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Cash holdings, risk, and expected returns ☆

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ABSTRACT

In this paper I develop and empirically test a model that highlights how the correlation between cash flows and a source of aggregate risk affects a firm's optimal cash holding policy. In the model, riskier firms (i.e., firms with a higher correlation between cash flows and the aggregate shock) are more likely to use costly external funding to finance their growth option exercises and have higher optimal savings. This precautionary savings motive implies a positive relation between expected equity returns and cash holdings. In addition, this positive relation is stronger for firms with less valuable growth options. Using a data set of US pubic companies, I find evidence consistent with the model's predictions.

1. Introduction

This paper studies how the correlation between cash flows and a source of aggregate risk affects the optimal cash holding policy of a firm. Using a three-period model of a firm's investing and financing decisions, I show how the riskiness of cash flows creates a novel motive for precautionary savings that is incremental to those already identified in prior studies. This additional precautionary savings motive allows me to explore the relation between cash holdings and equity returns and derive testable implications, which I verify using data on US public companies.

The model presented here extends the three-period framework of Kim, Mauer, and Sherman (1998) to allow for a source of aggregate risk. In my setup, a manager can finance investment with retained earnings or equity. Equity issuance involves pecuniary costs, such as bankers' and lawyers' fees, while savings allow the firm to avoid costly equity financing but earn a lower return than shareholders could obtain outside of the firm. The optimal cash holding policy is pinned down by the trade-off between the choice to distribute dividends in the current period or to save cash and thus avoid costly external financing in the future. Unlike Kim, Mauer, and Sherman (1998), I assume that investors are not risk-neutral. Specifically, shareholders value future cash flows using a stochastic discount factor driven by a source of aggregate

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risk. As a result, riskier firms (i.e., firms with a higher correlation between cash flows and the aggregate shock) have the highest hedging needs because they are more likely to experience a cash flow shortfall in those states in which they need external financing the most. Riskier firms' optimal savings are therefore higher than those of less risky firms.

This mechanism allows the model to produce a number of testable implications on the relation between cash holdings and expected equity returns. First, an increase in the riskiness of cash flows leads to an increase in both expected equity returns and retained earnings. In the data, a positive correlation should be observed between cash holdings and equity returns. Second, the magnitude of this correlation is larger for firms with less profitable investment opportunities. This prediction stems from the fact that, in the model, firms with less profitable investment opportunities have a smaller fraction of their total value tied to growth options and hence the expected return on these firms' assets in place has a larger weight in determining the overall expected return. As a result, a change in the riskiness of the cash flows produced by a firm's assets in place leads to a larger change in expected returns the smaller is the profitability of the firm's growth option. It follows that two firms that differ only in their future investment profitability experience the same increase in expected equity returns only if the firm with the more profitable investment opportunity experiences a larger increase in riskiness. Given that a larger increase in riskiness also causes a larger increase in cash holdings, a stronger marginal effect of expected equity returns should be observed on cash holdings across firms with more profitable growth options.

To test the model's predictions, I verify that an ex ante measure of expected returns has a significant impact on corporate cash policies. Specifically, I follow the method proposed by Gebhardt, Lee, and Swaminathan (2001) and modified by Wu and Zhang (2011) to construct an accounting-based measure for expected equity returns. Using this measure, I test whether the ex ante heterogeneity in expected equity returns is positively related to ex post differences in cash holdings, as predicted by the model. This analysis complements other studies (e.g., Opler, Pinkowitz, Stulz, and Williamson, 1999) that use cash flow volatility as a proxy for firm-level risk. The results show that changes in cash holdings from one period to the next are positively related to beginning-of-period expected equity returns. That is, firms with a higher expected equity return experience a larger increase in their cash balance. This result is robust to the inclusion of variables that control for expected cash flows and future investment opportunities, and it supports the finding of a precautionary savings motive driven by expected equity returns.

In addition, to test if the relation between expected returns and cash holdings is influenced by expected profitability, as predicted by the model, I run a subsample analysis using three different measures for the profitability of a firm's growth options. The results show that, when I use market size and current profitability as proxies, firms with higher expected profitability have a larger sensitivity of cash holdings to expected equity returns, thus confirming the model's prediction. When I use the third measure, the book-to-market ratio, the evidence is less favorable. This is not a surprise given that the book-to-market ratio is a catch-all proxy for many variables, besides future profitability.

In the second part of the empirical analysis, I perform a portfolio exercise in the spirit of Fama and French (1993) to test whether cash holdings carry a positive risk premium. I first run a simple portfolio sorting based on cash-to-asset ratios. This sorting is able to produce an equally weighted excess return of the high cash-to-assets portfolio over the low cash-to-assets portfolio that on average is positive and significant at 0.77% per month. When I use value-weighted returns, the excess return is still positive with a point estimate of 0.41% per month, but it is not significant. However, when I adjust for risk using the Fama and French (1993) or the Chen, Novy-Marx, and Zhang (2011) three-factor models, the risk-adjusted excess return of the high cash-to-assets portfolio over the low cash-to-assets portfolio is positive and significant both for equally and value-weighted excess returns. Next, I perform three independent two-way sorts on cash holdings and the same proxies for expected profitability used in the first part of the empirical analysis to verify that the cash holdings-related excess return is larger for firms with less valuable growth options. I find that, for equally weighted portfolios, the difference in the cash-related excess returns between high expected profitability firms and low expected profitability firms is positive, significant, and varying between 0.54% and 1.28% per month. As in the one-way sort case, the results are less supportive when I use value-weighted returns. In the latter case, the difference in the cash-related excess returns between high and low expected profitability firms is positive and significant only when I use the book-to-market ratio as a proxy. This leads to the conclusion that the evidence whether cash holdings carry a positive risk premium based on realized equity returns is not as strong as the one produced using the accounting-based measure for expected equity returns.

The model presented in this paper builds on the framework of Kim, Mauer, and Sherman (1998) by introducing a source of aggregate risk. In this way, the link between corporate precautionary savings and risk premia can be explicitly studied.[1] As in Kim, Mauer, and Sherman (1998), Gamba and Triantis (2008) study the interaction between cash holdings and financing constraints in a setup in which firms can both hoard cash and issue debt. They show that corporate liquidity is more valuable for small and younger firms because it allows them to improve their financial flexibility. They further show that combinations of debt and cash holdings that produce the same value of net debt have a different impact on a firm's financial flexibility. In a closely related model, Riddick and

[1] Other studies that provide a theory of optimal cash holdings are Huberman (1984), Almeida, Campello, and Weisbach (2004), Nikolov and Morellec (2009), Acharya, Almeida, and Campello (2007), Han and Qiu (2007), Asvanunt, Broadie, and Sundaseran (2010), Acharya, Davydenko, and Strebulaev (2011), and Bolton, Chen, and Wang (2011).

Whited (2009) show that the firm's propensity to save out of cash flows is negative and that cash flow volatility is more important than financing constraints in shaping the optimal cash holdings policy of a corporation.

These papers do not explicitly model the correlation of the firm's cash flows with an aggregate source of risk, and they do not study the link between the cross-section of equity returns and capital structure decisions. Building on Berk, Green, and Naik (1999) and Zhang (2005), George and Hwang (2010) and Gomes and Schmid (2010) propose two alternative models to rationalize the negative relation between book leverage and average excess returns, but in their models cash can be either distributed as dividends to shareholders or invested in new real assets. Livdan, Sapriza, and Zhang (2009), in contrast, develop a model in which a manager can issue risk-free corporate debt and save cash.[2] They show that the higher the shadow price of new debt, the lower the firm's ability to finance all the desired investments. As a result, the correlation of dividends with the business cycle increases, leading to higher risk and higher expected returns. While Livdan, Sapriza, and Zhang (2009) link risk premia to financing decisions, they do not study directly the determinants of corporate precautionary savings and the role of this variable in shaping the cross-section of equity returns.

