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Keywords: Cash flows, Cash flow timing pattern, asset prices, equity financing costs
JEL Classification: G12, G32, D25, E23

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Weiping Hu, Kai Li, and Xiao Zhang*

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Abstract

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1 Introduction

Using US firm-level data, we find that cash flow displays a strong timing pattern: on average, firms receive 70% of their cash flow in the second half of the year. The cash flow timing pattern therefore significantly influences cash flow volatility. Nevertheless, most empirical and theoretical studies of cash flow volatility have focused on exogenous cash flow shocks and their impact on firm decisions.[1] In this paper, we extend this discussion by including the endogenous volatility of cash flow—the cash flow timing pattern.

When selling goods to customers, firms can demand cash or accrued payments, which are composed of working capital such as account receivables and inventory investment. Requiring cash payments is costly because the supplier has to offer the customer a substantial discount as a reward for paying cash. Meanwhile, accrued payments are an important indicator of information transparency.[2] A higher accrued payment indicates lower transparency, resulting in higher information asymmetry and financing costs. Since year-end performance attracts more attention, firms have an incentive to collect cash by year-end and lower their financing costs by decreasing information asymmetry. Compared with financially unconstrained firms, *financially constrained* firms have more incentive to collect cash flow by year-end to improve information transparency. In summary, year-end cash collection reflects information about financially constrained firms' cash flow and external financing. As such, cash flow timing patterns should provide valuable insight into firm fundamentals and firms' exposure to aggregate risks. Motivated by this intuition, we focus on the implications of year-end cash collection for firms' asset prices and real quantities.

We start by documenting three empirical facts. First, we show that the cash flow timing pattern—the substantial collection of yearly cash flow at year-end—is prevalent at an aggregate level and persistent over decades. Second, at the cross-sectional level, the cash flow

[1] These studies include, among others, Minton and Schrand (1999), Han and Qiu (2007), Bates et al. (2009), Duchin (2010), and Brown et al. (2021).

[2] See, for example, Sloan (1996), Bradshaw et al. (2001), Teoh and Zhang (2011), Hirshleifer et al. (2012), and Terry et al. (2022).

timing pattern is more significant for financially constrained firms, implying that the year-end cash collection is positively related to financial constraints. Third, financially constrained firms with higher year-end cash collection (hereafter, YCC)[3]—that is, collecting more cash flow in the second half of the year compared with the first half of the year—earn a significantly higher risk premium. In this paper, we refer to the value-weighted expected return spread of 6.01% between the highest and lowest YCC firms as the year-end cash collection premium.

Motivated by these empirical facts, we rationalize the positive relationship between financial constraints, operating cash flow spread (hereafter, OCF spread),[4] and the YCC premium by building a dynamic model. Following the previous literature, firms in this model produce output using a stochastic technology that is subject to both idiosyncratic and aggregate productivity shocks. Firms finance investment, adjustment costs, cash savings, and dividend payouts with cash flow and equity issuance. Aggregate equity financing costs are stochastic and independent of aggregate productivity shocks. Firms make investment, cash savings, cash payments, equity financing, and payout decisions to maximize their values. Idiosyncratic productivity shocks drive cross-sectional heterogeneity. The model has three key features. First, sales are not immediately paid in cash. Demand for immediate cash payments is costly as the supplier needs to offer a substantial discount as a reward for paying cash. Thus, higher demand for cash payments decreases firms' profitability. Second, the equity issuance cost is a function of cash collection. A higher collection of cash payments results in lower information asymmetry and lower equity issuance costs. Third, we assume a deterministic regime shift in external attention. The literature shows that fiscal year-end earnings reports attract more attention (Brown and Pinello, 2007; Fan et al., 2010; Frankel et al., 2017). Financially constrained firms have high financing needs and thus are more likely to collect cash in the late year to increase the transparency of earnings information, which can lower the incurred

[3] We measure YCC as the decrease in noncash net working capital from fiscal Q2 to Q4. See details in Section 2.2.

[4] Operating cash flow spread is defined as the difference between operating cash flow in the late and early quarters of the year. See details in Appendix B.

external financing costs. Overall, our model highlights the importance of year-end cash collection. When making cash collection decisions, firms face a trade-off between profitability and immediate cash payments.

The cross-sectional variation in expected stock returns arises endogenously in the model because of different degrees of exposure to aggregate productivity and financial shocks. Financially constrained firms with high equity financing needs collect cash payments by year-end to avoid the high agency cost of year-end accrued earnings. Therefore, a positive relationship between YCC and financial constraints is well established in our model. Then, we document that a high YCC firm is riskier for two reasons. First, high YCC firms demand more cash payments for current sales. The future cash flow of high YCC firms primarily consists of immediate payments, and thus high YCC firms are more positively exposed to aggregate productivity shocks. Second, firms that collect more cash flow by year-end decrease their operating cash flow in the next period, meaning that they are more likely to issue equity in the future. Thus, high YCC firms are more positively exposed to aggregate financial shocks. In detail, high YCC firms perform worse when hit by a negative aggregate financial shock (an increase in the marginal cost of equity financing). These findings, taken together, indicate that year-end cash collection results in more risk exposure and higher stock returns.

Our model also suggests the presence of cross-sectional variation in cash decisions. First, we find that higher YCC firms, which have a more positive relationship between expected marginal financing costs and the discount factor, have a greater incentive to save cash. In detail, high YCC firms have high financing needs in the next period so that they are more influenced by aggregate financial shocks. In the spirit of Palazzo (2012), the positive relation between expected marginal financing costs and the discount factor (i.e., higher expected marginal financing costs associated with higher marginal utility) results in a higher marginal value of cash. Additionally, we also find an apparent pattern of cash holdings within a year in high YCC firms. That is, firms tend to hold more cash in the second half of the year relative to the first half. This seasonal change in cash holdings is closely related to year-end cash collection because there is a substitutable relationship between accrued payments and cash holdings (Opler et al., 1999). Specifically, firms would substitute cash holdings for accrued payments at year-end when accrued payments are disciplined the most. Therefore, at year-end, high YCC firms without high accrued earnings carried over to the next period have a greater incentive to hold cash than they do in the first half of the year.

Quantitatively, the baseline model with reasonable parameter values closely matches the aggregate- and firm-level moments of asset prices and real quantities. In addition, we reproduce the YCC spread using the simulated data and provide the cross-sectional characteristics at the portfolio level. In detail, we show that high YCC firms in the constrained subsample earn a higher return and also display a higher OCF spread, a lower return on assets (ROA), and higher cash savings, consistent with our model intuition. This evidence on the YCC spread and associated relation with other firm decisions is also observed in the data.

We then provide further empirical evidence that directly supports our model assumptions and implications. First, to understand the cross-sectional variation in the risk premiums of portfolios sorted on YCC, we compare the risk exposure to aggregate shocks (TFP and issuance cost shocks) from the lowest YCC portfolio to the highest YCC portfolio. We show that higher YCC firms have greater risk exposure to aggregate TFP and issuance cost shocks. We further use the generalized method of moments (GMM) to estimate the standard asset pricing equation and show that the aggregate TFP and issuance cost shocks are significantly positively priced in the cross-section of stock returns.

For robustness, we empirically review the ability of firm-level YCC to predict the cross-sectional stock returns using Fama and MacBeth (1973) regressions. This analysis allows us to control for an extensive list of firm characteristics that predict stock returns. The slope coefficient associated with the firm's YCC is both economically and statistically significant for the financially constrained subsample but not significant for the unconstrained subsample. More specifically, in the baseline specification in which we control for the market size, book-to-market ratio, financial leverage, ROA, and I/K ratio, a one-unit standard deviation increase in the constrained firm's YCC is associated with an increase of 0.947% in the corresponding expected stock return. We also verify that the positive YCC-return relation is not driven by other known predictors that are seemingly correlated with the YCC measure. In detail, we conduct a comprehensive conditional double analysis to test the validity of the YCC premium. Our results show that our YCC spread can still survive after controlling for the accrual effects in Sloan (1996), the counterparty premium in Grigoris et al. (2022), or the cash-related premium in Palazzo (2012). Moreover, to investigate whether the YCC spread could be explained by exposure to standard risk factors, we perform standard asset pricing tests. The results show that the alpha remains significant even after controlling for Carhart (1997) four factors, or Fama and French (2015) five factors, respectively.

Related literature

Our paper contributes to several strands of literature. First, the paper falls into a large literature that examines the dynamic implications of financial constraints on investment and cash holdings. Riddick and Whited (2009) and Bolton et al. (2011) suggest that firms hold cash because of financial constraints and cash flow shocks. Different from the previous cash literature, we focus on the cash flow timing pattern, which is an endogenous decision of cash collection, and examine its impact on cash and cross-sectional expected returns. Our paper is also closely related to Palazzo (2012) in that it suggests that riskier firms save more cash. However, our paper focuses on the firms exposed to both aggregate productivity and financial shocks, whereas Palazzo (2012) only focuses on aggregate productivity shocks.

This paper is closely related to the corporate finance literature which shows that the equity financing cost is time varying. For example, Warusawitharana and Whited (2015) and Bolton et al. (2013) suggest that equity financing costs vary because of mispricing. Eisfeldt and Muir (2016) focus on the role of the time-varying aggregate financing costs in explaining aggregate financing correlations. Our paper the complements previous literature by endogenously linking equity issuance costs to year-end cash collection decisions.

This paper builds on trade credit and the earnings management literature. Jones (1991), Dechow et al. (1995), and Leuz et al. (2003) show that higher accrued earnings lead to higher agency problems through the information asymmetry channel and therefore should be regulated. Massa et al. (2015) and Fang et al. (2016) suggest that short sellers discipline firms from earnings management. Thus, cash collection can decrease accrued earnings and increase information transparency. Recent literature suggests that monitors dislike accruals, but that it is also costly to increase information transparency. Terry et al. (2022) show that managers faces a trade-off between information disclosure and investment efficiency. They study the impact of monitoring on information disclosure through managers' compensation packages. Different from Terry et al. (2022), in our paper, firms are regulated through equity financing costs: higher accrued earnings resulting in costlier external financing. Grigoris et al. (2022) document that trade-credit increases the duration of supplier-customer links and hedges the aggregate searching cost for customers. Our paper complements previous work by quantifying the effect of accrued earnings on the aggregate equity issuance costs. More financially constrained firms have a higher incentive to decrease financing costs by increasing information transparency. This effect is widely recognized but absent in the previous literature.

The paper is also related to the investment-based asset pricing literature, which explores the asset pricing implications of risk exposure to aggregate shocks. Zhang (2005) provides an investment-based explanation for the value premium. Li (2011) and Lin (2012) focus on the relationship between R&D investment and expected stock returns. Eisfeldt and Papanikolaou (2013) focus on the cross-sectional asset pricing implications of organizational capital. Belo and Lin (2012) study the relationship between inventory growth and expected stock returns. Belo et al. (2019) investigate the asset pricing implications of time-varying aggregate equity financing costs. Lin et al. (2020) study firms' capital age and risk exposure to technology frontier shocks. In addition, our paper relates to the asset pricing literature that studies the implications of financial frictions for the cross-section of expected returns. Ai et al. (2020) present that firms with low asset collateralizability are more financially constrained and riskier. Li and Tsou (2019) show that the leased capital ratio measure is positively correlated with financial constraints. High leased capital firms are less exposed to systematic capital price fluctuations and thus earn lower average excess stock returns. Compared with these papers, our paper contributes to the literature by focusing on the implication of equity financing frictions on year-end cash collection, cash savings, and the cross-section of expected stock returns.

Finally, this paper contributes to the extensive macroeconomics literature that studies the role of credit market frictions in generating fluctuations across the business cycle (see Quadrini et al. (2011) and Brunnermeier et al. (2012) for recent reviews). The papers most closely related to ours are those emphasizing the importance of borrowing constraints and contract enforcements (Kiyotaki and Moore, 1997, 2012; Gertler and Kiyotaki, 2010; He and Krishnamurthy, 2013; Brunnermeier and Sannikov, 2014; Elenev et al., 2021). Gomes et al. (2015) study the asset pricing implications of credit market frictions in a production economy. Different from previous literature, our paper focuses on equity market frictions. We allow firms to decrease equity financing costs by increasing their cash collection, which increases the information transparency of earnings and relaxes financial constraints.

