investment rate:[16]

$$l^* = (r-\mu+\sigma_A\rho_A\eta_L)-\sqrt{(r-\mu+\sigma_A\rho_A\eta_L)^2 - 2\left(\alpha-\sigma_Y\rho_Y\eta_S - r + \mu - \sigma_A\rho_A\eta_L\right)/\kappa}. \quad (8)$$

[16] The inequality $(r-\mu+\sigma_A\rho_A\eta_L)^2 - 2\left(\mu-\sigma_Y\rho_Y\eta_S - r + \mu - \sigma_A\rho_A\eta_L\right) > 0$ guarantees that the investment policy is well defined.

Notably, the investment rate l^* is positive if the inequality

$$\alpha - \sigma_Y \rho_Y \eta_S > r - \mu + \sigma_A \rho_A \eta_L \tag{9}$$

holds, i.e., if risk-adjusted profitability (the left-hand side) is greater than the risk-adjusted required return (the right-hand side). In the following, we focus on cases in which this inequality is satisfied.

Symmetric exposure to short- and long-term shocks To isolate the effect of the relative magnitude of market risk prices (i.e., the effect of the slope of the term structure) on corporate investment, we start by considering the case in which the firm has symmetric exposure to the two risks, i.e., the equality $\sigma_A \rho_A = \sigma_Y \rho_Y$ holds. The next proposition relates the firm's optimal investment rate to the slope of the term structure of market risk prices (see Appendix A.2 for a proof).

Proposition 1 *If the firm is symmetrically exposed to the two sources of aggregate shocks (i.e., $\sigma_A \rho_A = \sigma_Y \rho_Y$), its optimal investment rate decreases with the slope of the term structure of risk prices.*

Proposition 1 demonstrates that if the firm is symmetrically exposed to short- and long-term aggregate shocks, an upward-sloping term structure of risk prices leads the firm to reduce its optimal investment rate compared to the flat case—i.e., the firm grows in size at a lower rate due to the greater discount on long-term assets associated with an increasing term structure. Conversely, a downward-sloping term structure leads the firm to increase its optimal investment rate compared to the flat case.

Asymmetric exposure to short- and long-term shocks Next, we relax the assumption of symmetric exposure to short- and long-term shocks. Proposition 2 formalizes that the firm's exposure to aggregate shocks is key to pin down the sensitivity of investment to the slope (see Appendix A.2).

Proposition 2 *If the firm is more exposed to aggregate long-term shocks than to short-term shocks (i.e., $\sigma_A \rho_A \geq \sigma_Y \rho_Y$), then the optimal investment rate decreases with the slope of the term structure of risk prices. If, instead, the firm's exposure to aggregate short-term shocks is sufficiently larger than the exposure to aggregate long-term shocks so that the inequality*

$$\rho_Y \sigma_Y \geq \rho_A \sigma_A \left[1 + \kappa(r - \mu + \eta \rho_A \sigma_A)\right] - \sqrt{\rho_A^2 \sigma_A^2 \left[\left(1 + \kappa(r - \mu + \eta \rho_A \sigma_A)\right)^2 - 1 - 2\alpha\kappa\right]}. \tag{10}$$

holds, then investment becomes increasing with the slope of the term structure.

Proposition 2 illustrates that the firm's exposure to aggregate shocks provides a source of cross-sectional heterogeneity in the observed corporate responses to the slope. Specifically, if the firm is more exposed to aggregate long-term shocks, investment decreases with the slope of the term structure, consistent with Proposition 1. This result is reversed—and investment becomes increasing with the slope—if the firm's exposure to aggregate short-term shocks is sufficiently larger than its exposure to long-term shocks. The reason is the following. When the firm's exposure to the two risks is asymmetric, a "level" effect adds to the slope effect on investment. When the firm is more exposed to the long-term shocks, the exposure-weighted level of the term structure is greater if it is upward-sloping (i.e., the firm is more exposed to the risk with the largest market price). The level effect compounds the slope effect, so an upward-sloping term structure leads to a stronger decrease in investment (compared to the case in which the firm is symmetrically exposed to the two risks). Conversely, if the firm is more exposed to the short-term shocks, the exposure-weighted level of the term structure is greater if it is downward-sloping. In this case, the higher level depresses investment while the downward slope should increase it. The level effect more than offsets the slope effect if the inequality (10) holds—all else equal, it is more likely to hold if the firm is less profitable (i.e., if α is smaller) or if assets growth μ is smaller (or more negative, if $\mu < 0$ represents depreciation). We investigate this result further in Section 5.2.

4.2 Firm policies in the presence of financing frictions

In the following, we assume that the firm faces financing frictions, as described in Section 3. Financing frictions imply that the firm finds it optimal to engage in precautionary policies, such as holding cash reserves, and adapts its optimal investment rate to the firm's financial stance. We next show that the slope of the term structure of risk prices has a key role in determining the optimal financing and investment policies.

Consider first the firm's cash retention and payout policies. Because external financing and liquidation are costly, it is optimal for the firm to delay equity issuance or liquidation decisions until cash reserves are depleted. When the cash reserves are depleted, the firm issues new equity if financing is not too costly (below we define conditions that warrant the optimality of refinancing versus liquidation). Otherwise, the firm enters default as it does not have funds to cover operating losses and continue operations. Notably, the benefit of holding cash decreases with cash reserves, whereas the opportunity cost of cash is constant. Thus, we conjecture that there is a target cash level M^*, at which costs and benefits are equalized. Above this target level, it is optimal to pay out all the excess cash to shareholders. Below this level, the firm retains earnings in the cash reserves.

Standard arguments yield that firm value satisfies the following Hamilton-Jacobi-Bellman (HJB) equation in the cash retention region $[0, M^*]$:

$$
\begin{aligned}
rV(a,m) = \max_l (\mu + l - \sigma_A \rho_A \eta_L) a V_a + \left[\left(\alpha - \sigma_Y \rho_Y \eta_S - l - \frac{\kappa}{2} l^2 \right) a + (r - \lambda) m \right] V_m \\
+ \frac{1}{2} a^2 \left(\sigma_A^2 V_{aa} + \sigma_Y^2 V_{mm} \right) . \qquad (11)
\end{aligned}
$$

The left-hand side of this equation represents the return required by investors under the risk-neutral measure. The right-hand side is the expected change in firm value on an infinitesimal time interval. The first term on the right-hand side represents the effect of changes in asset size on firm value, whereas the second term represents the effect of changes in cash reserves. These terms depend on the market risk prices η_L and η_S, respectively. The last term represents the effect of (asset and cash flow) volatility.

Equation (11) illustrates that two state variables—(illiquid) assets and cash—enter the firm's optimization problem. Homogeneity implies that we can solve for firm value by the firm cash-to-asset ratio, $c \equiv m/a$. We also define the scaled value function, denoted by $v(c)$:

$$V(a, m) \equiv a v(c). \tag{12}$$

Substituting equation (12) into equation (11) and dividing by a gives:

$$rv(c) = \max_{l} \left(\mu + l - \sigma_A \rho_A \eta_L\right)[v(c) - v'(c)c] + \left[\alpha - \sigma_Y \rho_Y \eta_S - l - \frac{\kappa l^2}{2} + (r - \lambda)c\right] v'(c) + \frac{v''(c)}{2}\left(\sigma_A^2 c^2 + \sigma_Y^2\right). \tag{13}$$

Differentiating the above equation with respect to l gives the optimal firm's investment rate (see Appendix A.3):

$$l(c) = \frac{1}{\kappa}\left(\frac{v(c)}{v'(c)} - 1 - c\right). \tag{14}$$

Plugging $l(c)$ back into equation (13) yields the following equation:

$$\left(r - \mu + \sigma_A \rho_A \eta_L\right) v(c) = \left[\alpha - \sigma_Y \rho_Y \eta_S + (r - \lambda - \mu + \sigma_A \rho_A \eta_L)c\right] v'(c) + \frac{v''(c)}{2}\left(\sigma_A^2 c^2 + \sigma_Y^2\right) + \frac{1}{2\kappa} \frac{\left[v(c) - (1+c)v'(c)\right]^2}{v'(c)}. \tag{15}$$

Equation (15) shows how the market prices of short-term and long-term shocks affect firm value. The first term on the right-hand side illustrates that a greater market price of short-term shocks η_S reduces the firm's expected profitability, and more so if the firm's cash flow shocks are more correlated with aggregate shocks (i.e., ρ_Y is greater) or more volatile (i.e., σ_Y is greater). In turn, the left-hand side of this equation illustrates that the market price of long-term shocks η_L leads to an increase in the return required by the investors. This effect commands a greater discount rate on future cash flows and, thus, should depress firm value. This effect is stronger if the firm's correlation with aggregate long-term shocks ρ_A is greater or if productive assets are more volatile (σ_A is greater).[17]

Equation (15) is solved subject to the following boundary conditions. If $c > C^*$, the firm pays out cash in excess of C^*, meaning that $v(c) = v(C^*) + c - C^*$ for any $c > C^*$. Subtracting $v(C^*)$ from both sides of this equation, dividing by $c - C^*$, and taking the limit as $c \to C^*$ shows that the firm satisfies the following value-matching condition at C^*:

$$v'(C^*) = 1. \tag{16}$$

To ensure optimality of the target payout threshold C^*, the super-contact condition needs to hold (see Dumas, 1991):

$$v''(C^*) = 0. \tag{17}$$

Because equity issuance is costly, the firm delays refinancing until cash reserves are depleted. If the firm raises equity when $c = 0$, the following boundary condition holds:

$$v(0) = v(C_*) - (1 + p)C_* - f, \tag{18}$$

where C_* represents the optimal issuance size. This equation implies that the value of the firm when cash reserves are depleted (the left-hand side) equals the post-issuance firm-value net of the associated financing costs (the right-hand side). The optimal issuance size C_* is endogenously determined by the following condition:

$$v'(C_*) = 1 + p, \tag{19}$$

[17] Note that the last term in the square brackets on the right-hand side shows that a greater η_L also leads to an increase in the return on cash. Yet, the opportunity cost of cash, i.e., the gap between the return required by the investors and the return on cash ($r - \mu + \sigma_A\rho_A\eta_L - (r - \lambda - \mu + \sigma_A\rho_A\eta_L) = \lambda$) remains constant and equal to λ.

guaranteeing that the marginal benefit (the left-hand side) and cost of equity issuance (the right-hand side) are equalized at the post-issuance cash level. The firm is better off issuing new equity than liquidating if the following inequality

$$v(C_*) - (1 + p)C_* - f > \phi \tag{20}$$

holds. The left-hand side of this inequality represents firm value at $c = 0$ if the firm raises equity, whereas the right-hand side represents firm value in liquidation.

We next turn to analyze our solution, to understand how the slope of the term structure of risk prices affects investment, payout, cash retention, the size of equity issuance, and the optimality of refinancing versus liquidation.

5 Model analysis

Table 1 reports our baseline parameterization. The risk-free rate is 0.045, and the opportunity cost of cash is 0.01. The cash flow drift α is 0.20, and μ is equal to –0.105, which lies in the ballpark of the depreciation rates in BCW (2011, 2013). We set the adjustment cost parameter to 2.85, which is in the range of the estimates of Eberly, Rebelo, and Vincent (2008).[18] Proportional and fixed financing costs are, respectively, equal to 0.06 and 0.002, in line with BCW (2013) and Décamps et al. (2017). Throughout our analysis, we focus on the case in which the firm refinances every time the cash reserves are depleted (i.e., condition (20) holds) unless otherwise noted.[19] To isolate the effect of the slope of the term structure on corporate policies, we start by assuming that the volatility of permanent and temporary shocks are both equal to 0.12, which is in line with the cash flow volatility in BCW (2013). Additionally, we analyze the case in which the

[18]Throughout our analysis, we rule out parameterizations for which investment rates are largely negative for any cash level (i.e., depicting a "sinking ship").

[19]For illustration, in Section 5.1 we also consider the case in which the firm liquidates the first time cash reserves are depleted (i.e., condition (20) does not hold.)

volatility of permanent shocks is greater than the volatility of transitory shocks, which is consistent with previous models (Décamps et al., 2017; Hackbarth, Rivera, and Wong, 2021; Lee and Rivera, 2020) as well as with the estimates of Gryglewicz et al. (2021).

Table 1

To focus on the effects associated with the slope of the term structure of risk prices, we assume that the sum $\eta_S + \eta_L$—gauging the level of the term structure—is constant across the different cases (increasing, decreasing, and flat), being equal to 0.4 in the baseline parameterization. Unless otherwise mentioned, we assume that $\eta_S = \eta_L = 0.2$ in the case in which the term structure is flat, $\eta_S = 0.05 < 0.35 = \eta_L$ in the increasing case, and $\eta_S = 0.35 > 0.05 = \eta_L$ in the decreasing case.

5.1 Symmetric correlation with aggregate shocks

We start by considering the case in which the firm's shocks are symmetrically correlated with short-term and long-term aggregate shocks (i.e., $\rho_Y = \rho_A$).