The determinants of corporate cash holdings and their time-series properties have been widely studied in the literature. Opler, Pinkowitz, Stulz, and Williamson (1999) show that for US public companies the cash-to-asset ratio is negatively related to size and book-to-market and positively related to capital expenditure, payouts, research and development expenditure, and cash flow volatility. Consistent with Opler, Pinkowitz, Stulz, and Williamson (1999), Han and Qiu (2007) show that the volatility of cash flows has a positive impact on a firm's precautionary motive for holding cash; this positive relation, however, is significant only for financially constrained firms. In this paper, I explore the link between a firm's cash holdings and its systematic risk (e.g., the correlation between cash flows and an aggregate source of risk) instead of its cash flow volatility. In a related paper, Simutin (2010) independently finds that firms with high excess cash holdings are more exposed to systematic risk and earn a positive and significant excess return over firms with low excess cash holdings.[3]

The outline of the paper is as follows. In Section 2, a simple financing problem in a three-period framework shows how a precautionary savings motive can generate a positive correlation between cash holdings and expected equity returns. Section 3 contains the empirical analysis. Section 4 concludes.

[2] Li, Livdan, and Zhang (2009) also study the interaction between the cost of equity and financing decisions, albeit in a model without debt.

[3] In this paper, corporate cash holdings are identified using a firm's cash-to-assets ratio. Other studies on the determinants of cash holdings are Almeida, Campello, and Weisbach (2004), Dittmar and Mahrt-Smith (2007), Harford, Mansi, and Maxwell (2008), and Nikolov and Morellec (2009). Bates, Kahle, and Stulz (2009) provide an empirical analysis of the evolution of the cash-to-assets ratio for US public companies over the period 1980–2006.

2. Model

This section presents a model that departs from the risk-neutral setup of Kim, Mauer, and Sherman (1998) by adding a stochastic discount factor and cash flows correlated with systematic risk. In what follows, a firm expects an investment opportunity in the near future and needs to decide whether to hoard cash, and thus earn a lower return than the opportunity cost of capital, or to distribute dividends in the current period, and thus increase the expected cost of future investment. This trade-off determines the current period's optimal saving policy. The assumption that cash flows are correlated with aggregate risk introduces an additional motive for precautionary savings that drives riskier firms to save more, and this additional motive—absent in a risk-neutral environment—is the key ingredient that generates a positive correlation between expected equity returns and a firm's cash holdings.

2.1. Setup

Consider a model, with periods indexed by $t=0,1,2$. At time $t=0$, a firm is endowed with initial cash holdings equal to C_0 and an asset (the risky asset) that produces a random cash flow in period 1 only.

At time 1, after the realization of the risky asset's cash flow, the firm has the option to install an asset (the safe asset) that produces a deterministic cash flow (C_2) at time $t=2$ that is not pledgable at time $t=1$. I assume that the investment opportunity arrives with probability π, $\pi \in [0,1]$, and bears a fixed investment cost $I=1$. If the firm has insufficient internal resources to pay for the fixed cost, it can issue equity by paying a unit issuance cost equal to λ. The assumptions of a stochastic cash flow and a fixed investment cost are made to generate the possibility of a liquidity shock and a consequent need for external financing at time $t=1$.

The firm can also transfer cash from one period to the next at the internal gross rate $\widehat{R} < R$, where R is the risk-free gross interest rate. Following Riddick and Whited (2009), an internal accumulation rate less than the risk-free interest rate can be justified by the fact that the firm pays corporate taxes on interest earned on savings. The timing of the model is illustrated in Fig. 1.

2.2. Pricing kernel and production

For the purposes of asset valuation, I introduce a stochastic discount factor (SDF), adopting a convenient parameterization as in Berk, Green, and Naik (1999) and Zhang (2005). A cash flow produced at time $t+1$ is discounted at time t using the SDF

$$M_{t+1} = e^{m_{t+1}} = e^{-r-(1/2)\sigma_z^2-\sigma_z\varepsilon_{z,t+1}}, \tag{1}$$

where $\varepsilon_{z,t+1} \sim \mathrm{N}(0,1)$ is the aggregate shock at time $t+1$. The formulation in Eq. (1) implies that the time 0 conditional mean of the SDF, $E_0[M_1]$, is equal to the inverse of the gross risk-free interest rate, $e^{-r} = 1/R$.

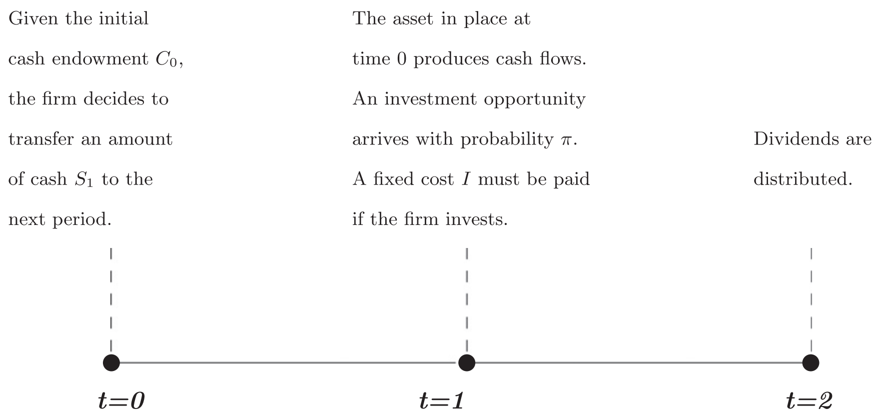

Fig. 1. Timing. This figure illustrates the timing of the three-period model.

The risky asset produces a pay-off equal to e^{x_1} at time 1, where

$$x_1 = \mu - \tfrac{1}{2}\sigma_x^2 + \sigma_x \varepsilon_{x,1}. \tag{2}$$

The idiosyncratic shock, $\varepsilon_{x,1} \sim N(0,1)$, is correlated with the error term of the pricing kernel so that the cash flows produced by the asset in place at time 0 are risky. I assume that $COV(\varepsilon_{z,1},\varepsilon_{x,1}) = \sigma_{x,z}$ and, as a consequence, $COV(x_1,m_1) = -\sigma_x\sigma_z\sigma_{x,z} = -\beta_{xm}$, where β_{xm} is the systematic risk of a project's cash flow. Under the above assumptions, the time 0 value of the cash flow that will be realized at time 1 is given by the certainty equivalent discounted at the (gross) risk-free interest rate:

$$E_0[e^{m_1}e^{x_1}] = E_0[e^{-r-(1/2)\sigma_z^2 - \sigma_z\varepsilon_{z,1} + \mu - (1/2)\sigma_x^2 + \sigma_x\varepsilon_{x,1}}] = e^{-r}e^{\mu-\beta_{xm}}. \tag{3}$$

As β_{xm} increases, the cash flow becomes more correlated with the aggregate shock and hence less valuable.

2.3. The firm's problem

At time 0, the firm has to decide how much of the initial cash endowment C_0 to distribute as dividends (D_0) and how much to retain as savings (S_1). Given that the return on internal savings $\widehat{R}$ is lower than the risk-free rate R, S_1 is always bounded above by C_0.