The paper is organized as follows. Section 2 provides empirical facts about the cash flow timing pattern and the relation between YCC and excess stock returns. Section 3 proposes a rationale for the empirical observations and presents a dynamic stochastic model in which a firm manages its cash collection, investment, and cash holdings. Section 4 discusses the calibration and simulation of the model to evaluate the role of YCC in explaining firm risk exposure and firm characteristics. Section 5 provides more supportive empirical evidence to the assumption and implications of the model, and Section 6 concludes.

2 Empirical Facts

In this section, we present the prevalence of the cash flow timing pattern resulting from YCC and its relation to financial constraints. We then sort our sample into quintile portfolios based on YCC and report the empirical evidence on annual excess returns.

2.1 Data

Our main sample covers the period between 1988 and 2019. We begin with all US public firms for which we have accounting information from the Compustat Fundamental Annual and quarterly databases. Monthly stock returns are from the Center for Research in Security Prices (CRSP). Asset pricing factors related to the Fama and French (2015) five-factor model and the Carhart (1997) four-factor model are downloaded from the data library of Kenneth French. We adopt the standard screening process for the CRSP/Compustat Merged Database. First, we exclude regulated utilities (Standard Industrial Classification (SIC) codes 4900-4999) and financial firms (SIC codes 6000-6999). Additionally, we only keep those with domestic common shares trading on NYSE, Amex, or Nasdaq. Following Campello and Giambona (2013), we exclude firm-year observations for which the value of total assets or sales is less than $1 million. All firm characteristics are winsorized at the 1% level. The potential delisting bias of stock returns is corrected following Shumway (1997).

2.2 Measuring cash flow, earnings, and year-end cash collection

We measure the year-end cash collection for firm i in year t by scaling the decrease in noncash net working capital from fiscal Q2 to Q4 by lagged total assets:

$$\text{YCC}_{i,t} = \frac{\text{NWC}_{i,t}^{\text{Q2}} - \text{NWC}_{i,t}^{\text{Q4}}}{\text{AT}_{i,t-1}}, \tag{1}$$

where $\text{NWC}_{i,t}^{Q2}$ and $\text{NWC}_{i,t}^{Q4}$ are the noncash net working capital of fiscal Q2 and Q4, respectively. The numerator of $\text{YCC}_{i,t}$, the change in noncash net working capital between fiscal Q2 and Q4, reflects the amount of collected cash near the end of the year.[5] Higher $\text{YCC}_{i,t}$ means more cash flows are collected by year-end, resulting in higher within-year volatility of cash flow.

The adjustment of $\text{YCC}_{i,t}$ not only can affect the cash flow distribution within a year but also contributes to the difference between earnings and operating cash flow. Specifically, it is customary for firms to make sales and receive payments from customers later, in which case earnings, currently in the form of working capital, are converted into cash flow in the future. Thus, the working capital management affects the mismatch between earnings recognition and cash payments, which drives quite an important difference between earnings and operating cash flow. We employ ROA (Compustat item IB) to measure a firm's profitability according to Ai et al. (2020), and we use net cash receipts from operating activities (Compustat item OANCF + XINT) to construct operating cash flows following Lian and Ma (2018). Table B1 in Appendix B reports details about the construction of the variables.

2.3 Cash flow timing pattern

2.3.1 The prevalence of cash flow timing pattern

The literature suggests that accrued payments are associated with earnings management issues. Since year-end performance attracts more attention (Chae, 2005),more cash flow is collected at year-end (Frankel et al., 2017). Using US firm-level data, we find a significant timing pattern of cash flows. Figure 1 shows the time-series plot of semiannual average operating cash flow from 1988 to 2019. Firms receive more cash flow in the second half of the year relative to the first half. On average, firms received less than 30% of their cash flow in the first half of the year, whereas they received more than 70% of their cash flow in the

[5] Noncash net working capital is measured as noncash current assets (item ACT-CHE) minus current liabilities (LCT) less short-term debt (DLC) and taxes payable (TXP).

second half. Overall, we find a strong cash flow timing pattern, which has been persistent for decades.

[Figure 1 is about here]

2.3.2 Cash flow timing pattern and financial constraint

Table 1 reports the average ratios of cash flow to total assets in the early (Q1 and Q2) and late (Q3 and Q4) quarters of the year associated with financial constraints, where the constraint is measured by the Whited-Wu index (hereafter, WW index, following Whited and Wu, 2006). The operating cash flow ratios of financially constrained firms in the early and late quarters of the year are 0.41 and 0.73, respectively. For financially constrained firms, the average OCF spread, defined as the difference between cash flow in the late and early quarters of the year divided by total assets, is 0.032. However, this term is 0.020 for unconstrained firms. The difference in the average OCF spread between financially constrained firms and unconstrained firms is 0.012, which is economically large and statistically significant at the 1% level. In summary, this result implies that financially constrained firms have a higher incentive to collect cash by year-end.

[Table 1 is about here]

2.4 Year-end cash collection and stock returns

2.4.1 Univariate portfolio sorting based on year-end cash collection

In this subsection, we provide empirical evidence on the relation between YCC and expected return. Table 2 shows an economically and statistically significant return spread between the lowest and highest YCC firms. The portfolios of firms that collect the lowest cash flows at year-end earn 8.316% value-weighted average annual excess returns and 10.116% equal-weighted average annual excess returns. In contrast, for the highest YCC portfolios, the value- and equal-weighted average annual returns are 12.169% and 13.440%, respectively. Overall, the results imply that the value- and equal-weighted return spreads between the highest and lowest YYC firms are 3.853% and 3.324%, respectively. The return spreads are statistically significant at least above the 5% level. We call the spread between the highest and lowest YCC portfolios the *year-end cash collection premium*.

[Table 2 is about here]

2.4.2 Double sorting with financial constraints

Motivated by the previous empirical findings (i.e., that YCC is related to financial constraints), we sort portfolios based on YCC within the financially constrained subsample and the unconstrained subsample, respectively. Specifically, we split our sample into financially constrained and unconstrained groups at the annual frequency with the four financial constraint proxies. Then, we sort the firms within each group into five portfolios based on year-end cash collection. Following the literature, we use four proxies to measure financial constraints: WW index, firm size, size and age index (hereafter, SA index, following Hadlock and Pierce, 2010), and non-dividend payment dummy. The firm is classified as financially constrained if its WW index is above the cross-sectional median, its SA index is above the cross-sectional median, it does not pay dividends, or its size is below the cross-sectional median.

[Table 3 is about here]

Table 3 reports annualized average excess stock returns across portfolios sorted on year-end cash collection. In Panel A, firms are financially constrained. When the financial constraint is measured by the WW index, the average return for the highest YCC portfolio is 14.922%, whereas it is 8.915% for the lowest YCC portfolio. The high-minus-low return spread is 6.007%, which is economically and statistically significant at the 1% level. For robustness, we also report the portfolio returns of financially constrained firms classified by alternative measures. The high-minus-low return spreads of financially constrained firms classified by size, SA index, and non-dividend payment dummy are 4.893%, 5.821%, and 7.685%, respectively.

Similarly, we report the value-weighted average portfolio returns for unconstrained firms in Panel B. In Panel B, the high-minus-low return spreads are 2.025%, 2.433%, 1.885%, and 0.359% for financially unconstrained firms, measured by the WW index, size, SA index, and non-dividend payment dummy, respectively. The spreads are neither economically nor statistically significant for the unconstrained subsample with respect to all measures of financial constraints.

Overall, these results demonstrate an economically large and statistically significant year-end cash collection premium for financially constrained firms. The results are robust with value- and equal-weighted average returns and different measures of financial constraints.

3 Dynamic Investment-based Model

To rationalize the empirical findings in Section 2, we build a dynamic structural model of investment, cash flow, cash collection, and firm financing at a semiannual frequency.

We first specify the firm's production and capital investment process. Next, we discuss the timing of cash collection and compare the definitions of earnings and cash flow. Then, we introduce the link between cash collection and equity financing costs. Finally, we discuss the firm's problem and asset pricing implications.

3.1 Production

Firms use physical capital (K_t) to produce output (Π_t). To save on notation, we omit firm index i whenever possible. The production function is given by

$$\Pi_t = e^{z_t + x_t} K_t^{\alpha} \tag{2}$$

where z_t and x_t is the level of the firm's idiosyncratic and aggregate productivity, respectively. The term K_t is physical capital, and $\alpha \in (0, 1)$ captures a decreasing returns-to-scale technology. Following Lin and Zhang (2013), the level of the firm's productivity is the sum of an idiosyncratic shock z_t, and an aggregate shock x_t, and both the idiosyncratic shock z_t and aggregate shock x_t follow an AR(1) process:

$$z_{t+1} = \rho_z z_t + \epsilon_{z,t+1} \tag{3}$$

$$x_{t+1} = \overline{x}(1 - \rho_x) + \rho_x x_t + \epsilon_{x,t+1} \tag{4}$$

where $\epsilon_{z,t+1}$ and $\epsilon_{x,t+1}$ are the firm-specific and aggregate productivity shocks, respectively. They are normally distributed with zero mean and standard deviation σ_z and σ_x. ρ_z and ρ_x are the autocorrelation of firm-specific and aggregate productivity shocks, respectively, and $\overline{x}$ is the long-run average aggregate productivity, which determines the long-run average scale of the economy.[6]

Physical capital evolves according to the standard law of motion:

$$K_{t+1} = I_t + (1 - \delta) K_t, \tag{5}$$

where I_t represents investment and δ denotes the depreciation rate of physical capital. A firm's purchase or sale of capital incurs convex adjustment costs, given by

$$\phi(I_t, K_t) = \frac{g I_t^2}{2 K_t}, \tag{6}$$

where g determines the slope of the marginal adjustment cost and is greater than zero.

[6] We set $\overline{x}$ such that the long-term average capital stock is normalized to be 1, which is standard in the literature (Boldrin et al., 2001; Zhang, 2005)

3.2 Demand for cash flow payments

In the model, products can be sold with immediate cash payments or accrued payments in the next period. To get immediate payment, firms (suppliers) need to offer a discounted price p_d to customers. Note that p_d should be smaller than $\frac{1}{1+r_f}$. Otherwise, customers have no incentive to pay in cash immediately. Thus, according to accrual-based accounting, a firm's earnings at time t are

$$\text{Earnings}_t = (1-\tau)[(1-\lambda_t)\Pi_t + p_d\lambda_t\Pi_t - f + r_sL_t] + \tau\delta K_t, \tag{7}$$

where τ is the corporate income tax rate. λ_t is the proportion of sales paid with cash at time t, which ranges from 0 to 1. $(1-\lambda_t)\Pi_t$ is the amount of accrued earnings, which are not received at time t but will be collected in the next period. $p_d\lambda_t\Pi_t$ is the amount of earnings paid by cash. f is the operating cost, and r_sL_t is the interest from saving cash L_t. r_s is the cash saving rate. Following the literature, we assume $r_s = r_f - \kappa$, in which κ is the constant wedge between the risk-free and saving rates. κ is greater than zero so that cash holdings are costly to firms (i.e., $r_s < r_f$); Otherwise, firms with financial frictions would strictly prefer to reinvest the profits in cash assets. The last term, $\tau\delta K_t$, is the tax deduction of depreciation.

On the other hand, according to cash flow-based accounting, a firm's operating cash flow (OCF) at time t is

$$\text{OCF}_t = (1-\tau)[(1-\lambda_{t-1})\Pi_{t-1} + p_d\lambda_t\Pi_t - f + r_sL_t] + \tau\delta K_t \tag{8}$$

According to the definition, OCF includes the payment of the accrued earnings at time $t-1$, $(1-\lambda_{t-1})\Pi_{t-1}$, but excludes the accrued payment, $(1-\lambda_t)\Pi_t$, at time t. Other items are the same as those in the earnings equation.

A comparison of earnings and operating cash flow in Equations (7) and (8) reveals that there is a timing difference between earnings recognition and cash payments, where

$$\text{Earnings}_t - \text{OCF}_t = (1-\tau)[(1-\lambda_t)\Pi_t - (1-\lambda_{t-1})\Pi_{t-1}]$$

When the firm always collects all of the profits instantly ($\lambda_{t-1} = \lambda_t = 1$), Earnings is equal to OCF. However, if the amount of accrued payments at time t is larger (smaller) than the amount of accrued payments at time $t-1$, the firm would achieve a lower (higher) level of cash flow.

3.3 Payout, monitoring, and financing

The firm needs to finance its capital investment, adjustment costs, and cash reserves with cash, cash flow, and equity financing. The firm's budget constraint can be written as

$$E_t = \text{OCF}_t - I_t - \phi_t - (L_{t+1} - L_t) \tag{9}$$

The first term is the operating cash flow defined in Equation (8). I_t and ϕ_t are the investment in physical capital and incurred capital adjustment cost, respectively. The last term $L_{t+1} - L_t$ represents the investment in cash holdings at time t. The firm's cash holdings are subject to non-negative constraint, $L_{t+1} \geq 0$.