Figure 1

Figure 1 shows the firm's investment rate $l(c)$ over the cash retention interval $[0, C^*]$ when the term structure of risk prices is flat, increasing, and decreasing. The left panel considers the case in which $\sigma_A = \sigma_Y$, which is analogous to that analyzed in Proposition 1 for the case with no financing frictions. It illustrates that the firm's investment rate is the lowest if the term structure of risk prices is increasing, in which case it always lies below the flat case. Conversely, the investment rate is the largest if the term structure of risk prices is decreasing, exceeding the investment rate associated with the flat case. The right panel displays the investment rate if $\sigma_A > \sigma_Y$, in which case the effect of the slope of risk prices is qualitatively similar but quantitatively stronger, consistent with

Proposition 2 absent financing frictions.

Figure 1 indicates that, if the term structure of risk prices is increasing, the firm may disinvest when its cash ratio is low, to avoid costly refinancing. Conversely, if the term structure is decreasing, the firm exhibits a positive investment rate for any level of cash reserves. That is, if the term structure is increasing, the firm may favor short-term (emergency) financing solutions such as asset sales rather than resorting to long-term ones that would strengthen the firm's liquidity position while preserving its productivity (such as equity issuance). Figure 2 further analyzes these patterns by varying not only the sign but also the steepness of the slope. The top (respectively, bottom) panel focuses on the case in which the term structure is increasing (decreasing). It shows that the effects of the slope on investment and asset sales are stronger if it is steeper.

Figure 2

Figure 3 studies the marginal value of cash, which is shown to be non-monotonic with the slope of the term structure. The reason is that cash serves to support investment as well as to avoid costly refinancing. When the cash ratio is high, cash serves mostly to finance investment. As cash flows are discounted less aggressively when the term structure is decreasing, the firm has a greater investment appetite, and cash is more valuable. When, instead, the cash ratio is low, cash serves primarily to avoid costly financing. As the surplus from financing is discounted more aggressively when the term structure is increasing, cash is more valuable in this case as it helps delay costly issuances.

Figure 3

We next investigate how the term structure impacts firm's financing choices, namely the size of cash reserves and of equity issuances. Figure 1 shows that the target payout threshold C^* is smaller if the term structure is increasing compared to the flat case, which means that the firm pays out cash to shareholders more often. In turn, the target payout threshold is larger if the term structure is decreasing compared to the flat case.

Table 2

Table 2 further investigates the firm's optimal cash thresholds when varying the slope of the term structure under the baseline parameterization in Table 1 (top panel), when financing frictions are more severe (i.e., $f = 0.01$, middle panel), and for $\sigma_Y > \sigma_A$ (bottom panel). It illustrates that the size of equity issuances is smaller if the term structure is increasing. I.e., because the surplus accruing to incumbent shareholders is discounted more aggressively if the term structure is increasing, the optimal size of equity issuances shrinks, all else equal. While this lower reliance on external financing may suggest that the firm may accumulate larger cash reserves, Table 2 shows that the target payout threshold is smaller if the term structure is increasing, which means that the firm pays out cash to the investors more often. Conversely, the optimal issuance size and the target payout level are larger when the term structure of risk prices is decreasing compared to the flat case. These effects are stronger if the term structure is steeper. Moreover, comparing the top and middle panels indicates that the threshold C^* is larger if the firm faces greater costs of equity issuance, in line with previous cash management models.

Table 2 also investigates the firm (dis-)investment policy by analyzing how the cash threshold above (below) which the firm's investment rate is positive (negative), denoted by C_0, varies with the slope.[20] The table shows that the threshold C_0 is larger if the term structure of risk prices is increasing and sufficiently steep, and more so if financing frictions are tighter (i.e., when f is greater, middle panel) or if the firm is more exposed to long-term shocks ($\sigma_A > \sigma_Y$, bottom panel). Conversely, if the term structure is decreasing, the firm is less likely to engage in asset sales. Table 2 then confirms that an increasing term

[20] I.e., (i.e., $l(C_0) = 0$. In the table, "n.a." indicates that the threshold does not lie in the interval $[0, C^*]$, in which case the firm's investment rate is always positive (.e., the firm never engages in asset sales).

structure not only reduces the firm's investment rate compared to the flat cases, but also increases the likelihood that the firm engages in asset sales when its cash ratio is low.

The last column of Table 2 looks at firm value at $c = 0$. It shows that firm value is the lowest (highest) when the term structure is increasing (decreasing). This result has implications for the firm's decision to liquidate or raise new equity whenever cash reserves are depleted. Recall that the firm finds it optimal to raise new financing at $c = 0$ (instead of liquidating) if condition (20) holds, in which case the firm continuation value is greater than the liquidation value of assets. If firm value decreases sufficiently due to the effect of an upward-sloping term structure, then the firm may find it optimal to liquidate the first time it runs out of cash. This means that, for issuance costs of a given size, the firm is more likely to find it optimal to liquidate if the term structure of risk prices is upward-sloping.

Figure 4

Consider now the case in which the firm liquidates the first time cash reserves are depleted, in which condition (20) does not hold. Figure 4 shows that the firm exhibits a positive investment rate only if the cash ratio is sufficiently high, and negative otherwise. As in the refinancing case, the positive investment rate is greater if the term structure is decreasing. Differently, the firm disinvests at a higher rate when the term structure is decreasing. The reason is the following. When the firm does not have access to external equity financing, disinvestment is the only source of fresh funds that helps avert a forced liquidation. Thus, differently from the refinancing case, disinvestment helps preserve the firm's long-term prospects by delaying liquidation. In this case, disinvesting at a higher rate signals a more precautionary policy, aimed at preserving the firm's survival. The right panel of this figure shows that, differently from the refinancing case, the marginal value of cash is monotonic with the slope of the term structure. As the firm does not have access to outside equity markets, cash is more valuable in this case in that it helps avert forced liquidations (rather than simply averting costly refinancing, as instead in the refinancing case). Thus, cash is more valuable when the term structure is decreasing.

The term structure of risk and the horizon of corporate policies Put together, our analysis illustrates that the slope of the term structure of risk prices importantly affects corporate horizon. Our model departs from previous works aimed at studying the horizon of corporate policies in at least two dimensions. First, it does not involve channels related to shareholders-managers agency conflicts nor stock market pressure due to quarterly reporting. Second, whereas previous contributions infer corporate horizon solely from a firm's appetite to invest in corporate growth, our model also looks at financial policies, which inform about the firm' balance between long-term financial resilience through precautionary policies versus emergency financing decisions (such as asset sales) that may harm long-term profitability.

Specifically, if the term structure is increasing, the firm reduces its investment in productive assets and pays out cash to shareholders more often. It also reduces the size of its precautionary target cash ratio and of equity issuances. The firm is more likely to disinvest productive assets when financial constraints tighten in order to delay costly equity issuance, at the cost of impairing long-term profitability. Overall, the firm favors current earnings and payouts over long-term growth through investment and precautionary cash retention—i.e., if the term structure of risk prices is upward-sloping, the firm shortens the horizon of corporate policies compared to the case in which the term structure is flat. Conversely, if the term structure is downward-sloping, the firm increases its investment rate (which benefits long-term profitability), delays payouts to shareholders, and increases its target cash ratio and the size of equity issuances. The firm also increases the size of equity issuances. That is, if the term structure is downward-sloping, the firm extends the horizon of corporate policies—i.e., not only it poses more emphasis on long-term investment than on current payouts, but also on precautionary financing policies aimed at strengthening the firm's financial resilience.

5.2 Asymmetric correlation with aggregate shocks

The firm's correlations with aggregate shocks play a key role in determining the extent to which the term structure of risk prices impacts corporate policies. Equation (15) illustrates that a greater correlation with aggregate long-term shocks ρ_A or a greater market price η_L both lead to an increase in the (risk-adjusted) return required by the investors. In turn, larger correlation with short-term shocks ρ_Y or a greater market price η_S both lead to a decrease in the expected (risk-adjusted) profitability of cash flows. We now investigate the role played by the relative size of ρ_Y and ρ_A.

Figure 5

Figure 5 shows the firm's optimal investment rate when varying the relative magnitude of the firm's correlation with aggregate shocks, under the assumption that the firm's volatilities assume the same value, $\sigma_A = \sigma_Y$. As long as the inequality $\sigma_A \rho_A \geq \sigma_Y \rho_Y$ holds (which is the case for the left and the middle plots), the firm exhibits a negative sensitivity of investment to the slope—i.e., investment is larger if the term structure is decreasing, as in Section 5.1. Conversely, if $\sigma_A \rho_A < \sigma_Y \rho_Y$ holds (which is the case in the right panel of this figure), the opposite pattern can arise—i.e., the investment rate is the largest if the term structure is increasing. These results are consistent with Proposition 2 for the case with no financing frictions. In fact, when the firm's exposure to aggregate shocks is asymmetric, a "level" effect compounds the slope effect, as explained in Section 4.1. The level effect boosts the effect of the slope (as isolated in the symmetric case) if the firm is more correlated with long-term shocks (i.e., in the left panel of Figure 5). Conversely, if the firm is more exposed to short-term shocks (as in the right panel of Figure 5), the level effect can more than offset the slope effect. Indeed, if the firm is more exposed to short-term aggregate shocks than to long-term ones and the term structure is decreasing, it is more exposed to the risk with the largest market price—in this case, the level effect is greater in magnitude and can more than offset the slope effect.

Figure 6

As shown by Proposition 2 for the case with no financing frictions, not all firms that are more exposed to short-term shocks exhibit a positive sensitivity of their investment rate to the slope—i.e., the level effect does not necessarily prevail on the slope effect. Specifically, Proposition 2 shows that $\sigma_Y \rho_Y$ needs to sufficiently exceed $\sigma_A \rho_A$ for the sensitivity of investment to the slope to become positive. Figure 6 confirms this result for the case with financing frictions. The figure shows that, when $\sigma_Y \rho_Y > \sigma_A \rho_A$, the sensitivity of investment to the slope is more likely to become positive if the firm is less profitable or if its assets depreciate at a higher rate, all else equal.

That is, by identifying sources of cross-sectional heterogeneity in the firm's response to the slope of risk prices, our analysis translates into practical guidance for empirical work by exploiting differential responses in the cross-section of firms based on their exposure to aggregate risks and, for firms that are more exposed to short-term shocks, based on firm characteristics.

5.3 Firm risk premia

Whereas so far we have focused on the effects of *market-wide* risk prices on corporate policies, we now investigate how they shape the endogenous *firm-level* risk premium.[21] A firm's conditional risk premium satisfies:

$$\theta(c) = \underbrace{\eta_L \rho_A \sigma_A \left(1 - \frac{cv'(c)}{v(c)}\right)}_{\theta_A(c)} + \underbrace{\eta_S \rho_Y \sigma_Y \frac{v'(c)}{v(c)}}_{\theta_Y(c)} . \tag{21}$$

[21]We adopt the heuristic approach of BCW (2011, 2013) in deriving the firm's expected return, which involves the comparison of the HJB under the physical and the risk-neutral probability measure.

The term $\theta_A(c)$ compensates investors for the exposure to long-term aggregate shocks, whereas the term $\theta_Y(c)$ for the exposure to short-term shocks. Both terms are a function of the cash-to-asset ratio, c, and, hence, endogenously move over time.[22]

Figure 7

The slope of the term structure affects the relative weight of $\theta_A(c)$ and $\theta_Y(c)$ on the overall risk premium—namely, if the term structure of risk prices is increasing (respectively, decreasing), $\theta_A(c)$ ($\theta_Y(c)$) has a larger weight, all else equal. In addition, the firm-specific exposure to the two risks also impacts the magnitude of the risk premium. Figure 7 shows that if the firm is more exposed to the long-term shock (respectively, short-term shock), its risk premium is larger if the term structure is increasing (decreasing). Furthermore, the model predicts that investment and risk premia are respectively increasing and decreasing with the cash ratio[23]—thus, our model delivers a negative endogenous relation between investment and risk premia, consistent with Li, Livdan, and Zhang (2009); Fama and French (2006); Anderson and Garcia-Feijóo (2006); Titman, Wei, and Xie (2004). Moreover, comparing Figure 7 with Figure 5 illustrates that investment and risk premia move in opposite directions when varying the slope of risk prices.

Importantly, our analysis shows that the term structure of risk prices affects the way financing frictions impact firms' risk premia. To see this, consider the conditional risk premium absent financing frictions:

$$\theta^* = \underbrace{\eta_L \rho_A \sigma_A}_{\theta^*_A} + \underbrace{\eta_S \rho_Y \sigma_Y \frac{1}{v^*}}_{\theta^*_Y}, \tag{22}$$

[22]Notably, the risk premium in equation (21) differs from that in previous dynamic corporate finance models with financing frictions (such as BCW, 2011), in which the firm is subject to short-term shocks and, thus, only includes the θ_Y component.

[23]While Figure 7 shows the ratio of risk premia in the sloped versus flat cases, unreported results show that the risk premium decrease with the firms cash ratio as in BCW (2011, 2013), irrespective of the slope of the term structure.

where v^* is firm value scaled by assets absent financing frictions (see Section 4.1 and Appendix A.2). The long-term component $\theta_A(c)$ is smaller in the presence of financing frictions—$\theta_A(c)$ and θ_A^* coincide at $c = 0$, and the inequality $\theta_A(c) < \theta_A^*$ holds for any $c \in (0, C^*]$. The reason is that financing frictions lead the firm to hold cash. Whereas productive assets are correlated with aggregate long-term risk, cash is a safe asset. Thus, the composition of productive assets and cash leads to a decline in the firm's exposure to long-term risk compared to the case with no financing frictions (in which the firm keeps no cash). Second, the short-term component $\theta_Y(c)$ can be either greater or smaller than θ_Y^* depending on its cash ratio, being greater (smaller) than θ_Y^* if the firm's cash ratio is small (large). On top of the aforementioned asset composition effect—which pushes the short-term premium down as the cash-to-asset ratio increases—the increased constraints associated with low cash reserves push the short-term premium above θ_Y^*.