To simplify the problem, I assume that the time 1 present discounted value of the safe project's cash flow, C_2/R, is greater than the investment cost when the safe project is entirely equity-financed, $1+\lambda$. This condition is sufficient to ensure that the firm always invests at time 1 if an investment opportunity arises. Conditional on investing at time 1, the firm issues equity only if corporate savings, S_1, plus the cash flow from the risky asset, e^{x_1}, are not enough to pay for the investment cost. In this case, the dividend at time 1, D_1, is negative and the firm pays a proportional issuance cost equal to λ. The last period's dividend is the cash flow produced by the safe asset, $D_2 = C_2$. If the firm does not invest at time 1, all the internal resources are distributed to shareholders and the time 2 dividend is zero. The problem of the firm can be written as

$$V_0 \equiv \max_{S_1 \geq 0} D_0 + E_0[M_1(D_1 + E_1[M_2 D_2])], \tag{4}$$

where

$$D_0 = C_0 - \frac{S_1}{\widehat{R}}, \tag{5}$$

$$D_1 = \begin{cases} (1+\lambda\chi_1)(S_1 + e^{x_1} - 1) & \text{with probability } \pi, \\ S_1 + e^{x_1} & \text{with probability } 1-\pi, \end{cases} \tag{6}$$

and

$$D_2 = \begin{cases} C_2 & \text{with probability } \pi, \\ 0 & \text{with probability } 1-\pi. \end{cases} \tag{7}$$

χ_1 is an indicator function that takes the value of one if the internal resources at time 1 are not enough to pay for the fixed cost of investment ($e^{x_1} + S_1 < 1$), and M_2 is the pricing kernel used in period 1 to evaluate any pay-off in period 2. Proposition A.1, in Appendix A, provides a condition for the existence and the uniqueness of an interior solution for the firm's problem.

Assuming an interior solution, the optimal saving policy is such that the firm equates the cost and the benefit of saving an extra unit of cash:

$$1 = \widehat{R}E_0[M_1] + \pi\lambda\widehat{R}E_0[M_1\chi_1] = \frac{\widehat{R}}{R} + \pi\lambda\widehat{R}E_0[M_1\chi_1]. \tag{8}$$

The marginal cost is simply one, the forgone dividend at time 0, and the marginal benefit is given by the expected dividend that the firm will distribute next period plus the expected reduction in equity issuance cost. The flat line in Fig. 2 reports the marginal cost of saving cash in period 0, and the decreasing line is the marginal benefit. The latter is decreasing in S_1 because the more cash a firm saves, the smaller the probability of issuing equity in the future and the smaller the expected reduction in equity issuance cost. If S_1 approaches the fixed investment cost, the probability of issuing equity approaches zero and the marginal benefit reduces to the present value of the dividend distributed next period $\widehat{R}/R$.

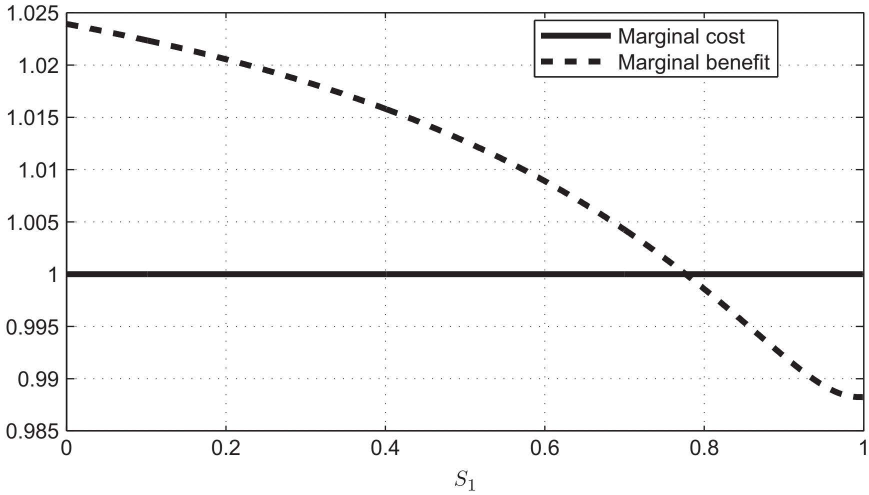

Fig. 2. Euler equation. This figure depicts the marginal cost (solid line) and the marginal benefit (dashed line) of saving cash in period 0.

Eq. (8) allows me to derive additional properties of the optimal saving policy. As the mean cash flow increases, the firm optimally lowers the time 0 amount of retained cash because the expected amount of internal resources increases, thus causing a reduction in the marginal benefit of saving. Without the equity issuance cost, the firm never saves because the return on internal savings is less than the risk-free interest rate. However, a positive value of λ generates a positive expected financing cost and the need for the firm to retain cash at time 0. The marginal benefit of retaining cash is also increasing in the probability of receiving an investment opportunity given that a higher investment probability produces a higher expected financing cost. The risk-free rate measures the opportunity cost of internal savings: The higher the risk-free rate relative to the internal rate, the more expensive it is for the firm to accumulate cash internally. As a consequence, the amount of cash transferred from period 0 to period 1 is decreasing in $R/\widehat{R}$. Proposition A.5 provides a formal derivation of the optimal savings policy's properties, and Fig. 3 provides a graphical description.

2.4. Risk, savings, and expected equity returns

This subsection explores a determinant of corporate savings that has been overlooked in previous studies: the correlation between cash flows and an aggregate source of risk. I show that the riskier the cash flows (i.e., the higher the correlation with aggregate risk), the higher the marginal benefit of transferring cash inter-temporally within the firm to lower the expected financing costs.

Exploiting the properties of the covariance between two random variables, I can rewrite the Euler equation in Eq. (8) as

$$1 = \widehat{R}E_0[M_1] + \pi\lambda\widehat{R}(E_0[M_1]E_0(\chi_1) + COV[M_1,\chi_1]). \quad (9)$$

Under risk-neutrality, the covariance term disappears from Eq. (9) and risk plays no role in determining the firm's optimal saving policy:

$$1 = \widehat{R}E_0[M_1] + \pi\lambda\widehat{R}E_0[M_1]E_0(\chi_1). \quad (10)$$

Having risky cash flows is not a necessary condition to generate a precautionary savings motive (see, for example, Riddick and Whited, 2009; Gamba and Triantis, 2008). Eq. (10) shows that if the probability of investing next period is zero, then the firm will never retain cash because the probability of issuing costly equity is also zero. However, the marginal benefit of retaining an extra unit of cash is increasing in the probability of investing next period and hence the precautionary motive is stronger in times when investment opportunities are likely to arise. The Euler equation under risk-neutrality also reveals that firms with the same expected cash flows and the same probability of investing next period will choose the same optimal savings policy given that they have the same probability of issuing equity next period.

By contrast, Eq. (9) shows that firms with the same expected cash flows and the same probability of investing next period will choose different savings policies depending on their cash flows' correlation with an aggregate shock. An increase in the covariance term will lower the expected value of firms' cash flows in those future states in which the firm is more likely to issue equity (namely, when the firm decides to invest and the realization of the aggregate shock is low). As a consequence, an increase in riskiness leads to an increase in the time 1 expected financing cost, ceteris paribus, and the firm reacts by increasing savings at time 0. This comparative static property is illustrated in Panel A of Fig. 4 and formalized in Proposition A.2.