If E_t is greater than zero, the firm pays out; and if E_t is smaller than zero, the firm raises external financing, which is more costly than cash financing. In particular, we assume that equity issuance costs take the following form:

$$\Psi(E_t, \lambda_t, s_t) = 1_{E_t<0}\left(a_0 - (a_1 + a_\lambda^{s_t}(1-\lambda_t))E_t + \frac{a_2}{2}\frac{E_t^2}{K_t}\right)\xi_t^{-a_3}, \tag{10}$$

where $1_{E_t<0}$ is an indicator function that is one if E_t is smaller than zero, suggesting that the firm issues equity. a_0 captures the fixed cost of accessing the market. a_1 is the constant linear cost of equity issuance. Then, we assume that the agency costs are determined by two components: (i) the proportion of accrued earnings and (ii) monitors' attention. The literature suggests that accrued earnings increase information asymmetry (Iliev, 2010; Massa et al., 2015; Fang et al., 2016) and thus incur higher financing costs. In addition, monitors' attention to cash flow payments within a fiscal year is asymmetric. According to the literature, monitors pay greater attention to fiscal year-end performance (Brown and Pinello, 2007; Fan et al., 2010; Frankel et al., 2017). To model the timing pattern, we consider a deterministic regime shift in $a_\lambda^{s_t}$ between two different states ($s_t \in \{L, H\}$), that is, a_λ^L in the first half of the year and a_λ^H in the second half of the year, in which $0 < a_\lambda^L < a_\lambda^H$. For each state, it switches to the other in the next period. These findings, taken together, indicate that the agency cost is $a_\lambda^{s_t}(1-\lambda_t)E_t$. The quadratic issuance cost, a_2, implies that equity issuance increases the asymmetry of information in equity markets, leading to a higher marginal cost of equity financing. Following Belo et al. (2019), the financing cost is also affected by the aggregate financial shock ξ_t and the issuance cost sensitivity a_3. The aggregate financial shock follows an AR(1) process:

$$\ln(\xi_{t+1}) = (1-\rho_\xi)\bar{\xi} + \rho_\xi \ln(\xi_t) + \epsilon_{\xi,t+1} \tag{11}$$

We assume that the unconditional expectation of aggregate financing cost is one.[7] $\epsilon_{\xi,t+1}$ is the aggregate shock to the financing cost, which is normally distributed with zero mean and standard deviation σ_ξ.

Finally, the effective cash flow D_t distributed to shareholders is given by

$$D_t = E_t - \Psi(E_t, \lambda_t, s_t) \tag{12}$$

[7] Under the restriction that the unconditional expectation of the aggregate financing cost to one, $\mathbb{E}_t(\xi) = 1$, we have $\mathbb{E}_t(\ln(\xi)) = -\frac{1}{2}Var(\ln\xi)$. Thus, $\bar{\xi} \equiv \mathbb{E}_t(\ln(\xi)) = -\frac{1}{2}(\frac{\sigma_\xi^2}{1-\rho_\xi^2})$.

Year-end cash collection behavior

We assume that t denotes the first half of a given year and $t+1$ denotes the second half. Then the year-end cash collection behavior can be expressed as the difference in accrued payments between the first and second half of the year, $(1-\tau)((1-\lambda_t)\Pi_t - (1-\lambda_{t+1})\Pi_{t+1})$. Because the year-end attention is higher than the attention at the beginning of the year, firms have a higher incentive to decrease their working capital by offering less trade credit to customers at year-end rather than at the beginning of the year. If the firm collects more cash flow at year-end, the year-end collection is larger than 0 ($(1-\tau)((1-\lambda_t)\Pi_t - (1-\lambda_{t+1})\Pi_{t+1}) > 0$). **Higher year-end collection suggests that more cash payments are collected by year-end**.

3.4 Firm's problem

The firm takes the stochastic discount factor (SDF) to value cash flows in period $t+1$, $M_{t,t+1}$ as given, we specify the SDF as a function of the two aggregate shocks

$$M_{t,t+1} = \frac{1}{1+r_f} \frac{\exp(-\gamma_x \Delta \ln(x_{t+1}) - \gamma_\xi \Delta \ln(\xi_{t+1})}{\mathbb{E}_t[\exp(-\gamma_x \Delta \ln(x_{t+1}) - \gamma_\xi \Delta \ln(\xi_{t+1})]} \tag{13}$$

where γ_x and γ_ξ are the market price of risk parameters with a positive sign, meaning that a negative shock from productivity (lower x_{t+1}) or financing costs (lower ξ_{t+1}) results in higher marginal utility. Note that we have normalized the SDF so that the risk-free rate is always equal to r_f.

We define $V_t(z_t, \xi_t, s_t, K_t, L_t, \lambda_{t-1}, \Pi_{t-1})$ as the cum-dividend market value. Firms solve the maximization problem by making capital investment, cash savings, and cash collection decisions:

$$\begin{aligned} & V_t(x_t, \xi_t, z_t, s_t, K_t, L_t, \lambda_{t-1}, \Pi_{t-1}) \\ = & \max_{K_{t+1}, L_{t+1}, \lambda_t} D_t + \mathbb{E}_t[M_{t,t+1} V_{t+1}(x_{t+1}, \xi_{t+1}, s_{t+1}, z_{t+1}, K_{t+1}, L_{t+1}, \lambda_t, \Pi_t)] \end{aligned} \tag{14}$$

Appendix A reports the detailed procedure for solving the model via value function iteration. In the following subsections, we solve the firm's optimal cash collection (Section 3.4.1) and cash savings (Section 3.4.2) policies and give the intuition behind them.

3.4.1 Optimal cash payment and the timing pattern

The optimal interior solution with respect to cash payment (λ_t) is

$$(1-\tau)p_d\Pi_t - \frac{\partial\Psi(E_t,\lambda_t,s_t)}{\partial\lambda_t} = \mathbb{E}_t\left[M_{t,t+1}\left((1-\tau)\Pi_t + \frac{\partial\Psi(E_{t+1},\lambda_{t+1},s_{t+1})}{\partial\lambda_t}\right)\right] \tag{15}$$

where $\frac{\partial\Psi(E_t,\lambda_t,s_t)}{\partial\lambda_t} = 1_{E_t<0}(a_\lambda^{s_t}E_t - (a_1 + a_\lambda^{s_t}(1-\lambda_t))(1-\tau)p_d\Pi_t + a_2E_t(1-\tau)p_d\Pi_t/K_t)\xi_t^{-a_3}$, and $\frac{\partial\Psi(E_{t+1},\lambda_{t+1},s_{t+1})}{\partial\lambda_t} = 1_{E_{t+1}<0}(1-\tau)\Pi_t((a_1 + a_\lambda^{s_{t+1}}(1-\lambda_{t+1})) - a_2E_{t+1}/K_{t+1})\xi_{t+1}^{-a_3}$

The Euler equation sets the benefit of increasing demand for cash payments at time t equal to the expected marginal discounted cost of increasing cash payments. The left-hand side of Equation (15) is the marginal benefit of increasing one unit percentage of λ_t at time t, which can be interpreted as the marginal increase in payouts (i.e., $(1-\tau)p_d\Pi_t$) plus the marginal decrease in financing costs (i.e., $-\frac{\partial\Psi(E_t,\lambda_t)}{\partial\lambda_t}$), which is caused by the higher information transparency and lower external financing. The right-hand side is the expected marginal cost of increasing one unit of λ_t at time t, including the expected marginal decrease in the dividend payment and the increase in the future equity issuance cost.

A firm's cash collection decision is determined by the discount cost and external financing costs. First, a firm with a high discount cost (low p_d) has less of an incentive to collect cash because it is less likely to offer costly discounted prices to its customers, all else equal. Second, a firm's cash collection can also be decided through the external financing channel. The more external financing is, the more benefit increasing cash payments would have. As a result, firms with more external financing tend to collect more cash flow at time t to substitute for external financing. In addition, increasing λ_t means that fewer earnings are carried over to the next period, which results in lower cash flow, and higher expected financing costs at time

$t+1$. Collectively, all else equal, firms with higher current financing needs tend to increase λ_t to lower their external financing costs. The increase in λ_t continues until the marginal value equals the expected marginal cost of increasing one unit percentage of λ_t.

Furthermore, the external financing channel drives the year-end cash collection in our model. Specifically, when the firm is more disciplined (i.e., at the end of the year), it is more inclined to increase cash payments because the marginal benefits of increasing λ are high ($a_\lambda^{s_t} = a_\lambda^H$)), whereas the marginal costs of increasing λ are low. However, those related benefits and costs are totally reversed in the next period, resulting in a higher accrual ratio at the beginning of the year. In Section 3.4.2, we explore more deeply the relationship between the year-end cash collection decision, the cash decision, and financial constraints.

3.4.2 Optimal cash holdings

This section discusses the optimal cash policy by analyzing the first-order condition of cash holdings. Then, we introduce two channels that affect the marginal value of cash. Finally, we establish the relationship between financial constraints and the marginal value of cash. Given the firm's optimization problem, the interior optimal cash policy should satisfy the following condition:

$$1 - \Psi'_{E_t}(E_t, \lambda_t, s_t) = \mathbb{E}_t\left[M_{t,t+1}(1+(1-\tau)r_s)(1-\Psi'_{E_{t+1}}(E_{t+1}, \lambda_{t+1}, s_{t+1}))\right] \tag{16}$$

The left-hand side of the equation is the marginal cost of increasing one unit of cash, the forgone dividend and the marginal financing cost at time t. The right-hand side of the equation is the marginal benefit of increasing one unit of cash at time $t+1$: the taxed interest rate plus the expected marginal reduction in the equity issuance cost.

Cash savings and aggregate risk

We can rewrite the right-hand side of Equation (16) as

$$\begin{aligned}
& \mathbb{E}_t\left[M_{t,t+1}(1+(1-\tau)r_s)(1-\Psi'_{E_{t+1}}(E_{t+1},\lambda_{t+1},s_{t+1}))\right] \qquad (17)\\
= \;& (1+(1-\tau)r_s)\{(1-\mathbb{E}_t[\Psi'_{E_{t+1}}(E_{t+1},\lambda_{t+1},s_{t+1})])/(1+r_f)\\
+ \;& Cov(M_{t,t+1},-\Psi'_{E_{t+1}}(E_{t+1},\lambda_{t+1},s_{t+1}))\}
\end{aligned}$$

According to Riddick and Whited (2009) and Eisfeldt and Rampini (2009), under risk-neutrality, the covariance term disappears from Equation (17) and risk plays no role in determining the firm's optimal savings policy:

$$1-\Psi'_{E_t}(E_t,\lambda_t,s_t)=\frac{1+(1-\tau)r^s}{1+r_f}(1-\mathbb{E}_t[\Psi'_{E_{t+1}}(E_{t+1},\lambda_{t+1},s_{t+1})])$$

The equation above highlights several pieces of intuition. First, cash derives value because it serves as an alternative to costly external financing and thus provides more financial flexibility in the future. Indeed, the firm optimally holds no cash if external financing is free. Second, the term $(1-\tau)r_s < r_f$ indicates that carrying cash holdings is costly for the firm because the interest is taxed and the interest rate is also lower than the risk-free rate. Thus, an optimal interior cash policy balances the flexibility benefit with the carrying cost.

However, in our model, the marginal value of cash is decided by two effects: the precautionary motive and risk consideration. First, the precautionary motive is reflected by the expected marginal financing costs, $-\mathbb{E}_t[\Psi'_{E_{t+1}}(E_{t+1},\lambda_{t+1},s_{t+1})]$ in Equation (16). Specifically, firms with higher expected marginal financing costs would undertake more financing costs in the future and thus would hold more cash to alleviate future financial difficulties. Second, the risk consideration is represented by the positive covariance term in Equation (16). When the aggregate financial shock is positively priced, firms will save more cash because the expected marginal financing costs covary positively with the discount factor. In detail, a negative aggregate financial shock would result in higher expected marginal financing costs and a higher discount factor. In our model, due to the covariance term, financially constrained firms measured with the marginal value of cash would suffer more from aggregate financial shocks than in the risk-neutrality model and thus save more cash.

