The Sensitivity of Cash Savings to the Cost of Capital*

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We show theoretically and empirically that in the presence of a time-varying cost of capital (COC), firms save cash out of external capital at a low cost to hedge against the risk of underinvestment in the *future* due to a higher COC. Such hedging motive drives the sensitivity of cash savings to the COC for both presently financially constrained and unconstrained firms. This sensitivity is especially pronounced for firms with a greater correlation between their COC and financing needs for future investments. The results cannot be fully explained by either the precautionary motive or the market-timing motive.

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Abstract

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Key Words: Cash savings, Hedging, Precautionary motive, Market timing, Financial Constraint.

JEL Classification: G32 G35.

1. Introduction

Capital market frictions make external capital costlier than internally generated funds, which may lead to suboptimal investment decisions (Myers (1984)). While the literature has suggested that firms mitigate such external financing constraints by saving cash from internal cash flows, cash savings from external capital are underexplored.[1] We find that firms in the United States save 28 cents from each dollar of equity capital raised compared to 15 cents from each dollar of internal cash flows. Moreover, external equity issuance alone explains 9.4% of corporate cash savings, while internal cash flows explain only 1.3%. Intuitively, when the cost of capital (COC) varies over time, firms are likely to benefit from issuing external capital and saving cash when the COC is relatively low. However, how time variation in the COC affects firms' cash savings behavior is not well understood.

Market frictions result in a deadweight loss for a firm when issuing external capital in the form of a higher COC (Campbell, Dhaliwal, and Schwartz (2012)). Firms can avoid the effect of external finance costs by holding cash (Myers and Majluf (1984)) and by hedging (Froot et al. (1993)). Bolton, Chen, and Wang (2011, 2013) suggest that cash can also reduce the sensitivity of investment to external finance. We show theoretically that when market frictions cause the COC to vary over time, firms try to reduce the overall COC by increasing cash when the COC is relatively low. Both presently financially constrained and unconstrained firms' cash savings are sensitive to the COC. The need to hedge against raising external capital at a higher cost for future investments is most pronounced for firms that face higher COC when having greater external capital needs. Our model also suggests that firms respond to a low

[1] See, among others, Almeida, Campello, and Weisbach (2004), Acharya et al. (2007), Han and Qiu (2007), Bates et al. (2009), Chang et al. (2014), and Qiu and Wan (2015).

COC by issuing excess external capital and hoarding cash if they anticipate external financing needs for future investments. Such savings can alleviate underinvestment due to a higher COC. Saving cash by raising external capital is costly. Nonetheless, with the time-varying costs of external capital, firms choose their optimal savings to balance the current COC and the expected COC for future investments. In particular, firms save more when (i) the current COC is low and (ii) they face a high correlation between the COC and external financing needs.

To test these predictions, we estimate the COC by the weighted average cost of capital. The cost of equity (COE) is estimated by the implied cost of capital which is the internal rate of return obtained by equating the stock price to the present value of future cash flow forecasts, and the cost of debt (COD) is the actual yield on the debt carried by the firm.[2] We show that the average cash holdings of firms are negatively associated with the average COC over the 39-year sample period (Figure 1). Moreover, firms save significantly more when the COC is lower relative to its historical average (Figure 2) and when they expect greater future investments (Figure 3). The empirical results also show that firms save significantly more from external capital when their COC decreases.

We measure a firm's hedging motive as the regression coefficient on the COC of the firm's external finance needs based on the standard proxies used in the literature. A high value indicates that the firm faces a higher COC when it needs more external capital. Consistent with the predictions of our model, we find that firms' cash savings from external capital are

[2]Claus and Thomas (2001) and Fama and French (2002) use the implied cost of capital (ICC) to measure the equity premium; Li, Ng, and Swaminathan (2013) and Lee, So, and Wang (2020) use the ICC to predict stock market return; Burgstahler, Hail, and Leuz (2006), Botosan and Plumlee (2005), Hughes, Liu, and Liu (2009) Frank and Shen (2016), Xu (2020), and Byoun and Wu (2020) use the ICC to estimate the COE. The COD is estimated using the same measure applied in Frank and Shen (2016) and Xu (2020).

more sensitive to the COC when their hedging needs are greater. Firms with greater hedging needs issue significantly more external capital in excess of current financial needs when the COC is relatively low. Future investment needs also influence the sensitivity of cash savings to the COC, especially for firms with strong hedging motives. These findings support our perspective on corporate hedging: firms save cash to hedge their future investments against a high COC.

When comparing the relative importance of equity and debt as sources of external capital, we find that firms save significantly more cash from equity issues (28 cents from each dollar of equity raised) than from debt issues (6 cents from each dollar of debt raised). Moreover, firms' cash savings are much more sensitive to the COE than to the COD.

To address the endogeneity concern that cash savings may affect the COC, we adopt an identification strategy that uses the Regulation Fair Disclosure (Reg FD) in 2000 as an exogenous shock to the COC and conduct a generalized triple difference analysis. Reg FD reduces COC by leveling the information playing field, especially for firms that are more prone to selective disclosure prior to the regulation, as shown in Chen et al. (2010). By exploiting the cross-sectional variation in the impact of Reg FD on the COC, we show that firms experiencing a larger decline in the COC exhibit an increased sensitivity of cash savings to external capital compared to firms with a smaller decline in the COC following Reg FD. We also conduct placebo tests to minimize the possibility that our results are driven by some omitted factors rather than changes in the COC. Our results are also robust to alternative COC measures and to adjustments for potential measurement errors.

We then investigate whether financial constraints explain the sensitivity of cash savings to the COC. We find that financially constrained and unconstrained firms both save more in response to a low COC and they both save more from external capital than from internal cash flows. Almeida et al. (2004) suggest that financially constrained firms save from cash flows to mitigate underinvestment due to financial constraints. Our findings suggest that firms save not only from cash flows to mitigate the effect of financial constraints, but also from external capital to hedge against higher financing costs for future investments. Saving from external capital when the COC is relatively low reduces underinvestment due to a higher future COC.

We also explore alternative motives that might explain the sensitivity of cash savings to the COC. The most plausible alternative is the market-timing motive, which suggests that firms save from equity issue proceeds to take advantage of overvalued stock (Alti (2006), Kim and Weisbach (2008), Bates, Kahle, and Stulz (2009), and Hertzel and Li (2010)). To test this alternative motive, we examine whether firms with high market timing motives are more likely to save cash and issue excess external capital when the COC is low than firms with low market timing motives. Using three market timing measures, we find no support for these predictions.

Keynes (1936) suggests that the main purpose of precautionary cash savings is to insulate the firm from external finance by saving from internal cash flows. Thus, the precautionary motive of Keynes does not predict that firms save cash out of external capital issuance when the COC is low as we document. However, McLean (2011) shows that the precautionary motive—measured by R&D, cash flow volatility, dividend payout, and their principal component—explains cash savings from equity issue proceeds. Accordingly, we examine whether firms with greater precautionary motives save more from external capital when the COC is relatively low. Although the precautionary motive has a positive effect on cash savings, it does not account for the sensitivity of cash savings to the COC. The effects of the hedging motive remain significant for both high and low precautionary motive firms. Our results suggest that the sensitivity of cash savings to the COC is best explained by firms' hedging needs stemming from the time variation in the COC.

2. Related Literature

Given that existing theories on cash savings mainly focus on firm's cash savings from internal cash flows, it is not apparent how these theories apply to cash savings from external capital. Previous studies offer market timing (Kim and Weisbach (2008)) and precautionary motive (McLean (2011)) as explanations for cash savings from equity issuance. DeAngelo, DeAngelo, and Stulz (2010), however, raise challenges for both motives. They find that the vast majority of firms with attractive market timing opportunities fail to issue stocks and many mature firms issue stocks without apparent financial difficulties. Moreover, Dittmar et al. (2019) maintain that the existing theories fail to explain the bulk of the within-firm variation in cash savings. Adding to this literature, we show that firms save to reduce the overall COC by transferring financial resources to future states of a higher COC. Accordingly, the market timing (to take advantage of overvalued stocks) and the precautionary motive (to prepare for uncertain contingencies) are not sufficient conditions for firms to save from external capital because firms will not issue external capital to save if they have no expected capital needs or if they can meet their future capital needs at a low COC. Our findings suggest that the COC has a significant and independent impact on corporate cash savings decisions and that external capital is an important source of cash savings for firms with greater hedging needs.

We also extend the literature on the effects of financial constraints on cash savings. Almeida et al. (2004) suggest that the cash flow sensitivity of cash captures the effect of financial constraints. Riddick and Whited (2009) challenge this interpretation by showing that financially constrained firms' cash savings and cash flows can be negatively related because firms reduce cash to increase investment after receiving positive cash flow shocks. In the financial constraint models, constrained firms trade off between current and future investments to save from cash flows. In our model, firms trade off not only between current and future investments but also between the current COC and the future COC to hedge against higher financing costs for future investments. The hedging motive drives the sensitivity of cash savings to the COC for both financially constrained and unconstrained firms. Our empirical results show that the cash savings of *both* financially constrained and unconstrained firms increase as the COC decreases. With the hedging motive, firms save not only from internal cash flows but also (and especially) from external capital to lower the overall COC, which in turn improves their overall investment efficiency.

The Bolton et al. (2013) continuous-time model shows that firms respond to fluctuations in financing conditions such as a probability of a crisis by adjusting cash, payout and investment decisions, and by timing the market to raise funds. While their model provides predictions on payout and investment decisions induced by financing conditions and financial crises, our model focuses more on identifying a cash saving motive of individual firms to reduce the overall external financing cost. Moreover, we provide supporting empirical evidence for the theoretically implied sensitivity of cash savings to the COC.

Acharya, Almeida, and Campello (2007) show that financially constrained firms' preference for cash savings from internal funds over preserving debt capacity depends on their need to hedge investment opportunities against income shortfalls. Our hedging motive distinguishes itself from their study in that we deal with cash savings from *both* internal cash flows and external capital (especially equity) in response to the COC. More importantly, *both* financially constrained and unconstrained firms save from external capital obtained with a relatively low COC to hedge against a higher COC for future investment.

Our study is also related to Azar, Kagy, and Schmalz (2016) who suggest that the cost of carry for cash holdings, which depends on the risk-free interest rate, is an important factor explaining the trend in corporate cash holdings over time. Gao, Whited, and Zhang (2020), however, find a hump-shaped relationship between cash holdings and interest rates. They rationalize this relationship in a model where firms' precautionary cash demand correlates with interest rates nonmonotonically. They suggest that interest rates are unlikely to explain the recent rise in corporate cash holdings.[3] We add to the literature by showing that corporate cash savings are closely related to time-varying COC, particularly to the COE and explaining that the hedging motive is an important determinant of corporate cash savings.

3. Hypothesis Development

3.1 A Model for Cash Savings with Time-Varying Costs of External Finance

We develop a three-date model to illustrate how cash savings are affected by the time-varying cost of external finance. The intuition from the analytical solution to the three-date model can also apply to a dynamic model, as shown in Appendix 5.

We consider a firm, endowed initially with W_t, that faces a two-period investment and financing decisions with zero discount rate. The investment at t produces $\pi(I_t) + z_{t+1}$, where

[3] Differing from Azar, Kagy, and Schmalz (2016) that estimate a weighted regression with the sum of each firm's total assets as weights, Gao, Whited, and Zhang (2020) estimate the unweighted regression that includes a squared interest rate term to account for a hump-shaped relation between cash and interest rate.

I_t is investment at the beginning of t, $\pi(I_t)$ is the expected cash flows at the end of t (or $t+1$) with homogeneous of degree 1, $\pi_I > 0$ and $\pi_{II} < 0$, and z_{t+1} is a cash flow shock to the investment. We assume z_{t+1} is i.i.d. normal with a zero mean and a variance of σ^2.[4] At $t+1$, after observing the random cash flow shock, the firm chooses investment, I_{t+1} and external finance, X_{t+1} for its investment opportunity.

The firm maximizes current shareholder wealth which is given as

$$
\begin{aligned}
V_t \;&=\; \max_{(I_t, C_t, X_t)} E_t\{\pi(I_t) + z_{t+1} - I_t - C_t - \lambda(\delta_t, X_t) + V_{t+1}\} \qquad (1)\\
&\quad \text{subject to} \quad I_t = W_t + X_t - C_t \quad \text{and} \quad C_t \geq 0,\\
&\quad \text{where} \quad V_{t+1} = \max_{(I_{t+1}, X_{t+1})} E_{t+1}\{\pi(I_{t+1}) + z_{t+2} - I_{t+1} - \lambda(\delta_{t+1}, X_{t+1})\}, \quad \text{and}\\
&\qquad I_{t+1} = X_{t+1} + \pi(I_t) + z_{t+1} + C_t,
\end{aligned}
$$

where C_t is cash saving at the beginning of t which returns the same amount at $t+1$, E_t is expectation taken over z given information at t, and X_t is external finance (or dividend if negative). The external financing decision is made at the beginning of each period. The firm's need for external capital at t is determined by the sum of investment and cash savings minus initial endowment. The firm pays out funds without costs if X_t is negative. The external finance cost is represented by $\lambda(\delta, X)$ for $X > 0$ with $0 < \lambda_X(\delta, X) < 1$. The external finance cost function implies that the marginal external finance cost increases with the amount of external capital raised and cannot be greater than its proceeds. The external finance cost is also an increasing function of δ ($\lambda_\delta(\delta, X) > 0$) which is the time-varying component of external financing cost related to market frictions such as agency problems, limited intermediation,[5]

[4] f_x and f_{xx} denote the first and second partial derivatives, respectively, of $f(x, y)$ with respect to x, and "*i.i.d*" stands for independent and identically distributed across firms and over time.

[5] According to Baker (2009), limited intermediation is intermediaries' inability to reinforce fundamental

investor preferences that drive fluctuation in risk premium, and/or market sentiment. For now, we assume δ is deterministic and independent of z but we relax this assumption in Section 3.2. The following time line shows the firm's cash flows and decisions.

t   t+1   t+2

$\pi(I_t) + z_{t+1} + C_t$ $\pi(I_{t+1}) + z_{t+2}$

$I_t = W_t + X_t - C_t$ $I_{t+1} = X_{t+1} + \pi(I_t) + z_{t+1} + C_t$

To explore the optimal cash savings, financing, and investment decisions in equation (1), we solve the model backwards, starting with the second-period financing and investment decisions:

$$\begin{aligned} V_{t+1} &= \max_{(I_{t+1},X_{t+1})} E_{t+1}\{\pi(I_{t+1}) + z_{t+2} - I_{t+1} - \lambda(\delta_{t+1}, X_{t+1})\} \\ &\qquad \text{subject to} \quad I_{t+1} = X_{t+1} + \pi(I_t) + z_{t+1} + C_t. \end{aligned} \tag{2}$$

The external capital raised by the firm at $t + 1$ depends on the cash flow generated from investment and cash saved at t. The first-order conditions with respect to the firm's optimal decisions on I_{t+1} and X_{t+1} are

$$\pi_I(I_{t+1}) = \mu_{t+1} \quad \text{and} \quad \mu_{t+1} = 1 + \lambda_X(\delta_{t+1}, X_{t+1}), \tag{3}$$

where μ_{t+1} is the Lagrangian for the constraint on X_{t+1}. These conditions imply that the optimal level of investment is below the first-best level (I^*_{t+1}), satisfying $\pi_I(I^*_{t+1}) = 1$, if the firm raises external capital with financing costs. Note that cash at $t+1$ is the sum of the cash flow from its initial investment and cash savings at t: $C_{t+1} = \pi(I_t) + z_{t+1} + C_t$. The first-best level of investment can be achieved if the firm has sufficient cash at $t + 1$ ($I^*_{t+1} \leq C_{t+1}$). If C_{t+1} is insufficient to cover the investment, the firm must rely on external finance, and its

value due to lack of competition or efficiency.

investment will be determined to satisfy $\pi_I(\hat{I}_{t+1}) = 1+\lambda_X(\delta_{t+1}, \hat{X}_{t+1}) > 1$. Thus, the firm may invest below the first-best level in the presence of the cost of external capital ($\hat{I}_{t+1} < I^*_{t+1}$).

Based on the above observations, we now have

$$\begin{aligned} E_t[V_{t+1}] &= \int\limits_{I^*_{t+1}-C_t-\pi(I_t)}^{\infty} \left\{\pi(I^*_{t+1}) - I^*_{t+1}\right\} g(z)dz \\ &+ \int\limits_{-\infty}^{I^*_{t+1}-C_t-\pi(I_t)} \left\{\pi(X_{t+1} + C_t + \pi(I_t) + z_{t+1}) - I_{t+1} - \lambda(\delta_{t+1}, X_{t+1})\right\} g(z)dz, \end{aligned} \tag{4}$$

where $g(z)$ is the probability density function (PDF) of z_{t+1}.

Moving back to the first period, the first order conditions (FOCs) for the firm's maximization problem with respect to I_t, C_t, and X_t can be expressed as

$$[1 + H]\pi_I(I_t) - 1 - \mu_t = 0, \tag{5}$$

$$H - 1 - \mu_t + \psi_t = 0, \tag{6}$$

$$-\lambda_X(\delta_t, X_t) + \mu_t = 0, \tag{7}$$

for $X_t > 0$, where μ_t and ψ_t are the Lagrangian multipliers for constraints on X_t and C_t, respectively, and

$$\begin{aligned} H &= \int\limits_{-\infty}^{I^*_{t+1}-C_t-\pi(I_t)} \left\{\pi_I(I_{t+1}) - 1 + \lambda_X(\delta_{t+1}, X_{t+1})\right\} g(z)dz \\ &= E_t\left[\pi_I(I_{t+1}) - 1 + \lambda_X(\delta_{t+1}, X_{t+1}) \,|\, X_{t+1} \geq 0\right], \end{aligned} \tag{8}$$

where $I_{t+1} = X_{t+1} + C_t + \pi(I_t) + z_{t+1}$. Appendix 1 provides the details of the derivation of these FOCs. Note that $H \geq 0$ represents the expected marginal benefit of cash due to the cost of external finance at $t+1$. The FOCs suggest that H is an important consideration for investment and cash savings decisions at t. In particular, when the firm relies on external finance ($X_t > 0$), it will choose the optimal investment where the marginal benefit of investment, $[1+H]\pi_I(I_t)$, is equal to its marginal cost, $1+\mu_t = 1+\lambda_X(\delta_t, X_t)$. Similarly, the optimal cash savings decision with external finance is made where the marginal benefit of cash savings, $H+\psi_t$, is equal to the marginal cost, $1+\mu_t = 1+\lambda_X(\delta_t, X_t)$. If the firm is unconstrained at t in that it has a sufficient initial endowment to make initial investment and cash savings ($X_t \leq 0$), the optimal cash savings will be set where its marginal benefit is equal to marginal cost ($H+\psi_t = 1$) without incurring external financing cost ($\lambda(\delta_t, X_t) = 0$ and $\mu_t = 0$). In this case, the firm's optimal investment is set at $(1+H)\pi_I(I_t) = 1$ (See Appendix 1).