The expected return between time 0 and time 1 is the ratio of the time 0 expected future dividends over the time 0 ex-dividend value of the firm P_0:

$$E_0[R_{0,1}] = \frac{E_0[D_1+P_1]}{P_0} = \frac{E_0[D_1+E_1(M_2D_2)]}{E_0[M_1(D_1+E_1[M_2D_2])}. \quad (11)$$

When the cash flows are uncorrelated with the stochastic discount factor, the expected equity return is equal to the

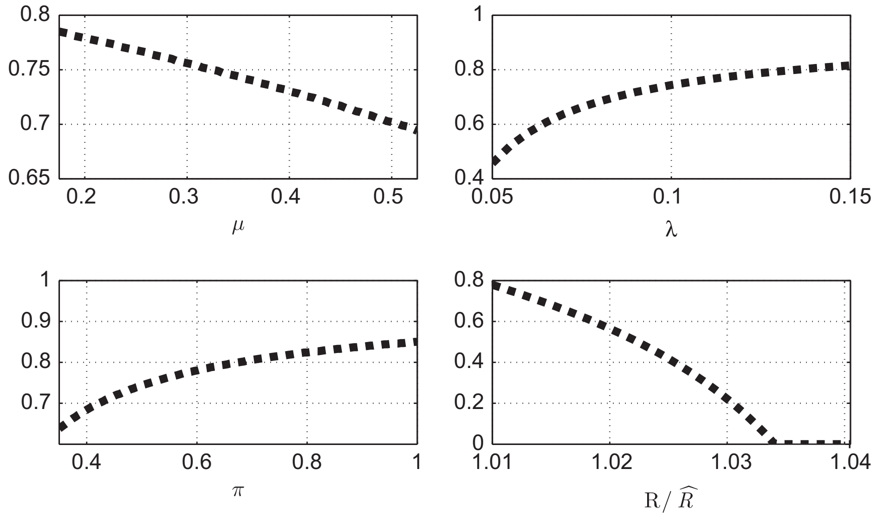

Fig. 3. The effects of varying μ, λ, π, and R. This figure depicts the optimal saving policy (vertical axis) as a function of the cash flow mean μ (top left panel), the cost of external financing λ (top right panel), the probability of investing in the future π (bottom left panel), and the ratio of the risk-free rate R over the internal accumulation rate $\widehat{R}$ (bottom right panel).

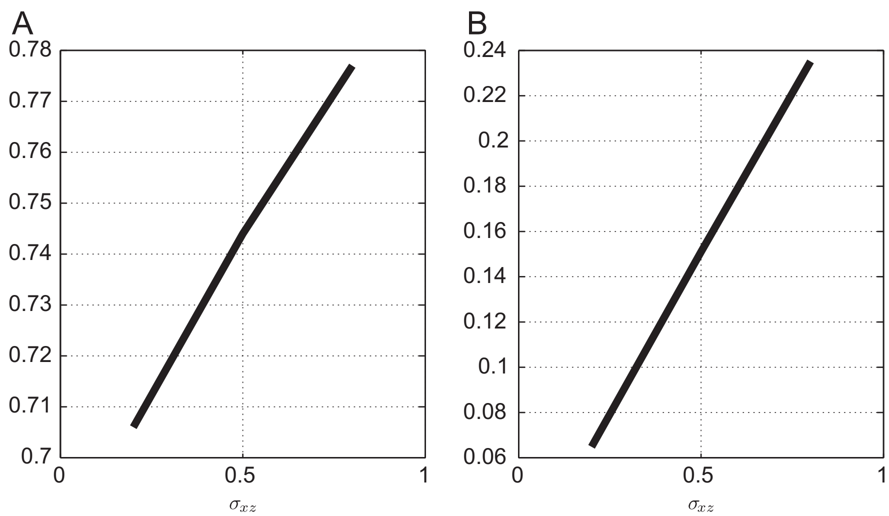

Fig. 4. The effects of a change in risk. This figure depicts the optimal saving policy (Panel A) and the expected equity returns (Panel B) as a function of σ_{xz}, the cash flows correlation with aggregate risk.

risk-free return R. When there is no investment opportunity ($\pi = 0$) or no equity issuance cost ($\lambda = 0$), the optimal policy for the firm is to set $S_1^* = 0$. This will make the expected equity return independent of the savings policy. These three cases are of no interest if the focus is to study the relation between savings and expected equity returns. Hence, risk, a positive expectation of future investment, and costly external financing are essential ingredients to explore the link between cash holdings and equity returns.

A change in the firm's systematic risk affects expected returns through two channels. The first channel works through the direct effect of a change in σ_{xz}. An increase in risk reduces the time 0 ex-dividend value of the firm, while the expected future dividends are not affected. The expected return increases. At the same time, a change in σ_{xz} affects the optimal choice of S_1^*, and this indirect effect moves the time 0 ex-dividend value and the expected future dividends in the same direction, so the overall effect on expected equity returns is indeterminate. Proposition A.3 in Appendix A shows that if the ex-dividend value of the firm P_0 is a decreasing function of the firm's riskiness σ_{xz}, then an increase in the time 1 riskiness of cash leads to higher expected equity returns. Fig. 4 illustrates the positive relation between risk and expected equity returns (Panel B) and the positive relation between optimal savings and expected equity returns implied by a change in risk (Panel A and B, respectively).

The model can also be used as a laboratory to study how heterogeneity in investment opportunities across firms affects the positive relation between optimal savings and expected returns. For the sake of analytical tractability, I use C_2 (the profitability of the investment opportunity) to introduce heterogeneity in growth options across firms. Consider two firms that differ only in their value of C_2. The firm with the most valuable investment opportunity has a payoff in period 2 larger than the payoff of the firm with the less valuable investment opportunity. These two firms have the same optimal saving policy because the Euler equation for savings does not depend on C_2, and the firm with the most valuable growth option has a larger market value V_0, a larger ex-dividend value P_0, and a smaller book-to-market ratio.

Given that the two firms share the same Euler equation for savings, a marginal increase in σ_{xz} causes the same change in optimal savings for both of them. However, the expected equity return depends on the value of C_2 and, as Proposition A.4 shows, its sensitivity to a change in risk is decreasing in the profitability of the future growth opportunity. This prediction stems from the fact that firms with a smaller C_2 have a smaller fraction of their value tied to the growth option and hence the expected return on these firms' assets in place is more important in determining their overall expected return. As a result, a change in the riskiness of the cash flows produced by a firm's assets in place leads to a larger change in expected returns the smaller is the profitability of the firm's growth option. It follows that a change in riskiness causes the same change in savings across the two firms, but a larger increase in expected return for the firm with the less valuable growth option. Thus, the model predicts a stronger positive relation between cash holdings and expected returns for firms with lower expected profitability.

2.5. Testable hypothesis

The model produces two testable hypotheses on the relation between corporate cash holdings and expected equity returns.

Hypothesis 1. Expected equity returns and firm cash holdings are positively related because firms with riskier assets in place are more likely to experience a cash flow shortfall when they are more likely to issue equity.

Hypothesis 2. The magnitude of the positive relation between expected equity returns and firm cash holdings depends on the profitability of future investment opportunities. The less profitable the growth opportunities, the larger the change in expected equity returns associated with the same change in cash holdings.

3. Cash holdings and the cross-section of equity returns: empirical analysis

>The empirical analysis consists of two parts. In Section 3.1, I investigate whether corporate cash holding policies are driven by a firm-level measure of expected equity returns after controlling for variables known to affect changes in the cash-to-assets ratio. In Section 3.2, I perform a standard portfolio analysis in the spirit of Fama and French (1993). I first sort portfolios according to their cash-to-asset ratio to test whether corporate cash holdings carry a positive risk premium, and I then study whether the cash-related risk premium varies across firms that differ in terms of their growth options' profitability.

3.1. Cash holdings and expected equity returns

The model in Section 2 shows that heterogeneity in firms' expected equity returns causes riskier firms to hoard more cash to reduce expected financing costs (Hypothesis 1). In this subsection, I test whether the variation in expected equity returns across firms is positively correlated with changes in cash holding policies. As noted by Black (1993) and Elton (1999), among others, the average realized equity return, used in standard portfolio analysis, is not a good proxy for expected returns. I, therefore, follow a recent strand of the financial accounting literature that uses firm-level data to construct accounting-based measures of expected equity returns. In particular, I rely on a methodology known as the residual income model that allows one to evaluate an implied rate of return (the proxy for expected equity returns) that equates the stock price of a company to the present discounted value of future dividends, as[4]

$$P_t = \sum_{i=1}^{\infty} \frac{E_t(D_{t+i})}{(1+r_e)^i}, \tag{12}$$

where P_t is the price of the stock at time t, $E_t(D_{t+i})$ is the time $t+i$ expected dividend, and r_e is the internal rate of return, the proxy for the equity cost of capital. Appendix B provides a detailed account of the methodology I adopt to derive the firm-level measure of expected equity returns.