Marginal value of cash and financial constraints

Following Bolton et al. (2011), the marginal value of cash is generally interpreted as capturing how financially constrained a firm is. The intuition is that cash is valuable for constrained firms. Firms respond to financial constraints by optimally managing their cash holdings so as to avoid situations of financial distress. According to Bolton et al. (2011), if the marginal value of cash is equal to or less than one, the firm is not suffering from the financial friction and thus is considered as financially unconstrained. However, if the marginal value of cash is greater than one, the firm has difficulties in obtaining funds because of the external financing costs. For interior solutions, the marginal value of cash is equal to $1 - \Psi'_E(E_t, \lambda_t, s_t) = 1 - 1_{E_t<0}(-(a_1 + a_\lambda^{s_t}(1-\lambda_t)) + a_2 E_t/K_t)\xi_t^{-a_3}$,[8] which implies that in our model, financially constrained firms defined by the marginal value of cash must trigger external financing ($E_t < 0$).

3.4.3 Financial constraints, year-end cash collection, and cash holdings

This section discusses three important implications of the relationship between financial constraints, year-end cash collection and cash holdings.

[8]We compute the expectation and derivative numerically for a few corner solutions since the first-order condition does not hold.

Year-end cash collection and cash timing pattern

We find that the year-end cash collection drives the cash timing pattern. To explore this relationship, we combine Equation (15) and Equation (16) as follows:

$$p_d - \frac{\partial \Psi(E_t, \lambda_t, s_t)}{\partial \lambda_t}/((1-\tau)\Pi_t) = \frac{1}{1+(1-\tau)r_s} - \Psi'_{E_t}(E_t, \lambda_t, s_t)/(1+(1-\tau)r_s) \quad (18)$$

The left- and right-hand sides of Equation (18) are the standardized forms of the left-hand sides of Equation (15) and Equation (16), respectively.[9] Despite the change in magnitude, we can still recognize the left-hand side of Equation (18) as the marginal cost of increasing accrued payments and the right-hand side of Equation (18) as the marginal cost of holding cash. This equation shows that the firm faces a trade-off between choosing to hold cash or increase accrued payments. It would adjust accrued payments until the cost of holding accrued payments is equal to the cost of holding cash. As a result, the year-end cash collection can result in the cash timing pattern. In detail, when the cost of increasing accrued payments is low at the beginning of the year, the firm would be more likely to substitute accrued payments for cash holdings. In contrast, at year-end when the cost of increasing accrued payments is high, the firm tends to substitute cash holdings for accrued payments. In other words, there is a substitutable relationship between accrued payments and cash holdings because both serve as a buffer against future cash flow shortfalls and thus increase future financial flexibility.

Financial constraints and year-end cash collection

Additionally, there is a positive relationship between year-end cash collection and financial constraints. For the interior solutions with respect to cash holdings, if $E_t < 0$, the firm is regarded as financially constrained because its marginal value of cash is greater than one.

[9] $p_d - \frac{\partial \Psi(E_t,\lambda_t,s_t)}{\partial \lambda_t}/((1-\tau)\Pi_t)$ is the left-hand side of Equation (15) divided by $(1-\tau)\Pi_t$. $\frac{1}{1+(1-\tau)r_s} - \Psi'_{E_t}(E_t, \lambda_t, s_t)/(1+(1-\tau)r_s)$ is the left-hand side of Equation (16) divided by $1+(1-\tau)r_s$. Both are equal to $\frac{1}{1+r_f} - \mathbb{E}_{\mathbb{t}}[M_{t,t+1} 1_{E_{t+1}<0}(-(a_1 + a_\lambda^{s_{t+1}}(1-\lambda_{t+1})) + a_2 E_{t+1}/K_{t+1})\xi_{t+1}^{-a_3}]$.

Because of the current financing needs ($E_t < 0$) and potential future financial frictions indicated by its high marginal value of cash, the financially constrained firm is more affected by the external financing channel. In detail, financially constrained firms are more likely to trigger external financing, which activates the terms $\frac{\partial \Psi(E_t,\lambda_t,s_t)}{\partial \lambda_t}$ and $\frac{\partial \Psi(E_{t+1},\lambda_{t+1},s_{t+1})}{\partial \lambda_t}$ in Equation (15). Therefore, they are more affected by the regime-shifting attention ($a_\lambda^{s_t}$), which drives the year-end cash collection. However, if $E_t \geq 0$, the firm is considered to be financially unconstrained. It does not have many financing needs—either currently or in the near future—and thus is less affected by the external financing channel.

Year-end cash collection and cash savings

Finally, we can observe a positive relationship between year-end cash collection and cash savings for two reasons. First, as we discussed above, year-end cash collection and cash savings are both positively affected by financial constraints. Second, high year-end cash collection results in more external financing in the future (lower E_{t+1}), which further contributes to expected marginal financing costs and the positive covariance term in Equation (17).

3.5 Asset pricing implications

In the model, firms make optimal capital investment, cash holdings, and cash collection decisions. Risk and expected stock returns are determined endogenously. To make the link explicit, we can evaluate the value function in Equation (14) at the optimum and obtain

$$V_t = D_t + \mathbb{E}_t[M_{t,t+1}V_{t+1}] \Rightarrow 0 = \mathbb{E}_t[M_{t,t+1}r^e_{t+1}] \tag{19}$$

where r^e_{t+1} is the stock excess return, equaling $V_{t+1}/[V_t - D_t] - (1 + r_f)$. With some algebra, Equation (19) can be rewritten as,

$$\mathbb{E}_t[r^e] = \gamma_x \times Cov(r^e_{t+1}, \Delta \ln(x_{t+1})) + \gamma_\xi \times Cov(r^e_{t+1}, \Delta \ln(\xi_{t+1})) = \beta_x \gamma_x \sigma_x^2 + \beta_\xi \gamma_\xi \sigma_\xi^2 \tag{20}$$

The equilibrium risk premiums in the model are determined by the endogenous covariances of the firm's excess stock returns with the two aggregate shocks (quantity of risk) and by the market price of the two risk parameters (γ_x and γ_ξ) in Equation (13). The pre-specified positive sign of the market prices of risk implies that, all else equal, assets with returns that have a more positive covariance with the aggregate productivity shock are riskier and offer higher average returns in equilibrium. Similarly, all else equal, assets with returns that have a more positive covariance with the aggregate financial shock are riskier and offer higher average returns in equilibrium. In Section 3.6, we explain the economic mechanism driving the cross-sectional variation in the YCC portfolios in detail.

3.6 The Mechanism

To explain the sign of the year-end cash collection premium in the model, we then describe how each of the priced shocks, ϵ_x and ϵ_ξ, respectively, contributes to the spread.

3.6.1 The contribution of ϵ_x

As discussed above, the risk exposure to aggregate productivity shocks is affected by the sales paid with cash, $p_d \lambda_t \Pi_t$. As a result, all else equal, firms that collect more cash flow (higher λ) at year-end are more exposed to aggregate productivity shocks. That is, the increase in aggregate productivity ($\epsilon_x > 0$) has a larger percentage of positive change on the operating cash flow of the high YCC firm relative to the low YCC firm. Therefore, $\beta_x^{YCC=high} > \beta_x^{YCC=low} > 0$.

3.6.2 The contribution of ϵ_ξ

The risk exposure to aggregate financial shocks is largely determined by the extent of external financing. Firms with high year-end cash collection do not carry over much of their earnings to the next period, resulting in more external financing (lower E_{t+1}). However, firms with low year-end cash collection have more cash flow in the next period and thus a low need for equity issuance. If there is a negative financial shock on all firms ($\epsilon_\xi < 0$), high YCC firms would be more negatively affected since they are more likely to pay the costs of accessing the equity market, implying $\beta_\xi^{YCC=high} > \beta_\xi^{YCC=Low} > 0$.

These findings, taken together, indicate that according to Equation (20), the risk premium between the high and low year-end cash collection portfolio is

$$\begin{aligned} & \mathbb{E}_t[r^e]^{YCC=high} - \mathbb{E}_t[r^e]^{YCC=low} \\ = \; & \underbrace{(\beta_x^{YCC=high} - \beta_x^{YCC=Low})}_{(+)}\gamma_x\sigma_x^2 + \underbrace{(\beta_\xi^{YCC=high} - \beta_\xi^{YCC=Low})}_{(+)}\gamma_\xi\sigma_\xi^2 \end{aligned} \tag{21}$$

The risk premium is positive.

4 Quantitative Model Implications

In this section, we calibrate the model parameters and solve the model numerically. We then investigate the model's quantitative predictions and discuss the targeted moments. Finally, we examine the mechanisms of the YCC premium.

4.1 Calibration

Table 4 shows the calibration of the model parameters. We carefully discuss the aggregate and firm-level moments targeted by our calibration. To quantitatively evaluate the calibration of the model parameters, we compare a wide set of aggregate and firm-level moments with those in the data in Table 5. To obtain the model-implied moments, we simulate the policy path for 5,000 firms with different productivity shock paths for 2,000 periods (1,000 years) at a semiannual frequency. Then we drop the first 1,000 periods to neutralize the impact of the initial condition, and the remaining simulated data for 1,000 periods are treated the same as those from the economy's stationary distribution. Finally, we simulate 100 samples and report the cross-sample average results as model moments.

[Table 4 is about here]

Firm's technology: general parameters. We set the curvature of the production function α to be 0.55, similar to Cooper and Haltiwanger (2006). The semiannual depreciation rate, δ, is set to be 0.01×6, as in Bloom (2009). We set the corporate tax rate to be 0.35 consistent with Hennessy and Whited (2005, 2007).

Firm's technology: costs. We calibrate the quadratic capital adjustment cost, g, to be 0.41, so as to match the volatility of firm-level investment rates (0.20 in the data and 0.08 in the model). The operating cost assumed largely determines firms' cash flow. Thus, we set f to be 0.05, which implies an average ratio of cash flow to assets of 0.15, which is close to the data at 0.10. We set the traditional equity issuance cost parameters to $a_0 = 0.01$, $a_1 = 0.11$, and $a_2 = 0.0004$, which imply the average proportion of external financing at 24%, close to the data moment at 39%, and the average cash ratio at 0.07, close to the data moment at 0.16. In addition, those equity financing cost parameters suggest that the fixed cost of equity issuance is around 1% of total proceeds and that the variable equity issuance cost is less than 10% of the amount of issuance, which is similar to the estimates in Altınkılıç and Hansen (2000) and Hennessy and Whited (2007). The value of the convex parameter a_2 is also consistent with Hennessy and Whited (2007). The issuance cost sensitivity parameter a_3 is calibrated to be 10.60 to match the volatility of the ratio of firm-level issuance to assets (0.19 in the data and 0.07 in the model). As we discussed in Section 3.4.1, p_d, a_λ^H, and a_λ^L are essential to target the timing pattern. We set p_d to be 0.95,[10] $a_\lambda^H = 0.25$ and $a_\lambda^L = 0.02$, to match the average year-end cash collection and the cash timing pattern (0.01 and 0.02 in the data; 0.01 and 0.01 in the model). Finally, the carrying cost of holding cash κ is set to be 0.005/2 following Livdan et al. (2009).

[10]The most common trade credit term is called "2-10 net 30", implying a 15.7% semiannual interest rate or a 37.24% annual interest rate. Since our model is solved at the semiannual frequency, we keep the semiannual discounted price p_d in a valid range from 0.843=1-15.7% to $0.9896 = \frac{1}{1+r_f}$.

Stochastic process. The persistence of idiosyncratic and aggregate productivity shocks, ρ_z and ρ_x, are calibrated to be 0.82 and 0.91 to match the autocorrelation of the ratio of firm-level cash flow to assets and the ratio of aggregate cash flow to assets (0.42 and 0.88 in the data, and 0.52 and 0.85 in the model). We set the conditional volatility of both idiosyncratic and aggregate productivity shocks to be $\sigma_z = 0.22$ and $\sigma_x = 0.06$ so as to match the volatility of the ratio of firm-level cash flow to assets and the ratio of aggregate cash flow to assets. Given the volatility and autocorrelation of the ratio of aggregate equity issuance to assets in the data (0.04 and 0.63), we set the conditional volatility of the aggregate issuance cost shock to be $\sigma_\xi = 0.01$ and the persistence of the aggregate issuance cost shock to be $\rho_\xi = 0.91$, implying that the volatility and autocorrelation of the ratio of aggregate issuance to assets are 0.02 and 0.80 in the model, respectively.