Figure 8

Figure 8 compares the risk premium and its components in the presence and in the absence of financing frictions. As confirmed by the middle panel, $\theta_A(c)/\theta_A^*$ is smaller than one for any level of cash reserves. Conversely, the right panel shows that $\theta_Y(c)/\theta_Y^*$ is smaller (greater) than one if cash reserves are sufficiently large (small). As a result, the risk premium $\theta(c)$ can be larger in the presence of financing frictions due to the dynamics of the short-term component $\theta_Y(c)$—specifically, the figure shows that $\theta(c)$ is greater than θ^* if the cash ratio is low and more so if the term structure is decreasing, in which case the weight of $\theta_Y(c)$ on $\theta(c)$ is greater. This result then rationalizes the conflicting evidence on the effect of financial constraints on stock returns (see, e.g., Lamont, Polk, and Saá-Requejo, 2001; Whited and Wu, 2006) by illustrating that these tests should condition on the firm's cash ratio and the slope of the term structure of risk prices.[24]

[24]Using novel measures of financial constraints using textual analysis, Buehlmaier and Whited (2018) shows that financial constraints risk is significantly priced, with debt-related risk being the most important (which, however, we do not analyze in out model) and equity-related risk being the least important.

5.4 Applications

Duration and asset prices Corporate horizon has an obvious impact on cash flow duration. Firms with a longer horizon delay payouts and invest more—meaning that they are willing to receive lower cash flows today to support growth and, then, receive larger cash flows in the future. Conversely, firms with a shorter horizon distribute more cash flows today and invest less, meaning that they are more profitable in the present but have meager growth prospects.

Our model illustrates that, if the term structure is increasing, the firm will exhibit a shorter duration—i.e., less investment and greater payouts today.[25] Also, as our analysis in Section 5.3 illustrates, the firm will have a greater risk premium. Conversely, if the term structure is decreasing, the firm will exhibit a longer duration—i.e., a larger investment rate and lower payouts. Moreover, in this case, the firm risk premium will be smaller.

Our model can then reproduce the negative relation between duration and expected returns observed in the data (Dechow, Sloan, and Soliman, 2004; Lettau and Wachter, 2007, 2011; Da, 2009; Weber, 2018). In this strand, recent works show that cash flow duration spans alternative risk factors including value, profitability, investment, and payout (see Chen and Li, 2018; Gonçalves, 2021a; Gormsen and Lazarus, 2021). Our model is consistent with this view. Because, as we show, short-duration firms exhibit low investment, greater payouts, and greater risk premia, our model is consistent with the view that the investment and payout factors are spanned by duration. Because of their lower investment compared to long-duration firms, short-duration ones are more profitable but exhibit lower growth and, thus, lower valuation ratios (see Figure 3). Thus, our model is also consistent with the view that duration subsumes the profitability and value factors.

See also Livdan, Sapriza, and Zhang (2009) and Bolton, Chen, and Wang (2013).

[25] For the sake of brevity, we focus on these case in which the firm is symmetrically exposed to the two risks and on the case in which the firm is more exposed to the long-term risk. The first case is helpful to single out the effect of the slope, whereas the second is consistent with the greater volatility of persistent shocks documented by Gryglewicz et al. (2021) as well as with the observation that the term structure of equity strip exposure to the overall equity market is upward sloping (see Gonçalves, 2021b).

As our model shows, cash flow duration is an endogenous variable and, specifically, largely depends on the firm's exposure to systematic (short- and long-term) risks and their risk prices. As a result, our model suggests that revisiting the role of cash flow duration conditional on the term structure of risk prices and the firm's exposure to risks with different horizons would be a fruitful avenue of research.

The distortions of ignoring the term structure of risk prices To illustrate the importance of accounting for the term structure of risk prices, we now quantify the distortions if the firm ignores it. To this end, Table 3 shows the percentage distortion in investment, optimal cash retention (and, thus, payout), and equity issuance when the term structure is either increasing/decreasing but the firm assumes that it is flat.

Our analysis implies that ignoring the slope when it is increasing (decreasing) leads to overinvestment (underinvestment).[26] The table shows that the distortions are notable and vary substantially with the steepness of the slope—when the gap between η_L and η_S is equal to 0.3 (i.e., an increasing slope), the investment rate is about 8.7% higher than optimal (i.e., if the firm correctly accounted for the slope). When the gap between η_L and η_S is equal to -0.3 (a decreasing slope), the investment rate is about 9.5% smaller than optimal. The magnitude of the distortion increases substantially if $\sigma_A > \sigma_Y$. In this case, if the firm ignores an increasing slope, it will exhibit a positive investment rate when cash reserves are close to zero even if it would be optimal to disinvest (not shown).

When ignoring an increasing term structure, the firm also builds excessive cash reserves, so it pays out dividends less often. Moreover, it raises more cash than optimal at refinancing events. Table 3 shows that the target cash level is about 5.8% larger than optimal when $\eta_L - \eta_S = 0.3$, and the equity issuance size is about 5.7% greater. Conversely, if $\eta_L - \eta_S = -0.3$, the firm keeps a cash balance about 7% smaller and reduces the size of equity issuances by 6.8%. Again, these distortions widen in size if $\sigma_A > \sigma_Y$.

Our analysis then warns that, because the term structure of risk prices shapes the

[26] To fix ideas, we focus on the investment distortions at the target cash level, C^*.

intertemporal tradeoffs at the heart of optimal decisions, ignoring it leads to substantial distortions. E.g., ignoring a downward-sloping term structure—which is consistent with the recent findings of sizable short-term equity risk premia—leads to overweight the short-term. Conversely, ignoring an upward slope leads to overweight the long-term.

Roadmap to empirical testing The slope of the term structure of risk is a macroeconomic phenomenon exogenous to the firm. One productive way to test our model would be to conduct comparative statics for the endogenous variables (investment, payouts, cash reserves, and equity issuances) relative to the slope of the term structure and the parameters governing the firm's sensitivity to it.[27] The cross-sectional heterogeneity in the response to the term structure suggested by our model (see Section 5.2) eases this approach. In particular, when the term structure increases (goes from negative, to flat, or to positive), we expect that firms that are symmetrically exposed to short- and long-term shocks: (1) decrease their investment rate, (2) pay out more to shareholders (in the form of dividends or share repurchases), (3) keep less cash, and (4) decrease the size of equity issuances. Firms that are relatively more exposed to long-term shocks should exhibit even stronger effects. In turn, firms that have a greater exposure to short-term shocks should exhibit a much lower effect and, depending on a host of firm characteristics (as described in Section 5.2), such an effect could be qualitatively the opposite.

If, instead, our results are not confirmed empirically, then either: (a) our theory is incorrect (i.e., the term structure does not impact corporate horizon empirically), or (b) our theory is right but managers do not take the term structure into account when making corporate decisions. It would be possible to test (b) by studying how firm value changes as the slope of the term structure varies. In particular, if managers do not take the term structure into account, then we should see an increase in firm value as the term structure flattens (i.e., goes from decreasing/increasing to flat), and a decrease in firm value as

[27] I.e., we would test whether the rich set of correlations stemming from our model is matched in the data—this approach is also adopted by Danis, Rettl, and Whited (2014).

the term structure becomes positively or negatively sloped (or the steepness increases). In fact, if firms do not take the term structure into account, they would be adopting suboptimal policies if the term structure is sloped (as illustrated in Table 3) but the right ones when the term structure is flat. Therefore, when the term structure goes from sloped to flat, such distortions should milden and lead to an increase in firm value. In turn, when the term structure goes from flat to sloped, the distortions would increase, then leading to a decrease in firm value.

6 Time-variation in risk prices

The analysis so far assumes that the term structure of risk prices is static. In this section, we relax this assumption and allow risk prices to vary over time. Consistently, van Binsbergen, Hueskes, Koijen, and Vrugt (2013), Gormsen (2020), and Bansal et al. (2021) document that the level and the slope of the term structure of equity vary with economic conditions, which can be rationalized in a general equilibrium setting with time-varying prices of risk (see Breugem et al., 2021).[28]

In this extension, we assume that the firm can be in two (observable) states $i = G, B$, where G denotes the good state (expansion) and B denotes the bad state (recession). We assume that the state switches from G to B (respectively, from B to G) with probability $\pi_G dt$ ($\pi_B dt$) on any $(t, t+dt)$. When the state switches, the market risk prices change. We denote by η_{AG} and η_{AB} (respectively, η_{YG} and η_{YB}) the market price of long-term (short-term) shocks in the good and in the bad state. Because our focus is on the time-variation of risk prices, we keep other quantities to be invariant across the two states.

In this augmented setting, firm value and policies are state-contingent. Specifically,

[28]Moreover, Haddad, Kozak, and Santosh (2020) and Giglio, Kelly, and Kozak (2020) stress that time-variation in risk prices is a critical property of the stochastic discount factor and equity term structure dynamics. Consistently, Chernov, Lochstoer, and Lundeby (2018) and Favero, Ortu, Tamoni, and Yang (2019) emphasize the importance of time-variation in risk prices by implementing tests of asset pricing models exploiting multi-horizon returns and their predictability.

the optimal investment rate in state i is given by:

$$l_i(c) = \frac{1}{\kappa}\left(\frac{v_i(c)}{v_i'(c)} - 1 - c\right). \quad (23)$$

We report the analytical details of the model solution in Appendix A.4.

We analyze the implications of this extension by considering again our baseline parameterization, focusing on the case $\sigma_Y = \sigma_A = 0.12$. Additionally, we assume that the transition intensities between the two states are symmetric, to mute any effect driven by the longer duration of one state over the other.[29] We realistically assume that the level of the term structure is higher in the bad state than in the good state and study the impact of a procyclical and countercyclical slope. That is, by analyzing both cases, we remain agnostic regarding the empirical discussion concerning the slope cyclicality. As we show that the procyclicality and countercyclicality have very different implications for the optimal firm policies, our analysis urges the empirical asset pricing literature to resolve this debate.

Figure 9

Procyclical slope The top panel of Figure 9 shows the optimal investment rate when the slope of risk prices is procyclical—i.e., it is increasing in expansion (the good state G) and decreasing in recession (the bad state B). The top left panel shows that the optimal investment rate is larger in the good state than in the bad state.[30] This result is the composition of two forces. In the good state, the term structure of risk prices is not only

[29]BCW (2013) assume that the transition intensity out of the good state G is 0.1—i.e., expansions on average last ten years—and the transition intensity out of bad state B is 0.5—i.e., recessions last on average two years. However, under the risk-neutral measure, the relative magnitude of these intensities flips in BCW (2013): the transition intensity out of the good state is 0.3 and the transition intensity out of the bad state is 0.167. We do not attach additional risk prices to state transitions and, thus, risk adjustments to transition intensities. Instead, our assumption that $\pi_G = \pi_B = 0.1$ helps us single out the effects driven by time-variation in the level and the slope of risk prices.

[30]In this plot, we assume that $\eta_{YG} = 0$ and $\eta_{AG} = 0.2$ in the good state so that the price of short-term shocks is smaller in the good state, whereas $\eta_{YB} = 0.6$ and $\eta_{AB} = 0.2$ so that the price of long-term shocks is smaller in the bad state.

increasing, but also lower in levels compared to the bad state. As a result, while the slope of the term structure should lead to less investment (as illustrated in the analysis in Section 5.1), the level acts as an offsetting strength. Offsetting strengths also arise in the bad state: Whereas we would expect greater investment resulting from the decreasing slope of the term structure, its higher level depresses these quantities.

To disentangle the effect of the slope, the top right panel considers an environment in which $\eta_{Yi} + \eta_{Ai}$ remains constant in the two states (i.e., $\eta_{YG} + \eta_{AG} = \eta_{YB} + \eta_{AB}$). In this environment, the investment rate is greater in the bad state—in which the term structure is decreasing—than in the good state, consistent with the analysis in Section 5. Overall, comparing the right and left top panels indicates that when the slope is procyclical, the time-variation in the level and in the slope of the term structure have opposite directional effects on investment. When risk prices are relatively low in expansion, firms should have greater incentives to invest, all else equal. However, the upward slope moderates this effect—the greater price of long-term shocks decreases the firm's optimal investment rate. Conversely, when the prices of risk are high in recession, firms reduce investment, but a downward-sloping term structure acts as a countervailing strength.