3.1.1. Cross-sectional regressions

In this subsection, I perform an exercise along the lines of Almeida, Campello, and Weisbach (2004) by testing whether changes in corporate cash holdings can be explained by a firm's expected return, as measured by r_e, among other variables known to affect firms' cash holding policies. Table 1 reports the results from the regression analysis. I exclude from the data set utilities [standard industrial classification Code (SIC) codes between 4900 and 4949] and financial companies (SIC codes between 6000 and 6999) because these sectors are subject to heavy regulation. The dependent variable in all of the regressions is the change in the cash-to-assets ratio (ΔCH) between years $t-1$, and t and all the explanatory variables are truncated at the top and bottom 1% to limit the influence of outliers. In the baseline regression, the set of explanatory variables includes the lagged value of ΔCH, which controls for cash holding policies' mean reverting dynamics as suggested by Opler, Pinkowitz, Stulz, and Williamson (1999), and the proxy for expected equity returns r_e evaluated at time $t-1$. The pooled ordinary least squares

[4] Easton and Monahan (2005) provide a survey of the different accounting-based measures of expected equity returns. The residual income model methodology used in this paper follows the work of Gebhardt, Lee, and Swaminathan (2001).

Table 1
Changes in cash holdings and expected equity returns: cross-sectional analysis.

This table displays the determinants of changes in cash holdings. The dependent variable in all of the regressions is the change in the cash-to-assets ratio ΔCH between years $t-1$ and t. In the baseline model (Column 1), the set of explanatory variables includes the lagged value of ΔCH_t, to control for the mean reverting dynamics of cash holdings policies as suggested by Opler, Pinkowitz, Stulz, and Williamson (1999), and the proxy for expected equity returns r_e measured in year $t-1$. In Column 2, I add the lagged value of ΔCH and r_e to the baseline regression in Almeida, Campello, and Weisbach (2004). CF is the cash flows-to-assets ratio, measured as the ratio of income before extraordinary items (IB item on Compustat) over total assets at the end of year t (item AT). BM_t is the natural logarithm of book equity over market equity at the end of year t. Book equity is equal to stockholder equity (item SEQ), plus balance sheet deferred taxes and investment tax credit (item TXDITC, if available), minus the book value of preferred stock. In order of availability, preferred stock is equal to item PSTKRV, or item PSTKL, or item PSTK. If item SEQ is missing, stockholder equity is equal to the book value of common equity (item CEQ) plus the par value of preferred stock (item PSTKL). If item SEQ and item CEQ are both missing, then stockholder equity is evaluated as total assets (item AT) minus total liabilities (item LT). Market equity is the fiscal year-end equity price (item PRCC_F) multiplied by the number of common shares outstanding (item CSHO). *Size* is the natural logarithm of total assets at the end of year t. In Column 3, the variable *NetEquity* is the ratio of net equity issuance over total assets. Net equity issuance is defined as the sale of common and preferred stocks (item SPPE) net of cash dividends (item DV) and purchase of common and preferred stocks (item PRSTKC). The variable *NetDebt* is the ratio of net debt issuance over total assets. Net debt issuance is defined as long-term debt issuance (item DLTIS) net of long-term debt reduction (item DLTR). The last variable, *NetInv*, is the ratio of net investment over total assets. Net investment is the sum of capital expenditures (item CAPX) plus acquisitions (item SCSTKC) net of sales of property (item SPPE). For the last three variables, data are collected whenever available. For example, if observations on sale of common and preferred stocks are available only, then *NetEquity* is equal to the sale of common and preferred stocks. For each of the three specification, I also run fixed effects and Fama and Macbeth regressions in addition to simple pooled ordinary least squares (OLS) regressions. The R^2 for fixed effects regressions is the within R^2. The R^2 for Fama and Macbeth regressions is the time series average of the cross-sectional R^2s. The sample period is from 1975 to 2009, and all the variables are truncated at the top and bottom 1% to limit the influence of outliers. The 1%, 5%, and 10% significance levels are denoted with ***, **, and *, respectively.

	Pooled OLS			Fixed effects			Fama and MacBeth		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ΔCH_{t-1}	−0.111***	−0.117***	−0.116***	−0.174***	−0.177***	−0.167***	−0.126***	−0.133***	−0.133***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.007)	(0.007)	(0.008)
r_e	0.104***	0.093***	0.088***	0.041***	0.083***	0.082***	0.086***	0.062***	0.039**
	(0.006)	(0.008)	(0.008)	(0.008)	(0.010)	(0.010)	(0.018)	(0.016)	(0.016)
CF_t		0.046***	0.071***		0.038***	0.061***		0.060***	0.093***
		(0.003)	(0.003)		(0.004)	(0.004)		(0.006)	(0.007)
BM_t		−0.002***	−0.005***		−0.004***	−0.009***		−0.001	−0.004***
		(0.000)	(0.000)		(0.001)	(0.001)		(0.001)	(0.001)
$Size_t$		0.000***	0.002***		0.001***	0.002***		−0.000	0.001***
		(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)
$NetEquity_t$			0.181***			0.252***			0.185***
			(0.007)			(0.010)			(0.013)
$NetDebt_t$			0.073***			0.120***			0.077***
			(0.004)			(0.005)			(0.007)
$NetInv_t$			−0.274***			−0.407***			−0.269***
			(0.004)			(0.006)			(0.011)
Constant	−0.012***	−0.015***	0.001	−0.007***	−0.018***	0.010***	−0.010***	−0.010***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
Number of Observations	107,266	107,266	107,266	107,266	107,266	107,266	107,266	107,266	107,266
R-squared	0.017	0.025	0.093	0.036	0.039	0.137	0.023	0.035	0.103

regression (OLS) regression (Column 1) shows that the coefficient on expected equity returns is positive and significant. A 0.10 increase in expected equity returns is associated on average with a 0.01 change in the cash-to-assets ratio. The significance of the coefficient on r_e does not disappear if I control for firm fixed effects (Column 4) or if I run Fama and Macbeth regressions to control for time effects in corporate cash policies.

In Column 2 of Table 1, I add the lagged value of ΔCH and r_e to the baseline regression in Almeida, Campello, and Weisbach (2004). CF is the cash flows-to-assets ratio, measured as the ratio of income before extraordinary items (item IB in Compustat) over total assets at the end of year t. BM_t is the natural logarithm of book equity over market equity at the end of year t. As in Davis, Fama, and French (2000), book equity is equal to stockholder equity (item SEQ), plus balance sheet deferred taxes and investment tax credit (item TXDITC, if available), minus the book value of preferred stock. In order of availability, preferred stock is equal to item PSTKRV, or item PSTKL, or item PSTK. If item SEQ is missing, stockholder equity is equal to the book value of common equity (item CEQ) plus the par value of preferred stock (item PSTKL). If item SEQ and item CEQ are both missing, then stockholder equity is evaluated as total assets (item AT) minus total liabilities (item LT). Market equity is the fiscal year end equity price (item PRCC_F) multiplied by the number of common shares outstanding (item CSHO). *Size* is the natural logarithm of total assets at the end of year *t*.

Table 1 shows that the cash flow sensitivity of cash (i.e., the coefficient on *CF*) is positive and significant over the entire sample in all of the regression specifications. In the pooled OLS case, a 0.10 increase in the cash flows-to-assets ratio is associated on average with an increase in the cash-to-assets ratio between 0.005 and 0.007. The sign of the coefficient on *BM* is in line with the findings in Almeida, Campello, and Weisbach (2004). A higher *BM* signals lower investment opportunities and is associated with a decrease in cash holdings. However, the significance is lost in one case when I run Fama and Macbeth regressions (Regression 8). The coefficient on *Size* is positive, and it is not significant only in the Fama and Macbeth regressions (Regression 8). Controlling for cash flows, investment opportunities, and physical size does not affect the sign and significance of the coefficient on r_e.