SDF. We set the semiannual risk-free rate to be 2.1%/2. We set the market price of risk on the aggregate productivity shock to be $\gamma_a = 7.44$ and the market price of risk on the aggregate financial shock to be $\gamma_\xi = 26.64$ by matching the average aggregate stock market return and the Sharpe ratio as closely as possible. This implies a market excess return of 5.25% and a Sharpe ratio of 0.72, which is reasonably close to 8.77 % and 0.68, respectively, in the data.

[Table 5 is about here]

4.2 Cross-sectional implications of the model

To further explain the model intuition on firms' optimal decisions and the risk premium, we report the model simulation at the portfolio level. Specifically, we sort firms based on YCC using the same method used in Section 2. We show that our model can reproduce the heterogeneity in firm characteristics including the cash flow timing pattern measured by the OCF spread, the cash timing pattern measured by the cash spread, excess stock return, cash savings (annual changes in cash), and annual cumulative ROA.[11]

[11] Appendix B describes how these characteristics are computed in the data.

[Table 6 is about here]

In Panel A of Table 6, we present the characteristics for constrained firms.[12] Using the empirical data, we find that firms with the highest YCC (H) present a more positive cash flow timing pattern, a higher cash spread, higher stock returns, more cash savings, and lower ROA than the firms with the lowest YCC (L). Next, we report the firm characteristics with the simulated data. Our model predicts that firms that collect more cash flow by year-end display the cash flow and cash timing pattern within one year. The OCF spread and cash spread range from 0.003 and -0.024 in the lowest YCC portfolio to 0.086 and 0.031 in the highest YCC portfolio, respectively. This result is consistent with the model prediction in Section 3.4.3. The long-short portfolio constructed using YCC earns an average excess return of 3.362% per year. Firms in the highest YCC portfolio have the strongest precautionary motive and thus increase their cash holdings by 0.026 compared with the last year, whereas this number is -0.036 in the lowest YCC group. There is a declining trend of ROA from the lowest YCC-sorted portfolio at 0.077 to the highest YCC-sorted portfolio at 0.034, which suggests that high YCC firms that collect more cash flow sacrifice profitability as a result of the costly discounted price. Overall, the results strongly confirm our key model predictions and also closely match the data moments.

However, as shown in Panel B, all these monotonic patterns are much weaker for unconstrained firms, in both the model and the data. Unconstrained firms have low financing needs and thus are less affected by the external financing channel. Therefore, they display a weak timing pattern in cash flow and cash holdings. In addition, unconstrained firms demand fewer immediate cash payments and less external financing and thus are less exposed to aggregate productivity and financial shocks, making them earn a lower return. Furthermore, unconstrained firms with high YCC are less affected by the costly discounted price. Therefore, there is a much slower declining trend in ROA in the unconstrained subsample relative to the constrained subsample. In summary, we show that our model predictions for

[12] We empirically classify financially constrained firms with the WW index. The results are similar using other financial constraint criteria.

unconstrained firm characteristics fit the data well. More importantly, the results further confirm the important role of financial constraints in explaining the cash flow timing pattern and high-minus-low YCC return spread.

The relative contribution of γ_x and γ_ξ

According to Equation (21), the YCC premium is qualitatively positive in the model. The quantitative importance of firms' exposure to different aggregate shocks is not observed. To evaluate the importance of these parameters for the model's results, we perform comparative statistics with respect to the market price of risk parameters, γ_x and γ_ξ.

Table 7 reports the market excess return and YCC premium with alternative specifications, which is compared against our baseline calibration. In column (2), we set the price of risk of the aggregate financial shock to zero. We find that the average excess returns decrease from 5.248% to 4.412% and the YCC premium decreases from 3.362% to 2.188%, implying that the aggregate financial shock has a non-trivial effect on the stock returns and YCC premium. In column (3), we set the price of risk of the aggregate productivity shock to zero. The average excess return drops significantly to 0.573%, and the YCC premium decreases to 0.488%, implying that the aggregate productivity shock drives the aggregate market premium and is also an important factor in deciding the YCC premium.

[Table 7 is about here]

5 Additional Empirical Evidence

5.1 Market price of macroeconomic shocks

This section shows that the firms' different degrees of exposure to macroeconomic shocks help us to understand the cross-sectional variation in the risk premiums of YCC-sorted portfolios. We undertake this analysis by assuming that the SDF that prices all assets in the economy is given by

$$M_t = 1 - b_{MKT} \times \mathrm{MKT_t} - \boldsymbol{b}'\mathbf{Macro_t} \tag{22}$$

Here, consistent with our model, we introduce two different macroeconomic shocks into $\mathbf{Macro_t}$, which is a 2×1 column vector that contains the proxies for aggregate financial and productivity shocks, and $\boldsymbol{b}$ is a 2×1 column vector of the corresponding market price of risk parameters. In detail, we use the issuance cost shock (ICS) data from Belo et al. (2019) to measure the aggregate financial shock and the log difference in total factor productivity (TFP) from the Federal Reserve Bank's official website to measure the aggregate productivity shock. For comparison, we also consider the standard capital asset pricing model (CAPM), which includes only the stock market factor (MKT). We then estimate the market price of risk parameters by two-step GMM using the standard asset pricing moment condition $\mathbb{E}[r^e_{it} M_t] = 0$, in which r^e_{it} is the excess return on portfolio i. We compute the sum of squared errors (SSQE), mean absolute pricing errors (MAPE), and the J-statistic of the overidentifying restrictions of the model. That is, all the pricing errors are zero if our model specification is correct.

[Table 8 is about here]

Panel A of Table 8 reports the risk characteristics for the five portfolios sorted on their YCC. First, the sensitivities with respect to the aggregate financial and productivity shocks both display a largely upward-sloping pattern from the lowest to the highest YCC quintile portfolio. These portfolios present an upward-sloping pattern of risk exposure with the empirical measures of the aggregate financial and productivity shocks. The differences in sensitivities between the highest and the lowest portfolio are significantly positive with t-statistics of 1.97 and 4.37, respectively. Namely, the highest YCC quintile faces a higher risk exposure than the lowest YCC quintile to aggregate financial and productivity shocks.

Panel B of Table 8 presents the two-step GMM results of market prices of risk using the identity matrix to weigh moment restrictions. We adjust the standard errors using the

Newey-West procedure with a maximum of three lags. The estimated market price of risk on the issuance cost shock (ICS) is statistically positive at the 10% level, with a value of 1.38 and a t-statistic of 1.82. That is, according to Equation (22), periods in which it is particularly costly to issue equity (low ICS) are usually associated with high marginal utility. The results also present a positive market price of risk on the total factor productivity shock (TFP), with a value of 1.04 and a t-statistic of 2.93, which is statistically significant at the 1% level. Additionally, the asset pricing model with ICS and TFP factors performs significantly better than the CAPM, reducing the sum of squares to 0.03 relative to 0.88 and the mean absolute pricing errors to 0.64 relative to 3.42. Last, the J-test is statistically insignificant and does not reject the model when we introduce the ICS and TFP factors, which implies that the average pricing error becomes smaller and even statistically insignificant. Therefore, the ICS and TFP factors in the asset pricing model are sufficient to capture the cross-sectional variations in the YCC-sorted portfolios.

5.2 Alternative channels

Our model suggests that the main explanation for the year-end cash collection premium is that the firms with high year-end cash collection are more financially constrained and more exposed to the aggregate shock of equity financing costs. Since our model suggests that this mechanism is quantitatively important in Section 3.6, it is still possible that the return spread is related to other mechanisms. Thus, in this section, we consider some alternative explanations and examine their impacts on the year-end cash collection premium.

5.2.1 The YCC premium versus the accruals effect

Sloan (1996) shows that firms with low accruals earn high future returns. Since the change in noncash net working capital is also a component of accruals, there is a mechanical relation between accruals and YCC. Following Sloan (1996), we define the accruals (denoted ACC) of firm i at time t as:

$$ACC_{i,t} = \frac{NWC_{i,t}^{Q4} - NWC_{i,t-1}^{Q4} - DP_{i,t}}{AT_{i,t-1}}, \tag{23}$$

where $DP_{i,t}$ is the depreciation of firm i at time t. There are some differences between the definitions of accruals and YCC. First, compared with the definition of YCC in Equation (1), the construction of accruals includes a depreciation term. We do not use depreciation when computing YCC because depreciation, as a tool of earnings management, would not affect cash flow items. Second, in terms of time span, ACC is calculated as the increase in noncash net working capital for the entire fiscal year, whereas YCC is constructed as the decrease in noncash net working capital in the second half of the fiscal year, resulting in a negative correlation between ACC and YCC. Since there is a large literature on the accrual anomaly suggesting that firms with high accruals earn a low return (see, e.g., Sloan, 1996; Hirshleifer et al., 2011), it is important to examine whether the year-end cash collection premium still exists after controlling for accruals. To do this, we implement a double-sort analysis following Grigoris et al. (2022). First, we construct the YCC spread across three accruals-sorted portfolios. The results in Panel A of Table 9 show that the YCC spread earns over 2.2 % per year among medium and high accrual firms. The YCC spread within these two accruals-sorted portfolios is significant at the 10% and 5% level, respectively. Furthermore, a joint test shows that the average YCC premium across all accrual groups is significant at the 5% level. In summary, our findings suggest that the YCC spread cannot be explained by the accruals effect of Sloan (1996).

In Panel B of Table 9, we reverse the order of the sorts to examine whether the accruals effect survives controlling for YCC. The results show that the accruals spread is statistically significant only within the portfolio of low YCC firms. Moreover, the null hypothesis that the accruals spread is zero across all three YCC-sorted portfolios is not rejected. Since conditioning portfolios on YCC drives out the accruals effect, while the converse does not hold, the economic determinants of the YCC premium may also shed light on the accruals effect of Sloan (1996).

[Table 9 is about here]

Recently, Grigoris et al. (2022) construct an R/S measure of a firm's trade receivables, a component of net working capital, which drives the counterparty premium. To distinguish our work from theirs, we also employ a double-sort analysis to examine whether the YCC premium still exists after controlling for the counterparty premium. Panel A of Table 10 shows that the YCC spread is 4.29% and 5.49%, both significant at the 1% level, in medium and high R/S-sorted groups, respectively. Moreover, the YCC spread is jointly significant across the three R/S-sorted portfolios, with a p-value of less than 0.01. However, Panel B of Table 10 shows that the counterparty premium in our sample is insignificant in all YCC-sorted portfolios.

[Table 10 is about here]

5.2.2 The YCC premium versus the cash-related premium

Palazzo (2012) proposes that riskier firms (i.e., firms with a higher correlation between cash flow and the aggregate shock) have higher financing needs and thus have higher optimal savings. This precautionary savings motive implies a positive relation between excess equity returns and cash holdings. Since our measure of YCC also varies positively with cash savings as well as cash holdings, we need to show whether our cross-sectional results are driven by the cash-related premium.

[Table 11 is about here]

We continue to conduct a double-sort analysis in Table 11. In Panel A, we show that the YCC spread is statistically significant across all cash-sorted portfolios, and the joint test suggests that the average YCC spread of all cash-sorted portfolios is significantly positive at the 1% level. In Panel B, the cash spread is insignificant across all cash-sorted portfolios, and the null hypothesis that the cash spread is zero across all three YCC-sorted portfolios is not rejected.

5.3 Asset pricing factor test

This subsection performs a number of standard asset pricing tests to investigate whether the YCC premium can be explained by standard risk factors, as represented by the Carhart (1997) four factor model and the Fama and French (2015) five-factor model.

To test the standard risk factor models, we perform time-series regressions of the excess returns of YCC-sorted portfolios on the Carhart (1997) four-factor model (FF3 factors and the momentum factor-MOM) in Panel A of Table 12, and the Fama and French (2015) five-factor model (FF3 factors, the profitability factor (RMW), and the investment factor (CMA)) in Panel B of Table 12.

[Table 12 is about here]

As we show in Table 12, the risk-adjusted returns (intercepts) of the YCC-sorted high-minus-low portfolio remain large and significant, ranging from 5.86% for the Carhart (1997) four-factor model in Panel A to 7.98% for the Fama and French (2015) five-factor model in Panel B with a t-statistic of 2.51, which is far above the 1% statistical significance level. In addition, the alpha implied by these standard factor models remains comparable to the YCC spread (i.e., the return on the high-minus-low portfolio) in Table 3.

Taken together, the results from the asset pricing tests in Table 12 suggest that the cross-sectional return spread across portfolios sorted on YCC cannot be explained by either the Carhart (1997) four-factor model or the Fama and French (2005) five-factor model. Hence, common risk factors cannot explain the higher returns associated with YCC. In the following subsection, we affirm the presence of the YCC-return relation by running Fama-MacBeth regressions to control for a bundle of firm characteristics.