In order to examine how the firm reacts when the firm expects higher external finance cost, we make the following additional assumptions about the second-order derivatives of $\lambda(\delta, X)$:

Assumption 1 *The external finance cost function, λ, satisfies:*

for $X > 0$,

(i) $\lambda_{XX}(\delta, X) > 0$;

(ii) $\lambda_{X\delta}(\delta, X) > 0$;

(iii) $\lambda_{\delta\delta}(\delta, X) > 0$;

for $X \leq 0$,

(iv) $\lambda_{XX}(\delta, X) = \lambda_{\delta\delta}(\delta, X) = \lambda_{X\delta}(\delta, X) = 0$.

Assumptions (i) - (iii) require that λ is a convex function which is obtained, for instance, under the costly-state-verification approach of Froot et al. (1993). Assumption (ii) also implies that the marginal cost of external finance increases with higher δ. Assumption (iv) for $X \leq 0$ reiterates that there is no cost when the firm does not raise external capital.

The above assumptions are also consistent with the intuition that a lower cost of external capital at t should increase optimal cash savings, external finance, and investment. Specifically, the FOCs at t and Assumption 1 imply $\frac{dC_t}{d\delta_t} < 0$, $\frac{dX_t}{d\delta_t} < 0$, and $\frac{dI_t}{d\delta_t} < 0$ as shown in Appendix 2. However, our main interest is in how the firm's cash savings decision alters with consideration of future COC. The following proposition establishes this link by showing the effects of δ_{t+1} on the firm's optimal decisions at t:

Proposition 1 *The optimal investment, $\hat{I}_t$, external finance, $\hat{X}_t$, and cash savings, $\hat{C}_t$, at t exhibit the following properties:*

For $\hat{X}_t > 0$,

$$\frac{\partial \hat{C}_t}{\partial \delta_{t+1}} > 0, \quad \frac{\partial \hat{X}_t}{\partial \delta_{t+1}} > 0, \quad \text{and} \quad \frac{\partial \hat{I}_t}{\partial \delta_{t+1}} < 0.$$

For $\hat{X}_t \leq 0$,

$$\frac{\partial \hat{X}_t}{\partial \delta_{t+1}} > 0, \quad \frac{\partial \hat{C}_t}{\partial \delta_{t+1}} > 0, \quad \text{and} \quad \frac{\partial \hat{I}_t}{\partial \delta_{t+1}} = 0.$$

Proof: See Appendix 2.

Proposition 1 suggests that when the firm expects a higher δ_{t+1} and hence higher COC at $t+1$, the value of cash available at $t+1$ becomes greater, which increases the firm's incentives to save by raising external capital. Thus, the firm will raise additional external capital to increase its savings at t. However, increasing investment at t to generate more cash at $t+1$ is less attractive because of diminishing returns on investment as suggested by the concave production function. Even when the firm is presently unconstrained in that it has enough cash at hand to make its optimal investment and savings decisions at t, it will not change investment but increase cash by reducing payout (given $X_t \leq 0$) in reaction to higher δ_{t+1}. The optimal investment at t is not affected by the expected COC at $t+1$ because the marginal return on cash remains constant while that on investment is decreasing. Consequently, when the firm expects a higher cost of external finance at $t+1$, it is more beneficial to save cash than to increase investment at t, since cash savings help the firm hedge against the higher future cost of external finance at a lower cost. If the firm does not save at t and faces low internal cash flow at $t+1$, then it will result in an increase in the amount of external capital at a higher cost and a reduction in the amount of investment at $t+1$.

We also note that the effects of expected investment I_{t+1} on the firm's optimal decisions at t are similar to those of δ_{t+1} (Appendix 2), which leads to the following corollary:

Corollary 1 *The optimal investment, $\hat{I}_t$, external finance, $\hat{X}_t$, and cash savings, $\hat{C}_t$, at t exhibit the following properties:*

For $\hat{X}_t > 0$,

$$\frac{\partial \hat{C}_t}{\partial I_{t+1}} > 0, \quad \frac{\partial \hat{X}_t}{\partial I_{t+1}} > 0, \quad \text{and} \quad \frac{\partial \hat{I}_t}{\partial I_{t+1}} < 0.$$

For $\hat{X}_t \leq 0$,

$$\frac{\partial \hat{X}_t}{\partial I_{t+1}} > 0, \quad \frac{\partial \hat{C}_t}{\partial I_{t+1}} > 0, \quad \text{and} \quad \frac{\partial \hat{I}_t}{\partial I_{t+1}} = 0.$$

Thus, when expecting profitable future investment opportunities, the firm will increase cash savings and external finance at t. The firm will also reduce investment at t by trading off between the marginal return on current investment and that on future investment. Together with the FOCs at t, the proposition and the corollary suggest that firms expecting higher external finance costs or greater investment are likely to increase cash savings by raising external capital beyond current investment, i.e., they issue excess capital. The firm will save more when it faces a lower COC at t relative to the COC at $t+1$ while expecting greater investment at $t+1$. Cash saved at the lower COC at t reduces the amount of external capital that must be raised under the higher COC at $t+1$, which reduces the overall COC for the firm over time. This inter-temporal smoothing of COC is a key insight of the model.

3.2 Hedging Motive

In this section, we extend our analysis to incorporate uncertainty in external finance costs and investment opportunities. In the discussion above, we assume that the time-varying cost component of external finance stemming from market frictions and investor preferences, δ, is nonstochastic, and thus independent of the cash flows from its assets in place. However, cash flow shock z due to aggregate economic uncertainty may affect both δ and investment opportunities, which drives a correlation between financing costs and external capital. Such correlation induces an incentive to save more cash to hedge against costs for external capital needs. We refer this as the "hedging motive" of cash savings.

We redefine δ and $\pi(I)$ at $t+1$ to capture the changes in external finance cost and investment opportunities correlated with cash flow shock z. For simplicity, we assume $\delta^o = \delta + \frac{\alpha\sigma_\delta}{\sigma}z$ and $\pi^o(I) = \pi(I)(1+\beta z)$, where α and β measure the correlation strength between z and δ^o and the effect of z on investment opportunities, respectively.[6] For a given optimal

[6]We assume the external finance component follows a normal distribution with mean δ and variance σ_δ^2. Consequently, δ^o can be considered a conditional expectation given z. Variables without subscript are at $t+1$.

investment I^o, the optimal external finance is given by $X^o = I^o - \pi(I_t) - C - z$.

To examine the effect of z on the expected cost of external finance at $t+1$, we take a Taylor expansion on $\lambda(\delta^o, X^o)$ around $\delta^o = E(\delta^o) = \bar{\delta}$ and $X^o = E(X^o) = \bar{X}$ as follows:

$$E[\lambda(\delta^o, X^o)] \approx \lambda(\bar{\delta}, \bar{X}) + \frac{1}{2}\Big\{\lambda_{\delta\delta}(\bar{\delta}, \bar{X})Var(\delta^o) + 2\lambda_{\delta X}(\bar{\delta}, \bar{X})Cov(\delta^o, X^o) + \lambda_{XX}(\bar{\delta}, \bar{X})Var(X^o)\Big\}. \tag{9}$$

The second term on the right hand side of equation (9) measures the curvature of external finance costs. A positive value of this term indicates that the external finance costs associated with low cash flow (large external finance) states are higher than those incurred in high cash flow (small external finance) states. Thus, the hedging motive arises as the firm is trying to reduce the variation in the expected external finance cost captured by the second term. The benefit of hedging is determined by the convexity of the external finance cost function and the effects of z on δ^o and X^o. For the given convexity of λ, the covariance term is crucial for the hedging motive. For example, if a negative shock to z is expected to increase δ^o, while reducing investment and consequently its external finance, the firm will have a less incentive to hedge against the increasing costs for external capital needs. If a negative shock to z is expected to increase both X^o and δ^o, the firm will have a greater incentive to hedge against the increasing costs for external capital needs.

In Appendix 3, we show

$$\delta^o = \delta + \frac{\alpha\sigma_\delta}{\sigma}z = \delta + \gamma\left(X^o - \bar{X}\right), \tag{10}$$

where $\gamma = \frac{d\delta^o}{dX^o}$. The correlation between δ^o and X^o through uncertain shock z is the key determinant of the hedging motive against external finance costs.

Similar to equation (8), we have the expected marginal value of cash at $t+1$ as follows:

$$H^o = E_t\left[\pi_I^o(I_{t+1}^o) - 1 + \lambda_X(\delta^o, X^o) + \gamma\lambda_\delta(\delta^o, X^o) \,\middle|\, X^o \geq 0\right]. \tag{11}$$

Equation (11) indicates that the expected marginal value of cash at $t+1$ stemming from additional investment without external finance is increasing with γ. The derivative of H^o with respect to C_t is given by

$$H_C^o = E_t\left[\pi_{II}^o(I^o) - \lambda_{XX}(\delta^o, X^o) - 2\gamma\lambda_{X\delta}(\delta^o, X^o) - \gamma^2\lambda_{\delta\delta}(\delta^o, X^o) \,\middle|\, X^o \geq 0\right]. \tag{12}$$

Equations (11) and (12) suggest that the marginal value of cash and its rate of change (the concavity of cash value) are greater when the cost of external capital is highly correlated with external capital needs.[7] The concavity of cash value implies that the firm incurs greater loss from reduced investment due to the external finance cost when there is a negative cash flow shock and that cash savings at t increase the firm value by reducing the variation in external finance. Thus, the greater concavity of cash value with higher γ implies a greater hedging incentive because the effect of cash savings at t on the firm value is greater for firms with high correlation between δ^o and X^o.

Since the expected external finance cost and the expected marginal value of cash is the key consideration for cash saving at t, optimal decisions at t are also affected by γ. Proposition 2 establishes the properties of optimal decisions at t with respect to γ:

Proposition 2 *The optimal levels of cash savings, C_t^o, external finance, X_t^o, and investment, I_t^o, exhibit the following dependence on γ:*

[7] Froot et al. (1993) show that when financing opportunities vary with the return on risky assets, firms have a greater hedging incentive and such hedging incentive arises from the concavity of a profit function.

For $X_t^o > 0$,

$$\frac{\partial C_t^o}{\partial \gamma} = \frac{\partial C_t^o}{\partial \delta^o}\frac{\partial \delta^o}{\partial \gamma} > 0, \quad \frac{\partial X_t^o}{\partial \gamma} = \frac{\partial X_t^o}{\partial \delta^o}\frac{\partial \delta^o}{\partial \gamma} > 0 \quad \text{and} \quad \frac{\partial I_t^o}{\partial \gamma} = \frac{\partial I_t^o}{\partial \delta^o}\frac{\partial \delta^o}{\partial \gamma} < 0.$$

For $X_t^o \leq 0$,

$$\frac{\partial C_t^o}{\partial \gamma} > 0, \quad \frac{\partial X_t^o}{\partial \gamma} > 0, \quad \text{and} \quad \frac{\partial I_t^o}{\partial \gamma} = 0.$$

Proof: See Appendix 4.

Proposition 2 implies that the sensitivities of the optimal cash savings and external finance decisions to the COC are magnified by the correlation between external capital needs and external finance cost as measured by γ. Firms with high γ may have to reduce investments at $t+1$ due to higher external finance costs when facing lower cash flows; these firms can issue external capital (or reduce payout if $X_t^o \leq 0$) at time t at a lower cost and save for future investment, thereby reducing their overall cost of external finance. Consequently, the amount of cash savings and excess capital issuance at t should be larger when firms expect greater investment and a higher COC in the future. The optimal investment at t, however, is less affected by γ because it is more beneficial to save cash (with a constant marginal rate of return) than to increase investment (with a decreasing marginal rate of return).

Given these results, we propose the following hedging motive hypotheses:

Hypothesis 1a Firms with a high correlation between external capital needs and COC will save more when the COC is relatively low.

Hypothesis 1b Firms with a high correlation between external capital needs and COC will issue more excess external capital when the COC is relatively low.

Hypothesis 1c Firms with greater future expected investments will save more when the COC is relatively low.

4. The Data and Variables

4.1 The Sample

The initial sample consists of all U.S. firms from the annual Compustat files for the period of 1981–2019. We require that firms have the value of assets greater than $5 million and have positive values for equity, cash holdings and net sales. Financial firms (SIC codes 6000-6799) and regulated utilities (SIC codes 4900-4999) are excluded from the sample. Observations with missing net income and stock issuance proceeds are also excluded. Stock price information is from the Center for Research in Security Prices (CRSP), the nominal GDP growth rates are from the Bureau of Economic Analysis, and the interest rates are from the Federal Reserve Bank of St. Louis.

To estimate the cost of equity, we obtain analysts' earnings and growth forecasts from Institutional Brokers Estimate System (I/B/E/S). We require non-missing data for the prior year's book value, earnings, and dividends. When explicit forecasts are unavailable, we obtain forecasts by applying the long-term growth rate to the prior year's earnings forecast.

4.2 Cost of Capital

It is challenging to estimate individual firms' cost of capital because the cost of equity and the cost of debt are not directly observable. As an attempt, we measure the COE using the implied cost of capital approach, which estimates the *ex ante* expected return implied by market prices (Gebhardt, Lee, and Swaminathan (2001) and Li, Ng, and Swaminathan (2013)). Specifically, the ICC is the discount rate, which equates a stock's present value of expected cash flows to its current price. According to the discounted cash flow model, the stock price of a firm at time t is

$$P_t = \sum_{k=1}^{\infty} \frac{E_t(FE_{t+k})}{(1 + ICC_t)^k}, \tag{13}$$

where P_t is the market value of the stock at time t, $E_t(FE_{t+k})$ is the expected free cash flow to equity at time $t + k$, and ICC_t is the implied cost of equity capital.

To estimate the cost of equity, we use three different models proposed by Gebhardt, Lee, and Swaminathan (2001), Claus and Thomas (2001), and Li, Ng, and Swaminathan (2013). Detailed procedures for this estimation are provided in Appendix 7. The consensus analyst forecasts from I/B/E/S are used to predict future earnings per share. Given that firms are required to file their financial statements within 90 days of the fiscal year end, we estimate the COE using the earliest forecasts available after three months of the prior fiscal year end. The reported results are based on the Gebhardt, Lee, and Swaminathan (2001), approach. The results are robust to the alternative COE estimation methods.

We estimate the COC as follows:

$$COC_{i,t} = \frac{Debt_{i,t}}{MVA_{i,t}} COD_{i,t}(1 - TaxRate) + (1 - \frac{Debt_{i,t}}{MVA_{i,t}})COE_{i,t}, \tag{14}$$

where $COC_{i,t}$ is the weighted average cost of capital for firm i in year t. $\frac{Debt_{it}}{MVA_{it}}$ is the market leverage ratio. $COD_{i,t}$ is the cost of debt for firm i in year t, measured as the actual yield on the debt carried by the firm, as in Frank and Shen (2016). The COC is estimated for each firm in each year.

4.3 Hedging Motive Measures

We measure the hedging motive by the regression coefficient of external capital needs on the COC.[8] Three proxies are used to capture firms' needs for external capital: KZ index, external finance dependence, and financial deficit. Following Baker, Stein, and Wurgler (2003), we use the KZ index to measure external finance dependence as follows:

$$KZ = -1.002CF - 39.368DIV - 1.315CASH + 3.139LEV, \tag{15}$$

where CF is the operating income before depreciation and amortization (oibdp) divided by net property, plant and equipment at the beginning of the period (PPE); DIV is cash dividend divided by PPE; $CASH$ is cash and equivalents divided by PPE; and LEV is long-term debt divided by long-term debt plus total equity.

Following Rajan and Zingales (1998), external finance is measured by:

$$External = (CapEx - OCF)/CapEx, \tag{16}$$

where $CapEx$ is capital expenditures; and OCF is the operating income before depreciation and amortization (oibdp) .

We also follow Shyam-Sunder and Myers (1999), Frank and Goyal (2003), and Byoun (2008) to define financial deficit as follows:

$$Deficit = (Div + Acq + Inv - ICF1)/TA, \tag{17}$$

where Div is cash dividend; Acq is acquisitions; Inv is net investments; $ICF1$ is income before extraordinary (ibc) items plus depreciation and amortization (dpc) and TA is total assets at the beginning of the period.

[8] The hedging motive measured by the regression coefficient is consistent with γ in our model. In the earlier version of the paper, we also measure the hedging motive based on the correlation coefficient between the COC and external capital needs. The results are similar.

We use the industry median *External* based on the 2-digit SIC code and the firm-level *Deficit* and *KZ* as proxies for external capital needs. To measure hedging needs, we obtain annual external capital needs measures and compute their regression coefficients on individual firms' COCs over the sample period. Based on the coefficients, we define firms in the top 30 percent as high hedging needs firms and those in the bottom 30 percent as low hedging needs firms, dropping the middle 40 percent.

5. Empirical Analysis

5.1 Univariate Analysis

The summary statistics for the firm characteristic variables and the COC are reported in Table 1 Panel A. The average cash holding is 11% of total assets and the cash savings rate is approximately 1.18% of total assets. The average COC is 8.49%, with an average COE of 9.62% and an average COD of 7.01%. Panel B shows the decomposition of the standard deviation of the COC across firms and over time. As expected, the COD exhibits less variation than the COE cross-sectionally and over time.

Figure 1 plots the average annual cash holdings relative to the average COC, COE, and COD over the sample period. The striking symmetry of the two series suggests that firms increase (decrease) cash when the COC is low (high). Thus, the COC appears to be an important driver of corporate cash holding behavior over time. Notably, the COC declined significantly until the early 2000s, which may help explain the increasing trend in cash holdings over the same period documented by Bates et al. (2009).

To further examine how a relatively low COC drives corporate cash savings, we obtain a firm's COC minus its historical average for firms with a minimum of 3 years of data. Figure

2 plots cash savings across deciles of the deviation of COC from the historical average for the sample period of 1981-2019 and the subsample periods of 1981-1999 and 2000-2019. The downward-sloping graphs indicate that firms save more when COC is below the historical average.

Figure 3 plots current year cash savings across future investment (subsequent three-year average) deciles. The figure shows that firms with greater future investment save more cash in the current year, which is consistent with the prediction of the hedging motive for cash savings that firms save cash for future investments.