Countercyclical slope In the bottom panel of Figure 9, we consider the case in which the slope is countercyclical—i.e., it is decreasing in expansion and increasing in recession.[31] The bottom left panel shows that investment is greater in the good state, similar to the top left panel. Again, this is the composition of the effect driven by time-variation in level and slope of the term structure. Yet, in this case, time variation in level and slope have the same qualitative effect, as illustrated by the bottom right panel in which we assume that the sum of the prices of risk $\eta_{Yi} + \eta_{Ai}$ is constant across the two states. In fact, when prices of risk are relatively high in the bad state, the firm cuts its investment rate. Furthermore, upward-sloping market prices in the bad state further reduce the firm's

[31] In the top panel, we assume that $\eta_{YG} = 0.2$ and $\eta_{AG} = 0$ in the good state so that the price of long-term risk is smaller in the good state, whereas $\eta_{YB} = 0.2$ and $\eta_{AB} = 0.6$ so that the price of short-term risk is smaller in the bad state.

optimal investment rate. Conversely, in the good state, market risk prices are lower in levels and are downward-sloping, which both have a positive effect on investment.

7 Concluding Remarks

Over the last decade, two parallel lines of work have absorbed the attention of financial economists. In corporate finance, works have growingly acknowledged the differential impact of short-term (temporary) and long-term (permanent) shocks on optimal decision-making. In parallel, the asset pricing literature has questioned the view that equity market mostly remunerate the long-term and shown that short-term risk premia are sizable. While the second strand has path-breaking implications for discount rates used by corporations, there is no work that integrates these two lines of work. In this paper, we start filling this gap. We introduce heterogeneity in the pricing of short-term (temporary) risk and long-term (persistent) risk into a dynamic corporate finance model with financing frictions, showing that it affects the firm's balance between short-term objectives (e.g., current earnings and payouts) and long-term ones (e.g., growth through investment).

Our model shows that firms should extend the horizon of corporate policies if short-term shocks have a greater market price than long-term ones (which is consistent with the sizable short-term risk compensation supported by the equity term structure literature). Ignoring this relative pricing leads to distorted corporate policies that put too much emphasis on the short term—specifically, it leads firms to underinvest, pay out dividends too often, hold inadequate precautionary cash reserves, and favor disinvestment to costly refinancing when financial constraints tighten. Notably, whereas the horizon of corporate policies has been largely investigated by the previous literature through the lens of managerial incentives and optimal contracting, we provide a novel explanation based on the heterogeneous pricing of aggregate risk of various persistence. Our analysis is extended to allow for heterogeneous firm exposure to these risks and time variation in risk prices, consistent with the evidence.

A Appendix

A.1 Risk prices and the term structure of equity

In this Appendix, we link the relative prices of short-term and long-term risks to the slope of the term structure of equity risk premia.

In Section 3, we assume that the stochastic discount factor is described by equation (1). Additionally, we now assume that there is an equity market index in the economy. The payout of the equity market index, denoted by D_t, satisfies the following dynamics:

$$d\log D_t = (\bar{D} + D_{At})dt + dD_{Yt}, \tag{24}$$

where we assume that D_{At} follows:

$$dD_{At} = -\lambda_A D_{At}dt + s_A d\tilde{W}_t,$$

and D_{Yt} follows:

$$dD_{Yt} = -\lambda_Y D_{Yt}dt + s_Y d\tilde{B}_t.$$

The component D_{At} induces a stochastic trend and, thus, its fluctuations accumulate over time and capture permanent risk. Instead, the component D_{Yt} produces stationary fluctuations and, thus, captures transitory risk. The joint dynamics of the stochastic discount factor and the payout of the equity market are inspired by the recent asset pricing literature on the term structure of equity (e.g., Breugem et al., 2021).

We compute the term structure of equity risk premia, i.e., the instantaneous risk premium on the dividend strip as a function of maturity. The dividend strip price with maturity τ is the present value of the market dividend paid out at the horizon τ and has exponential closed form:

$$P(t,\tau) = \xi_t^{-1}\exp\left[p_0(\tau) + p_\xi(\tau)\log\xi_t + p_D(\tau)\log D_t + p_A(\tau)D_{At} + p_Y(\tau)D_{Yt}\right],$$

where the coefficients satisfy the following HJB equation:

$$\begin{aligned}
0 = {} & p_0'(\tau) + p_\xi'(\tau)\log\xi_t + p_D'(\tau)\log D_t + p_A'(\tau)D_{At} + p_Y'(\tau)D_{Yt} \\
& + p_\xi(\tau)(-r - \eta_A^2/2 - \eta_Y^2/2) + p_\xi(\tau)^2(\eta_A^2 + \eta_Y^2)/2 + p_D(\tau)(\bar{D} + D_{At} - \lambda_Y D_{Yt}) \\
& + p_D(\tau)^2 s_Y^2/2 + p_A(\tau)(-\lambda_A D_{At}) + p_A(\tau)^2 s_A^2/2 + p_Y(\tau)(-\lambda_Y D_{Yt}) + p_Y(\tau)^2 s_Y^2/2 \\
& + p_\xi(\tau)p_D(\tau)(-\eta_Y s_Y) + p_\xi(\tau)p_A(\tau)(-\eta_A s_A) + p_\xi(\tau)p_Y(\tau)(-\eta_Y s_Y) + p_D(\tau)p_Y(\tau)s_Y^2,
\end{aligned}$$

with initial conditions $p_\xi(0) = p_D(0) = 1$ and $p_A(0) = p_Y(0) = 0$. Calculations give

$$\begin{aligned}
p_0(\tau) =& (\bar{D} - r)\tau + \frac{s_A^2}{4\lambda_A^3}\left(4e^{-\lambda_A\tau} + 2\lambda_A\tau - 3 - e^{-2\lambda_A\tau}\right) \\
&+ \frac{s_Y^2}{4\lambda_Y}(1 - e^{-2\lambda_Y\tau}) + \frac{s_Y\eta_Y}{\lambda_Y}(e^{-\lambda_Y\tau} - 1), \\
p_\xi(\tau) =& 1, \\
p_D(\tau) =& 1, \\
p_A(\tau) =& \frac{1 - e^{-\lambda_A\tau}}{\lambda_A}, \\
p_Y(\tau) =& e^{-\lambda_Y\tau} - 1.
\end{aligned}$$

Thus, the dividend strip prices can be simply written as

$$P(t,\tau) = D_t \exp\left[p_0(\tau) + p_A(\tau)D_{At} + p_Y(\tau)D_{Yt}\right].$$

In turn, we derive the risk premium as a function of the horizon:

$$\begin{aligned}
rp(t,\tau) =& -\frac{1}{dt}\left\langle\frac{d\xi_t}{\xi_t}, \frac{dP(t,\tau)}{P(t,\tau))}\right\rangle = p_A(\tau)s_A\eta_A + \left[1 + p_Y(\tau)\right]s_Y\eta_Y \\
=& s_A\eta_A\frac{(1 - e^{-\lambda_A\tau})}{\lambda_A} + s_Y\eta_Y e^{-\lambda_Y\tau}.
\end{aligned} \tag{25}$$

The first term on the right hand side of equation (25) induces an upward-sloping effect with the horizon, whereas the second term induces a downward-sloping effect. As a result, the slope of the term structure of equity can be either positive or negative. The larger (smaller) the market price of long-term risk relative to the market price of short-term risk, the stronger the upward-sloping (downward-sloping) effect. By calculations, the slope of the risk premium is given by:

$$\partial_\tau rp(t,\tau) = e^{-\lambda_A\tau}s_A\eta_A - e^{-\lambda_Y\tau}\lambda_Y s_Y\eta_Y. \tag{26}$$

Notably, the slope depends on the market prices of risk and the exposure of the market dividend (i.e., the payout of the equity index) to the risks s_A and s_Y (scaled by the rate at which these shocks dissipate—i.e., the speed of mean reversion). In our example, the sign of the slope only depends on the sign of $\eta_A - \eta_Y$ when $s_A/s_Y = \lambda_Y$ and $\lambda_A = \lambda_Y$, otherwise both the prices of risks and the exposures to risks affect its sign.[32] The relevance of both prices of risk and exposures is consistent with our firm-level analysis, where the impact

[32] In general equilibrium, η_A and η_Y are endogenous and naturally increase with s_A and s_Y respectively (see, e.g., Breugem et al., 2021). It turns out that the relative price of the two risks is a first order determinant of the slope of the equity risk premium term structure.

of relative risk pricing depends on the firm's exposure to such risks.

A.2 Proof of the results in Section 4.1

Denoting by dW_t the risk-neutral counterpart of $d\hat{W}_t$, standard arguments yield the risk-neutral dynamics of the firm's productive assets, given by the following equation:

$$dA_t = (\mu + l_t - \sigma_A \rho_A \eta_L) A_t dt + \sigma_A A_t dW_t.$$

Similarly, we denote the risk-neutral counterpart of $d\hat{B}_t$ by dB_t and obtain the risk-neutral dynamics of the firm's operating revenues:

$$dY_t = (\alpha - \sigma_Y \rho_Y \eta_S) dt + \sigma_Y dB_t.$$

In the case with no financing frictions, the firm keeps no cash. Firm value, denoted by $V^*(a)$ in this environment, satisfies the following HJB equation:

$$rV^*(a) = \max_{l^*} \left(\mu + l^* - \sigma_A \rho_A \eta_L\right) a V^*_a(a) + \frac{1}{2} a^2 \sigma_A^2 V_{aa}(a) + \left(\alpha - \sigma_Y \rho_Y \eta_S - l - \frac{\kappa l^2}{2}\right) a. \tag{27}$$

Conjecture that $V^*(a) = av^*$, where v^* represents firm value scaled by productive assets. Substituting this expression into equation (27) yields

$$rv^* = \max_{l^*} \left(\mu + l^* - \sigma_A \rho_A \eta_L\right) v^* + \left(\alpha - \sigma_Y \rho_Y \eta_S - l^* - \frac{\kappa (l^*)^2}{2}\right). \tag{28}$$

Maximizing this equation with respect to l^* gives the optimal investment rate reported in equation (8) in the main text. Substituting equation (8) into the above equation gives an expression for scaled firm value in the absence of financing frictions. We next prove Proposition 1 and Proposition 2, which relate the firm's optimal investment rate to the slope of the term structure of risk prices.

Proof of Proposition 1 This proposition focuses on the case in which the firm is symmetrically exposed to long-term and short-term aggregate shocks, i.e., $\sigma_A \rho_A = \sigma_Y \rho_Y \equiv \sigma\rho$ (in the rest of this proof, we use $\sigma\rho$ to ease the notation). To focus on the relative magnitude of η_S versus η_L, we assume that the sum of the market prices of risk is constant and denote it by $\eta \equiv \eta_S + \eta_L$. Namely, we assume that the market price of long-term and short-term shocks respectively satisfy $\eta_L \equiv \eta\epsilon$ and $\eta_S \equiv \eta(1-\epsilon)$, with $\epsilon \in [0, 1]$. If $\epsilon = \frac{1}{2}$, the term structure of market risk prices is flat. If $\epsilon \in \left[0, \frac{1}{2}\right)$, the term structure is downward-sloping. If, instead, $\epsilon \in \left(\frac{1}{2}, 1\right]$, the term structure is upward-sloping. Using this notation, equation (8) boils down to:

$$l^* = (r - \mu + \sigma\rho\eta\epsilon) - \sqrt{(r - \mu + \sigma\rho\eta\epsilon)^2 - 2\left(\alpha - \sigma\rho\eta(1-\epsilon) - r + \mu - \sigma\rho\eta\epsilon\right)/\kappa}. \quad (29)$$

Differentiating with respect to ϵ gives:

$$\frac{\partial l^*}{\partial \epsilon} = \eta\rho\sigma\left(1 - \frac{r - \mu + \sigma\rho\eta\epsilon}{\sqrt{(r - \mu + \sigma\rho\eta\epsilon)^2 - 2\left(\alpha - \sigma\rho\eta - r + \mu\right)/\kappa}}\right). \quad (30)$$

The second term in the square root of this equation is positive if equation (9) in the main text holds (guaranteeing that the investment rate is positive when the firm faces no financing frictions). Notably, if this term is positive, then equation (30) is negative. That is, if ϵ increases, investment decreases. Thus, the firm invests more if the term structure is downward sloping than if it is flat or, even more so, if it is upward sloping. The claim in Proposition 1 follows. $\diamond$

Proof of Proposition 2 This proposition focuses on the case in which the firm is asymmetrically exposed to long-term and short-term aggregate shocks, i.e., $\sigma_A\rho_A \neq \sigma_Y\rho_Y$. As in the proof of Proposition 1, we use the following notation: $\eta_L \equiv \eta\epsilon$ and $\eta_S \equiv \eta(1-\epsilon)$, with $\epsilon \in [0, 1]$. The first derivative of the optimal investment rate (equation (8)) with respect to ϵ satisfies:

$$\begin{aligned}\frac{\partial l^*}{\partial \epsilon} =& \eta\rho_A\sigma_A\left(1 - \frac{r - \mu + \sigma_A\rho_A\eta\epsilon}{\sqrt{(r - \mu + \sigma_A\rho_A\eta\epsilon)^2 - 2\left(\alpha - \sigma_Y\rho_Y\eta(1-\epsilon) - r + \mu - \sigma_A\rho_A\eta\epsilon\right)/\kappa}}\right) \\ & - \frac{\eta}{\kappa}\frac{(\rho_A\sigma_A - \rho_Y\sigma_Y)}{\sqrt{(r - \mu + \sigma_A\rho_A\eta\epsilon)^2 - 2\left(\alpha - \sigma_Y\rho_Y\eta(1-\epsilon) - r + \mu - \sigma_A\rho_A\eta\epsilon\right)/\kappa}}. \end{aligned} \quad (31)$$

The first term on the right-hand side is negative, being analogous to the term in equation (30). It then follows that if $\rho_A\sigma_A \geq \rho_Y\sigma_Y$—i.e., if the firm is relatively more exposed to aggregate long-term shocks than to short-term aggregate shocks—then the result in Proposition 1 continues to hold, and the optimal investment rate decreases with the slope of the term structure of risk prices.