5.4 Fama-MacBeth regressions

In this subsection, we extend the previous analysis to the investigation of the link between YCC and future stock returns using firm-level multivariate regressions that include firms' YCC and other characteristics as return predictors. In particular, we perform standard firm-level cross-sectional regressions (Fama and MacBeth, 1973) to predict future stock returns:

$$r^e_{i,t+1} = \alpha + \beta \times \text{YCC}_{i,t} + \gamma \times \text{Controls}_{i,t} + \varepsilon_{i,t+1} \tag{24}$$

where $r^e_{i,t+1}$ is stock i's cumulative excess return from July of year t to June of year $t+1$. The control variables include year-end cash collection (YCC), the natural logarithm of market capitalization at the end of each June (ME) deflated by the GDP deflator, the natural logarithm of book-to-market ratio (BM), book leverage (Book Lev), profitability (ROA), and investment rate (I/K). All independent variables are normalized to a zero mean and a one standard deviation after winsorization at the 1st and 99th percentiles to reduce the impact of outliers. To avoid using future information, all the balance sheet variables are based on the values available before the end of year t; we also adjust all independent variables for standard errors by a Newey-West adjustment.

[Table 13 is about here]

We divide our sample into financially constrained and unconstrained subsamples, and then estimate cross-sectional regressions at an annual frequency for each subsample. Table 13 shows that regressions exhibit a significantly positive slope coefficient on YCC for financially constrained firms but not for financially unconstrained firms. Specifically, the coefficient estimates for constrained firms vary between 0.947 and 1.092 and are all statistically significant at better than the 5% level, whereas those for unconstrained firms are not significantly different from zero. Therefore, the results of Fama-MacBeth regressions across financially constrained firms are consistent with our theoretical prediction that high YCC firms are more risky and thus are expected to earn a higher return.

5.5 Characteristics across portfolios

Our model can quantitatively reproduce a monotonic pattern between YCC and other firm characteristics such as cash savings. To empirically examine this prediction, we report the medians of firm characteristics across five portfolios sorted on YCC in Table 14 for the constrained subsample.

[Table 14 is about here]

In Panel A, we first show a decreasing trend in both the noncash net working capital ratio (NWC Ratio) and profitability (ROA) from low to high YCC portfolios. That is, by decreasing noncash net working capital, firms can thus collect more cash by year-end at the expense of profitability. Second, in terms of firms' saving policy, the cash savings (Δ Cash) characteristic displays a monotonically increasing pattern from 0.010 in the lowest portfolio to 0.031 in the highest portfolios. Last, there is no monotonic relationships found in the book-to-market ratio (B/M), investment rate (I/K), and leverage ratio (Book Lev) across YCC-sorted portfolios.

Panel B reports the portfolio medians of year-end cash collection (YCC), the operating cash flow spread (OCF Spread), the investment-to-assets spread (I/A Spread), the profitability spread (ROA Spread), and the cash spread (Cash Spread). The spread of a variable is computed as the difference between the corresponding values in the late part of the year and the early part of the year. First, we show an upward pattern in the cash spread and OCF spread from the lowest to highest portfolios. This means that firms can receive more cash flow at year-end by manipulating their working capital, and they save more cash in the late part of the year to hedge the cash flow shortfall in the early part of the following year. However, we do not find a significant pattern in the ROA spread and I/A spread. On the one hand, the ROA spread is close to zero across all five portfolios—much smaller than the OCF spread, 0.040, in the highest YCC portfolio—implying that the timing pattern of operating cash flow might not result from earnings manipulations. On the other hand, we find a positive I/A spread in all portfolios, and there is not much variation in the I/A spread. One possible explanation is that the I/A spread could be driven by other factors, such as tax minimization (Xu and Zwick, forthcoming).

6 Conclusion

We investigate firms' year-end cash collection behavior and its implications for asset pricing and cash holdings. We document a significant cash flow timing pattern; that is, firms collect more than 70% of their yearly cash flow by year-end. Then, we show that this timing pattern is positively related to financial constraints. Further, a long-short portfolio constructed from firms with high versus low year-end cash collection generates a 6.01% average excess return.

We develop a production model with two types of payment, namely, accrued and immediate cash payment, to explain the cash flow timing pattern and the high-minus-low YCC portfolio return spread. In the model, suppliers can demand cash payment by offering customers a price discount or allowing customers to pay in the next period. Thus, high cash collection reduces profitability. However, higher cash collection also leads to higher information transparency and reduces the cost of accessing the financial market. As firms attract more attention by year-end, they collect more cash flow to increase information transparency by year-end. Financially constrained firms have a greater incentive to collect more cash flow by year-end, increasing equity financing in the next period. The economic mechanism of the YCC spread is that the future cash flow of high YCC firms primarily consists of immediate payments. Thus, they are more exposed to aggregate productivity shocks. In addition, high YCC firms need to offer more of a discount to customers, and thus they are less profitable in financing future investments and more exposed to aggregate financial shocks.

Through calibration and simulation, we show that the model can reproduce the empirical cash flow timing pattern well. In addition, the model predicts that high YCC firms are less profitable, save more cash, and show a higher within-year spread in their cash holdings.

We provide empirical evidence supporting the predictions. The model also quantitatively matches the YCC premium to the data. The implications of our model assumptions are further supported by empirical tests.

Finally, our paper extends the implications of and confirms the importance of aggregate equity financing cost shocks suggested by Eisfeldt and Muir (2016) and Belo et al. (2019). We assume that the aggregate issuance cost shocks are exogenous. By affecting firms' YCC, cash savings, and investment decisions, these shocks are likely to affect aggregate quantities as well. An interesting direction for future research would be to endogenize the aggregate shocks in a general equilibrium setup, which may be important for an accurate understanding of the YCC premium.

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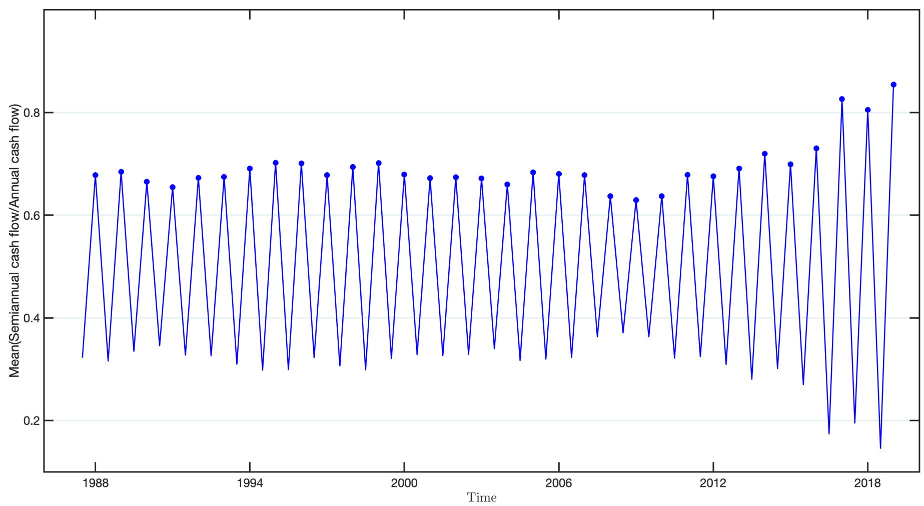

Figure 1: The Timing Pattern of Operating Cash Flow

This figure shows the prevalence of the cash flow timing pattern. We report the average ratio of semiannual cash flows to cumulative cash flows within a firm's fiscal year. Blue dots indicate the second half of the fiscal year.

Table 1: Financial Constraints and Cash Flow Timing Pattern

This table presents summary statistics for the cash flow timing pattern of our sample. The detailed definition of OCF refers to Table B1 in Appendix B. Early OCF is the cumulative operating cash flow from fiscal Q1 to Q2 divided by lagged total assets. Late OCF is the cumulative operating cash flow from fiscal Q3 to Q4 divided by lagged total assets. OCF Spread is the corresponding difference between Late OCF and Early OCF. We split the whole sample into constrained and unconstrained firms at the end of the fiscal year with the WW index, constructed by Whited and Wu (2006). We report time-series averages and standard deviation of the cross-sectional mean of these variables value-weighted by firm market capitalization at fiscal year-end. The sample period is from 1988 to 2019.

	Const.		Uncon.		Const-Uncon
	Mean	SD	Mean	SD	Diff
Early OCF (Q1+Q2)	0.041	0.004	0.053	0.004	
Late OCF (Q3+Q4)	0.073	0.005	0.074	0.006	
OCF Spread (Late-Early)	0.032	0.006	0.020	0.006	0.012***

Table 2: Portfolios Sorted on Year-end Cash Collection

The table reports the average excess returns for portfolios sorted on year-end cash collection. The detailed definition of the year-end cash collection measure refers to Section 2.2. The sample period is from July 1989 to December 2019. At the end of June of each year t, we sort the sample into quintiles based on their year-end cash collection available at the end of year t-1, where quintile 1 (quintile 5) contains the firms with the lowest (highest) year-end cash collection. We hold the portfolios for one year, from July of year t until June of year t + 1. Both value- and equal-weighted portfolio returns are reported. Newey and West (1986) robust t-statistics are reported in parentheses. We annualize returns by multiplying by 12.

Equal weight	L	2	3	4	H	H-L
$\mathbb{E}[R] - R_f(\%)$	10.116	10.687	10.771	11.572	13.440	3.324
(t)	(5.184)	(5.052)	(5.583)	(5.684)	(5.932)	(2.374)
Value weight	L	2	3	4	H	H-L
$\mathbb{E}[R] - R_f(\%)$	8.316	8.938	8.254	9.321	12.169	3.853
(t)	(3.815)	(3.584)	(3.432)	(4.154)	(3.613)	(2.115)

Table 3: Portfolios Sorted on Year-end Cash Collection: Subsample Evidence

The table reports the average excess returns for portfolios sorted on year-end cash collection. The detailed definition of the year-end cash collection measure refers to Section 2.2. The sample period is from July 1989 to December 2019. We split the whole sample into financially constrained and unconstrained subsamples at the end of every June, as classified by the WW index, total assets, SA index, and dividend payment dummy at the end of year t-1. Then, we report the average value-weighted excess return and Newey-West adjusted t-statistics for five YCC-sorted portfolios, as well as for the long-short portfolio denoted by H-L, in constrained subsamples (Panel A) and unconstrained subsamples (Panel B). We hold the portfolios for one year, from July of year t until June of year t + 1. Newey and West (1986) robust t-statistics are reported in parentheses. We annualize returns by multiplying by 12.

Panel A Constrained Subsample

	L	2	3	4	H	H-L
	Financially constrained firms - WW index					
$\mathbb{E}[R] - R_f(\%)$	8.915	11.712	10.944	12.121	14.922	6.007
(t)	(2.241)	(3.414)	(3.041)	(3.424)	(3.627)	(3.064)
	Financially constrained firms - Total Asset					
$\mathbb{E}[R] - R_f(\%)$	9.736	10.264	10.942	11.084	14.629	4.893
(t)	(2.770)	(3.214)	(3.502)	(3.434)	(3.851)	(2.256)
	Financially constrained firms - SA index					
$\mathbb{E}[R] - R_f(\%)$	10.544	10.554	8.371	10.852	16.365	5.821
(t)	(2.493)	(3.381)	(2.970)	(3.084)	(3.880)	(1.923)
	Financially constrained firms - Non-Dividend					
$\mathbb{E}[R] - R_f(\%)$	8.482	9.359	10.834	13.932	16.167	7.685
(t)	(1.944)	(2.592)	(3.154)	(3.558)	(3.489)	(2.243)

Panel B Unconstrained Subsample

	L	2	3	4	H	H-L
	Financially unconstrained firms - WW index					
$\mathbb{E}[R] - R_f(\%)$	8.779	8.249	8.221	9.911	10.804	2.025
(t)	(3.265)	(3.469)	(3.367)	(3.764)	(3.760)	(1.282)
	Financially unconstrained firms - Total Asset					
$\mathbb{E}[R] - R_f(\%)$	8.463	8.751	8.174	9.777	10.896	2.433
(t)	(3.161)	(3.584)	(3.332)	(3.759)	(3.787)	(1.580)
	Financially unconstrained firms - SA index					
$\mathbb{E}[R] - R_f(\%)$	8.364	8.424	8.608	9.419	10.249	1.885
(t)	(3.215)	(3.487)	(3.468)	(3.662)	(3.701)	(1.436)
	Financially unconstrained firms - Dividend					
$\mathbb{E}[R] - R_f(\%)$	9.050	8.001	8.344	9.308	9.409	0.359
(t)	(3.649)	(3.351)	(3.463)	(3.630)	(3.487)	(0.258)

Table 4: Calibration

This table presents the calibrated parameter values of the baseline model. The model is calibrated at the semiannual frequency.