5.2 Sensitivities of Cash Savings to Cash Sources

Firms may save cash from internal or external capital. To examine how cash savings are associated with cash sources in a multivariate setting, we run the following regression:

$$\Delta Cash_{it} = \lambda_0 + \lambda_1 ExCapital_{it} + \lambda_2 ICF_{it} + \lambda_3 X_{it-1} + f_i + \gamma_t + \varepsilon_{it} \tag{18}$$

where $\Delta Cash_{it}$ is the change in cash and equivalents for firm i in year t; ICF_{it} is internal cash flow; $ExCapital_{it}$ is the sum of the net equity issue and net debt issue. Each variable is divided by total assets at the beginning of the period. X_{it-1} is a vector of control variables and f_i is firm fixed effects. γ_t controls for year fixed effects. Following Opler et al. (1999) and Bates et al. (2009), we include the following control variables: M/B_{it-1}, market-to-book asset ratio; $Cash_{it-1}$, lagged cash-to-asset ratio; Vol, cash flow volatility; $Leverage_{it-1}$, leverage ratio;[9] $Size_{it-1}$, the logarithm of total assets; NWC_{it}, net working capital excluding cash and

[9]Previous studies show that firms with more volatile cash flows tend to hold more cash (Bates et al. (2009) and McLean (2011)). The inclusion of cash flow volatility as an independent variable helps control for the effect of precautionary motive of cash savings. We include leverage to control for potential effects of capital structure. Although firms may hedge by altering their capital structure, this change will only enable firms to optimize debt and equity, but cannot neutralize common component in the COE and the COD.

equivalents divided by total assets at $t-1$; $CapEx_{it}$, capital expenditures divided by total assets at $t-1$; $Acquisitions_{it}$, acquisitions divided by total assets at $t-1$; $Divdend_{it}$, cash dividend divided by total assets at $t-1$. We winsorize all variables at 2 and 98 percentiles to mitigate the effects of outliers.

We first estimate the model without firm and year fixed effects. The results are reported in Table 2. The coefficient estimate of external capital ($ExCapital$) is 0.2822 and significant, whereas that of internal cash flows (ICF) is 0.2299 and significant. To evaluate the relative importance of external capital to internal cash flows, we estimate the standardized beta coefficients. Column 5 of Table 2 shows that the standardized beta coefficient of external capital is much larger than that of internal cash flow (0.6691 vs. 0.1806), which indicates that external capital is a major source of firms' cash savings.

When we include firm fixed effects (Column 2), year fixed effects (Column 3), and firm and year fixed effects (Column 4), the coefficient estimates of the cash sources remain positive and significant. The estimates also show that M/B and cash flow volatility have positive effects on cash savings, while lagged cash, dividend, leverage, firm size, net working capital, capital expenditures, and acquisitions have negative effects.

5.3 Cost of Capital and Cash Savings

To test whether firms' cash savings are sensitive to the COC, we include the COC and its interactions with external capital ($ExCapital$) and internal cash flows (ICF) in equation (18). The estimation results are reported in Table 3. For brevity, we do not report estimates on control variables. The negative and significant coefficient estimates of the COC suggest that firms save more when the COC is low. The economic magnitude of the impact is also significant. A one percentage point decrease in the COC is associated with an approximately 16% increase in cash savings. The negative coefficient estimates of its interaction with external capital indicate that firms save significantly more from external capital when the COC is lower.

6. Hedging Motive

Our model suggests that in the presence of the time-varying COC, firms with a high correlation between their COC and external financing needs (high hedging motive) have more incentives to raise external capital and save cash at a relatively low COC. Such cash savings should be more pronounced when firms are expecting greater future investments. We test these predictions in this section.

6.1 Hedging Needs and Cash Savings

To test hypothesis 1a that firms with high hedging motives save more when the COC is relatively low, we examine whether the sensitivity of cash savings to the COC is more pronounced for firms with high hedging needs. We split the sample into high and low hedging needs firms based on the hedging motive measures and report the results in Table 4. Hedging Motives 1 to 3 represent the correlation coefficients between the COC and each of the three measures of external capital needs ($External$, $Deficit$, and KZ), respectively.

The coefficient estimates of the interaction terms between external finance proceeds and the COC ($ExCapital \times COC$) are significant and negative only for high hedging needs firms, indicating that firms with greater hedging motives save more from external capital when the COC is relatively low. The results are consistent with hypothesis 1a.

6.2 Hedging Needs and Excess Capital Issuance

Hypothesis 1b predicts that firms with greater hedging needs issue excess capital when the COC is relatively low. To test this prediction, we define excess capital issuance as net external capital issue proceeds minus financial deficit, which represents the portion of external capital that is saved as cash. Panel A of Table 5 reports the results for firms with high and low hedging needs based on three hedging motive measures. The coefficient estimates of the COC are negative and significant only for firms with high hedging needs. These results are consistent with hypothesis 1b, indicating that firms with high hedging needs issue excess external capital to save as cash when the COC is lower.

6.3 Future Investment and Cash Savings

We now test hypothesis 1c, which predicts that firms save cash to fund future investments, with the following regression:

$$\Delta Cash_{it} = \alpha_0 + \alpha_1 FInvest_{it} + \alpha_2 ICC_{it} + \alpha_3 FInvest_{it} \times ICC_{it} + \alpha_4 X_{it-1} + f_i + \gamma_t + \varepsilon_{it} \tag{19}$$

where $FInvest_{it}$ is future investment at time t for firm i, defined as the average of investment scaled by lagged total assets in the subsequent three years.[10] The same set of control variables used in equation (18) are included. We expect firms to save more when they expect greater future investment ($\alpha_1 > 0$) because their realized future investment will be positively correlated with managers' ex ante expected investment. We estimate equation (19) separately for firms with low and high hedging needs. Since the incentive to save cash for future expected investment will be greater when facing a relatively low COC, we expect a negative sign for

[10] The use of realized future investment is in line with the use of future stock returns in previous studies (Baker et al. (2003) and DeAngelo et al. (2010)).

α_3, especially for firms with greater hedging needs.

Panel B in Table 5 reports the results for high and low hedging needs firms based on three hedging motive measures. The coefficient estimates of future investment are positive and significant only for firms with high hedging needs. Moreover, the coefficient estimates of the interaction term between future investment and the COC are all negative and significant only for high hedging needs firms. These findings provide support for hypothesis 1c that firms with hedging needs save cash at a low cost for future investments.

6.4 Equity versus Debt

Thus far, our results show that firms save cash from external capital and that this saving behavior is affected by the COC. As equity and debt are two main sources of external capital, we investigate their relative importance for firms' cash savings. We first run a simple regression for each of the cash sources and report the results in Table 6 Panel A. The coefficient estimate of net equity issues ($EIssue$) is 0.2804 and significant, with an adjusted R^2 of 9.4%. The coefficient estimate of debt issues ($DIssue$) is a mere 0.0556, and the adjusted R^2 is 0.71%. The estimated coefficient of internal cash flows (ICF) is 0.1503 and statistically significant, with an adjusted R^2 of 1.3%. When we include all cash sources along with control variables (column 4) and firm fixed effects (column 5), the coefficient estimates of all the cash sources remain positive and significant. Overall, equity is the most important source for cash savings.

We then examine the relative importance of the COE and the COD for firms' cash savings by including the interaction terms of COE (COD) with net equity issue proceeds (net debt issue proceeds) and internal cash flows into our regression model. As shown in Table 6 Panel B, the coefficient estimates of COE are negative and significant for firms with high hedging motives, while the coefficient estimates of COD are mostly insignificant. For all firms in Column (1), the coefficient estimates of both $Eissue \times COE$ and $ICF \times COE$ are negative and significant. The coefficient estimate of $Dissue \times COD$ is also negative and significant but that of $ICF \times COD$ is insignificant. These results suggest that firms' cash savings from equity issuance and internal cash flows are both sensitive to the COE, whereas cash savings from internal cash flows show little sensitivity to the COD.

When the sample is split into low and high hedging needs firms in the remaining columns, we find that the coefficient estimates of both $Eissue \times COE$ and $ICF \times COE$ are significant and negative only for high hedging needs firms. Thus, COE appears to be an important consideration in firms' cash savings decisions, particularly for firms with high hedging needs.

6.5 Exogenous Shock to the Cost of Capital

An endogeneity concern may arise if firms' cash savings affect their COC or if other confounding factors drive the observed relationship. To ease this concern and buttress our results for the causal effects of the COC on cash savings, we exploit an exogenous event that affects firms' COC. In particular, we use Regulation Fair Disclosure (Reg FD) as a shock to the COC and investigate whether firms experiencing a greater reduction in their COC in the post-Reg FD period save more from external capital than firms experiencing a smaller reduction in COC. Reg FD, effected on October 23, 2000, prohibits selective disclosure of material information to a subset of market participants, such as analysts and institutional investors, without simultaneously disclosing it to the public. By curtailing selective disclosure, the Securities and Exchange Commission (SEC) believed that Reg FD would encourage continued widespread investor participation in capital markets, enhancing market efficiency and liquidity, and more effective capital raising. As a result, Reg FD lowers the COC for those firms with selective disclosure before Reg FD (Chen et al. (2010)).

Following Chen et al. (2010), we use market-to-book ratios (M/B) and R&D as firm characteristics indicative of selective disclosure and classify firms into treated and control groups. Specifically, treatment and control firms are defined as the top and bottom 30% ranked by the M/B ratio or as the top 50% ranked by the R&D-to-sales ratio among positive R&D firms and zero-R&D firms, respectively. M/B ratio and R&D-to-sales ratio are measured as of the end of September 2000 before Reg FD. We set the *Post* dummy as one for 2000-2003 and zero for 1997-1999.

Columns (1) and (2) in Table 7 show the results for the M/B- and R&D-based measures of selective disclosure, respectively. For both measures, the coefficient estimates of the triple interaction term $Treated \times ExCapital \times Post$ are positive and significant, which indicates that cash savings from external capital have significantly increased for firms with a larger reduction in the COC relative to firms with a smaller reduction in the COC following the legislation.

To ease the concern that the results may be driven by some omitted variables that affect both the COC and cash savings, we also conduct placebo tests based on the fictitious event years of 2008 and 2011. The sample period is 6 years around the fictitious event year. The results of the placebo tests reported in Columns (3)-(6) show that none of the coefficient estimates of $Treated \times ExCapital \times Post$ are significant. Thus, the results appear to be unique around Reg FD and are less likely due to other confounding factors. These findings boost our confidence that the COC has a causal impact on corporate cash savings from external capital.

It is also possible that the above results simply capture pre-existing divergent trends or differences in treatment and control groups that are unrelated to the shock to COC. To explore this possibility, we investigate the dynamics of firms' cash savings from external capital surrounding the shock. If this alternative explanation holds true, we should observe more cash savings from external capital by treatment firms prior to Reg FD. To check this, we replace $Post$ with year indicator variables associated with the years surrounding Reg FD. Figure 4 presents the coefficient estimates of the triple interaction term $Treated \times ExCapital \times Year$ with 90% confidence interval. As shown in both panels, the differences in the sensitivities of cash savings to external capital between treated and control groups are close to zero before Reg FD. Firms experiencing a larger decline in the COC save significantly more cash from external capital than firms experiencing a smaller decline in the COC after Reg FD. Therefore, it is less likely that our results are driven by pre-existing divergent trends in treated and control firms or reverse causality.

6.6 Robustness

Although we have shown that the COC has a significant impact on cash savings in the natural experimental setting, there can be an endogeneity concern due to measurement errors in the COC. As a remedy for measurement errors in the COC, we estimate the model using high-order cumulants as suggested by Erickson et al. (2014). Table A1 in Appendix 8 reports the estimation results. The coefficient estimates of the interaction of external capital and COC in Columns (1) and (2) are negative and significant for high hedging motive firms, whereas they are insignificant for lower hedging motive firms. The results are consistent with our main estimations. We also examine whether our results are robust to alternative measures of the COC using the Claus and Thomas (2001) and Li, Ng, and Swaminathan (2013) approaches as specified in Appendix 7. The results in Columns (3)-(6) show that our findings are robust to these alternative COC measures.

7. Financial Constraints and Alternative Hedging Measure

7.1 Financial Constraints

Since financial constraints are an important consideration for firms' cash savings decisions (Almeida et al. (2004)), it is possible that our results simply reflect financial constraints. To investigate this possibility, we examine whether financial constraints explain the cash savings behavior observed in Table 3. Following previous studies, we use credit rating, the WW (Whited and Wu (2006)) index, and the HP (Hadlock and Pierce (2010)) index to define financially constrained and unconstrained firms. Financially constrained (unconstrained) firms are defined as those without (with) credit ratings or in the top (bottom) 30 percent of the WW index or the HP index.

The results in Table 8 Panel A show that both financially constrained and unconstrained firms save more when the COC is relatively low. In terms of economic magnitude, one standard deviation decrease in the COC is associated with an approximately 4.52% (6.11%) increase in cash savings for unconstrained (constrained) firms based on HP index. The estimated coefficients of $ExCapital \times COC$ are negative and significant for both constrained and unconstrained firms. Firms' cash savings from external capital in response to the COC are also economically significant for both financially constrained and unconstrained firms. When $ExCapital \times COC$ decreases by one standard deviation, the cash savings of financially unconstrained (constrained) firms increase by 21% (10%) based on HP index. The estimated coefficients of $ICF \times COC$ are also negative and significant for both constrained and financially constrained firms.

We further test whether financial constraints help explain firms' excess capital issuance in response to a low COC and the effects of future investments on cash savings. To this end, we partition firms with high (low) hedging motives into financially constrained and unconstrained firms. The unreported tables show that both financially constrained and unconstrained firms with high hedging motives raise external capital in excess of current financial needs when the COC is relatively low.[11] The estimated coefficients of $FInvest \times COC$ are negative and significant for both constrained and unconstrained firms with high hedging motives, while the coefficients are insignificant for both constrained and unconstrained firms with low hedging motives. Overall, these results suggest that financial constraints cannot fully explain the sensitivity of cash savings to the COC.

7.2 Acharya, Almeida, and Campello (2007) Hedging Measure

Acharya et al. (2007) (AAC, henceforth) suggest that financially constrained firms save cash to hedge investment opportunities against income shortfalls, while unconstrained firms do not have a propensity to save cash out of cash flows. They measure a firm's hedging needs by the correlation between the firm's cash flows from current operations and its industry-level median R&D expenditures. We investigate whether their hedging needs measure explains the sensitivity of cash savings to the COC.

We conduct tests based on our hedging motive and AAC hedging needs measures for

[11] The tables are available upon request.

financially constrained and unconstrained firms. We report the results for high hedging motive firms in Panel B of Table 8. The coefficient estimates of $ExCapital \times COC$ are negative and significant for both constrained and unconstrained firms when our hedging motive measure is used. These results are consistent with the finding in Panel A that both financially constrained and unconstrained firms save from external capital when the COC is relatively low. When the AAC measure is used, however, the coefficient estimates of $ExCapital \times COC$ are insignificant for financially constrained firms, whereas the coefficient estimate of $ICF \times COC$ is negative and significant for constrained firms. The results are consistent with the finding of Acharya et al. (2007) that financially constrained firms save from internal funds when they have high hedging needs against a cash flow shortage. However, the AAC hedging measure does not fully capture firms' needs of saving cash from external capital in response to a lower COC.

8. Alternative Explanations

8.1 Market Timing Motive

The market timing hypothesis suggests that firms may time the market and issue equity when it is overvalued. Mispricing in the stock market may be driven by nonfundamental components of the stock price such as investor sentiment, which affects the COC directly but not cash flows (Campbell, Polk, and Vuolteenaho, 2010). When such mispricing drives current COC below the expected COC, the firm may see an opportunity to issue external capital and save. Such cash savings, however, are not motivated by future investments (Bolton, Chen, and Wang, 2013). If market timing drives firms' cash savings behavior, the sensitivity of excess capital to the COC should be larger for firms with higher market timing motive. These arguments lead to the following market timing hypotheses:

Hypothesis 2a Firms with greater market timing motives save more from external capital when the COC is relatively low than do firms with lower market timing motives.

Hypothesis 2b Firms with greater market timing motives issue more excess external capital when the COC is relatively low than do firms with lower market timing motives.

Using three market timing measures, we conduct a series of tests to investigate whether the marketing timing motive can explain our results. The first market timing measures is the yearly timing (Timing 1) constructed by Kayhan and Titman (2007), which is the sample covariance between external financing and the market-to-book ratio over a five-year period. This market timing measure captures the idea that a firm raises more external capital by taking advantage of short-term overvaluation that is determined by the firm's current M/B ratio relative to its M/B in surrounding years. The second market timing measure is the long-term timing (Timing 2) in Kayhan and Titman (2007), which is the product of the average market-to-book ratio and the average external financing over a five-year period. This measure captures a firm's market timing incentive by its M/B ratio relative to all firms in general. The third market timing measure (Timing 3) is the mispricing proxy developed by Stambaugh et al. (2015). This measure is constructed as the average of a stock's ranking percentiles for each of 11 anomaly variables, where a higher rank is associated with a greater relative degree of overpricing based on the given anomaly variable. The most overpriced stocks have the highest composite rankings. For each measure of market timing, we define firms in the top 30 percent as firms with high market timing motives and those in the bottom 30 percent as firms with low market timing motives.

To test market timing hypothesis 2a, we estimate the regression models for firms with high or low market timing motives based on the three market timing measures. As shown in Table 9 Panel A, the coefficient estimates of $ExCapital \times COC$ are negative and significant for both firms with high market timing motives and firms with low market timing motives. The results are inconsistent with market timing hypothesis 2a that firms with greater market timing motives save more from external capital when the COC is relatively low.

In Panel C, we test market timing hypothesis 2b on excess external capital. The results show that the coefficient estimates of the COC are negative and significant for both low and high market timing motive firms, which is inconsistent with the hypothesis that excess capital issues are mainly driven by the market timing motive. Both low and high market timing motive firms issue excess external capital to save when the COC is lower.

As a further investigation, we also examine whether the market timing motive explains the effects of future investment on cash savings by estimating model (19) separately for high and low market timing firms. In Panel D, the coefficient estimates of $FInvest \times COC$ are negative and significant for both firms with high market timing motives and firms with low market timing motives. Thus, the market timing motive does not fully explain the sensitivity of firms' cash savings to the COC.

8.2 Precautionary Motive

According to the precautionary motive, firms can avoid external financing by saving cash from internal cash flows (Fazzari et al. (1998), Almeida et al. (2004), Opler et al. (1999), and Bates et al. (2009)). Taking advantage of a relatively low COC to save cash from external capital is not considered as the main reason for precautionary cash savings. In particular, Keynes (1936) argues that the quantity of cash demanded for precautionary purposes is not sensitive to changes in the COC because it is mainly determined by the general activity of the economic system and the level of income. Nevertheless, given the recent finding that the precautionary motive drives firms to save from equity issuance (McLean (2011)), we examine whether the cash savings of firms with stronger precautionary motives are more sensitive to the COC. Specifically, we test the following precautionary motive hypotheses:

Hypothesis 3a Firms with greater precautionary motives save more when the COC is relatively low than do firms with lower precautionary motives.

Hypothesis 3b Firms with greater precautionary motives issue more excess external capital when the COC is relatively low than firms with lower precautionary motives.

To test these hypotheses, we follow previous studies and use R&D spending, cash flow volatility, and nondividend payout as measures of precautionary motives that represent unforeseen opportunities and contingencies requiring sudden expenditures. Cash flow volatility is the 10-year standard deviation of average industry cash flow based on the 2-digit SIC code. We pay particular attention to the precautionary measure of McLean (2011) based on the first principal component of R&D spending and cash flow volatility. For R&D spending, cash flow volatility and their first principal component, we define the top 30% of firms as high precautionary firms and the bottom 30% as low precautionary firms. We also treat nondividend-paying firms as high precautionary firms and dividend-paying firms as low precautionary firms.