Consider now the case in which the inequality $\rho_A\sigma_A \geq \rho_Y\sigma_Y$ does not hold. Equation (31) can be rewritten as follows:

$$\frac{\partial l^*}{\partial \epsilon} = \eta\rho_A\sigma_A\left(1 - \frac{r - \mu + \sigma_A\rho_A\eta\epsilon + 1/\kappa - \rho_Y\sigma_Y/(\kappa\rho_A\sigma_A)}{\sqrt{(r - \mu + \sigma_A\rho_A\eta\epsilon + 1/\kappa)^2 - 2\left(\alpha - \sigma_Y\rho_Y\eta(1-\epsilon) + 1/(2\kappa)\right)/\kappa}}\right). \quad (32)$$

If the second term in parenthesis is smaller than one, then $\frac{\partial l^*}{\partial \epsilon} > 0$. By calculation, we find that this is the case if the following inequality holds:

$$\rho_Y \sigma_Y \geq \rho_A \sigma_A \left[1 + \kappa(r - \mu + \eta \rho_A \sigma_A)\right] - \sqrt{\rho_A^2 \sigma_A^2 \left[(1 + \kappa(r - \mu + \eta \rho_A \sigma_A))^2 - 1 - 2\alpha\kappa\right]}.$$

That is, when this is the case, then $\frac{\partial l^*}{\partial \epsilon} > 0$. Note that this inequality is more likely to hold if α is smaller (i.e., if the firm is less profitable) or if μ is more negative (i.e., assets depreciate more quickly). ⋄

A.3 Proof of the results in Section 4.2

We now derive firm value in the presence of financing frictions. Equation (12) gives:

$$V_m(a,m) = v'(c) \qquad V_{mm}(a,m) = \frac{v''(c)}{a}$$

$$V_a(a,m) = v(c) - cv'(c) \qquad V_{aa}(a,m) = \frac{c^2}{a} v''(c)$$

Plugging these expressions back into equation (11) yields the scaled HJB equation (see equation (13)). Differentiating equation (13) with respect to the investment rate gives the following first-order condition:

$$[v(c) - v'(c)c] - v'(c) - \kappa l v'(c) = 0.$$

Solving for this equation gives the expression for $l(c)$ reported in equation (14). Substituting $l(c)$ back into the HJB equation yields:

$$\begin{aligned} rv(c) = &\left[\mu + \frac{1}{\kappa}\left(\frac{v(c)}{v'(c)} - 1 - c\right) - \sigma_A \rho_A \eta_L\right] [v(c) - v'(c)c] + \frac{v''(c)}{2}\left(\sigma_A^2 c^2 + \sigma_Y^2\right) \\ &+ \left[\alpha - \sigma_Y \rho_Y \eta_S - \frac{1}{\kappa}\left(\frac{v(c)}{v'(c)} - 1 - c\right) - \frac{1}{2\kappa}\left(\frac{v(c)}{v'(c)} - 1 - c\right)^2 + (r - \lambda)c\right] v'(c) \end{aligned}$$

and, by calculations, equation (15) follows. Scaled firm value $v(c)$ is then solved subject to the boundary conditions reported in Section 4.2, which are standard and can be derived using arguments similar to Décamps et al. (2017).

Consider now firm value at the target payout threshold, C^*. Using conditions (16) and (17) into equation (15) gives:

$$(r - \mu + \sigma_A \rho_A \eta_L)\, v(C^*) = \alpha - \sigma_Y \rho_Y \eta_S + (r - \lambda - \mu + \sigma_A \rho_A \eta_L) C^* + \frac{1}{2\kappa}\left[v(C^*) - C^* - 1\right]^2.$$

As in Malamud and Zucchi (2019), define $w \equiv v(C^*) - C^*$ to obtain an expression for

$v(C^*)$ as a function of C^*. Substituting in the equation above, we get

$$(r - \mu + \sigma_A \rho_A \eta_L)\, w = \alpha - \sigma_Y \rho_Y \eta_S - \lambda C^* + \frac{1}{2\kappa}(w^2 - 2w + 1),$$

so we need to solve

$$\frac{1}{2\kappa} w^2 - \left(r - \mu + \sigma_A \rho_A \eta_L + \frac{1}{\kappa}\right) w + \alpha - \sigma_Y \rho_Y \eta_S - \lambda C^* + \frac{1}{2\kappa} = 0$$

which gives[33]

$$w = \kappa \left[r - \mu + \sigma_A \rho_A \eta_L + \frac{1}{\kappa} - \sqrt{\left(r - \mu + \sigma_A \rho_A \eta_L + \frac{1}{\kappa}\right)^2 - \frac{2}{\kappa}\left(\alpha - \sigma_Y \rho_Y \eta_S - \lambda C^* + \frac{1}{2\kappa}\right)} \right].$$

and, thus, $v(C^*) = w + C^*$.

A.4 Proof of the results in Section 6

In this section, we derive firm value when the term structure varies with the business cycle. Standard arguments imply that, in each state $i = G, B$ (with $i \neq j$), firm value satisfies the following HJB equation:

$$\begin{aligned} rV_i(a,m) = \max_{l_i} (\mu + l_i - \sigma_A \rho_A \eta_{Ai}) a V_{ia} + \left[\left(\alpha - \sigma_Y \rho_Y \eta_{Yi} - l_i - \frac{\kappa}{2} l_i^2\right) a + (r - \lambda) m\right] V_{im} \\ + \frac{1}{2} a^2 \left(\sigma_A^2 V_{iaa} + \sigma_Y^2 V_{imm}\right) + \pi_i \left(V_j(a,m) - V_i(a,m)\right). \end{aligned} \tag{33}$$

Let us define the scaled value function in each state $v_i(c)$, with $V_i(a,m) \equiv a v_i(c)$. Substituting this into equation (33) and dividing by a, we get

$$\begin{aligned} rv_i(c) = \max_{l_i} \; (\mu + l_i - \sigma_A \rho_A \eta_{Ai}) \left[v_i(c) - v_i'(c) c\right] + \left[\alpha - \sigma_Y \rho_Y \eta_{Yi} - l_i - \frac{\kappa l_i^2}{2} + (r - \lambda) c\right] v_i'(c) \\ + \frac{v_i''(c)}{2} \left(\sigma_A^2 c^2 + \sigma_Y^2\right) + \pi_i \left(v_j(c) - v_i(c)\right). \end{aligned} \tag{34}$$

Differentiating the above equation with respect to l_i gives the optimal investment rate reported in equation (23). Plugging $l_i(c)$ back into equation (34) yields the following

[33] We choose the solution that is continuous in the limit in which the second term in the square bracket tends to zero.

system of ordinary differential equations:

$$(r-\mu+\sigma_A\rho_A\eta_{Ai})\,v_i(c) = [\alpha-\sigma_Y\rho_Y\eta_{Yi}+(r-\lambda-\mu+\sigma_A\rho_A\eta_{Ai})c]\,v_i'(c) + \frac{v_i''(c)}{2}\left(\sigma_A^2c^2+\sigma_Y^2\right) + \frac{1}{2\kappa}\frac{[v_i(c)-(1+c)v_i'(c)]^2}{v_i'(c)} + \pi_i\,[v_j(c)-v_i(c)]\,. \tag{35}$$

This equation is subject to boundary conditions that are similar to those in the one-state model in Section 4. In each state, there exists a target payout threshold C_i^* above which all excess cash is paid out to investors, i.e., $v_i'(C_i^*)=1$. This target level C_i^* satisfies the super-contact condition in each state, $v_i''(C_i^*)=0$. Suppose that the target cash level is greater in the state i, $C_i^*>C_j^*$. Then, if the state switches from i to j while the cash-to-asset ratio is in $c\in[C_j^*,C_i^*]$, the firm pays a lumpy payout equal to $c-C_j^*$, meaning that: $v(C)=v(C_j^*)+c-C_j^* \quad c\in[C_j^*,C_i^*]$. Furthermore, when the cash ratio decreases sufficiently, the firm raises new equity.[34] Denote by $\underline{C}_i\geq 0$ the issuance boundary in state i. For any $c\in[0,\underline{C}_i]$, firm value satisfies the following boundary equation:[35]

$$v_i(c)=v_i(C_{*i})-(1+p)(C_{*i}-c)-f \tag{36}$$

where C_{*i} denotes the post-issuance cash ratio that satisfies the following boundary condition $v_i'(C_{*i})=1+p$. If the firm raise funds before the cash buffer is depleted in one of the two states, it must be that $v_i'(\underline{C}_i)=1+p$ in that state. Otherwise, the firm raise fresh financing when it reaches zero (which implies that $v_i'(0)>1+p$, meaning that it is optimal to delay equity financing up to $c=0$).

In each state, at the target cash level C_i^*, firm value satisfies

$$(r-\mu+\sigma_A\rho_A\eta_{Ai})\,v_i(C_i^*) = [\alpha-\sigma_Y\rho_Y\eta_{Yi}+(r-\lambda-\mu+\sigma_A\rho_A\eta_{Ai})C_i^*] + \frac{1}{2\kappa}\,[v_i(C_i^*)-(1+C_i^*)]^2+\pi_i\,[v_j(C_i^*)-v_i(C_i^*)]\,,$$

which boils down to

$$(r-\mu+\sigma_A\rho_A\eta_{Ai}+\pi_i)\,w_i = [\alpha-\sigma_Y\rho_Y\eta_{Yi}-(\pi_i+\lambda)C_i^*]+\frac{1}{2\kappa}\left[w_i^2-2w_i+1\right]+\pi_i v_j(C_i^*).$$

[34] For simplicity, we focus on the case in which liquidating is never preferred to raising fresh financing. Equivalently, the left-hand side of equation (36) is always greater than the recovery rate of assets, ϕ.

[35] Because the firm faces the same issuance cost in the two states, heuristic arguments imply that it should be optimal for the firm to raise funds when cash reserves are depleted. However, we cast the problem in the general case in which we allow the firm to raise financing for a positive cash ratio. As we show in the main text, the firm indeed issues new equity when the cash buffer is depleted.

where we have defined $w_i \equiv v_i(C_i^*) - C_i^*$. By calculations, we get

$$w_i = \kappa \left[B_i - \sqrt{B_i^2 - \frac{2}{\kappa}\left(\alpha - \sigma_Y \rho_Y \eta_{Yi} - (\pi_i + \lambda)C_i^* + \frac{1}{2\kappa} + \pi_i v_j(C_i^*)\right)} \right]$$

where we have defined $B_i = r - \mu + \sigma_A \rho_A \eta_{Ai} + \pi_i + \frac{1}{\kappa}$.

A.5 The model with short-term investment

In this section, we extend our baseline model by allowing the firm to engage in short-term investment that can enhance the firm's cash flow profitability. Namely, we assume that cash flows are governed by the following dynamics:

$$dX_t = A_t d\mathcal{Y}_t = A_t \left[\vartheta(1 + s_t)dt + \sigma_Y d\hat{B}_t \right] \tag{37}$$

$$= \vartheta(1 + s_t)A_t dt + \sigma_Y A_t \left(\rho_Y d\tilde{B}_t + \sqrt{1 - \rho_Y^2} d\tilde{B}_t^Y \right). \tag{38}$$

The interpretation of this equation is similar to (5), with the only difference that the manager can boost the average cash flow by s_t by incurring a monetary cost that is proportional to assets, $A_t g_s(s)$, with[36]

$$g_s(s) = \frac{\kappa_s s^2}{2}. \tag{39}$$

where κ_s is a positive constant. That is, this investment does not entail an increase in the firm's assets (its capital stock) but it increases the firm's profitability in the short-term. Alternatively, this cost can be interpreted as effort, in which case the associated quadratic cost is not necessarily monetary. Under these assumptions, the firm problem becomes

$$V(A, M) = \sup_{U,H,l,s,\tau} E^Q \left[\int_0^\tau e^{-rt} (dU_t - dH_t) + e^{-r\tau} \ell_\tau \right],$$

i.e., there is an additional endogenous choice related to short-term investment.