As a last robustness check, I test whether the uses and sources of funds from financing and investing operations between $t-1$ and t have any effect on the positive correlation between expected equity returns and changes in cash holdings (Column 3). The variable *NetEquity*) is the ratio of net equity issuance over total assets. I measure net equity issuance as the sale of common and preferred stocks (item SCSTKC) net of cash dividends (item DV) and the purchase of common and preferred stocks (item PRSTKC). The variable *NetDebt* is the ratio of net debt issuance over total assets, where net debt issuance is defined as long-term debt issuance (item DLTIS) net of long-term debt reduction (item DLTR). The last variable, *NetInv*, is the ratio of net investment over total assets. Net investment is the sum of capital expenditures (item CAPX) plus acquisitions (item AQC) net of sales of property (item SPPE).[5]

The coefficients on the three variables have the expected sign and are always significant. An increase in external financing (*NetEquity* and *NetDebt*) between $t-1$ and t contributes to an increase in the liquid resources held by the firm at the end of period *t*. An increase in investing activity is associated with a reduction in the cash-to-assets ratio. Controlling for uses and sources of funds between time $t-1$ and t helps improve the degree to which cash holding changes can be explained—the R^2 more than doubles—but the sign and statistical significance of the proxy for expected equity returns are not affected.

[5] For all of the variables, I collect the data whenever available. For example, if I have only observations on the sale of common and preferred stock, then *NetEquity* is equal to the sale of common and preferred stock.

3.1.2. Subsample analysis

In this subsection, I explore how future profitability affects the coefficient on expected equity returns. According to the model, expected equity returns of firms with more valuable growth options are less sensitive to a change in the riskiness of assets in place (Hypothesis 2). As a consequence, two firms that differ only in their future investment profitability experience the same increase in expected equity returns only if the firm with the more profitable investment opportunity experiences a larger increase in riskiness. Given that a larger increase in riskiness also causes a larger increase in cash holdings, a stronger marginal effect of expected equity returns should be observed on cash holdings across firms with more profitable growth options.

The model also predicts that an increase in future profitability causes an increase the firm's market value and a corresponding decrease in the book-to-market ratio. It follows that size and book-to-market are two natural proxies that one can use to measure future profitability. However, these two variables, being a function of a firm's market price, are at best a noisy proxy and for this reason I also include the return on equity (ROE) as an additional measure of expected profitability.[6]

I sort firms according to their expected profitability following three schemes. First, I divide firms into two size categories using the firm's market capitalization in period $t-1$: small firms (firms in the bottom 30% of the size distribution) and large firms (firms in the top 30% of the size distribution). Then, I sort firms into two book-to-market categories: small book-to-market firms (firms in the bottom 30% of the book-to-market distribution) and large book-to-market firms (firms in the top 30% of the book-to-market distribution). Finally, I sort firms into two ROE categories: small ROE firms (firms in the bottom 30% of the ROE distribution) and large ROE firms (firms in the top 30% of ROE distribution). Market capitalization and the book-to-market ratio are measured as described in Subsection 3.1.1, and ROE is the ratio of income before extraordinary items (item IB in Compustat) over the one-period lagged book value of equity, also defined in Section 3.1.1. The sorting is performed at an annual frequency, and I use the one-period lagged value of the market capitalization, book-to-market ratio, and ROE to align their timing with the one I use for the expected equity returns proxy. Observations with missing values for the three variables are dropped from the sample.

Table 2 reports the coefficient on the expected equity return for the different book-to-market, size, and ROE categories. When I use book-to-market to measure expected profitability, the results are in line with what would expected only when pooled OLS regressions are considered. In this case, the coefficients on the proxy for the expected equity return are always positive and, in one case, low book-to-market firms have a coefficient larger

[6] Current profitability, as measured by the return on equity, is a highly persistent variable and for this reason it can be considered a good measure of expected profitability.

Table 2
Changes in cash holdings and expected equity returns: subsamples analysis.

This table reports the coefficients and standard errors (in parenthesis) on the proxy for expected equity returns r_e for the different regression specifications described in Table 1 across different subsamples of data. Firms are sorted according to their expected profitability following three schemes. First, firms are sorted into two size categories using the firm's market capitalization: small firms (firms in the bottom 30% of the size distribution, subsample *Small Size*) and large firms (firms in the top 30% of the size distribution, subsample *Large Size*). Then, firms are sorted into two book-to-market categories: small book-to-market firms (firms in the bottom 30% of the book-to-market distribution, subsample *Low BM*) and large book-to-market firms (firms in the top 30% of the book-to-market distribution, subsample *High BM*). To conclude, firms are sorted into two return on equity (ROE) categories: small ROE firms (firms in the bottom 30% of the ROE distribution, subsample *Low ROE*) and large ROE firms (firms in the top 30% of ROE distribution, subsample *High ROE*). BM_t is the natural logarithm of book equity over market equity at the end of year t. Book equity is equal to stockholder equity (item SEQ), plus balance sheet deferred taxes and investment tax credit (item TXDITC, if available), minus the book value of preferred stock. In order of availability, preferred stock is equal to item PSTKRV, or item PSTKL, or item PSTK. If item SEQ is missing, stockholder equity is equal to the book value of common equity (item CEQ) plus the par value of preferred stock (item PSTKL). If item SEQ and item CEQ are both missing, then stockholder equity is evaluated as total assets (item AT) minus total liabilities (item LT). Market equity is the fiscal year-end equity price (item PRCC_F) multiplied by the number of common shares outstanding (item CSHO). Size is measured as market equity. ROE is the ratio of income before extraordinary items (item IB in Compustat) over the one-period lagged book value of equity. The sorting is performed at an annual frequency, and I use the one-period lagged value of the market capitalization, book-to-market ratio, and ROE to align their timing with the one used for the expected equity returns proxy. Observations with missing values for the above three variables are dropped from the sample. The sample period is from 1975 to 2009, and all the variables are truncated at the top and bottom 1% to limit the influence of outliers. The 1%, 5%, and 10% significance levels are denoted with ***, **, and *, respectively.

	Pooled OLS			Fixed effects			Fama and MacBeth		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Small Size	0.080***	0.050***	0.070***	0.014	0.036*	0.072***	0.055***	−0.017	−0.001
(N=32,193)	(0.010)	(0.012)	(0.012)	(0.017)	(0.019)	(0.018)	(0.020)	(0.019)	(0.019)
Large Size	0.078***	0.141***	0.111***	0.031**	0.097***	0.081***	0.078***	0.115***	0.068***
(N=32,193)	(0.010)	(0.016)	(0.015)	(0.012)	(0.018)	(0.017)	(0.021)	(0.020)	(0.019)
Low BM	0.139***	0.040*	0.083***	−0.079***	−0.056*	−0.012	0.095*	−0.137**	−0.114**
(N=32,193)	(0.016)	(0.021)	(0.021)	(0.027)	(0.034)	(0.033)	(0.047)	(0.051)	(0.050)
High BM	0.065***	0.074***	0.090***	0.042***	0.055***	0.096***	0.022	−0.002	0.032*
(N=32,193)	(0.010)	(0.011)	(0.011)	(0.014)	(0.015)	(0.015)	(0.017)	(0.018)	(0.017)
Low ROE	0.104***	0.040***	0.041***	−0.040**	0.009	0.029	0.116***	0.041	0.004
(N=32,193)	(0.009)	(0.012)	(0.012)	(0.017)	(0.019)	(0.018)	(0.027)	(0.025)	(0.023)
High ROE	0.080***	0.185***	0.135***	0.092***	0.227***	0.138***	0.049**	0.198***	0.105***
(N=32,193)	(0.012)	(0.017)	(0.017)	(0.019)	(0.025)	(0.023)	(0.023)	(0.031)	(0.031)

and more than two standard errors away from the estimated value for high book-to-market firms (Regression 1). The empirical results are more supportive of the model's prediction when expected profitability is measured using size or ROE as proxies. In the former case, the estimated sensitivity of cash holdings to a change in expected equity returns for small firms is smaller and more than two standard errors away from the estimated value for large firms in five cases (Regressions 2, 3, 5, 8, and 9). In the latter case, the estimated sensitivity of cash holdings to a change in expected equity returns for low ROE firms is smaller and more than two standard errors away from the estimated value for high ROE firms in seven cases (Regressions 2, 3, 4, 5, 6, 8, and 9).