Table 9 Panel B shows that the estimated coefficients of $ExCapital \times COC$ are mostly negative and significant for both low and high precautionary firms. The results are not consistent with precautionary hypothesis 3a that firms with greater precautionary motives save more when the COC is relatively low. In Panel C, we test precautionary hypothesis 3b on excess external capital and find that the coefficient estimates of the COC are negative and significant for both low and high precautionary motive firms. The results are inconsistent with hypothesis 3b that firms with greater precautionary motives issue more capital in excess of current financial needs than firms with lower precautionary motives when the COC is relatively low.

We also examine whether the precautionary motive explains the effects of future investment on cash savings. As shown in Panel D, the coefficient estimate of $FInvest \times COC$ is insignificant for firms with high precautionary motives, but significant for firms with low precautionary motive. Thus, there is no supporting evidence that the precautionary motive fully explains the sensitivity of firms' cash savings to the COC.

9. Conclusions and Discussions

We develop a theoretical model showing that in the presence of a time-varying COC, firms channel funds into future states with a high COC by saving cash from external capital when the current COC is relatively low. In particular, when a firm expects a higher COC for future investments, it will increase cash savings from external capital at a low cost to lower the *overall* cost of capital. Cash savings and excess external financing show greater sensitivities to the COC among firms with greater hedging needs.

Consistent with the theoretical predictions, we find that both financially constrained and unconstrained firms save more cash from external capital than they save from internal cash flows. The cash savings of firms with greater hedging needs are particularly sensitive to their COC. Moreover, firms with greater hedging needs tend to issue excess external capital when the COC is relatively low. Our findings cannot be fully explained either by the precautionary motive or by the market timing motive.

In summary, our study illustrates that firms' hedging motive to transfer funds from a low COC state to a higher COC state through cash savings is an important consideration for corporate cash savings policies. Previous studies show that credit lines also play an important role in firms' liquidity and risk management (Sufi (2009) and Acharya et al. (2014)). How the time-varying COC affects firms' choice between cash and credit lines is an interesting question. Extending our theoretical framework and empirical results to answer this question seems a fruitful area for future research.

References

Acharya, V., Almeida, H., Campello, M., 2007. Is cash negative debt? A hedging perspective on corporate financial policies. Journal of Financial Intermediation 16, 515–554.

Acharya, V., Almeida, H., Ippollito, F., Perez, A., 2014. Credit lines as monitored liquidity insurance: Theory and evidence. Journal of Financial Economics 112, 287–319.

Almeida, H., Campello, M., Weisbach, M. S., 2004. The cash flow sensitivity of cash. Journal of Finance 59, 1777–1804.

Alti, A., 2006. How persistent is the impact of market timing on capital structure. Journal of Finance 61, 1681–1710.

Azar, J., Kagy, J.-F., Schmalz, M. C., 2016. Can changes in the cost of carry explain the dynamics of corporate 'cash' holdings? Review of Financial Studies 29, 2194–2240.

Baker, M., 2009. Capital market-driven corporate finance. Annual Reviews of Financial Economics 1, 181–205.

Baker, M., Stein, J., Wurgler, J., 2003. When does the market matter? stock prices and the investment of equity-dependent firms. Quarterly Journal of Economics 118, 969–1006.

Bates, T. W., Kahle, K. M., Stulz, R. M., 2009. Why do U.S. firms hold so much more cash than they used to? Journal of Finance 64, 1985–2021.

Bolton, P., Chen, H., Wang, N., 2011. A unified theory of tobin's q, corporate investment, financing, and risk management. The Journal of Finance 66, 1545–1578.

Bolton, P., Chen, H., Wang, N., 2013. Market timing, investment, and risk management. Journal of Financial Economics 109, 40–62.

Botosan, C. A., Plumlee, M. A., 2005. Assessing alternative proxies for the expected risk premium. Accounting Review 80, 21–53.

Burgstahler, D. C., Hail, L., Leuz, C., 2006. The importance of reporting incentives: Earnings management in european private and public firms. The Accounting Review 81, 983–1016.

Byoun, S., 2008. How and when do firms adjust their capital structures toward targets? Journal of Finance 63, 3069–3096.

Byoun, S., Wu, K., 2020. Understanding the effects of alternative cost-of-equity proxies on corporate investment and financing. Baylor University working paper.

Campbell, J., Dhaliwal, D., Schwartz, W., 2012. Financing constraints and the cost of capital: Evidence from the funding of corporate pension plans. Review of financial studies 25, 868–912.

Campbell, J. Y., Polk, C., Vuolteenaho, T., 2010. Growth or glamour? Fundamentals and systematic risk in stock returns. Review of Financial Studies 23, 305–344.

Chang, X., Dasgupta, S., Wong, G., Yao, J., 2014. Cash-flow sensitivities and the allocation of internal cash flow. Review of Financial Studies 27, 3628–3657.

Chen, Z., Dhaliwal, D. S., Xie, H., 2010. Regulation fair disclosure and the cost of equity capital. Review of Account Studies 15, 106–144.

Claus, J., Thomas, J., 2001. Equity premia as low as three percent? Evidence from analysts' earnings forecasts for domestic and international stock markets. The Journal of Finance 56, 1629–1666.

DeAngelo, H., DeAngelo, L., Stulz, R. M., 2010. Seasoned equity offerings, market timing, and the corporate lifecyle.

Dittmar, A., Duchin, R., Harford, J., 2019. Corporate cash holdings: A review of the empirical research. University of Michigan working paper.

Erickson, T., Jiang, C. H., Whited, T. M., 2014. Minimum distance estimation of the errors-in-variables model using linear cumulant equations. Journal of Econometrics 183, 211–221.

Fama, E. F., French, K. R., 2002. Testing tradeoff and pecking order predictions about dividends and debt. Review of Financial Studies 15, 1–33.

Fazzari, S. M., Hubbard, R. G., Petersen, B., 1998. Financing constraints and corporate investment. Brooking Papers on Economic Activity 1, 141–155.

Frank, M. Z., Goyal, V. K., 2003. Testing the pecking order theory of capital structure. Journal of Financial Economics 67, 217–248.

Frank, M. Z., Shen, T., 2016. Investment and the weighted average cost of capital. Journal of Financial Economics 119, 300–315.

Froot, K., Scharfstein, D., Stein, J., 1993. Risk management: Coordinating corporate investment and financing policies. The Journal of Finance 48, 1629–1658.

Gao, X., Whited, T. M., Zhang, N., 2020. Corporate money demand. Review of Financial Studies forthcoming.

Gebhardt, W. R., Lee, C. M. C., Swaminathan, B., 2001. Towards an ex-ante cost of capital. Journal of Accounting Research 38, 135–176.

Gomes, J. F., 2001. Financing investment. American Economic Review 91, 1263–1285.

Gomes, J. F., Yaron, A., Zhang, L., 2006. Asset pricing implications of firms financing constraints. Review of Financial Studies 19, 1321–1356.

Hadlock, C. J., Pierce, J. R., 2010. New evidence on measuring financial constraints: Moving beyond the KZ index. Review of Financial Studies 23, 1909–1940.

Han, S., Qiu, J., 2007. Corporate precautionary cash holdings. Journal of Corporate Finance 13, 43–57.

Hertzel, M. G., Li, Z., 2010. Behavioral and rational explanations of stock price performance around seos: Evidence from a decomposition of market-to-book ratios. Journal of Financial and Quantitative Analysis 45 (4), 1–24.

Hughes, J., Liu, J., Liu, J., 2009. On the relation between expected returns and implied cost of capital. Review of Accounting Studies 14, 246–259.

Kayhan, A., Titman, S., 2007. Firms' histories and their capital structures. Journal of Financial Economics 83, 1–32.

Keynes, J., 1936. The general theory of employment, interest and money.

Kim, W., Weisbach, M., 2008. Motivations for public equity offers: An international perspective. Journal of Financial Economics 87, 281–307.

Lee, C., So, E. C., Wang, C. C., 2020. Evaluating firm-level expected-return proxies: Implications for estimating treatment effects, Review of Financial Studies, forthcoming.

Li, Y., Ng, D. T., Swaminathan, B., 2013. Predicting market returns using aggregate implied cost of capital. Journal of Financial Economics 110, 419–436.

McLean, R. D., 2011. Share issuance and cash savings. Journal of Financial Economics 99, 693–715.

Myers, S. C., 1984. The capital structure puzzle. Journal of Finance 39, 575–592.

Myers, S. C., Majluf, N. S., 1984. Corporate financing and investment decisions when firms have information that investors do not have. Journal of Financial Economics 13, 187–221.

Opler, T., Pinkowitz, L., Stulz, R., Williamson, R., 1999. The determinants and implications of corporate cash holdings. Journal of Financial Economics 60, 4–46.

Qiu, J., Wan, C., 2015. Technology spillovers and corporate cash holdings. Journal of Financial Economics 115, 558–573.

Rajan, R. G., Zingales, L., 1998. Financial development and growth. American Economic Review 88, 393–410.

Riddick, L. A., Whited, T. M., 2009. The corporate propensity to save. Journal of Finance 64, 1729–1766.

Shyam-Sunder, L., Myers, S. C., 1999. Testing static trade-off against pecking order models of capital structure. Journal of Financial Economics 51, 219–244.

Stambaugh, R. F., Yu, J., Yuan, Y., 2015. Arbitrage asymmetry and the idiosyncratic volatility puzzle. Jounral of Finance 70, 1903–1948.

Sufi, A., 2009. Bank lines of credit in corporate finance: An empirical analysis. Review of Financial Studies 22, 1057–1088.

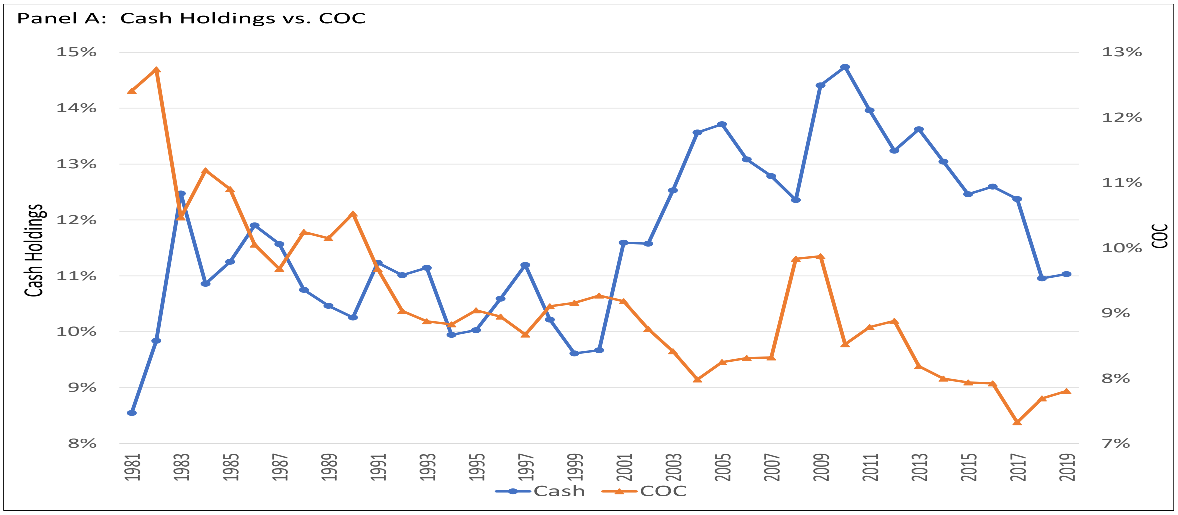
Whited, T., Wu, G., 2006. Financial constraints risk. Review of Financial Studies 19, 531–559.

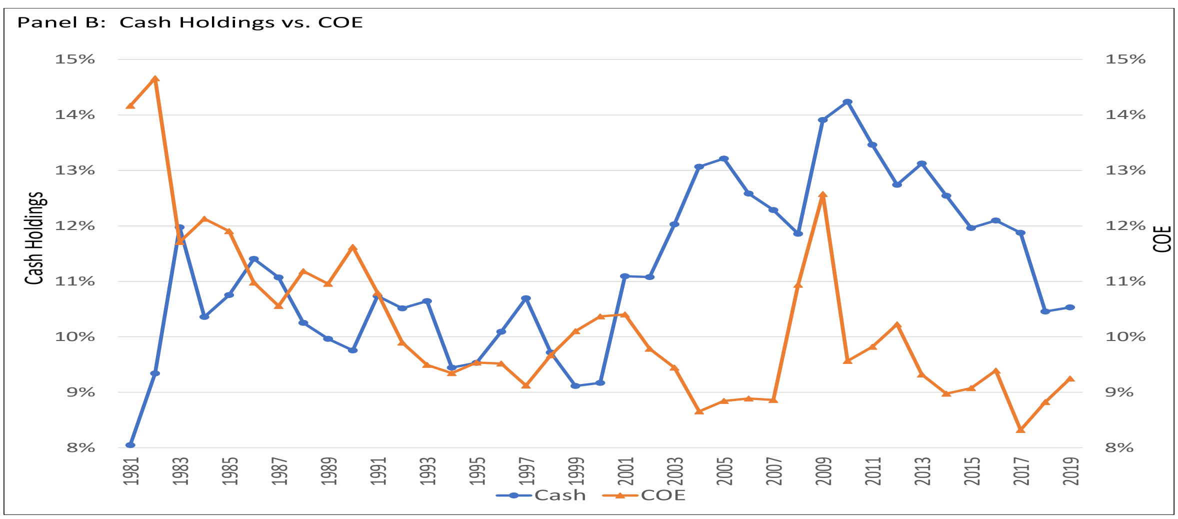
Whited, T. M., 1992. Debt, liquidity constraints, and corporate investment: Evidence from panel data. Journal of Finance 47, 1425–1460.

Xu, Z., 2020. Economic policy uncertainty, cost of capital, and corporate innovation. Journal of Banking and Finance 111, forthcoming.

Figure 1: Cash Holdings versus Cost of Capital

This figure plots firms' average cash holdings relative to the level of the cost of capital (COC, COE, COD) from 1981 to 2019. Cash is cash and equivalents divided by total assets.





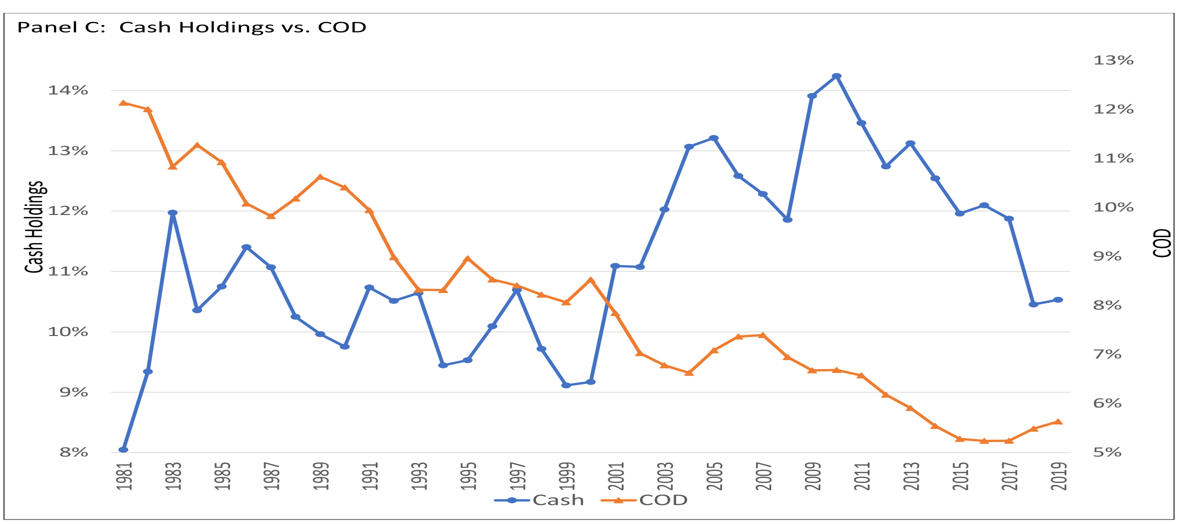


Figure 2: Cost of Capital and Cash Savings

The figure presents firms' cash savings across deciles of the deviation of cost of capital (COC) from its historical average for firms with a minimum of three-year observations for the sample period of 1981-2019 and the subsample periods of 1981-1999 and 2000-2019. Cash savings is the changes in cash and equivalents divided by total assets at the beginning of the year.

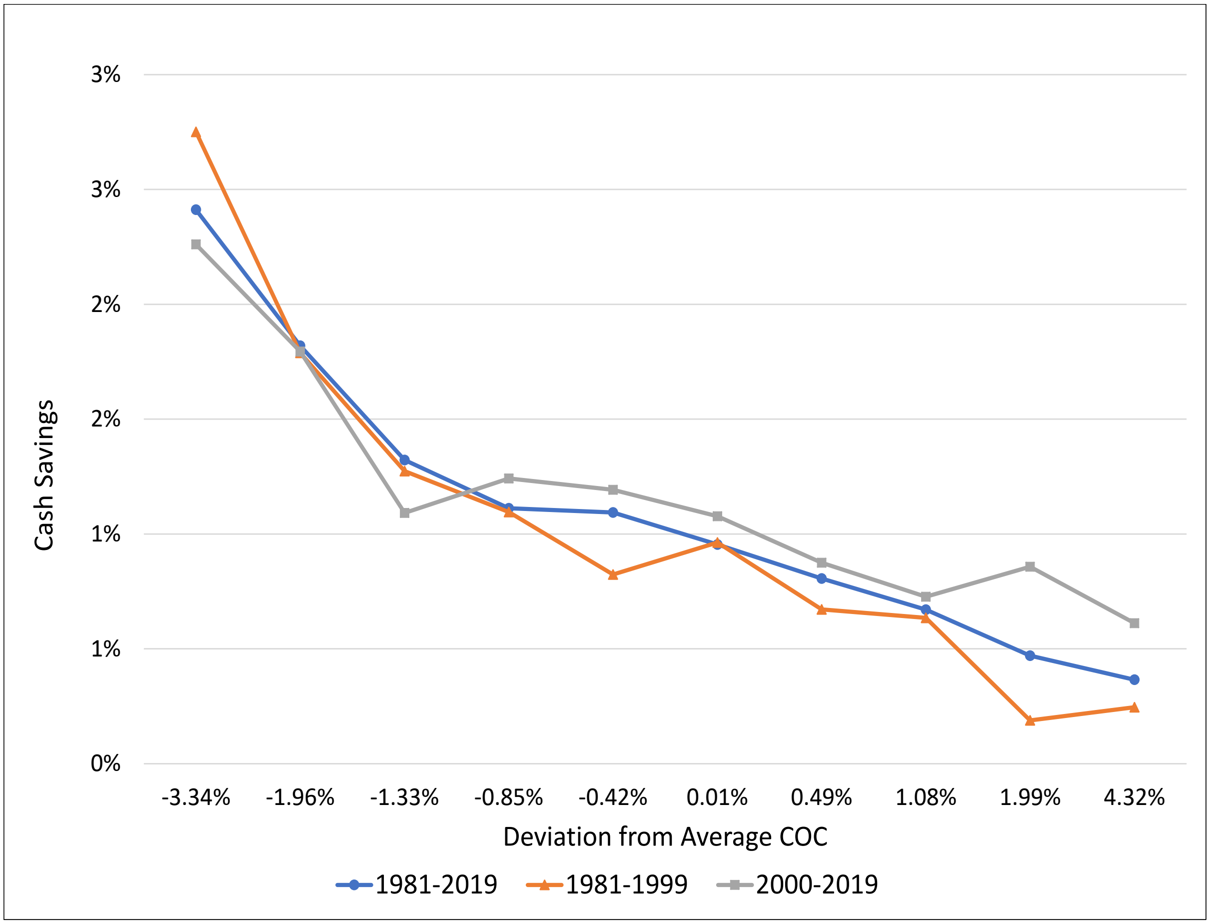


Figure 3: Cash Savings versus Future Investment

This figure plots firms' cash savings relative to future investment deciles. Future investment is defined as the three subsequent year average of net investment. Cash saving is the current year change in cash and equivalents divided by lagged total assets.