Following similar argument as in the main version of the model, firm value satisfies the following Hamilton-Jacobi-Bellman (HJB) equation in the cash retention region $[0, M^*]$:

$$\max_{l,s} \; (l + \mu - \sigma_A \rho_A \eta_L) a V_a + \left[\left(\vartheta(1 + s) - \sigma_Y \rho_Y \eta_S - l - \frac{\kappa}{2} l^2 - \frac{\kappa_s}{2} s^2 \right) a + (r - \lambda) m \right] V_m$$
$$+ \frac{1}{2} a^2 \left(\sigma_A^2 V_{aa} + \sigma_Y^2 V_{mm} \right) = r V(a, m) \tag{40}$$

[36]This specification implies that it is increasingly more costly to improve the profitability of cash flows when the firm is larger.

which admits an interpretation similar to equation (11). Substituting equation (12) into equation (11) and dividing by a gives:

$$\max_{l,s}\ (\mu + l - \sigma_A\rho_A\eta_L)\left[v(c) - v'(c)c\right] + \left[\vartheta(1+s) - \sigma_Y\rho_Y\eta_S - l - \frac{\kappa l^2}{2} - \frac{\kappa_s s^2}{2} + (r-\lambda)c\right]v'(c) + \frac{v''(c)}{2}\left(\sigma_A^2 c^2 + \sigma_Y^2\right) = rv(c) \tag{41}$$

Differentiating the above equation with respect to l gives the optimal firm's investment rate in equation (14). In turn, the firm's optimal short-term investment is given by

$$s = \frac{\vartheta}{\kappa_s}. \tag{42}$$

Plugging the optimal short- and long-term investment rate back into equation (41) yields:

$$(r - \mu + \sigma_A\rho_A\eta_L)\,v(c) = \left[\vartheta\left(1 + \frac{\vartheta}{2\kappa_s}\right) - \sigma_Y\rho_Y\eta_S + (r - \lambda - \mu + \sigma_A\rho_A\eta_L)c\right]v'(c) + \frac{v''(c)}{2}\left(\sigma_A^2 c^2 + \sigma_Y^2\right) + \frac{1}{2\kappa}\frac{\left[v(c) - (1+c)v'(c)\right]^2}{v'(c)}$$

which is solved subject to the same boundary conditions as in the baseline model.

Figure 10 shows our main result. We use the parameterization in Table 1 and, in addition, assume that $\kappa_s = \kappa_l$ and $\vartheta = 0.194$, so that the resulting cash flow drift stemming from the optimization over short-term investment is comparable to its value in our baseline parameterization.[37] Figure 10 shows that the firm focuses increasingly more on long-term investment as cash reserves increase and financial constraints are relaxed. Moreover, and crucially, the balance between short- and long-term investment shifts as the slope of the term structure changes. Compared with the case in which the term structure is flat, the firm tilts its focus towards long-term investment when the term structure is decreasing—i.e., the ratio of long-short to total investment rises. The opposite is true when the term structure is increasing, in which case the firms shifts its focus to short-term investment. These results are consistent with the firm extending (shortening) its horizon when the term structure is decreasing (increasing). If the term structure is flat, the ratio of long to total investment goes from 28% when the cash reserves are almost depleted to 57% when the firm holds its target cash level. If the term structure is increasing, this ratio goes from 21% when the cash reserves are close to zero to 54% when the firm holds its target cash level. If the term structure is decreasing, the ratio goes from 35% to 59%.

[37] I.e., $\vartheta + \frac{\vartheta^2}{2\kappa_s} = 0.2006$ which is the value of the cash flow drift α in the baseline version of our model.

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Table 1: Baseline parameters.

Parameter	Description	Value
r	Risk-free rate	0.045
λ	Opportunity cost of cash	0.01
μ	Growth (depreciation) rate of assets	-0.105
κ	Adjustment cost coefficient	2.85
α	Mean cash flow rate	0.20
σ_A	Volatility of persistent shocks	{0.12,0.18}
σ_Y	Volatility of transitory shocks	0.12
ϕ	Recovery rate in liquidation	0.90
p	Proportional financing cost	0.06
f	Fixed financing cost	0.002
ρ_A	Firm's correlation with persistent aggregate shocks	0.40
ρ_Y	Firm's correlation with transitory aggregate shocks	0.40
$\eta_S + \eta_L$	Sum of the market price of persistent and transitory shocks	0.40

Table 2: Refinancing, payouts, disinvestment, and firm value. The table reports the optimal issuance size C_*, the target cash level C^*, the threshold C_0 below which the firm disinvests, and firm value at $c = 0$ ($v(0)$) as a function of the gap between the market price of long-term and short-term shocks (by keeping the sum of the two risk prices constant), which in turn determines whether the slope of the term structure of market risk prices is increasing (denoted as I), flat (denoted as F), or decreasing (denoted as D). The top panel focuses on the case $\sigma_A = \sigma_Y = 0.12$, the middle panel assumes that $f = 0.01$, and the bottom panel focuses on the case $\sigma_A = 0.18 > \sigma_Y = 0.12$.

Slope	$\eta_L - \eta_S$	C_*	C^*	C_0	$v(0)$
Refinancing					
$\sigma_Y = \sigma_A = 0.12$					
I	0.40	0.045	0.205	n.a.	1.213
I	0.20	0.046	0.213	n.a.	1.225
F	0.00	0.048	0.221	n.a.	1.238
D	-0.20	0.050	0.232	n.a.	1.254
D	-0.40	0.053	0.245	n.a.	1.274
$f = 0.01,\ \sigma_Y = \sigma_A = 0.12$					
I	0.40	0.081	0.240	0.030	1.199
I	0.20	0.083	0.247	0.027	1.210
F	0.00	0.087	0.257	0.025	1.223
D	-0.20	0.092	0.271	0.022	1.237
D	-0.40	0.105	0.293	0.020	1.254
$\sigma_A = 0.18 > \sigma_Y = 0.12$					
I	0.40	0.040	0.183	0.016	1.117
I	0.20	0.042	0.191	0.008	1.143
F	0.00	0.044	0.203	n.a.	1.174
D	-0.20	0.047	0.219	n.a.	1.214
D	-0.40	0.053	0.248	n.a.	1.273

Table 3: POLICY DISTORTIONS. The table reports the distortions associated with ignoring the slope of the term structure of risk prices—i.e., assuming it is flat when actually is increasing (denoted as I) or decreasing (denoted as D)—on firm's investment (gauged at the target cash level, $l(C^*)$), target cash (C^*), and the size of equity issuance (C_*). The top panels focus on the refinancing case, whereas the bottom panels focus on the liquidation case (for both $\sigma_A = \sigma_Y = 0.12$ and $\sigma_A = 0.18 > \sigma_Y = 0.12$).

	$\eta_L - \eta_S$	$l(C^*)$	C^*	C_*
Refinancing				
$\sigma_Y = \sigma_A = 0.12$				
I	0.40	11.40%	7.61%	7.39%
I	0.30	8.65%	5.84%	5.68%
I	0.20	5.84%	4.00%	3.88%
I	0.10	2.96%	2.05%	1.99%
D	-0.10	-3.05%	-2.18%	-2.12%
D	-0.20	-6.22%	-4.52%	-4.38%
D	-0.30	-9.53%	-7.06%	-6.80%
D	-0.40	-13.03%	-9.85%	-9.44%
$\sigma_A = 0.18 > \sigma_Y = 0.12$				
I	0.40	46.58%	10.80%	10.04%
I	0.30	33.22%	8.43%	7.86%
I	0.20	21.15%	5.89%	5.58%
I	0.10	10.14%	3.15%	3.23%
D	-0.10	-9.47%	-3.47%	-3.27%
D	-0.20	-18.43%	-7.46%	-7.06%
D	-0.30	-27.11%	-12.23%	-11.59%
D	-0.40	-35.82%	-18.26%	-17.18%

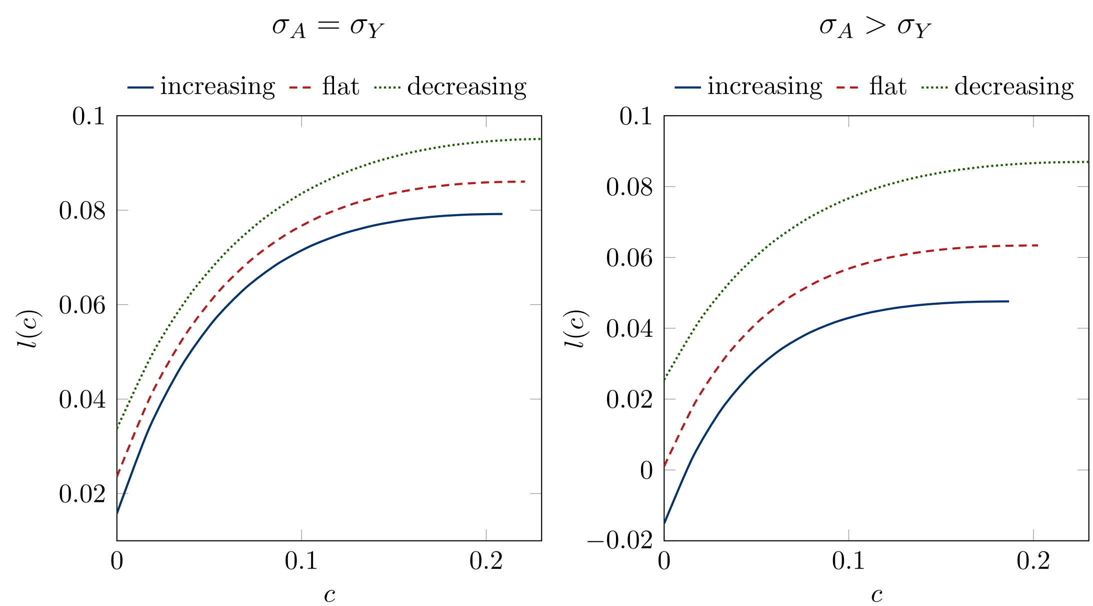

Figure 1: Optimal investment rate. The figure shows the optimal investment rate as a function of the cash ratio $c \in [0, C^*]$ when varying the slope of the term structure of market risk prices. The increasing case features $\eta_S = 0.05 < \eta_L = 0.35$, the flat case features $\eta_S = \eta_L = 0.2$, and the decreasing case features $\eta_S = 0.35 > \eta_L = 0.05$. The left panel focuses on the case $\sigma_A = \sigma_Y = 0.12$, whereas the right panel assumes $\sigma_A = 0.18 > \sigma_Y = 0.12$.

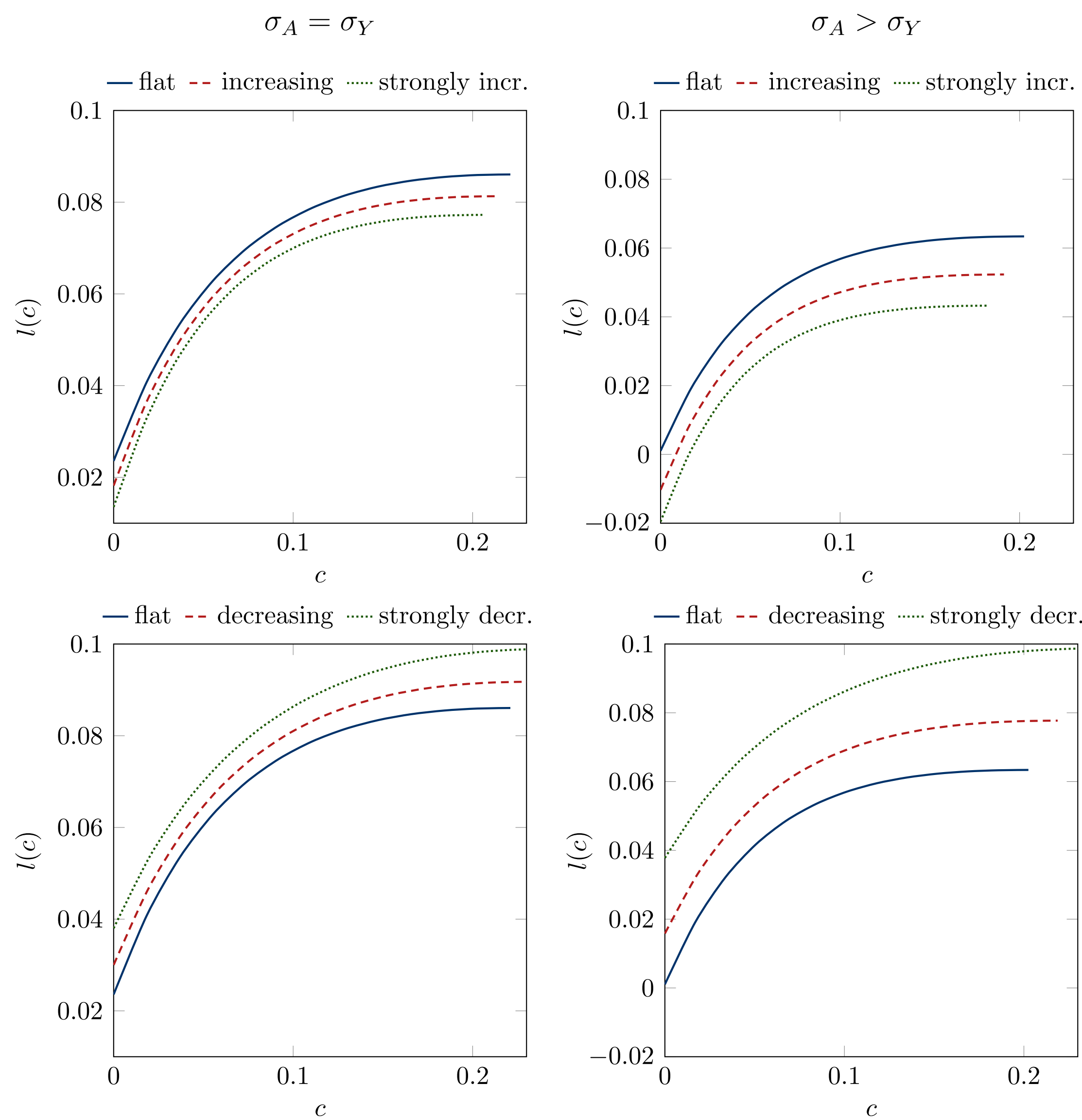

Figure 2: Varying the steepness of the slope. The top panel shows the firm's optimal investment rate as a function of the cash ratio $c \in [0, C^*]$ when the term structure of risk prices is flat (solid line) and increasing (dashed and dotted lines). The bottom panel shows firm value and investment rate when the term structure is flat (solid line) and decreasing (dashed and dotted lines). The left panel depicts the case $\sigma_A = \sigma_Y$, whereas the right panel depicts the case $\sigma_A > \sigma_Y$.