Overall, the empirical analysis performed using an accounting-based proxy for expected equity returns produces results consistent with the model's predictions. First, an increase in the proposed measure for expected equity returns is associated with an increase in cash holdings. Second, the data also show support for the hypothesis that the marginal effect of expected equity returns on cash holdings should be stronger across firms with more profitable growth options when size and ROE are used as proxies for expected profitability.

3.2. *Portfolio analysis*

In this subsection, I perform a standard portfolio analysis in the spirit of Fama and French (1993) that uses realized returns instead of expected returns. I first sort portfolios according to their cash-to-asset ratio to test whether corporate cash holdings carry a positive risk premium (Hypothesis 1), and I then study whether the cash-related risk premium varies across firms that differ in terms of their growth options' profitability (Hypothesis 2).

3.2.1. *Data*

Stock prices and quantities come from the Center for Research in Securities Prices (CRSP) and accounting data come from Compustat Quarterly. To begin, I match the companies in CRSP with companies in Compustat that have the same value for the security identifier PERMNO. I then eliminate observations for which the first six digits of the Compustat Committee on Uniform Security Identification Procedures (CUSIP) code differ from the first six digits of the CRSP CUSIP code or the CRSP name CUSIP (NCUSIP) code.

I consider only ordinary common shares (share codes 10 and 11 in CRSP), and I exclude observations related to suspended, halted, or non listed shares (exchange codes lower than 1 and higher than 3). I also require that a stock has reported returns for at least 24 months prior to portfolio formation. If a stock undergoes a performance delist after portfolio formation and the delisting return is missing, I follow Shumway (1997) and assign to the missing equity returns a value of -30%.[7]

A stock's market value (*Size*) is defined as the value of the firm's market capitalization at portfolio formation. The monthly risk-free interest rate and the observations for the Fama and French and momentum factors are taken from Kenneth French's website.[8]

As in Section 3.1.1, I use the SIC code in Compustat to exclude from the data set utilities (SIC codes between 4900 and 4949) and financial companies (SIC codes between 6000 and 6999) because these sectors are subject to heavy regulation. I construct the book-to-market ratio (*BM*) by dividing the book value of equity by the market value of equity at portfolio formation. Following Chen, Novy-Marx, and Zhang (2011), the book value is equal to the book value of shareholders equity, plus balance sheet deferred taxes and investment tax credits (item TXDITCQ, if available), minus the book value of preferred stock. Shareholder equity is measured using stockholders' equity (item SEQQ). If the variable is not available, I use common equity (item CEQQ) plus the carrying value of preferred stock (item PSTKQ). If both shareholder equity and common equity are missing, I use total assets (item ATQ) minus total liabilities (item LTQ). The book value of preferred stock is measured using the redemption value (item PSTKRQ, if available). If the quantity is missing, I use the carrying value (item PSTKQ, if available). The cash-to-assets ratio (*CH*) is defined as the value of corporate cash holdings (item CHEQ) over the value of the firm's total assets (item ATQ). The return on equity is the ratio of income before extraordinary items (item IBQ) over the one-quarter-lagged book value of equity. Companies with a negative book-to-market ratio or a negative cash-to-assets ratio are excluded from the sample. I use the quarterly accounting data available in month t in portfolios sorts starting at time $t+i+1$ if there has been an earnings announcement (item RDQ) in month $t+i$, where $i=1, 2, 3$.[9]

3.2.2. One-way sorts

I start the portfolio analysis by sorting firms according to their cash-to-assets ratio using ten deciles containing on average 248 firms. Following the strategy that Chen, Novy-Marx, and Zhang (2011) use to construct their return on assets (ROA) factor (a cash-related variable), I rebalance portfolios at a monthly frequency starting at the beginning of July 1972 and ending in December 2009, and I assume a one-month holding period. Table 3 reports the time series average of the cross-sectional mean and median values for the book-to-market, market size, net assets, profitability, and post-ranking βs across the ten portfolios. The book-to-market ratio is used as a proxy for future investment opportunities (growth options). Net assets (defined as total assets net of cash holdings) is used as a proxy for the physical size of a company and, given their high correlation, is also a proxy for the level of future expected cash flows. Current profitability, measured as the return on equity, is used as a proxy for future profitability. Following Fama and French (1992), I use post-ranking β's to approximate a firm's systematic risk instead of pre-ranking β's because the former can be more precisely estimated.

Book-to-market, physical size, market value, and current profitability are decreasing over the ten portfolios. A simple Wilcoxon rank sum test rejects the null hypothesis that the values of the cross-sectional medians for the top and bottom deciles are generated by the same continuous distribution. Companies with a high level of cash relative to assets tend to be physically small, low market value firms with a low book-to-market ratio and negative profitability. The positive correlation between the post-ranking β's and the cash-to-assets ratio provides preliminary evidence of a positive correlation between a firm's systematic risk and its savings policy, as implied by the model.[10] Also, the two size measures show a hump-shaped relation with the cash-to-assets ratio.

Table 4 shows that difference in returns between the top and bottom cash-to-assets deciles is positive for both the equally weighted (0.69% per month) and the value-weighted (0.38% per month) portfolio and statistically different from zero for the equally weighted portfolios (Panel A). In the other panels of Table 4, I use three different risk-adjusted measures of excess returns: the classical capital asset pricing model (CAPM), Sharpe (1964) and Littner (1965), the Fama and French (1993) three-factor model, and the Chen, Novy-Marx, and Zhang (2011) three-factor model.

Panel B shows that the difference in loadings on the market factor (MKT) is positive and significantly different from zero for both the equally weighted and the value-weighted portfolios. In addition, the simple CAPM model cannot be rejected for the value-weighted portfolio given the low value of the Gibbons, Ross, and Shanken (1989) (GRS) statistics (1.00, with a p-value of 0.44). The CAPM model seems to be a good candidate to explain the variation in excess returns across the ten cash-sorted portfolio. Table 3, however, shows that high cash firms not only have a higher post-ranking β but they also have more growth opportunities (low book-to-market ratio),

[7] The CRSP codes for poor performance delists can be found in the CRSP Delisting Returns guide, at http://www.crsp.com/crsp/resources/papers/crsp_white_paper_delist_returns.pdf.

[8] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

[9] A more conservative approach, where I use the accounting data from the latest fiscal quarter that precedes portfolio formation by at least six months if item RDQ is missing, delivers very similar results.

[10] For a similar result relating excess cash holdings and other firm characteristics, see Simutin (2010).

Table 3
Characteristics of the ten cash-to-assets portfolios.