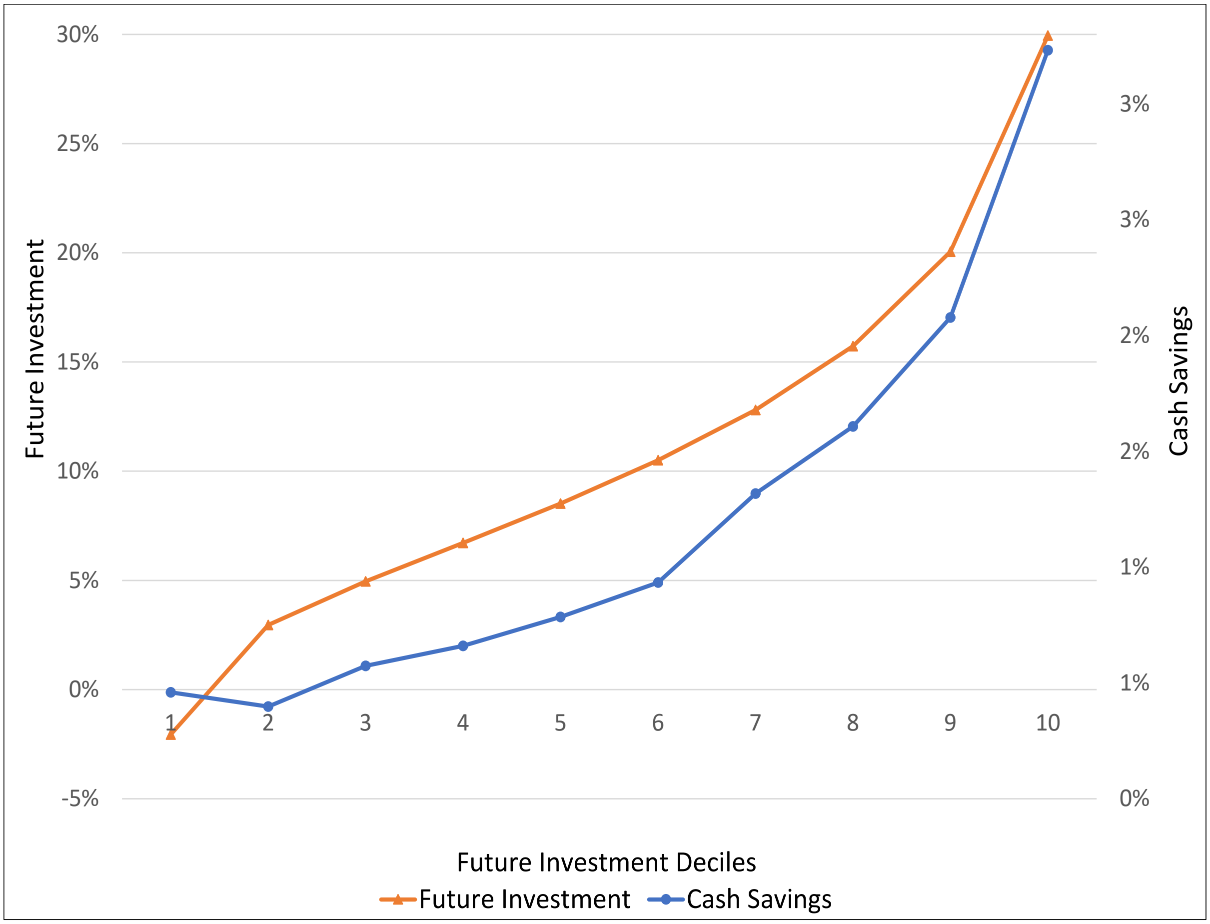
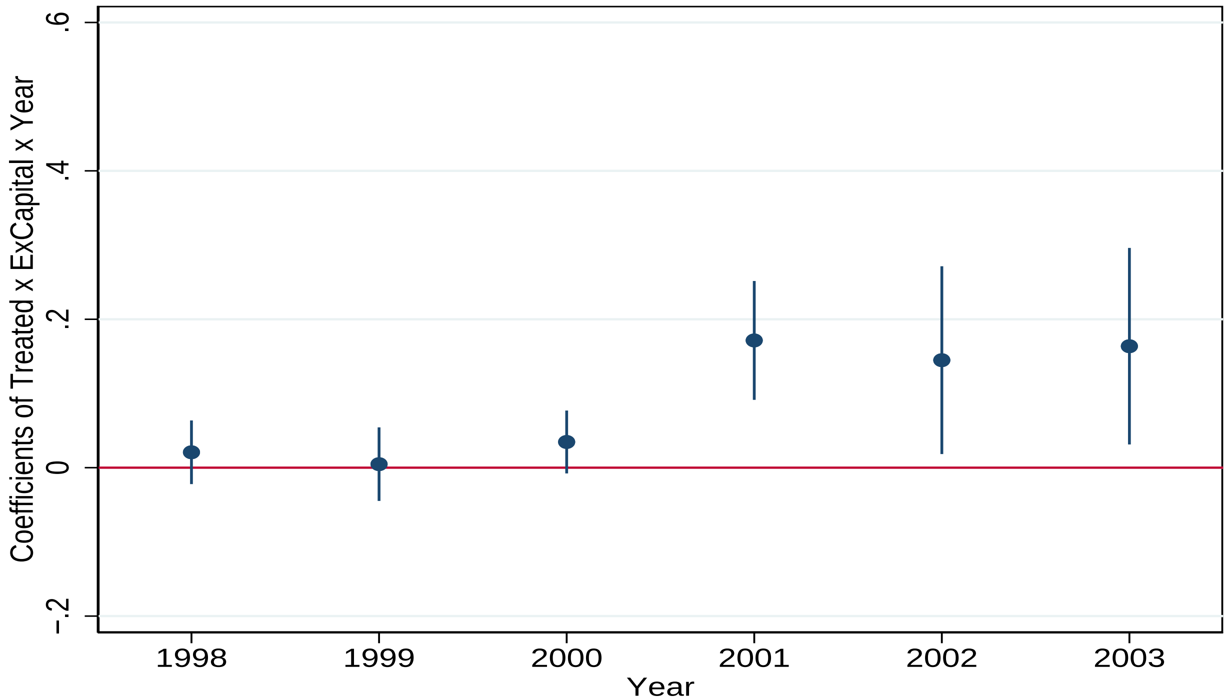


Figure 4: Dynamics of the Effects

This figure plots the differences in the sensitivities of cash savings to external capital around the adoption of Reg FD in October 2000 between treated and control firms. In the top panel, treatment firms are the top 50% of R&D-to-Sales ratio among positive R&D firms and control firms are zero-R&D firms. In the bottom panel, treatment and control firms are defined as top and bottom 30% of market-to-book ratio, respectively. All partition variables are measured as of the end of September 2000 before Reg FD.



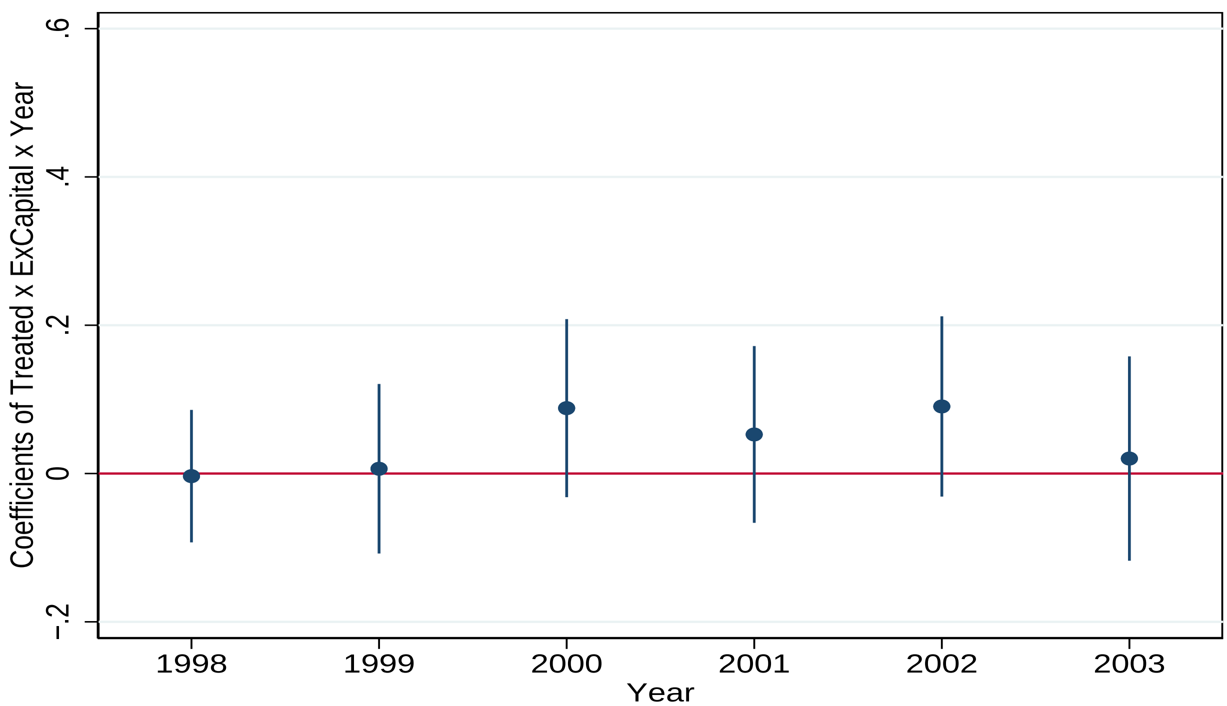


Table 1: Summary Statistics

This table reports the summary statistics of firm characteristics (Panel A) and standard deviation of cost of capital cross firms and over time (Panel B). ΔCash is the change in cash and equivalents ($Cash$) divided by total assets at the beginning of the year. $ExCapital$ and ICF are external capital and internal cash flow, respectively. NWC is net working capital excluding cash and equivalents. M/B is market-to-book asset ratio. Vol is cash flow volatility. $CapEx$ is capital expenditures. COE is cost of equity. COD is cost of debt. COC is weighted average of cost of capital. Detailed variable definitions are provided in the Appendix 6.

Panel A: Summary Statistics			
	Mean	Median	Standard Deviation
ΔCash	0.0118	0.0020	0.0808
Cash	0.1106	0.0644	0.1214
ExCapital	0.0330	-0.0109	0.1943
ICF	0.0221	0.0257	0.0613
Size	6.7279	6.6094	1.9510
M/B	1.7310	1.4398	0.9405
Vol	0.0108	0.0075	0.0102
Dividend	0.0141	0.0058	0.0200
Leverage	0.2456	0.2323	0.1625
NWC	0.1042	0.0866	0.1709
CapEx	0.0854	0.0602	0.1070
Acquisitions	0.0449	0.0000	0.1079
R&D	0.0258	0.0000	0.0479
COE	0.0962	0.0920	0.0328
COD	0.0701	0.0671	0.0292
COC	0.0849	0.0822	0.0249

Panel B: Decomposition of Standard Deviation		
	Cross-section	Time-series
COE	0.0256	0.0239
COD	0.0255	0.0200
COC	0.0199	0.0180

Table 2: Sensitivities of Cash Savings to Cash Sources

This table reports the sensitivities of cash savings to external capital and internal cash flows. The dependent variable is the change in cash and equivalents divided by total assets at the beginning of the year. *ExCapital* and *ICF* are external capital and internal cash flow, respectively. Control variables include *Leverage*, leverage ratio; *Size*; *NWC*, net working capital excluding cash and equivalents; *M/B*, market-to-book asset ratio; *Vol*, cash flow volatility, *CapEx*, capital expenditures; *Acquisitions*; *Divdend*; *lagged Cash*. Firm fixed effects are included in Column (2). Year fixed effects are included in Column (3). Firm and year fixed effects are included in Column (4). Standardized beta coefficients are reported in Column (5). Detailed variable definitions are provided in the Appendix 6. Standard errors are clustered at the firm level and corrected for heteroscedasticity. ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.

	(1)	(2)	(3)	(4)	(5)
ExCapital	0.2822***	0.2999***	0.2826***	0.2962***	0.6691
	[0.0060]	[0.0065]	[0.0059]	[0.0065]	
ICF	0.2299***	0.2212***	0.2356***	0.2189***	0.1806
	[0.0071]	[0.0079]	[0.0072]	[0.0080]	
Cash	-0.0894***	-0.2324***	-0.0897***	-0.2395***	-0.1419
	[0.0043]	[0.0068]	[0.0043]	[0.0070]	
M/B	0.0111***	0.0102***	0.0127***	0.0116***	0.14
	[0.0005]	[0.0007]	[0.0005]	[0.0007]	
Vol	0.1469***	0.3378***	0.1890***	0.1064**	0.0192
	[0.0319]	[0.0508]	[0.0338]	[0.0518]	
Dividend	-0.0038	0.0417	-0.0513***	0.03	-0.001
	[0.0192]	[0.0332]	[0.0196]	[0.0338]	
Leverage	-0.0348***	-0.0314***	-0.0338***	-0.0267***	-0.0718
	[0.0021]	[0.0038]	[0.0021]	[0.0038]	
Size	-0.0023***	-0.0100***	-0.0017***	-0.0139***	-0.0565
	[0.0002]	[0.0006]	[0.0002]	[0.0009]	
NWC	-0.0330***	0.0310***	-0.0373***	0.0310***	-0.0689
	[0.0025]	[0.0054]	[0.0025]	[0.0054]	
CapEx	-0.2756***	-0.3607***	-0.2882***	-0.3616***	-0.3626
	[0.0070]	[0.0086]	[0.0071]	[0.0087]	
Acquisitions	-0.3401***	-0.3528***	-0.3359***	-0.3475***	-0.4607
	[0.0079]	[0.0086]	[0.0079]	[0.0086]	
R&D	0.0925***	-0.1667***	0.0870***	-0.1637***	0.0564
	[0.0091]	[0.0324]	[0.0092]	[0.0322]	
Firm FEs	No	Yes	No	Yes	No
Year FEs	No	No	Yes	Yes	No
Observations	59,564	59,507	59,564	59,507	59,564
Adj. R^2	0.2685	0.3474	0.2826	0.3599	0.2685

Table 3: The Cost of Capital and Cash Savings

This table reports the sensitivities of cash savings to the cost of capital and sources of cash. The dependent variable is the change in cash and equivalents divided by total assets at the beginning of the year. *COC* is weighted average cost of capital. *ExCapital* and *ICF* are external capital and internal cash flow, respectively, divided by total assets at the beginning of the year. Detailed variable definitions are provided in the Appendix 6. The coefficient estimates of the control variables are not reported for brevity. Standard errors are clustered at the firm level and corrected for heteroscedasticity. ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
COC	-0.0196	-0.0177	0.0005	-0.1742***	-0.1685***	-0.1551***
	[0.0152]	[0.0156]	[0.0151]	[0.0218]	[0.0224]	[0.0219]
ExCapital	0.3299***	0.2826***	0.3339***	0.3380***	0.2960***	0.3409***
	[0.0128]	[0.0060]	[0.0130]	[0.0136]	[0.0065]	[0.0137]
ICF	0.2289***	0.3080***	0.3265***	0.2125***	0.2997***	0.3121***
	[0.0072]	[0.0249]	[0.0252]	[0.0080]	[0.0263]	[0.0264]
ExCapital×COC	-0.5985***		-0.6399***	-0.5314***		-0.5605***
	[0.1356]		[0.1371]	[0.1432]		[0.1440]
ICF×COC		-0.8380***	-1.0227***		-0.9151***	-1.0344***
		[0.2376]	[0.2400]		[0.2509]	[0.2515]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	No	No	No	Yes	Yes	Yes
Year FEs	No	No	No	Yes	Yes	Yes
Observations	59,564	59,564	59,564	59,507	59,507	59,507
Adj. R^2	0.2697	0.2689	0.2702	0.3620	0.3615	0.3625

Table 4: Hedging Motive

This table compares the impacts of the cost of capital on the sensitivities of cash savings to external capital between firms with high and low hedging motives. The dependent variable is the change in cash and equivalents divided by total assets at the beginning of the year. *ExCapital* and *ICF* are external capital and internal cash flow, respectively, divided by total assets at the beginning of the year. High and low hedging-need firms are defined as those in the top 30 percent and those in the bottom 30 percent, respectively based on the correlation between industry-level external finance and the COC (Hedging Motive 1), the correlation between financial deficit and the COC (Hedging Motive 2), and the correlation between *KZ* index and the COC (Hedging Motive 3). Detailed variable definitions are provided in the Appendix 6. Firm and year fixed effects are controlled. The coefficient estimates of the control variables are not reported for brevity. Standard errors are clustered at the firm level and corrected for heteroscedasticity. ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.

	Hedging Motive 1		Hedging Motive 2		Hedging Motive 3	
	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
COC	-0.1905***	-0.0733*	-0.3746***	0.1614***	-0.3583***	0.1211***
	[0.0389]	[0.0405]	[0.0363]	[0.0380]	[0.0381]	[0.0341]
ExCapital	0.3409***	0.3137***	0.4783***	0.3104***	0.3806***	0.2392***
	[0.0260]	[0.0222]	[0.0314]	[0.0246]	[0.0247]	[0.0237]
ICF	0.2941***	0.2884***	0.3994***	0.1932***	0.3538***	0.1670***
	[0.0453]	[0.0502]	[0.0405]	[0.0492]	[0.0413]	[0.0435]
ExCapital×COC	-0.9302***	-0.276	-1.7274***	0.0857	-1.1970***	-0.2543
	[0.2609]	[0.2439]	[0.2872]	[0.2812]	[0.2491]	[0.2412]
ICF×COC	-1.0880***	-0.7474	-1.7938***	-0.0104	-1.6359***	0.2709
	[0.4000]	[0.5212]	[0.3573]	[0.4624]	[0.3727]	[0.4489]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	17,770	17,633	17,795	17,660	17,710	17,945
Adj. R^2	0.3561	0.3748	0.3736	0.3816	0.3691	0.3015

Table 5: Excess Capital Issuance and Future Investment

This table compares the sensitivities of excess capital issuance to cost of capital (Panel A) and the sensitivities of cash savings to future investment (Panel B) between firms with high and low hedging motives. The dependent variable in Panel A is excess capital issues. COC is weighted average cost of capital. The dependent variable in Panel B is the change in cash and equivalents divided by total assets at the beginning of the year. $FInvest$ is future investment defined as the average of three subsequent years of capital expenditures plus acquisitions plus R&D divided by lagged total assets. High and low hedging-need firms are defined as those in the top 30 percent and those in the bottom 30 percent, respectively based on the correlation between industry-level external finance and the COC (Hedging Motive 1), the correlation between financial deficit and the COC (Hedging Motive 2), and the correlation between KZ index and the COC (Hedging Motive 3). Firm and year fixed effects are controlled. Detailed variable definitions are provided in the Appendix 6. The coefficient estimates of the control variables are not reported for brevity. Standard errors are clustered at the firm level and corrected for heteroscedasticity. ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.