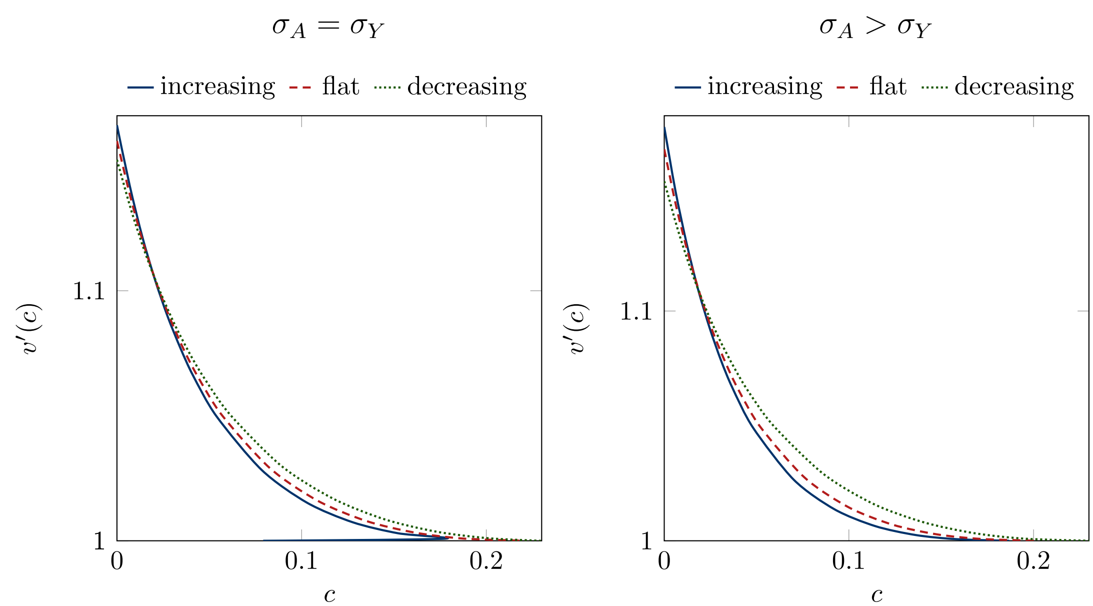

Figure 3: The value of cash. The figure shows the marginal value of cash as a function of the cash ratio $c \in [0, C^*]$ when varying the slope of the term structure of market risk prices. The increasing case features $\eta_S = 0.05 < \eta_L = 0.35$, the flat case features $\eta_S = \eta_L = 0.2$, and the decreasing case features $\eta_S = 0.35 > \eta_L = 0.05$. The left panel focuses on the case $\sigma_A = \sigma_Y = 0.12$, whereas the right panel assumes $\sigma_A = 0.18 > \sigma_Y = 0.12$.

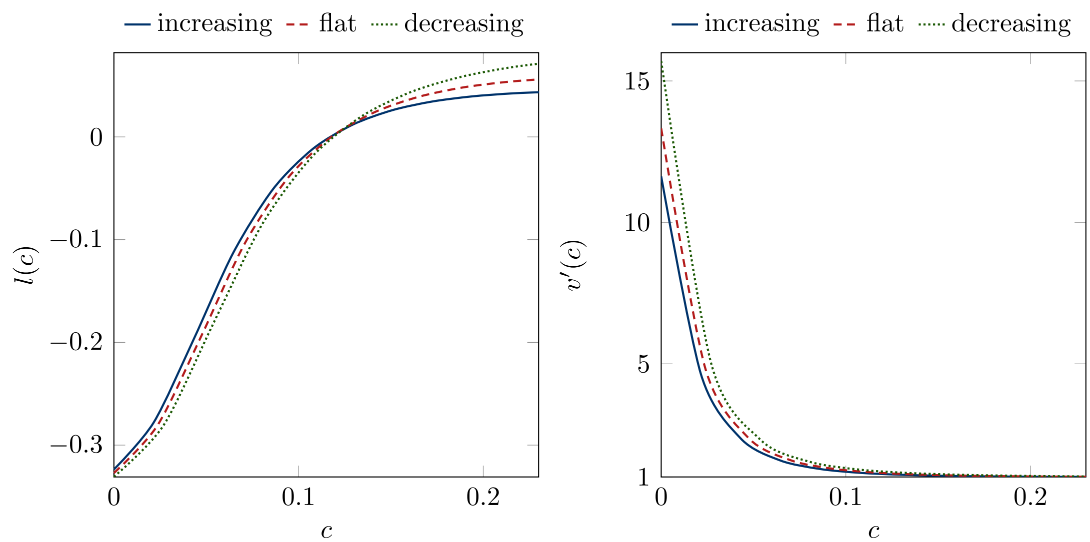

Figure 4: Investment and value of cash with liquidation. The figure shows the firm's optimal investment rate $l(c)$ (left panel) and the marginal value of cash $v'(c)$ (right panel) as a function of the cash ratio $c \in [0, C^*]$ when varying the slope of the term structure of market risk prices. The increasing case features $\eta_S = 0.05 < \eta_L = 0.35$, the flat case features $\eta_S = \eta_L = 0.2$, and the decreasing case features $\eta_S = 0.35 > \eta_L = 0.05$. We consider the case $\sigma_A = 0.18 > \sigma_Y = 0.12$.

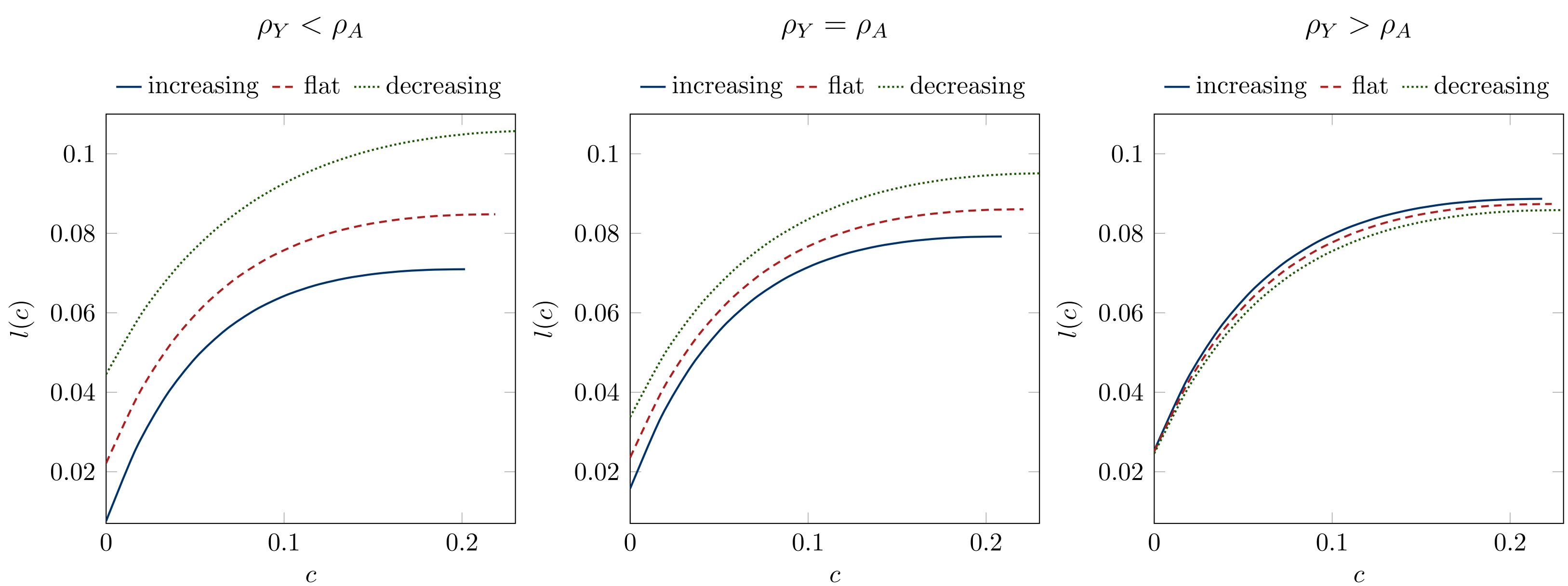

Figure 5: ASYMMETRIC EXPOSURE TO SHORT-TERM AND LONG-TERM SHOCKS. The figure represents the optimal investment rate as a function of the cash ratio $c \in [0, C^*]$. The left panels represent the case in which $\rho_Y = 0.35 < \rho_A = 0.45$, the middle panels represent the case in which $\rho_Y = \rho_A = 0.4$ (as in the baseline), and the right panels represent the case in which $\rho_Y = 0.45 > \rho_A = 0.35$. To ease comparison and single out the effect of different correlations, we focus on the case $\sigma_A = \sigma_Y = 0.12$.

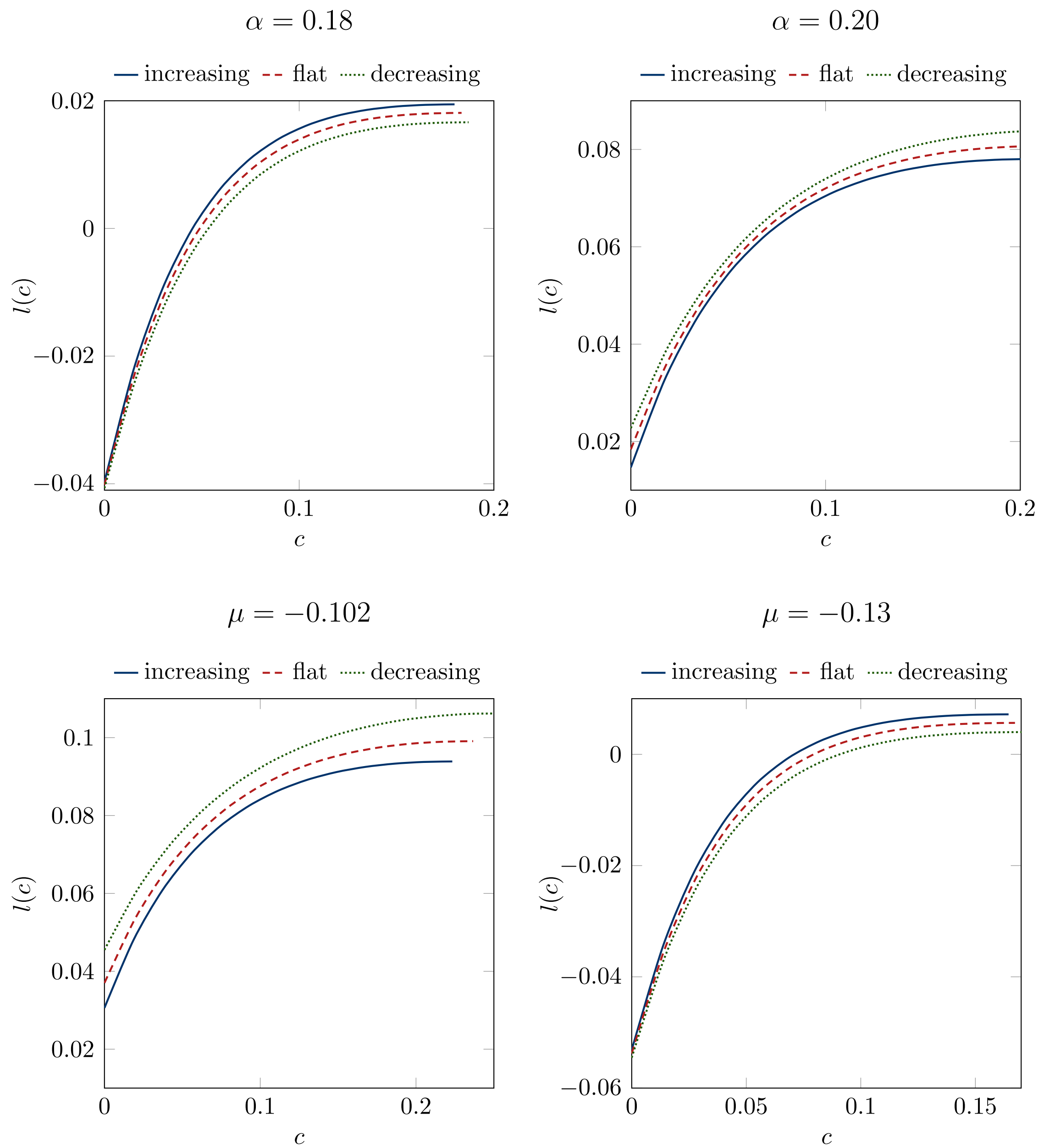

Figure 6: EXPOSURE TO SHORT-TERM SHOCKS AND FIRM CHARACTERISTICS. The figure represents the optimal investment rate as a function of the cash ratio $c \in [0, C^*]$. We assume that $\rho_Y = 0.45$ and $\rho_A = 0.4$ and $\sigma_Y = \sigma_A = 0.12$, so that $\sigma_Y \rho_Y > \sigma_A \rho_A$. In the top panel, we vary firm profitability α, whereas in the bottom panel we vary the depreciation rate of assets μ.