Parameters	Symbol	Value
Technology		
Returns to scale	α	0.55
Corporate tax rate	τ	0.35
Rate of depreciation for capital	δ	0.06
Quadratic capital adjustment cost	g	0.41
Operating cost	f	0.05
Fixed financing cost	a_0	0.01
Linear financing cost	a_1	0.11
Quadratic financing cost	a_2	0.0004
Issuance cost sensitivity	a_3	10.60
Agency cost high	a_λ^H	0.25
Agency cost low	a_λ^L	0.02
Discounted price	p_d	0.95
Carrying cost	κ	0.005/2
Stochastic process		
Persistence of idiosyncratic productivity shock	ρ_z	0.82
STD of idiosyncratic productivity shock	σ_z	0.22
Persistence of aggregate productivity shock	ρ_x	0.91
STD of aggregate productivity shock	σ_x	0.06
Persistence of aggregate financial shock	ρ_ξ	0.91
STD of aggregate financial shock	σ_ξ	0.01
SDF		
Semiannual risk-free rate	r_f	2.1%/2
Risk aversion to productivity shock	γ_x	7.44
Risk aversion to financing shock	γ_ξ	26.64

Table 5: Target Moments

This table presents the selected target moments used for the calibration of the baseline model. We compare the moments in the data with moments of simulated data. The model-implied moments are the mean value of the corresponding moments across 100 samples of simulated data, each with 5,000 firms and 1,000 semiannual observations (500 years). The empirical data moments are calculated annually. We time-aggregate the semiannual simulated data to make model-implied moments comparable with the empirical data. The empirical data are from 1988 to 2019.

Moments	Data	Model
Aggregate-Level		
Average stock market excess return (%)	8.77	5.25
Sharpe ratio of stock market returns	0.68	0.72
Standard dev. of aggregate cash flow	0.02	0.02
Autocorrelation of aggregate cash flow	0.88	0.85
Standard dev. of issuance ratio	0.04	0.02
Autocorrelation of issuance ratio	0.63	0.80
Average proportion of issuing equity	0.39	0.24
Firm-Level		
Standard dev. of investment rate	0.20	0.08
Standard dev. of issuance ratio	0.19	0.07
Standard dev. of cash flow	0.07	0.08
Autocorrelation of cash flow	0.42	0.52
Mean of cash ratio	0.16	0.07
Mean of cash flow ratio	0.10	0.15
Mean of year-end cash collection	0.01	0.01
Mean of cash spread	0.02	0.01

Table 6: Firm Characteristics and Expected Returns in the Data and Model

This table reports the moments in the model-simulated data for the constrained subsample (Panel A) and the unconstrained subsample (Panel B) at the portfolio level. A firm is considered as financially constrained if the marginal value of cash is greater than one. Detailed variable definitions refer to Table B1 in Appendix B.

Panel A: Constrained Subsample

	L	2	3	4	H	H-L
Data						
OCF Spread	-0.005	0.006	0.011	0.019	0.040	0.045
Cash Spread	0.009	0.011	0.017	0.019	0.050	0.041
$\mathbb{E}[R] - R_f(\%)$	8.915	11.712	10.944	12.121	14.922	6.007
Δ Cash	0.010	0.008	0.011	0.016	0.031	0.021
ROA	0.050	0.031	0.025	0.019	0.005	-0.045
Model						
OCF Spread	0.003	0.006	0.007	0.017	0.086	0.083
Cash Spread	-0.024	-0.002	0.001	0.014	0.031	0.055
$\mathbb{E}[R] - R_f(\%)$	4.958	5.700	5.871	7.501	8.320	3.362
Δ Cash	-0.036	-0.004	-0.004	0.015	0.026	0.062
ROA	0.077	0.065	0.063	0.036	0.034	-0.043

Panel B: Unconstrained Subsample

	L	2	3	4	H	H-L
Data						
OCF Spread	0.001	0.007	0.011	0.019	0.035	0.035
Cash Spread	-0.001	0.001	0.004	0.007	0.023	0.023
$\mathbb{E}[R] - R_f(\%)$	8.779	8.249	8.221	9.911	10.804	2.025
Δ Cash	0.001	0.001	0.001	0.003	0.008	0.007
ROA	0.070	0.056	0.056	0.057	0.055	-0.016
Model						
OCF Spread	-0.001	0.001	0.001	-0.002	0.014	0.015
Cash Spread	-0.010	-0.002	0.001	0.005	0.019	0.029
$\mathbb{E}[R] - R_f(\%)$	2.552	2.887	2.924	3.053	3.367	0.815
Δ Cash	-0.007	-0.004	0.001	0.001	0.016	0.023
ROA	0.110	0.107	0.106	0.100	0.102	-0.008

Table 7: Alternative Calibrations

This table presents certain comparative statics exercises. We specify the stochastic discount factor to have a zero price of risk of aggregate financial shock, $\gamma_\xi = 0$, in column (2) and a zero price of risk of aggregate productivity shock, $\gamma_x = 0$, in column (3), respectively. The reported statistics for each alternative specification of the model are obtained from 100 samples of simulated data, each with 5,000 firms and 1,000 semiannual observations.

	Benchmark (1)	$\gamma_\xi = 0$ (2)	$\gamma_x = 0$ (3)
Lowest YCC	4.958	4.145	0.353
2	5.700	4.640	0.574
3	5.871	4.772	0.586
4	7.501	5.646	0.892
Highest YCC	8.320	6.333	0.841
Market excess return (%)	5.248	4.412	0.573
YCC premium (H-L)	3.362	2.188	0.488

Table 8: Estimating the Market Price of Risk

This table presents the risk price estimates for the aggregate financial and productivity shocks. In Panel A, we use the YCC-sorted portfolios as test portfolios and report risk exposure with respect to the measures of aggregate macroeconomic shocks: the aggregate financial shock and the productivity shock. Panel B reports the average estimates of the market prices of risk associated with the CAPM estimated with and without aggregate financial and productivity shocks. The asset pricing models are estimated with the generalized method of moments (GMM) using the standard asset pricing moment condition $E_T[r^e_{i,t}M_t] = 0$, in which $M_t = 1 - b_{MKT} \times \mathrm{MKT_t} - \boldsymbol{b'}\mathbf{Macro_t}$. $\mathrm{MKT_t}$ is the (demeaned) market excess return and b_M is the corresponding market prices of risk on the SDF. $\mathbf{Macro_t}$ includes measures of aggregate macroeconomic shocks: the first one is the issuance cost shock (ICS), constructed by Belo et al. (2019) at the annual frequency to measure the aggregate financial shock; the second one is the aggregate productivity shock measured by the log difference in total factor productivity (TFP). All shocks are normalized to have zero mean and unit standard deviation. We report HAC t-statistics computed errors using the Newey-West procedure adjusted for a maximum of three lags. As a measure of fit, we report the sum of squared errors (SSQE), mean absolute pricing errors (MAPE), and the J-statistic of the overidentifying restrictions of the model. The sample includes annual data from 1988 to 2019.

Panel A: Portfolio Risk Exposure

	L	2	3	4	H	H-L
ICS	5.41	4.80	6.23	6.45	8.28	2.87
(t)	(1.61)	(1.80)	(2.01)	(1.79)	(2.03)	(1.97)
TFP	2.49	5.87	4.13	3.89	7.68	5.19
(t)	(0.48)	(1.21)	(0.88)	(0.88)	(1.57)	(4.37)

Panel B: Price of Risks

Parameters	CAPM	+ICS+TFP
b_{MKT}	0.74	0.44
(t)	(3.71)	(1.71)
b_{ICS}		1.38
(t)		(1.82)
b_{TFP}		1.04
(t)		(2.93)
SSQE(%)	0.88	0.03
MAPE(%)	3.42	0.64
J-test	5.54	0.48
p	0.24	0.79

Table 9: Controlling for Accruals: Double-sort Analysis

This table reports value-weighted portfolio returns obtained from a conditional double-sort procedure following Grigoris et al. (2022) for financially constrained firms measured by the WW index of Whited and Wu (2006). In Panel A, the control variable (i.e., the first-stage sorting variable) is a firm's total accruals, and the second-stage sorting variable is a firm's year-end cash collection (YCC). The sorting is conducted as follows. First, at the end of each June, we sort the cross section of firms into three portfolios on the basis of accruals using the 30th and 70th percentiles of the cross-sectional distribution of accruals from the fiscal year ending in calendar year t-1. Second, with each of these accruals-sorted portfolios, we further sort firms into three additional portfolios on the basis of YCC using the 30th and 70th percentiles of YCC from the fiscal year ending in calendar year t-1. This process produces nine portfolios that are each held from the beginning of July in year t to the end of June in year t + 1, at which point all portfolios are rebalanced. In Panel B, the order of the sorting procedure is reversed. The last two rows in Panel A (Panel B) show the YCC (accruals) spread along with its associated p-value in parentheses. These p-values are computed using Newey and West (1986) robust standard errors. Each panel also reports the p-value from a joint test on the null hypothesis that the YCC (accruals) spread across all three (accruals) (YCC) sorted portfolios in Panel A (Panel B) is zero. The sample period is from July 1988 to December 2019. We annualize returns by multiplying by 12.

Panel A: Controlling for accruals

	Low Accruals	Medium	High Accruals	
Low YCC	14.26	12.37	8.15	
Medium	14.87	12.99	12.03	
High YCC	14.58	14.57	11.71	
Spread	0.31	2.20	3.56	Joint test
P value	(0.86)	(0.09)	(0.02)	(0.03)

Panel B: Controlling for YCC

	Low YCC	Medium	High YCC	
Low Accruals	12.14	12.34	12.99	
Medium	11.59	13.50	15.60	
High Accruals	7.58	10.37	13.52	
Spread	-4.56	-1.97	0.53	Joint test
P value	(0.09)	(0.44)	(0.86)	(0.18)

Table 10: Controlling for Receivable-to-sales Ratio (R/S): Double-sort Analysis

This table reports value-weighted portfolio returns obtained from a conditional double-sort procedure following Grigoris et al. (2022) for financially constrained firms measured by the WW index of Whited and Wu (2006). In Panel A, the control variable (i.e., the first-stage sorting variable) is a firm's receivable-to-sales (R/S) ratio, and the second-stage sorting variable is a firm's year-end cash collection (YCC). The sorting is conducted as follows. First, at the end of each June, we sort the cross section of firms into three portfolios on the basis of R/S using the 30th and 70th percentiles of the cross-sectional distribution of R/S from the fiscal year ending in calendar year t-1. Second, with each of these R/S-sorted portfolios, we further sort firms into three additional portfolios on the basis of YCC using the 30th and 70th percentiles of YCC from the fiscal year ending in calendar year t-1. This process produces nine portfolios that are each held from the beginning of July in year t to the end of June in year t + 1, at which point all portfolios are rebalanced. In Panel B, the order of the sorting procedure is reversed. The last two rows in Panel A (Panel B) show the YCC (R/S) spread along with its associated p-value in parentheses. These p-values are computed using Newey and West (1986) robust standard errors. Each panel also reports the p-value from a joint test on the null hypothesis that the YCC (R/S) spread across all three (R/S) (YCC) sorted portfolios in Panel A (Panel B) is zero. The sample period is from July 1988 to December 2019. We annualize returns by multiplying by 12.