Panel A: Excess Issuance

	Hedging Motive 1		Hedging Motive 2		Hedging Motive 3	
	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
COC	-1.0103***	0.4535***	-0.4472***	-0.084	-0.5884***	0.0526
	[0.0583]	[0.0598]	[0.0632]	[0.0665]	[0.0622]	[0.0597]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	17,795	17,660	17,770	17,633	17,710	17,945
Adj. R^2	0.2653	0.2185	0.2147	0.2143	0.1997	0.2038

Panel B: Future Investment

	Hedging Motive 1		Hedging Motive 2		Hedging Motive 3	
	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
FInvestment	0.0924**	0.0530	0.1324***	-0.0137	0.1588***	-0.0453
	[0.0382]	[0.0444]	[0.0418]	[0.0431]	[0.0416]	[0.0355]
FInvest$\times$ COC	-0.9929**	-0.4774	-1.3847***	0.0291	-1.8154***	0.6280
	[0.4208]	[0.4975]	[0.4429]	[0.4734]	[0.4538]	[0.4009]
COC	-0.2252***	-0.1303*	-0.2984***	-0.0799	-0.4068***	0.0409
	[0.0608]	[0.0693]	[0.0557]	[0.0675]	[0.0644]	[0.0553]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	13,908	13,474	14,025	13,540	13,410	14,139
Adj. R^2	0.2035	0.1773	0.1939	0.1682	0.2006	0.1713

Table 6: Cash Savings: Equity vs Debt

This table compares cash savings from equity issues versus debt issues versus internal cash flows (Panel A) and the sensitivities of cash savings to sources of cash and cost of capital between firms with high and low hedging motives (Panel B). The dependent variable is the change in cash and equivalents divided by total assets at the beginning of the year. High and low hedging-need firms are defined as those in the top 30 percent and those in the bottom 30 percent, respectively based on the correlation between industry-level external finance and the COC (Hedging Motive 1), the correlation between financial deficit and the COC (Hedging Motive 2), and the correlation between KZ index and the COC (Hedging Motive 3). Detailed variable definitions are provided in the Appendix 6. The coefficient estimates of the control variables are not reported for brevity. Standard errors are clustered at the firm level and corrected for heteroscedasticity. ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.

	Panel A: Equity vs Debt				
	(1)	(2)	(3)	(4)	(5)
Eissue	0.2804***			0.4741***	0.5001***
	[0.0069]			[0.0090]	[0.0099]
Dissue		0.0556***		0.2658***	0.2953***
		[0.0043]		[0.0077]	[0.0083]
ICF			0.1503***	0.2291***	0.2122***
			[0.0061]	[0.0072]	[0.0081]
Controls	No	No	No	Yes	Yes
Firm FEs	No	No	No	No	Yes
Year FEs	No	No	No	No	Yes
Observations	65,398	65,398	65,398	59,564	59,507
Adj. R^2	0.0940	0.0071	0.0130	0.2663	0.359

	Panel B: Cost of Equity vs Cost of Debt						
		Hedging Motive 1		Hedging Motive 2		Hedging Motive 3	
	All	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
COE	0.011	-0.1238***	0.0142	-0.1998***	0.1204***	-0.1905***	0.0793***
	[0.0148]	[0.0278]	[0.0299]	[0.0271]	[0.0278]	[0.0264]	[0.0247]
COD	-0.1427***	0.0591	-0.0009	-0.0514	0.0709	-0.0483	0.0493
	[0.0245]	[0.0794]	[0.0842]	[0.0784]	[0.0805]	[0.0790]	[0.0672]
Eissue	0.5601***	0.5488***	0.5143***	0.6164***	0.5688***	0.5863***	0.3284***
	[0.0245]	[0.0474]	[0.0432]	[0.0446]	[0.0415]	[0.0424]	[0.0489]
Dissue	0.3621***	0.3131***	0.3590***	0.3611***	0.3705***	0.3542***	0.2961***
	[0.0147]	[0.0258]	[0.0261]	[0.0279]	[0.0294]	[0.0272]	[0.0223]
ICF	0.3866***	0.2888***	0.3291***	0.4264***	0.2575***	0.3684***	0.1971***
	[0.0275]	[0.0469]	[0.0505]	[0.0457]	[0.0501]	[0.0420]	[0.0438]
Eissue×COE	-0.6070**	-1.1583**	-0.4279	-0.9207**	-0.6645	-1.6044***	0.2512
	[0.2591]	[0.4766]	[0.4619]	[0.4620]	[0.4355]	[0.4446]	[0.4997]
Dissue×COD	-0.9277***	-0.7475**	-0.9972***	-1.1978***	-1.0199***	-0.9228***	-0.7881***
	[0.1614]	[0.2925]	[0.3010]	[0.3182]	[0.3484]	[0.3014]	[0.2311]
ICF×COE	-1.5180***	-1.2391***	-1.3521***	-1.9480***	-0.5869*	-1.7244***	-0.3131
	[0.1795]	[0.2837]	[0.3363]	[0.2677]	[0.3249]	[0.2607]	[0.2981]
ICF×COD	-0.1019	0.5764	0.4394	0.3588	-0.1956	0.325	0.4758
	[0.2445]	[0.4340]	[0.4808]	[0.4237]	[0.4346]	[0.3566]	[0.4250]
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	59,507	17,770	17,633	17,795	17,660	17,710	17,945
Adj. R^2	0.3518	0.3616	0.3568	0.3756	0.3677	0.373	0.3021

Table 7: The Effect of Exogenous Shocks to the Cost of Capital on Cash Savings
This table reports the effects of exogenous shocks to the cost of capital on cash savings. We use Regulation Fair Disclosure of 2000 (Reg FD) (Columns 1 and 2) as a shock to the cost of capital. We set the *Post* dummy as zero for 1997-1999 and one for 2000-2003. The remaining columns report placebo tests based on fictitious event years of 2008 (Columns 3 and 4) and 2011 (Columns 5 and 6). In Columns 1, 3, and 5, treated firms are the top 50% of R&D-to-Sales ratio among positive R&D firms and control firms are zero-R&D firms. In Columns 2, 4, and 6, treatment and control firms are defined as top and bottom 30% of market-to-book ratio, respectively. All partition variables are measured as of the end of September 2000 before Reg FD. The dependent variable is the change in cash and equivalents divided by total assets at the beginning of the year. Firm and year fixed effects are controlled. Detailed variable definitions are provided in the Appendix 6. The coefficient estimates of the control variables are not reported for brevity. Standard errors are clustered at the firm level and corrected for heteroscedasticity. ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.

	Reg FD		Placebo 1		Placebo 2	
	(1)	(2)	(3)	(4)	(5)	(6)
Treated×Post	0.0075	0.0083**	0.0080	0.0030	0.0003	0.0042
	[0.0060]	[0.0040]	[0.0049]	[0.0036]	[0.0051]	[0.0034]
ExCapital×Post	0.0303	0.0674**	0.0588**	0.0146	-0.0123	0.0237
	[0.0194]	[0.0272]	[0.0282]	[0.0213]	[0.0267]	[0.0214]
ICF×Post	0.0139	0.0708	-0.0002	0.0034*	0.0010	0.0042
	[0.0410]	[0.0541]	[0.0023]	[0.0018]	[0.0031]	[0.0030]
Treated×ExCapital×Post	0.0860**	0.0982**	-0.0505	-0.0012	-0.0133	-0.0044
	[0.0383]	[0.0408]	[0.0415]	[0.0345]	[0.0443]	[0.0393]
Treated×ICF×Post	0.0883	-0.0039	-0.0013	-0.0064**	-0.0003	-0.0052
	[0.1016]	[0.0939]	[0.0035]	[0.0030]	[0.0044]	[0.0034]
Treated×ExCapital	-0.0372	0.0105	0.0737***	0.0455**	0.0506	0.0751**
	[0.0268]	[0.0134]	[0.0261]	[0.0200]	[0.0377]	[0.0305]
Treated×ICF	0.1000	0.1254**	0.0079**	0.0065**	0.0029	0.0061**
	[0.0821]	[0.0543]	[0.0039]	[0.0030]	[0.0041]	[0.0030]
ExCapital	0.3500***	0.0952***	0.3760***	0.3717***	0.4312***	0.3941***
	[0.0195]	[0.0104]	[0.0309]	[0.0253]	[0.0289]	[0.0286]
ICF	0.1687***	0.1164***	0.0038**	0.0051***	0.0074***	0.0053***
	[0.0313]	[0.0287]	[0.0016]	[0.0018]	[0.0023]	[0.0020]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,317	11,249	6,099	8,538	6,177	7,825
Adj. R^2	0.4301	0.2437	0.5164	0.4705	0.4727	0.4805

Table 8: Constrained vs Unconstrained Firms

This table compares the sensitivities of cash savings to cost of capital and sources of cash between financially constrained and unconstrained firms (Panel A). Constrained and unconstrained firms are defined as firms that do not have a credit rating and firms that have a credit rating (Columns 1 and 2), top and bottom 30% of WW index (Whited and Wu (2006)) (Columns 3 and 4), top and bottom 30% of HP index (Hadlock and Pierce (2010)) (Columns 5 and 6), respectively. The dependent variable is the change in cash and equivalents divided by total assets at the beginning of the year. *ExCapital* and *ICF* are external capital and internal cash flow, respectively, divided by total assets at the beginning of the year. Panel B compares cash savings from external capital and internal capital for financially constrained and unconstrained firms with high hedging motive using our hedging measure and using the Acharya et al. (2007) measure. The reported results are based on WW index and Hedging Motive 1 measure. Firm and year fixed effects are controlled. Detailed variable definitions are provided in the Appendix 6. The coefficient estimates on the control variables are not reported for brevity. Standard errors are clustered at the firm level and corrected for heteroscedasticity. ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.

Panel A: Cash Savings and the Cost of Capital						
	Rating		WW Index		HP Index	
	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained	Constrained
	(1)	(2)	(3)	(4)	(5)	(6)
COC	-0.0729***	-0.2982***	-0.1645***	-0.3488***	-0.1194***	-0.2116***
	[0.0243]	[0.0461]	[0.0378]	[0.0521]	[0.0431]	[0.0496]
ExCapital	0.3149***	0.3722***	0.3590***	0.3709***	0.3641***	0.3505***
	[0.0181]	[0.0223]	[0.0280]	[0.0232]	[0.0364]	[0.0246]
ICF	0.2910***	0.3750***	0.2988***	0.3697***	0.3852***	0.3569***
	[0.0311]	[0.0485]	[0.0553]	[0.0457]	[0.0579]	[0.0485]
ExCapital×COC	-0.4020**	-0.6819***	-0.8258***	-0.4541*	-1.0842***	-0.5147**
	[0.1911]	[0.2405]	[0.2891]	[0.2520]	[0.3394]	[0.2554]
ICF×COC	-1.1879***	-1.2552***	-1.1266**	-1.3089***	-1.9377***	-1.4170***
	[0.3005]	[0.4571]	[0.5168]	[0.4397]	[0.5536]	[0.4550]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	37,889	20,197	17,418	17,746	11,755	17,564
Adj. R^2	0.3342	0.419	0.3431	0.4331	0.3043	0.4001

	Panel B: Compare with AAC Measure			
	High Hedging Motive		High AAC Measure	
	Unconstrained	Constrained	Unconstrained	Constrained
	(1)	(2)	(3)	(4)
COC	-0.1862***	-0.4688***	-0.0814*	-0.3491***
	[0.0710]	[0.1123]	[0.0473]	[0.0655]
ExCapital	0.3692***	0.4344***	0.3026***	0.3541***
	[0.0454]	[0.0442]	[0.0336]	[0.0298]
ICF	0.3685***	0.4285***	0.2362***	0.3379***
	[0.0850]	[0.0988]	[0.0669]	[0.0590]
ExCapital×COC	-1.4010***	-1.2916***	-0.5579*	-0.3939
	[0.4499]	[0.4695]	[0.3282]	[0.3244]
ICF×COC	-1.6097**	-2.0681**	-0.6756	-1.0523*
	[0.7943]	[0.8692]	[0.6305]	[0.5711]
Controls	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Observations	4,850	3,808	10,693	10,909
Adj. R^2	0.3282	0.4540	0.3118	0.4106

Table 9: Alternative Motives

This table reports the test results of alternative motives for cash saving: market timing and precautionary Motive. The dependent variable is the change in cash and equivalents divided by total assets at the beginning of the year. Panel A compares the impacts of cost of capital on the sensitivities of cash savings to external capital between firms with high vs. low market timing motive. We measure market timing by the yearly timing (Timing 1), long-term timing (Timing 2) following Kayhan and Titman (2007), and mispricing proxy (Timing 3) developed by Stambaugh et al. (2015). For each measure, we define firms in the top 30 percent as firms with high market timing motive and those in the bottom 30 percent as firms with low market timing motive, dropping the middle 40 percent. Panel B compares the impacts of cost of capital on sensitivities of cash savings to equity issues between firms with high and low precautionary motives. Firms with high (low) precautionary motives are defined as those without (with) dividend payments, those in the top 30 percent (bottom 30 percent) based on R&D expenditures, the industry-level median cash flow volatility (*CF Risk*), and a precautionary motive measure (*Precaution*), respectively. *ExCapital* and *ICF* are external capital and internal cash flow, respectively, divided by total assets at the beginning of the year. Panel C and D test whether market timing or precautionary motive explains the sensitivities of excess capital issuance to cost of capital and the sensitivities of cash savings to future investment. For brevity, the results based on Timing 1 measure and *Precaution* are reported. Firm and year fixed effects are controlled. Detailed variable definitions are provided in the Appendix 6. The coefficient estimates of the control variables are not reported for brevity. Standard errors are clustered at the firm level and corrected for heteroscedasticity. ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.

Panel A: Market Timing Motive						
	Timing 1		Timing 2		Timing 3	
	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
COC	-0.2591***	-0.1276***	-0.2522***	-0.1680***	-0.1913***	-0.1518***
	[0.0531]	[0.0477]	[0.0577]	[0.0516]	[0.0512]	[0.0414]
ExCapital	0.3782***	0.3695***	0.3612***	0.3296***	0.3628***	0.3497***
	[0.0374]	[0.0343]	[0.0335]	[0.0398]	[0.0304]	[0.0253]
ICF	0.3200***	0.3632***	0.3456***	0.1986***	0.4029***	0.2637***
	[0.0547]	[0.0655]	[0.0642]	[0.0614]	[0.0639]	[0.0455]
ExCapital×COC	-0.7202*	-1.0525***	-0.8110**	-0.7619*	-0.6172*	-0.6422**
	[0.4128]	[0.3497]	[0.3611]	[0.4125]	[0.3302]	[0.2761]
ICF×COC	-1.3467***	-1.7534**	-1.8003***	-0.2250	-1.5796**	-0.9183**
	[0.5103]	[0.6830]	[0.6551]	[0.5757]	[0.6544]	[0.4260]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,407	11,401	11,509	11,627	14,245	14,159
Adj. R^2	0.3539	0.3339	0.3494	0.2987	0.3961	0.3624

Panel B: Precautionary Motive								
	Dividend		R&D		CFSD		Precaution	
	High	Low	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
COC	-0.1241***	-0.2778***	-0.2152***	-0.1186***	-0.1018***	-0.3678***	-0.0772**	-0.2655***
	[0.0252]	[0.0440]	[0.0357]	[0.0278]	[0.0374]	[0.0470]	[0.0393]	[0.0468]
ExCapital	0.2520***	0.3840***	0.4110***	0.2533***	0.3942***	0.3263***	0.3927***	0.3376***
	[0.0194]	[0.0192]	[0.0204]	[0.0188]	[0.0232]	[0.0270]	[0.0263]	[0.0265]
ICF	0.1302***	0.4224***	0.3946***	0.2082***	0.3530***	0.0356	0.4185***	0.2210***
	[0.0345]	[0.0406]	[0.0380]	[0.0358]	[0.0365]	[0.0747]	[0.0431]	[0.0603]
ExCapital×COC	-0.1966	-0.6165***	-0.6676***	-0.2602	-0.5542**	-0.6472**	-0.6750**	-0.6999***
	[0.1927]	[0.2100]	[0.2308]	[0.1905]	[0.2483]	[0.2694]	[0.2886]	[0.2677]
ICF×COC	0.1453	-1.8812***	-1.4409***	-0.4854	-1.3951***	1.2313*	-2.0530***	-0.3904
	[0.3304]	[0.3933]	[0.3642]	[0.3427]	[0.3729]	[0.6590]	[0.4382]	[0.5530]
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	34,489	24,367	27,766	31,572	17,703	17,111	17,228	17,154
Adj. R^2	0.2862	0.4124	0.4280	0.2978	0.4322	0.3674	0.4015	0.3797

Panel C: Excess Issuance				
	Market Timing		Precautionary	
	High	Low	High	Low
	(1)	(2)	(3)	(4)
COC	-0.5057***	-0.3341***	-0.3738***	-0.3482***
	[0.0986]	[0.0864]	[0.0673]	[0.0803]
Controls	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Observations	11,407	11,401	17,228	17,154
Adj. R^2	0.1750	0.2086	0.2094	0.2446

Panel D: Future Investment				
	Market Timing		Precautionary	
	High	Low	High	Low
	(1)	(2)	(3)	(4)
Finvest	0.0629	0.0814	0.0363	0.0721
	[0.0556]	[0.0523]	[0.0456]	[0.0470]
FInvest× COC	-1.1302*	-1.2347*	-0.1439	-0.8619*
	[0.6232]	[0.6437]	[0.5521]	[0.4952]
COC	-0.3101***	-0.1396*	-0.2410***	-0.3518***
	[0.0881]	[0.0797]	[0.0699]	[0.0784]
Controls	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Observations	8,867	9,011	13,309	13,960
Adj. R^2	0.1477	0.17	0.1785	0.2106