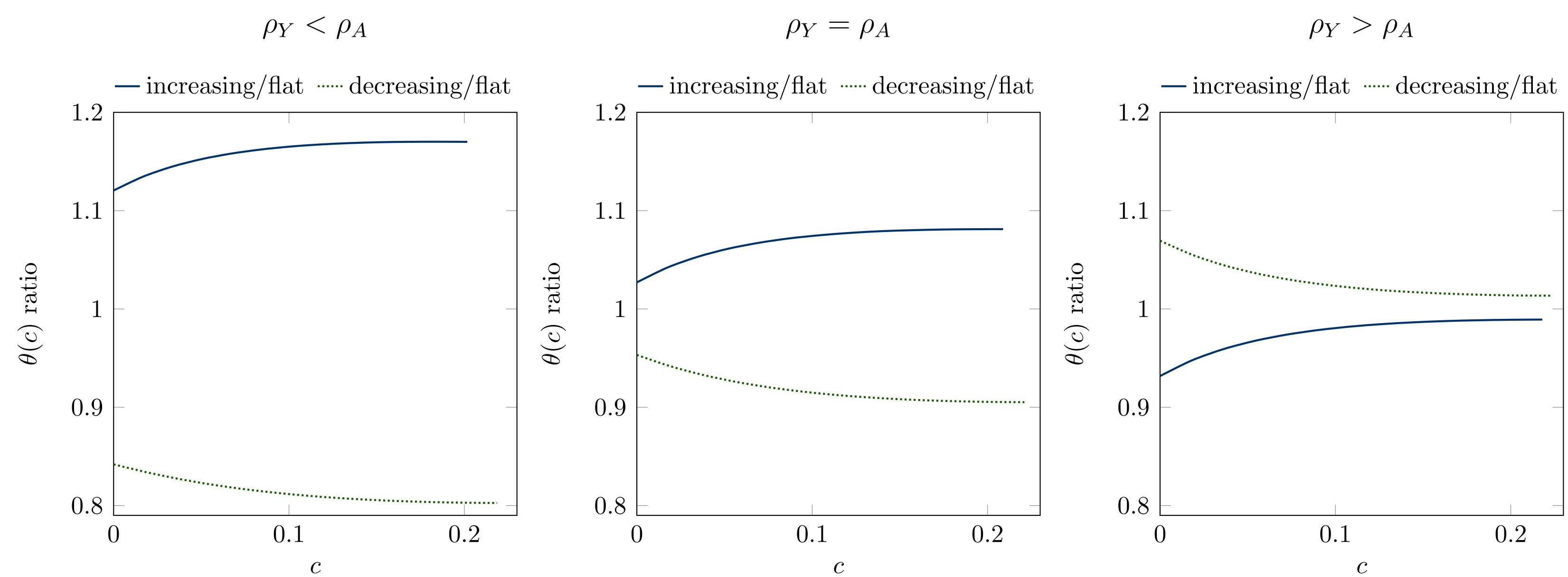

Figure 7: THE FIRM RISK PREMIUM. The figure shows the ratio of the firm's risk premium in the sloped cases (increasing and decreasing) over the flat case as a function of the firm's cash ratio $c \in [0, C^*]$ when $\rho_Y = 0.35 < \rho_A = 0.45$ (left panel), when $\rho_Y = \rho_A = 0.4$ (middle panel, as in the baseline environment), and when $\rho_Y = 0.45 > \rho_A = 0.35$ (right panel). To ease the comparison and single out the effect of different correlations, we focus on the case $\sigma_A = \sigma_Y = 0.12$.

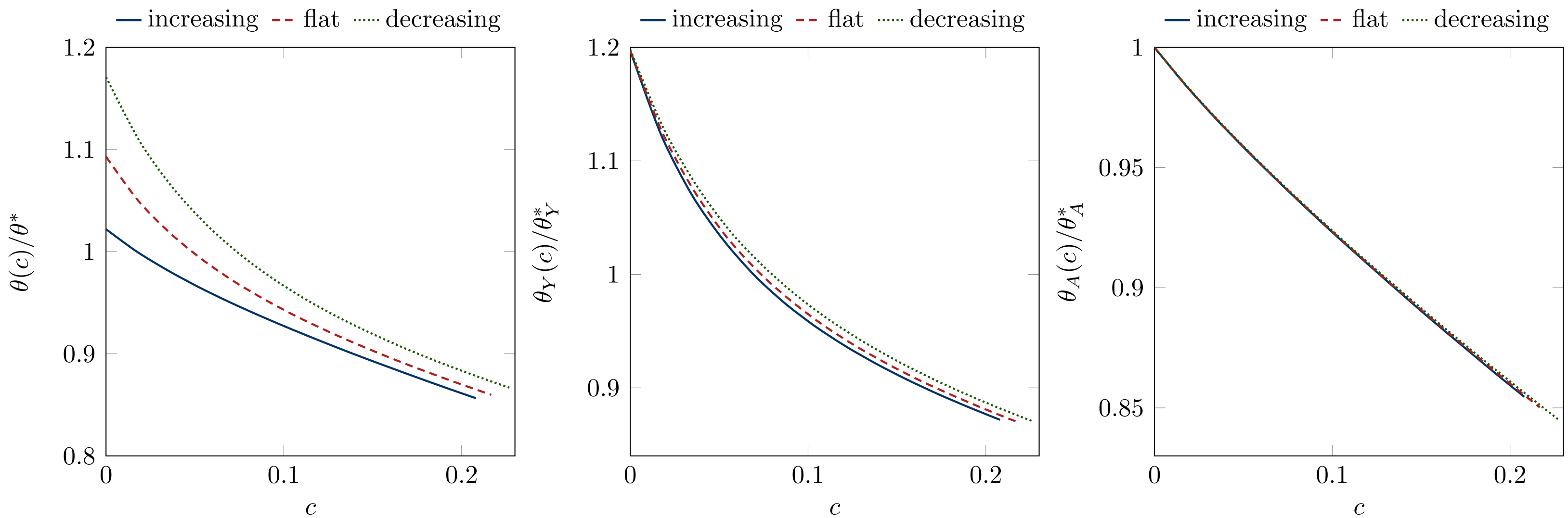

Figure 8: THE FIRM RISK PREMIUM AND FINANCING FRICTIONS. The figure shows the ratio of the firm's risk premium and its components in the presence ($\theta(c)$, $\theta_A(c)$, and $\theta_Y(c)$) and in the absence (θ^*, θ_A^*, and θ_Y^*) of financing frictions as a function of the cash ratio $c \in [0, C^*]$ and when varying the slope of the term structure of risk prices. The increasing case features $\eta_S = 0.05 < \eta_L = 0.35$, the flat case features $\eta_S = \eta_L = 0.2$, and the decreasing case features $\eta_S = 0.35 > \eta_L = 0.05$.

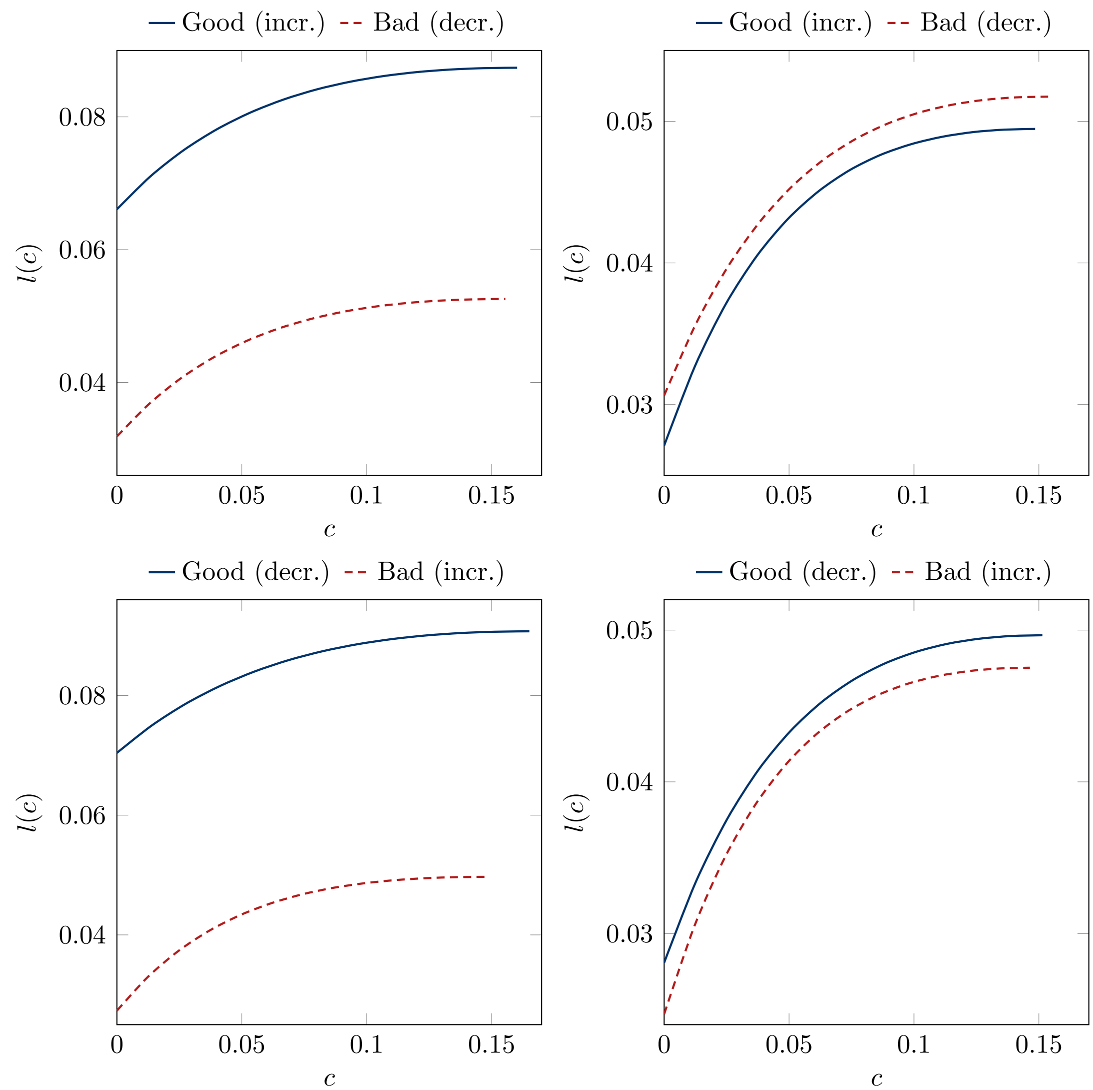

Figure 9: TIME-VARIATION IN RISK PRICES. The top panel represent the optimal investment rate as a function of the cash ratio $c \in [0, C_i^*]$ when the slope of the term structure is procyclical. In the left panel, we set $\eta_{YG} < \eta_{AG} = \eta_{AB} < \eta_{YB}$, whereas in the right panel we continue to assume that the slope is procyclical but additionally impose $\eta_{YG} + \eta_{AG} = \eta_{YB} + \eta_{AB} = 0.6$. The bottom panel represent the case in which the term structure is countercyclical. In the left panel, we set $\eta_{AG} < \eta_{YG} = \eta_{YB} < \eta_{AB}$, whereas in the right panel we continue to assume that the slope is countercyclical but additionally impose $\eta_{YG} + \eta_{AG} = \eta_{YB} + \eta_{AB} = 0.6$.

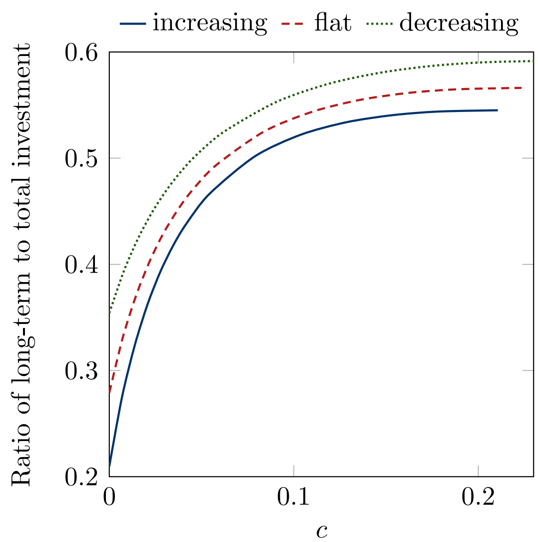

Figure 10: LONG- VS SHORT-TERM INVESTMENT. The figure shows the ratio of long-term investment to total investment (short-term plus long-term) as a function of the cash ratio $c \in [0, C^*]$ when varying the slope of the term structure of market risk prices. The increasing case features $\eta_Y = 0.05 < \eta_A = 0.35$, the flat case features $\eta_Y = \eta_A = 0.2$, and the decreasing case features $\eta_Y = 0.35 > \eta_A = 0.05$. We focus on the case $\sigma_A = \sigma_Y = 0.12$.