Panel A: Controlling for R/S

	Low R/S	Medium	High R/S	
Low YCC	11.43	11.20	10.24	
Medium	12.76	12.77	12.30	
High YCC	13.51	15.49	15.73	
Spread	2.08	4.29	5.49	Joint test
P value	(0.21)	(0.00)	(0.00)	(0.00)

Panel B: Controlling for YCC

	Low YCC	Medium	High YCC	
Low R/S	11.12	12.85	15.45	
Medium	11.12	11.88	12.37	
High R/S	10.16	12.32	15.22	
Spread	-0.96	-0.53	-0.23	Joint test
P value	(0.72)	(0.83)	(0.93)	(0.74)

Table 11: Controlling for Cash: Double-sort Analysis

This table reports value-weighted portfolio returns obtained from a conditional double-sort procedure following Grigoris et al. (2022) for financially constrained firms measured by the WW index of Whited and Wu (2006). In Panel A, the control variable (i.e., the first-stage sorting variable) is a firm's cash ratio, and the second-stage sorting variable is a firm's year-end cash collection (YCC). The sorting is conducted as follows. First, at the end of each June, we sort the cross section of firms into three portfolios on the basis of cash using the 30th and 70th percentiles of the cross-sectional distribution of cash from the fiscal year ending in calendar year t-1. Second, with each of these cash-sorted portfolios, we further sort firms into three additional portfolios on the basis of YCC using the 30th and 70th percentiles of YCC from the fiscal year ending in calendar year t-1. This process produces nine portfolios that are each held from the beginning of July in year t to the end of June in year t + 1, at which point all portfolios are rebalanced. In Panel B, the order of the sorting procedure is reversed. The last two rows in Panel A (Panel B) show the YCC (cash) spread along with its associated p-value in parentheses. These p-values are computed using Newey and West (1986) robust standard errors. Each panel also reports the p-value from a joint test on the null hypothesis that the YCC (cash) spread across all three (cash) (YCC) sorted portfolios in Panel A (Panel B) is zero. The sample period is from July 1988 to December 2019. We annualize returns by multiplying by 12.

Panel A: Controlling for Cash

	Low Cash	Medium	High Cash	
Low YCC	10.17	10.98	10.96	
Medium	13.86	12.62	12.04	
High YCC	13.50	15.45	15.29	
Spread	3.33	4.47	4.33	Joint test
P value	(0.08)	(0.00)	(0.01)	(0.00)

Panel B: Controlling for YCC

	Low YCC	Medium	High YCC	
Low Cash	10.11	11.69	13.92	
Medium	9.56	11.10	13.95	
High Cash	12.53	13.80	13.51	
Spread	2.42	2.10	-0.41	Joint test
P value	(0.28)	(0.39)	(0.89)	(0.34)

Table 12: Asset Pricing Tests of YCC-sorted Portfolios

This table shows the coefficients of regressions of excess returns of YCC-sorted portfolios on the factors from the Carhart (1997) four-factor model (Panel A) and the Fama and French (2015) five-factor model (Panel B). The t-statistics (in parentheses) are computed based on Newey and West (1986) adjusted standard errors. Firms are classified as constrained in year t if their year-end WW index is higher than the corresponding median in year t-1. The sample period is from July 1988 to December 2019. We annualize returns by multiplying by 12.

Panel A: Carhart Four-Factor Model

	L	2	3	4	H	H-L
α_{C4}	2.14	-0.31	3.53	6.10	8.01	5.86
(t)	(0.90)	(-0.15)	(1.71)	(3.11)	(3.16)	(1.93)
MKT	1.22	1.06	1.10	1.07	1.12	-0.09
(t)	(22.41)	(18.72)	(24.21)	(20.61)	(19.00)	(-1.26)
SMB	0.34	0.29	0.18	0.22	0.39	0.05
(t)	(2.67)	(2.64)	(2.45)	(2.56)	(4.32)	(0.29)
HML	-0.33	-0.28	-0.19	-0.23	-0.65	-0.32
(t)	(-4.51)	(-4.46)	(-1.77)	(-3.57)	(-5.90)	(-2.40)
MOM	-0.24	-0.14	-0.16	-0.19	-0.24	-0.00
(t)	(-4.43)	(-3.55)	(-2.10)	(-3.89)	(-3.16)	(-0.04)

Panel B: Fama-French Five-Factor Model

	L	2	3	4	H	H-L
α_{FF5}	1.98	-0.06	3.41	5.39	9.96	7.98
(t)	(0.88)	(-0.03)	(1.58)	(2.51)	(3.67)	(2.51)
MKT	1.22	1.04	1.11	1.10	1.08	-0.14
(t)	(19.25)	(20.71)	(20.30)	(18.02)	(16.32)	(-1.64)
SMB	0.30	0.29	0.14	0.20	0.18	-0.12
(t)	(2.47)	(2.84)	(1.53)	(1.97)	(1.86)	(-1.01)
HML	-0.09	-0.11	-0.04	-0.09	-0.33	-0.24
(t)	(-0.83)	(-1.18)	(-0.34)	(-0.86)	(-2.47)	(-1.79)
RMW	-0.13	-0.05	-0.14	-0.08	-0.58	-0.45
(t)	(-0.81)	(-0.48)	(-1.02)	(-0.65)	(-3.95)	(-2.47)
CMA	-0.45	-0.42	-0.21	-0.21	-0.36	0.09
(t)	(-2.46)	(-2.38)	(-1.09)	(-1.57)	(-1.48)	(0.39)

Table 13: Fama-MacBeth Regression

This table reports the results of Fama-MacBeth regressions of annual cumulative firm-level excess stock returns on lagged firm characteristics. The regression coefficients reported in the table are the time-series averages of the slope coefficients from year-by-year cross-sectional regressions. We split the whole sample into financially constrained and unconstrained subsamples at the end of every June, as classified by the WW index, total assets, SA index, and dividend payment dummy at the end of year t-1. Our control variables include Log ME, Log BM, Book Lev, ROA, and I/K. The detailed definitions refer to Table B1 in Appendix B. The t-statistics (in parentheses) are computed based on Newey and West (1986) adjusted standard errors. The annual data start in 1988 and end in 2019.

Dep Var	Measure of Financial Constraint							
$E[R] - R_f(\%)$	WW index		Total Asset		SA index		Payout	
	Con	Uncon	Con	Uncon	Con	Uncon	Con	Uncon
YCC	0.947**	0.670	1.016**	0.363	1.092***	0.354	0.995**	0.598
(t)	(2.102)	(1.691)	(2.462)	(0.933)	(2.862)	(0.875)	(2.325)	(1.349)
Log ME	-2.202	-1.628*	-3.246*	-2.393**	-2.867*	-1.934**	-1.503	-1.794**
(t)	(-1.407)	(-1.800)	(-1.871)	(-2.267)	(-2.032)	(-2.491)	(-1.294)	(-2.388)
Log BM	1.753*	-0.064	1.839*	-0.757	1.837*	-0.665	1.564	0.186
(t)	(1.711)	(-0.067)	(1.973)	(-0.723)	(1.910)	(-0.676)	(1.449)	(0.208)
Book Lev	0.234	0.229	0.123	-0.061	0.051	0.210	0.110	0.528
(t)	(0.211)	(0.296)	(0.109)	(-0.087)	(0.044)	(0.286)	(0.096)	(0.776)
ROA	0.563	0.760	0.828	-0.002	1.054	-0.570	1.100	1.096
(t)	(0.532)	(0.628)	(0.818)	(-0.001)	(1.093)	(-0.306)	(1.126)	(0.816)
I/K	-0.647**	-0.772	-0.562*	-1.028	-0.675**	-0.917	-0.984***	-1.128
(t)	(-2.068)	(-1.080)	(-1.865)	(-1.148)	(-2.150)	(-1.106)	(-2.837)	(-1.574)
Observations	31,047	30,009	31,872	29,983	31,474	30,381	36,111	25,744
R-squared	0.040	0.054	0.041	0.059	0.042	0.053	0.043	0.051

Table 14: Summary Statistics

This table reports the median of firm characteristics (Panel A) and timing proxies (Panel B) across five YCC-sorted portfolios in the constrained subsample. Firms are classified as constrained in year t if their year-end WW index is higher than the corresponding median in year $t-1$. YCC is defined in Section 2.2. Bm is the book-to-market ratio. I/K is the ratio of investment to purchased capital. ROA is the income before extraordinary items divided by lagged assets. NWC Ratio is the noncash net working capital scaled by total assets. Book Lev is the sum of long- and short-term debt divided by total assets. Δ Cash is the change in cash holdings over one fiscal year divided by lagged assets. Our timing proxies are the corresponding average differences between the second half of the fiscal year and the first half of the fiscal year, including operating cash flow spread (OCF Spread), investment-to-asset spread (I/A Spread), return on assets spread (ROA Spread), and cash spread (Cash Spread). Detailed definitions refer to Table B1 in Appendix B. The sample starts in 1988 and ends in 2019.

Panel A. Firm Characteristics

	L	2	3	4	H
BM	0.439	0.514	0.533	0.528	0.488
I/K	0.297	0.238	0.219	0.223	0.246
ROA	0.050	0.031	0.025	0.019	0.005
NWC Ratio	0.209	0.125	0.096	0.096	0.113
Book Lev	0.155	0.175	0.184	0.179	0.155
Δ Cash	0.010	0.008	0.011	0.016	0.031

Panel B. Timing pattern

	L	2	3	4	H
YCC	-0.063	-0.014	0.006	0.026	0.077
OCF Spread	-0.005	0.006	0.011	0.019	0.040
I/A Spread	0.004	0.002	0.003	0.004	0.004
ROA Spread	0.006	0.003	0.001	0.000	-0.004
Cash Spread	0.009	0.011	0.017	0.019	0.050

Appendix A Solution Procedure

The model is solved on discrete grids by value function iteration. Equation (14) is very hard to solve numerically, however, because it has more than five state variables. The computational burden dramatically rises as the number of state variables increases. The value of the firm is a function of productivity (z_t), aggregate level of external financing cost (ξ_t), attention state (s_t), capital (K_t), cash holdings (L_t), lagged proportion of cash payments (λ_{t-1}), and lagged output (Π_{t-1}). Without loss of generality, we let $H_t = L_t + \frac{(1-\tau)(1-\lambda_{t-1})\Pi_{t-1}}{1+r_s(1-\tau)}$. Then the firm's pre-financing payout in Equation (9) can be rewritten as

$$E_t = (1+r_s(1-\tau))H_t + (1-\tau)p_{dt}\lambda_t\Pi_t - (1-\tau)f + \tau\delta K_t - I_t - \frac{gI_t^2}{2K_t} + \frac{(1-\tau)(1-\lambda_t)\Pi_t}{1+r_s(1-\tau)} - H_{t+1} \tag{25}$$

Substituting Equation (25) with Equation (14), the firm's problem can then be summarized by the following Bellman equation:

$$V_t(x_t, \xi_t, s_t, z_t, K_t, H_t) = \max_{K_{t+1}, H_{t+1}, \lambda_t} D_t + \mathbb{E}_t[M_{t,t+1}V_{t+1}(x_{t+1}, \xi_{t+1}, s_{t+1}, z_{t+1}, K_{t+1}, H_{t+1})] \tag{26}$$

The goal of a numerical solution is to obtain a mapping from $(x_t, \xi_t, s_t, z_t, K_t, H_t)$ to $V_t(x_t, \xi_t, s_t, z_t, K_t, H_t)$. Note that we can distinguish cash holdings (L_t) from H_t as we still have information about the policy path of λ_{t-1}.

Appendix B

Table B1: Definition of Variables

Variables	Definition	Source
ME	Market capitalization deflated by GDP deflator at the end of June in year t.	CRSP
OCF	Operating cash flow (OANCF + XINT) divided by lagged assets	Compustat
ROA	Income before extraordinary items (IB) divided by lagged assets	Compustat
YCC	For details, refer to Section 2.2	Compustat
Accrual	For details, refer to Section 5.2.1	Compustat
BM	Ratio of book equity to market equity, where both book equity and market equity values follow the definitions in Fama and French (1993).	Compustat
Book Lev	Sum of long-term liability (DLTT) and current liability (DLCT) divided by total assets (AT).	Compustat
I/K	Ratio of investment (CAPX-SPPE) to purchased capital (PPENT).	Compustat
NWC	Noncash net working capital ((ACT-CHE)-(LCT-DLC-TXP)).	Compustat
Cash	Cash equivalents (CHE) divided by total assets (AT)	Compustat
Δ Cash	Changes in cash holdings (CHECH) over one fiscal year divided by lagged total assets (AT)	Compustat

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Table B1 – continued from previous page

Variables	Definition	Source
SA Index	Following Hadlock and Pierce (2010)	Compustat
WW Index	Following Whited and Wu (2006)	Compustat
Size	Natural logarithm of total assets (AT) deflated by GDP deflator	Compustat
Dividend dummy	Dummy variable equal to 1 if the firm's dividend payment (DVT) over the year was positive	Compustat
OCF spread	Difference between operating cash flow in the last two fiscal quarters (OANCF Q3+XINT Q3+OANCF Q4+XINT Q4) and operating cash flow in the first two fiscal quarters (OANCF Q1+XINT Q1+OANCF Q2+XINT Q2) divided by lagged total assets (AT). Other spread variables (such as the I/K Spread, for example) are constructed similarly.	Compustat