Appendix 1: The first-order conditions

For $X_t > 0$, the Lagrangian for the maximization problem in equation (1) at t can be written as follows:

$$\begin{aligned}L_t(I_t, C_t, X_t) &= E_t[\pi(I_t) + z_{t+1} - I_t - C_t - \lambda(\delta_t, X_t)] + \mu_t[X_t - I_t - C_t + W_t] + \psi_t C_t \\ &+ \int\limits_{I^*_{t+1}-C_t-\pi(I_t)}^{\infty} \left\{\pi(I^*_{t+1}) - I^*_{t+1}\right\} g(z)dz \qquad \text{(A.1)} \\ &+ \int\limits_{-\infty}^{I^*_{t+1}-C_t-\pi(I_t)} \{\pi(X_{t+1} + C_t + \pi(I_t) + z_{t+1}) - I_{t+1} - \lambda(\delta_{t+1}, X_{t+1})\} g(z)dz.\end{aligned}$$

where μ_t and ψ are Lagrange multipliers for the constraints in equation (1). Applying Leibnitz integral rule, the first order conditions for I_t, C_t, X_t, and μ_t, respectively, are

$$\begin{aligned}\frac{\partial L_t}{\partial I_t} &= \pi_I(I_t) - 1 - \mu_t + \pi_I(I_t)\left[\pi(I^*_{t+1}) - I^*_{t+1}\right] g[I^*_{t+1} - C_t - \pi(I_t)] \\ &\quad + \pi_I(I_t)\left(\int\limits_{-\infty}^{I^*_{t+1}-C_t-\pi(I_t)} \{\pi_I(X_{t+1} + C_t + \pi(I_t) + z_{t+1}) - 1 + \lambda_X(\delta_{t+1}, X_{t+1})\} g(z) \right. \\ &\quad \left. - \left[\pi(I^*_{t+1}) - I^*_{t+1}\right] g[I^*_{t+1} - C_t - \pi(I_t)] \right) \\ &= \pi_I(I_t) - 1 - \mu_t \\ &\quad + \pi_I(I_t)\left(\int\limits_{-\infty}^{I^*_{t+1}-C_t-\pi(I_t)} \{\pi_I(X_{t+1} + C_t + \pi(I_t) + z_{t+1}) - 1 + \lambda_X(\delta_{t+1}, X_{t+1})\} g(z)dz \right) \\ &= [1 + H]\pi_I(I_t) - 1 - \mu_t = 0 \qquad \text{(A.2)} \\ \frac{\partial L_t}{\partial C_t} &= H - 1 - \mu_t + \psi_t = 0 \qquad \text{(A.3)} \\ \frac{\partial L_t}{\partial X_t} &= -\lambda_X(\delta_t, X_t) + \mu_t = 0 \qquad \text{(A.4)} \\ \frac{\partial L_t}{\partial \mu_t} &= X_t - I_t - C_t + W_t = 0, \qquad \text{(A.5)}\end{aligned}$$

where

$$H = \int_{-\infty}^{I^*_{t+1}-C_t-\pi(I_t)} \{\pi_I(X_{t+1}+C_t+\pi(I_t)+z_{t+1}) - 1 + \lambda_X(\delta_{t+1}, X_{t+1})\}\, g(z)dz. \tag{A.6}$$

If the firm is financially unconstrained with sufficient initial endowment to make the initial investment and cash savings decisions ($W_t \geq C_t + I_t$ or $X_t \leq 0$), we have $\lambda(\delta_t, X_t) = 0$ and the first order conditions are

$$\frac{\partial L_t}{\partial I_t} = (1+H)\pi_I(I_t) - 1 = 0 \tag{A.7}$$

$$\frac{\partial L_t}{\partial C_t} = H - 1 + \psi_t = 0 \tag{A.8}$$

$$\frac{\partial L_t}{\partial X_t} = \mu_t = 0 \tag{A.9}$$

$$\frac{\partial L_t}{\partial \mu_t} = X_t - I_t - C_t + W_t = 0. \tag{A.10}$$

Given $\pi_{II} < 0$ and Assumption 1, the second-order condition is also satisfied as the Hessian matrix of the Lagrangian is negative definite.

Appendix 2: Comparative Statics and Proof of Proposition 1

To examine how optimal investment, $\hat{I}_t$, cash savings, $\hat{C}_t$, and external finance $\hat{X}_t$ are affected by COC at t, we rearrange the FOCs in equations (A.2) to (A.5):

$$[1+H]\pi_I(\hat{I}_t) - 1 - \lambda_X(\delta_t, \hat{X}_t) = 0 \tag{A.11}$$

$$H - 1 - \lambda_X(\delta_t, \hat{X}_t) = 0 \tag{A.12}$$

$$\hat{X}_t - \hat{I}_t - \hat{C}_t + W_t = 0, \tag{A.13}$$

From the FOCs we have $\pi_I(\hat{I}_t) = \frac{H}{1+H}$ which implies $\pi_I(\hat{I}_t) - 1 = \frac{-1}{1+H} < 0$. We also assume the second-order condition with respect to I_t is satisfied: i.e., $\pi_{II}(\hat{I}_t) - \frac{H_I}{(1+H)^2} < 0$. These conditions imply $\pi_{II}(\hat{I}_t)(1+H) + H_I[\pi_I(\hat{I}_t) - 1] < 0$.

We now differentiate each of the FOCs in equations (A.11) to (A.13) w.r.t. δ_t as follows:

$$\begin{aligned}
\{H_I\pi_I(\hat{I}_t) + (1+H)\pi_{II}(\hat{I}_t)\}\frac{d\hat{I}_t}{d\delta_t} + H_C\pi_I(\hat{I}_t)\frac{d\hat{C}_t}{d\delta_t} - \lambda_{XX}\frac{d\hat{X}_t}{d\delta_t} - \lambda_{X\delta} &= 0 \quad (A.14)\\
H_I\frac{d\hat{I}_t}{d\delta_t} + H_C\frac{d\hat{C}_t}{d\delta_t} - \lambda_{XX}\frac{d\hat{X}_t}{d\delta_t} - \lambda_{X\delta} &= 0 \quad (A.15)\\
-\frac{d\hat{I}_t}{d\delta_t} - \frac{d\hat{C}_t}{d\delta_t} + \frac{d\hat{X}_t}{d\delta_t} &= 0 \quad (A.16)
\end{aligned}$$

where

$$\begin{aligned}
H_C &= \int_{-\infty}^{I^*_{t+1}-\hat{C}_t-\pi(\hat{I}_t)} \left[\pi_{II}(\hat{X}_{t+1}+\hat{C}_t+\pi(\hat{I}_t)+z_{t+1}) - \lambda_{XX}(\delta_{t+1},\hat{X}_{t+1})\right] g(z)dz < 0,\\
H_I &= \pi_I(\hat{I}_t)H_C < 0. \quad (A.17)
\end{aligned}$$

H_I and H_C represent the rate of change in the marginal benefit of cash due to increased investment and cash savings at time t, respectively.

After subtracting $\pi_I(\hat{I})$ times (A.15) from (A.14), the determinant of the Jacobian matrix of the derivatives is

$$\begin{aligned}
D &= \begin{vmatrix} (1+H)\pi_{II}(\hat{I}_t) & 0 & (\pi_I - 1)\lambda_{XX} \\ H_I & H_C & -\lambda_{XX} \\ -1 & -1 & 1 \end{vmatrix}\\
&= (1+H)\pi_{II}(\hat{I}_t)[H_C - \lambda_{XX}(\delta_t,\hat{X}_t)] - \lambda_{XX}(\delta_t,\hat{X}_t)H_C[\pi_I(\hat{I}_t)-1]^2 > 0. \quad (A.18)
\end{aligned}$$

By the implicit function theorem and Crammer's rule we get

$$\frac{\partial\hat{I}_t}{\partial\delta_t} = \frac{\begin{vmatrix} (1-\pi_I)\lambda_{X\delta} & 0 & (\pi_I-1)\lambda_{XX} \\ \lambda_{X\delta} & H_C & -\lambda_{XX} \\ 0 & -1 & 1 \end{vmatrix}}{D} = \frac{\lambda_{X\delta}(\delta_t,\hat{X}_t)H_C[1-\pi_I(\hat{I}_t)]}{D} < 0, \quad (A.19)$$

$$\begin{aligned}
\frac{\partial\hat{C}_t}{\partial\delta_t} &= \frac{\begin{vmatrix} (1+H)\pi_{II}(\hat{I}_t) & (1-\pi_I)\lambda_{X\delta} & (\pi_I-1)\lambda_{XX} \\ H_I & \lambda_{X\delta} & -\lambda_{XX} \\ -1 & 0 & 1 \end{vmatrix}}{D} \quad (A.20)\\
&= \frac{\lambda_{X\delta}(\delta_t,\hat{X}_t)\left\{[H_I[\pi_I(\hat{I}_t)-1] + (1+H)\pi_{II}(\hat{I}_t)\right\}}{D} < 0,
\end{aligned}$$

$$\frac{\partial \hat{X}_t}{\partial \delta_t} = \frac{\begin{vmatrix} (1+H)\pi_{II}(\hat{I}_t) & 0 & (1-\pi_I)\lambda_{X\delta} \\ H_I & H_C & \lambda_{X\delta} \\ -1 & -1 & 0 \end{vmatrix}}{D} \tag{A.21}$$
$$= \frac{\lambda_{X\delta}(\delta_t, \hat{X}_t)\left\{[H_C[\pi_I(\hat{I}_t) - 1]^2 + (1+H)\pi_{II}(\hat{I}_t)\right\}}{D} < 0.$$

These results suggest that the firm decreases investment, cash savings, and external finance when facing higher external finance cost.

To prove Proposition 1, we differentiate each FOC w.r.t. δ_{t+1} as follows:

$$\{H_I\pi_I(\hat{I}_t) + (1+H)\pi_{II}(\hat{I}_t)\}\frac{d\hat{I}_t}{d\delta_{t+1}} + H_C\pi_I(\hat{I}_t)\frac{d\hat{C}_t}{d\delta_{t+1}} - \lambda_{XX}(\delta_t, \hat{X}_t)\frac{d\hat{X}_t}{d\delta_{t+1}} + H_\delta\pi_I(\hat{I}_t) = 0 \tag{A.22}$$
$$H_I\frac{d\hat{I}_t}{d\delta_{t+1}} + H_C\frac{d\hat{C}_t}{d\delta_{t+1}} - \lambda_{XX}(\delta_t, \hat{X}_t)\frac{d\hat{X}_t}{d\delta_{t+1}} + H_\delta = 0 \tag{A.23}$$
$$-\frac{d\hat{I}_t}{d\delta_{t+1}} - \frac{d\hat{C}_t}{d\delta_{t+1}} + \frac{d\hat{X}_t}{d\delta_{t+1}} = 0 \tag{A.24}$$

where

$$H_\delta = \int_{-\infty}^{I^*_{t+1}-\hat{C}_t-\pi(\hat{I}_t)} \lambda_{X\delta}(\delta_{t+1}, \hat{X}_{t+1})g(z)dz > 0. \tag{A.25}$$

H_δ represents the rate of change in the marginal benefit of cash due to an increase in external finance cost at $t+1$.

After subtracting $\pi_I(\hat{I})$ times (A.23) from (A.22), the determinant of the Jacobian matrix of the derivatives remains the same as D. Thus, we get

$$\frac{\partial \hat{I}_t}{\partial \delta_{t+1}} = \frac{\begin{vmatrix} 0 & 0 & (\pi_I - 1)\lambda_{XX} \\ -H_\delta & H_C & -\lambda_{XX} \\ 0 & -1 & 1 \end{vmatrix}}{D} = \frac{\lambda_{XX}(\delta_t, \hat{X}_t)H_\delta[\pi_I(\hat{I}_t) - 1]}{D} < 0, \tag{A.26}$$

$$\frac{\partial \hat{C}_t}{\partial \delta_{t+1}} = \frac{\begin{vmatrix} (1+H)\pi_{II}(\hat{I}_t) & 0 & (\pi_I - 1)\lambda_{XX} \\ H_I & -H_\delta & -\lambda_{XX} \\ -1 & 0 & 1 \end{vmatrix}}{D} \tag{A.27}$$
$$= \frac{-H_\delta \left\{ \lambda_{XX}(\delta_t, \hat{X}_t)[\pi_I(\hat{I}_t) - 1] + (1+H)\pi_{II}(\hat{I}_t) \right\}}{D} > 0,$$

$$\frac{\partial \hat{X}_t}{\partial \delta_{t+1}} = \frac{\begin{vmatrix} (1+H)\pi_{II}(\hat{I}_t) & 0 & 0 \\ H_I & H_C & -H_\delta \\ -1 & -1 & 0 \end{vmatrix}}{D} \tag{A.28}$$
$$= \frac{-H_\delta(1+H)\pi_{II}(\hat{I}_t)}{D} > 0.$$

The result for $X_t \leq 0$ follows by noting $\lambda_{XX}(\delta_t, \hat{X}_t) = 0$. These results suggest that both the optimal cash saving and the optimal external finance at t increase, while the optimal investment does not increase, when expecting a higher COC at $t+1$.

We also note that differentiating the FOCs w.r.t. I_{t+1} yields the same results as the above with δ replaced by I_{t+1}:

$$\{H_I \pi_I(\hat{I}_t) + (1+H)\pi_{II}(\hat{I}_t)\}\frac{d\hat{I}_t}{dI_{t+1}} + H_C \pi_I(\hat{I}_t)\frac{d\hat{C}_t}{dI_{t+1}} - \lambda_{XX}(\delta_t, \hat{X}_t)\frac{d\hat{X}_t}{dI_{t+1}} + H_{I_{t+1}}\pi_I(\hat{I}_t) = 0 \tag{A.29}$$
$$H_I \frac{d\hat{I}_t}{dI_{t+1}} + H_C \frac{d\hat{C}_t}{dI_{t+1}} - \lambda_{XX}(\delta_t, \hat{X}_t)\frac{d\hat{X}_t}{dI_{t+1}} + H_{I_{t+1}} = 0 \tag{A.30}$$
$$-\frac{d\hat{I}_t}{dI_{t+1}} - \frac{d\hat{C}_t}{dI_{t+1}} + \frac{d\hat{X}_t}{dI_{t+1}} = 0 \tag{A.31}$$

where

$$H_{I_{t+1}} = \int_{-\infty}^{I^*_{t+1} - \hat{C}_t - \pi(\hat{I}_t)} \lambda_{XX}(\delta_{t+1}, \hat{X}_{t+1}) g(z) dz > 0. \tag{A.32}$$

Thus, we get the following as in equations A.26 - A.28

$$\frac{\partial \hat{I}_t}{\partial I_{t+1}} = \frac{\lambda_{XX}(\delta_t, \hat{X}_t) H_I [\pi_I(\hat{I}_t) - 1]}{D} < 0, \tag{A.33}$$

$$\frac{\partial \hat{C}_t}{\partial I_{t+1}} = \frac{-H_{I_{t+1}}\left\{\lambda_{XX}(\delta_t, \hat{X}_t)[\pi_I(\hat{I}_t) - 1] + (1+H)\pi_{II}(\hat{I}_t)\right\}}{D} > 0,$$

$$\frac{\partial \hat{X}_t}{\partial I_{t+1}} = \frac{-H_{I_{t+1}}(1+H)\pi_{II}(\hat{I}_t)}{D} > 0. \tag{A.34}$$

The result for $X_t \leq 0$ follows by noting $\lambda_{XX}(\delta_t, \hat{X}_t) = 0$.

Appendix 3: External Finance Cost and Investment Decisions Conditional on Cash Flow

Consider a production function $\pi^o(I) = \pi(I)\,(1+\beta z)$, where β measures the effect of z on investment opportunities. Given that π is homogeneous of degree one, $\pi_I^o(I) = \pi_I(I)\,(1+\beta z) = \pi_I\left[I(1+\beta z)\right](1+\beta z)$, that is, the expected and marginal profits of production remain the same. Thus, for a given z, the optimal investment and external finance stemming from $\pi^o(I)$ should be given by $I^o = \bar{I} + \beta\bar{I}z$ and $X^o = I^o - \pi(I_t) - C - z = \bar{X} + (\beta\bar{I} - 1)z$, where $\bar{I}$ and $\bar{X}$ are the expected values of I^o and X^o, respectively. Thus, we have $\frac{dX^o}{dz} = \beta\bar{I} - 1$.

Given $\delta^o = \delta + \frac{\alpha\sigma_\delta}{\sigma}z$, we also have $\frac{d\delta^o}{dz} = \frac{\alpha\sigma_\delta}{\sigma}$. Based on the above results, we measure the relative effects of z on δ^o and X^o as follows:

$$\gamma = \frac{d\delta^o}{dX^o} = \frac{\left[\frac{d\delta^o}{dz}\right]}{\left[\frac{dX^o}{dz}\right]} = \frac{\alpha\sigma_\delta}{(\beta I - 1)\sigma}. \tag{A.35}$$

Noting $X^o - \bar{X} = (I\beta - 1)z$, we obtain

$$\delta^o = \delta + \frac{\alpha\sigma_\delta}{\sigma}z = \delta + \frac{\alpha\sigma_\delta}{(I\beta - 1)\sigma}(X^o - \bar{X}) = \delta + \gamma\left(X^o - \bar{X}\right). \tag{A.36}$$

We also note that conditional on z, $\frac{d\delta^o}{dX^o} = \frac{\rho\sigma_\delta}{\sigma_X}$, where σ_X and ρ are the standard deviation of X^o and the correlation between X^o and δ^o. Thus, the correlation between X^o and δ^o is critical in determining the relative effects of z on δ^o and X^o.

Appendix 4: Proof of Proposition 2

Using $\lambda(\delta_{t+1}^o, X_{t+1}^o)$, π^o, and H^o, we obtain results similar to Proposition 1 in terms of the optimal decisions at t, I_t^o, C_t^o, and X_t^o by solving the maximization program in equation (A.1). It turns out that γ only affects H^o and its derivatives through $\lambda(\delta^o, X^o)$ at $t+1$. Consequently, we have the following:

$$H^o = \int_{-\infty}^{I^*-C_t-\pi(I_t)} \{\pi_I^o(I^o) - 1 + \lambda_X(\delta^o, X^o) + \gamma\lambda_\delta(\delta^o, X^o)\}\, g(z)dz > 0. \tag{A.37}$$

Thus, we have

$$\begin{aligned}
H_C^o &= \int_{-\infty}^{I_{t+1}^*-C_t-\pi(I_t)} \{\pi_{II}^o(I^o) - \lambda_{XX}(\delta^o, X^o) - 2\gamma\lambda_{X\delta}(\delta^o, X^o) \\
&\quad -\gamma^2\lambda_{\delta\delta}(\delta^o, X^o)\Big\}\, g(z)dz < 0, \\
H_\delta^o &= \int_{-\infty}^{I_{t+1}^*-C_t-\pi(I_t)} \{\lambda_{X\delta}(\delta^o, X^o) + \gamma\lambda_{\delta\delta}(\delta^o, X^o)\}\, g(z)dz > 0, \\
H_\gamma^o &= \int_{-\infty}^{I_{t+1}^*-C_t-\pi(I_t)} \left\{\lambda_{X\delta}(\delta^o, X^o)(X^o - \bar{X}) + \gamma\lambda_{\delta\delta}(\delta^o, X^o)(X^o - \bar{X})\right\} g(z)dz > 0,
\end{aligned}$$

given $X^o > \bar{X}$ for $z < I_{t+1}^* - C_t - \pi(I_t)$. We also have $H_I^o = \pi_I(\hat{I}_t)H_C^o < 0$ and $H_\gamma^o = H_\delta^o\left(\frac{d\delta^o}{d\gamma}\right)$.

After differentiating the FOCs with respect to γ, the determinant of the Jacobian matrix of the derivatives on the FOCs is

$$D^o\left(\frac{d\delta^o}{d\gamma}\right) = \left\{(1+H)\pi_{II}(\hat{I}_t)[H_C - \lambda_{XX}(\delta_t, \hat{X}_t)] - \lambda_{XX}(\delta_t, \hat{X}_t)H_C[\pi_I(\hat{I}_t) - 1]^2\right\}\left(\frac{d\delta^o}{d\gamma}\right).$$

We then derive

$$\frac{\partial I_t^o}{\partial\gamma} = \frac{\partial I_t^o}{\partial\delta^o}\frac{\partial\delta^o}{\partial\gamma} = \frac{\lambda_{XX}(\delta_t^o, X_t^o)H_\delta^o[\pi_I(I_t^o) - 1]}{D^o} < 0, \tag{A.38}$$

$$\frac{\partial C_t^o}{\partial\gamma} = \frac{\partial C_t^o}{\partial\delta^o}\frac{\partial\delta^o}{\partial\gamma} = \frac{-H_\delta^o\{\lambda_{XX}(\delta_t^o, X_t^o)[\pi_I(I_t^o) - 1] + (1+H^o)\pi_{II}(I_t^o)\}}{D^o} > 0, \tag{A.39}$$

$$\frac{\partial X_t^o}{\partial\gamma} = \frac{\partial X_t^o}{\partial\delta^o}\frac{\partial\delta^o}{\partial\gamma} = \frac{-H_\delta^o(1+H^o)\pi_{II}(I_t^o)}{D^o} > 0, \tag{A.40}$$

The result for $X_t^o \leq 0$ follows by noting $\lambda_{XX}(\delta_t^o, X_t^o) = 0$.

Appendix 5: A Dynamic Model

We build upon the models of Whited (1992), Whited and Wu (2006) and Gomes et al. (2006) to consider the effects of the time-varying cost of external capital on cash savings in a dynamic setting. The firm maximizes the expected discounted value of future cash flows:

$$V_t = \max_{(I_t, K_{t+j}, C_{t+j})_{j=0}^{\infty}} E_t \sum_{j=0}^{\infty} M_{t,t+j} \{d_{t+j} - \lambda_t(X_t, \gamma)\}, \tag{A.41}$$

where E_t is the expectation operator conditional on information at time t, $M_{t,t+j}$ is the discount factor at time t for cash flows at $t+j$, and d_{t+j} is cash flow at time $t+j$ given as:

$$d_t = \pi(K_t, S_t) - \phi(K_t, I_t) - I_t + X_t + C_t - C_{t+1}, \tag{A.42}$$

where K_t is the capital stock at time t; I_t is investment between t and $t+1$; X_t is the amount of external finance at t; $\pi(K_t, S_t)$ is the cash flow at time t from production with the first partial derivative with regard to K given as $\pi_K > 0$; S_t is an exogenous state variable; $\phi(K_t, I_t)$ is the cost of adjustment, with the partial derivatives satisfying $\phi_I > 0, \phi_{II} > 0$ and $\phi_K < 0$;[12] C_t is the liquid asset called "cash" at time t.

Thus, the model allows firms to invest in two distinctive assets with possibly different returns: capital stock K_t and cash C_t. The external finance cost function, $\lambda_t(X_t, \gamma)$, varies with time, which may be due to market frictions such as asymmetric information. γ is a measure of the strength of the correlation between the external capital needs and the cost of external capital. We also assume $\lambda_t(X_t) > 0$ and $\lambda_t'(X_t) > 0$ for $X_t > 0$ whereas $\lambda_t(X_t) = 0$ for $X_t \leq 0$, which implies that the marginal external financing cost increases with the amount of external capital raised (see Gomes (2001)).

Capital accumulation follows the rule:

$$K_{t+1} = (1 - \delta)K_t + I_t, \tag{A.43}$$

where δ is the depreciation rate, $\delta \in (0, 1)$. The dividend constraint is

$$d_t \geq d^*, \tag{A.44}$$

This constraint on d has the same effect as a restriction on external capital as seen in financial constraint models.

[12] These conditions imply a convex adjustment cost with economies of scale. $f_x = f'$ and $f_{xx} = f''$ denote the first and second derivatives, respectively, of $f(x)$ with respect to x.

The Lagrangian function conditional on the information set at time t is

$$V_t = \max_{(I_{t+j},K_{t+j},C_{t+j},X_{t+j})_{j=0}^{\infty}} E_t \sum_{j=0}^{\infty} M_{t,t+j} \{(1+\mu_{t+j})d_{t+j} - \lambda_{t+j}(X_{t+j},\gamma) \tag{A.45}$$
$$-q_{t+j}[K_{t+1+j} - (1-\delta)K_{t+j} - I_{t+j}]\}$$

where q_t and μ_t are the Lagrange multipliers for constraints (A.43) and (A.44), respectively. The first-order conditions for maximizing the firm value at t with respect to I_t, K_{t+1}, C_{t+1}, and X_{t+1}, respectively, are given as follows:

$$\frac{\partial V_t}{\partial I_t} = -(1+\mu_t)[\phi_I(K_t,I_t)+1]+q_t = 0; \tag{A.46}$$

$$\frac{\partial V_t}{\partial K_{t+1}} = E_t\left(M_{t,t+1}\left\{(1+\mu_{t+1})[\pi_K(K_{t+1},S_{t+1}) - \phi_K(K_{t+1},I_{t+1})] + (1-\delta)q_{t+1}\right\}\right)$$
$$-q_t = 0; \tag{A.47}$$

$$\frac{\partial V_t}{\partial C_{t+1}} = E_t\{M_{t,t+1}(1+\mu_{t+1})\} - (1+\mu_t) = 0; \quad \text{and} \tag{A.48}$$

$$\frac{\partial V_t}{\partial X_t} = 1+\mu_t - \lambda_t'(X_t,\gamma) = 0. \tag{A.49}$$

Equation (A.46) suggests that a firm's optimal investment is determined to be where the product of the opportunity cost of external financing and the marginal cost of adjustment is equal to the marginal rate of return on the investment at t. Clearly, the firm's investment in the presence of external financing costs will be less than optimal.

Without time-varying external financing costs ($\lambda_t' = \lambda_{t+1}'$), condition (A.48) also implies that saving cash today does not affect firm value. In the presence of the time-varying costs of external capital, however, the firm's investment and cash savings decisions depend on the relative (in an intertemporal sense) costs of external capital. To see this, note that we obtain the following equations from equations (A.46) - (A.48):

$$\phi_I(K_t, I_t) + 1 = E_t\Bigg\{ M_{t,t+1}\left(\frac{1+\lambda'_{t+1}(X_t,\gamma)}{1+\lambda'_t(X_t,\gamma)}\right)\Bigg[1 + \pi_K(K_{t+1}, S_{t+1}) \tag{A.50}$$

$$-\phi_K(K_{t+1}, I_{t+1}) + (1-\delta)\big[\phi_I(K_{t+1}, I_{t+1}) + 1\big]\Bigg]\Bigg\}; \quad \text{and}$$

$$E_t\left\{ M_{t,t+1}\left(\frac{1+\lambda'_{t+1}(X_t,\gamma)}{1+\lambda'_t(X_t,\gamma)}\right)\right\} = 1. \tag{A.51}$$

The relative costs of external finance, $\Lambda_t(\gamma) = (1+\lambda'_{t+1}(X_t,\gamma))/(1+\lambda'_t(X_t,\gamma))$, in equations (A.50) and (A.51) represent the effect on the investment and savings decisions from the intertemporal variation in the costs of external finance and the correlation between the expected cost of external capital and future capital needs.

Given Assumption 1 for the two-period model regarding the external finance cost function, it is straightforward to see that $\Lambda_t(\gamma)$ is an increasing function of γ for $\lambda'_t < \lambda'_{t+1}$:, i.e., the effect of the intertemporal costs of external capital is magnified for firms with a greater correlation between the expected COC and future external capital needs.

Appendix 6: Definitions of Variables

The following are variable definitions used in this study. Items in parentheses are variable names as used in the Compustat annual database.

Acquisitions = acquisitions (aqc) / lagged total assets (at)

Cash = cash and cash Equivalents (che) / total assets (at)

Cost of Capital (COC) = weighted average cost of capital

ΔCash = change in cash and cash equivalents (chech) / lagged total assets (at)

Cost of Debt (COD) = whichever is the greater: interest expense (xint) divided by the average of total debt at the beginning and the end of the year ; or AAA-rated bond yield (also winsorized at 6 and 94 percent)

Cost of Equity (ICC) = Implied Cost of capital

Credit Spread ($Spread$) = difference in yield between maturity matched Treasury yield and AAA-rated corporate bonds

Dividend = cash dividend (dv) / lagged total assets (at)

External Capital ($ExCapital$) =Net Equity Issuance ($EIssue$) + Net Debt Issuance ($DIssue$)

External Finance ($External$) = [capital expenditures (capx) - operating cash flow (oibdp)]/capx

External Finance Dependence (KZ) = $-1.002CF - 39.368DIV - 1.315CASH + 3.139LEV$, where CF = operating cash flow (oibdp)/ lagged plant and equipment (ppent)

Excess Issuance = Net Equity Issuance ($EIssue$) + Net Debt Issuance ($DIssue$) − Financial Deficit ($Deficit$)

Financial Deficit ($Deficit$) = [dividends + acquisitions + net investment - internal cash flow]/ lagged total assets (at)[13]

Future Investment ($FInvest$) = the average of three subsequent years of [capital expenditures (capx) + acquisitions (acq) + R&D]/ lagged total assets (at)

HP index = $-0.737Size + 0.043Size^2 - 0.04Age$, where $Size$ is the natural logarithm of total assets capped by \$4.65 billion and Age is the number of years since the firm's initial offering capped by 37

Internal Cash Flow (ICF) = [income before extraordinary items (ibc) + depreciation and amortization (dpc)] / lagged plant and equipment (ppent)

Leverage = [short-term debt (dlc) + long-term debt (dltt)] / total assets (at)

M/B = market value of assets / total assets (at), where market value of assets is given by total assets (at) - common equity (ceq) + market value of common equity (common shares outstanding (csho) × share price (prcc))

[13] We follow Rajan and Zingales (1998) to include the change in the non-financial components of net working capital as part of funds from operations in defining the financial deficit and external finance dependence.

Net Debt Issuance ($DIssue$) = [long-term debt issues (dltis) - long-term debt reduction (dltr) + change in current debt (dlcch)] / lagged total assets (at)

Net Equity Issuance ($EIssue$) = [sale of common and preferred stock (sstk) - purchase of common and preferred stock (prstkc)] / lagged total assets (at)

Net Investment (INV) = [increase in investment (invch) + capital expenditures (capx) + other use of funds (fuseo)- sales of property and plants (sppe) - sales of investment (siv) - short-term investment change (ivstch) -other investment activities (ivaco)]/lagged total assets (at)

Net Working Capital NWC = [current assets (act) - Current Liabilities (lct) - Cash (che)] / total assets

Precaution = the first principal component of firm-level R&D and 2-digit industry cash flow volatility ($CFRisk$).

R&D = research and development expense (xrdq) / Sales

Size = logarithm of total assets (at)

Tax Rate ($Taxr$) =whichever is the lower: tax payment (txt) divided by pretax income (pi) or the statutory maximum tax rate

Timing 1 $= \hat{cov}(ExCapital, M/B)$

Timing 2 $= \overline{M/B} * \overline{ExCapital}$

Timing 3 = mispricing proxy based on the average of a stock's ranking percentiles for each of 11 anomaly variables

Vol (Cash Flow Volatility)] = standard deviation of 2-digit SIC industry average cash flow (ICF) for the prior ten years

WW index = -0.091ICF-0.062 Div+0.021LTD-0.044Size+0.102ISG-0.035SG, where Div is an indicator for dividend; LTD is long-term debt ratio; ISG is industry sales growth rate; and SG is the firm's sales growth rate

Appendix 7: Estimation procedure for the COE

The Li, Ng, and Swaminathan (2013) model is as follows:

$$P_t = \sum_{k=1}^{15} \frac{FE_{t+k} \times [1 - b_{t+1} + \frac{(b_{t+1} - \frac{g_t}{ICC_t})}{15} \times (k-1)]}{(1+ICC_t)^k} + \frac{FE_{t+15} \times (1-b_t)}{(ICC_t - g_t)(1+ICC_t)^{15}}. \quad \text{(A.52)}$$

The model has two parts: 1) the present value of cash flows up to year $(t+15)$; and 2) the present value of cash flows beyond year $t+15$. For the first two years' earnings, we use the median forecasts by analysts and forecast earnings FE_{t+k} from year $t+3$ to year $t+T+1$ as $FE_{t+k} = FE_{t+2} \times (1 + g_{t+3} \exp\{g_t^g \times (k-2)\})$. We assume that the earnings growth rate g_{t+3} will mean-revert exponentially to steady-state values by year $t+T+2$. The assumption implies that $g_{t+3} \exp\{g_t^g \times 15\} = g_t$ with g_t^g being the growth rate of growth rate g_{t+2}, which yields $g_t^g = \ln\left(\frac{g_t}{g_{t+2}}\right)/15$. For g_{t+3}, we use the median long-term growth rate forecast of analysts. If the long-term growth rate forecast is not available, we estimate it using the first two years' forecast earnings: $g_{t+3} = \frac{FE_{t+2}}{FE_{t+1}} - 1$. The steady-state earning growth rate (g_t) is assumed to be a rolling average of annual GDP growth rate.

We construct the stream of dividends as $D_{t+k} = FE_{t+k} \times (1 - b_{t+k})$ for $1 \leq k \leq 15$. The initial retention ratio is estimated as b_{t+1} = [1- Cash Dividend$_t$ /Net Income$_t$]. For years $t+2$ to $t+T+1$, we estimate the retention rate as $b_{t+k} = b_{t+1} - \frac{(b_{t+1} - \frac{g_t}{ICC_t})}{15} \times (k-1)$. The retention rate is assumed to revert linearly to a steady-state rate $b_t = \frac{g_t}{ICC_t}$ by year $t+T+1$. After terminal year, we estimate the terminal value of remaining cash flows using the Gordon growth model: $FE_{t+15} \times (1-b_t)/(ICC_t - g_t)$.

The Gebhardt, Lee, and Swaminathan (2001) model is based on the following equation:

$$P_t = BE_t + \sum_{k=1}^{12} \frac{(ROE_{t+k} - ICC_t)BE_{t+k-1}}{(1+ICC_t)^k} + \frac{(ROE_{t+12} - ICC_t)BE_{t+11}}{ICC_t(1+ICC_t)^{12}} \quad \text{(A.53)}$$

where ROE_{t+k} is the return on equity at $t+k$ which is assumed to revert linearly to the median industry ROE by year $t+12$ starting with $ROEt+3$. The industry median ROE is the past 10-year average of the industry median based on the 2-digit SIC code, excluding firms with losses. For the first three years' earnings, we use the median forecasts by analysts FE_{t+k} and the book value of equity is estimated by $BE_{t+k} = BE_{t+k-1} + FE_{t+k} \times b_{t+1}$, where b_{t+1} is the retention ratio at $t+1$. Beyond the third year, we use the linear interpolation to the industry median ROE to forecast the firm ROE. We assume that economic profits $(ROE - ICC)$ after year 12 are zero.

The Claus and Thomas (2001) model is based on the economic profit for shareholders as in the following equation:

$$P_t = BE_t + \sum_{k=1}^{5} \frac{FE_{t+k} - ICC_t \times BE_{t+k-1}}{(1 + ICC_t)^k} + \frac{(FE_{t+5} - ICC_t \times BE_{t+4})(1 + g_t)}{(ICC_t - g_t)(1 + ICC_t)^5} \quad \text{(A.54)}$$

where P_t is the current stock price and the growth rate after 5 years, g_t, is estimated by inflation rate. We obtain the initial forecast value of equity as $BE_{t+1} = BE_t + FE_{t+1} \times b_{t+1}$, where BE_t is the book equity value per share at t; FE_{t+1} is forecast earnings per share at $t+1$; and b_{t+1} is the retention ratio as defined above.

Appendix 8: Robustness Check

Table A1: Hedging Motive: Robustness

This table reports the robustness of the impacts of cost of capital on the sensitivities of cash savings to external capital between firms with high and low hedging motives. The dependent variable is the change in cash and equivalents divided by total assets at the beginning of the year. *ExCapital* and *ICF* are external capital and internal cash flow, respectively, divided by total assets at the beginning of the year. High and low hedging-need firms are defined as those in the top 30 percent and those in the bottom 30 percent, respectively based on the correlation between industry-level external finance and COC. We use high order linear cumulants (Erickson et al. (2014)) to account for measurement errors in the cost of capital measure (Columns 1 and 2). Li et al. (2013) (Columns 3 and 4) and Claus and Thomas (2001) (Columns 5 and 6) are used as alternative COE measures. Detailed variable definitions are provided in the Appendix 6. Firm and year fixed effects are controlled. The coefficient estimates of the control variables are not reported for brevity. Standard errors are clustered at the firm level and corrected for heteroscedasticity. ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively.

	High-Order Cumulants		Li et al. (2013)		Claus and Thomas (2001)	
	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
COC	-0.0605	0.2412***	-0.0517	-0.014	-0.0074	0.0229
	[0.0776]	[0.0925]	[0.0352]	[0.0389]	[0.0258]	[0.0352]
ExCapital	0.5079***	0.4404***	0.4415***	0.3675***	0.2771***	0.2621***
	[0.0400]	[0.0457]	[0.0256]	[0.0231]	[0.0154]	[0.0180]
ICF	0.5218***	0.3772***	0.4449***	0.2971***	0.2942***	0.2090***
	[0.1037]	[0.1271]	[0.0412]	[0.0499]	[0.0237]	[0.0292]
ExCapital×COC	-1.6390***	-0.2357	-0.6815***	-0.1061	-0.2388**	-0.0713
	[0.4344]	[0.5328]	[0.2600]	[0.2459]	[0.1133]	[0.1288]
ICF×COC	-1.7179	0.1469	-2.0530***	-0.0654	-0.7654***	-0.1023
	[1.1031]	[1.4293]	[0.4030]	[0.5616]	[0.1296]	[0.2407]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	No	No	Yes	Yes	Yes	Yes
Year FEs	No	No	Yes	Yes	Yes	Yes
Observations	18,394	18,135	13,926	14,094	17,206	17,294
Adj. R^2			0.4390	0.3917	0.3507	0.3525