Portfolios are rebalanced monthly starting in July 1972 and ending in December 2009. I use the quarterly accounting data in month t in portfolios sorts starting at time $t+i+1$ if there has been an earnings announcement (item RDQ) in month $t+i$, where $i=1$, 2, 3. This table reports the time series average of cross-sectional mean values of firms' characteristics across the ten portfolios with median values reported in the squared brackets. *N* is the number of firms in each portfolio. *CAR* is the cash-to-assets ratio, defined as the value of corporate cash holdings (item CHEQ in Compustat) over the value of the firm's assets (item ATQ). *BM* is the ratio of the book value of equity divided by the market value of equity at portfolio formation. *Market Size* is the market value of equity at portfolio formation. The book value of equity is equal to the book value of shareholders equity, plus balance sheet deferred taxes and investment tax credits (item TXDITCQ, if available), minus the book value of preferred stock. Shareholder equity is measured using stockholders' equity (item SEQQ). If the variable is not available, I use common equity (item CEQQ) plus the carrying value of preferred stock (item PSTKQ). If both shareholder equity and common equity are missing, I use total assets (item ATQ) minus total liabilities (item LTQ). The book value of preferred stock is measured using the redemption value (item PSTKRQ, if available). If the quantity is missing, I use the carrying value (item PSTKQ, if available). *Net Assets* is total assets (item ATQ) net of cash holdings (item CHEQ). *ROE* is the ratio of income before extraordinary items (item IBQ) over the one-quarter-lagged book value of equity. β is the post-ranking β evaluated following the procedure described in Fama and French (1992). P-value is the *p*-value of the non parametric Wilcoxon rank sum test of the null hypothesis that data in the low cash-to-assets portfolio and data in the high cash-to-assets portfolio are independent samples from identical continuous distributions with equal medians.

Portfolio	*N*	*CAR*	*BM*	*Market Size*	*Net Assets*	*ROE*	β
1	**248**	**0.00**	**1.20**	**974.70**	**1354.37**	**0.01**	**1.33**
		[0.00]	[1.09]	[784.19]	[987.70]	[0.01]	[1.34]
2	**248**	**0.01**	**1.15**	**1493.21**	**2108.42**	**0.01**	**1.32**
		[0.01]	[1.05]	[849.86]	[1261.69]	[0.01]	[1.32]
3	**248**	**0.02**	**1.10**	**1848.21**	**2169.16**	**0.01**	**1.31**
		[0.02]	[1.02]	[1314.58]	[1898.26]	[0.01]	[1.32]
4	**248**	**0.04**	**1.11**	**1819.23**	**1906.42**	**0.02**	**1.32**
		[0.03]	[1.00]	[1087.07]	[1389.78]	[0.01]	[1.33]
5	**248**	**0.06**	**1.03**	**1756.73**	**1728.24**	**0.02**	**1.33**
		[0.05]	[0.95]	[1108.28]	[1367.59]	[0.01]	[1.33]
6	**248**	**0.09**	**0.97**	**1922.14**	**1685.22**	**0.01**	**1.34**
		[0.08]	[0.91]	[1183.53]	[1529.11]	[0.02]	[1.34]
7	**248**	**0.13**	**0.92**	**1660.99**	**1000.82**	**0.02**	**1.36**
		[0.12]	[0.82]	[999.50]	[847.30]	[0.01]	[1.36]
8	**248**	**0.20**	**0.82**	**1302.11**	**606.92**	**0.01**	**1.38**
		[0.18]	[0.74]	[781.47]	[489.26]	[0.02]	[1.38]
9	**248**	**0.30**	**0.75**	**1111.08**	**383.97**	**0.00**	**1.41**
		[0.28]	[0.69]	[612.73]	[306.95]	[0.02]	[1.41]
10	**248**	**0.52**	**0.65**	**646.69**	**131.74**	**−0.05**	**1.47**
		[0.52]	[0.61]	[529.24]	[85.26]	[−0.01]	[1.47]
P-value		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

low current profitability (low ROE), and small market size. High cash firms thus would be expected to be less exposed to the sources of risk proxied by the value (HML), investment (INV), and profitability (ROE) factors and more exposed to the sources of risk proxied by the size (SMB) factor. Panels C and D in Table 4 show that this is the case because the differences in factor loadings have the expected negative sign and are significantly different from zero at the 1% level in all but one case. At the same time, the difference in loadings on the market factor remains significantly different from zero only when value-weighted returns adjusted using the Chen, Novy-Marx, and Zhang three-factor model are considered.

To summarize, the one-way sort results show that the cash-related excess return is positive and significant only for equally weighted portfolios and the high cash-to-assets portfolio has a significantly different exposure to the sources of risk associated with firms' size, growth opportunities, and current profitability. When I use the Fama and French three-factor model to control for the size and value premia, the cash-related risk-adjusted excess returns are significantly different from zero and equal to 1.10% and 0.80% per month for equally and value0-weighted portfolios, respectively. When I use the Chen, Novy-Marx, and Zhang three-factor model to control for the investment and profitability premia, the cash-related risk-adjusted excess returns are also significantly different from zero and equal to 1.26% and 0.89% per month for equally and value weighted portfolios, respectively.

3.2.3. Two-way sorts

The simple sorting based on the cash-to-assets ratio shows that firms in the top decile of the cash-to-assets distribution earn a positive excess return over firms in the bottom decile. To evaluate whether the magnitude of the positive relation between cash holdings and equity returns is affected by the profitability of future growth options, I sort the data along two dimensions: cash-to-assets and a proxy for future profitability. The sorting is performed using quintile breakpoints for both variables. As in Section 3.1.2, I use market size, book-to-market, and current profitability (ROE) to proxy for expected profits. I use a monthly rebalancing strategy to sort according to the cash-to-assets, market size, and ROE variables and an annual rebalancing strategy for portfolios sorted on

Table 4
Equity returns and risk-adjusted returns across the ten cash-to-assets portfolios.

Portfolios are rebalanced monthly starting in July 1972 and ending in December 2009. I use the quarterly accounting data in month t in portfolios sorts starting at time $t+i+1$ if there has been an earnings announcement (item RDQ) in month $t+i$, where $i=1, 2, 3$. This table reports results for both equally weighted and value-weighted portfolios. CH_1 is the bottom cash-holding decile, CH_5 is the fifth cash-holding decile, CH_{10} is the top cash-holding decile, and ΔCH is the difference between the top and bottom cash-holding deciles. Panel A reports the average realized equity returns in excess of the risk-free rate and the corresponding t-statistics. Panel B, Panel C, and Panel D report the risk-adjusted equity returns (α) and the factor loadings (βs) with the corresponding t-statistics using the classical capital asset pricing model (Sharpe, 1964; Littner, 1965), the Fama and French (1993) three-factor model, and the Chen, Novy-Marx, and Zhang (2011) three-factor model, respectively. GRS and $p(GRS)$ are the Gibbons, Ross, and Shanken (1989) test statistics and the corresponding p-value, respectively. $m.a.e.$ is the mean absolute error of the risk-adjusted equity returns. The t-statistics are evaluated following Newey and West (1987) and using 12 lags. The t-statistics of the difference in factor loadings between the top and bottom cash-holding deciles are evaluated using robust t-statistics.

	Equally weighted				**Value-weighted**			
	CH_1	CH_5	CH_{10}	ΔCH	CH_1	CH_5	CH_{10}	ΔCH
Panel A: $r_i^e = E[r_t^i - r_t^f]$								
r_i^e	0.51	0.90	1.19	0.69	0.39	0.44	0.77	0.38
$t_{r_i^e}$	1.66	2.87	2.76	2.14	1.72	1.91	2.05	1.33
Panel B: $r_t^i - r_t^f = \alpha + \beta_{MKT}(MKT_t - r_t^f) + \varepsilon_t^i$								
α	0.04	0.41	0.62	0.58	−0.02	0.03	0.20	0.22
t_α	0.23	2.08	2.04	1.95	−0.22	0.27	0.96	0.87
β_{MKT}	1.08	1.15	1.34	0.26	0.96	0.97	1.34	0.38
$t_{\beta_{MKT}}$	17.90	20.31	18.20	3.47	25.76	35.78	14.40	5.68
	$GRS=4.02$ p(GRS)=0.00 m.a.e=0.35				$GRS=1.00$ $p(GRS)=0.44$ $m.a.e=0.11$			
Panel C: $r_t^i - r_t^f = \alpha + \beta_{MKT}(MKT_t - r_t^f) + \beta_{SMB}SMB_t + \beta_{HML}HML_t + \varepsilon_t^i$								
α	−0.35	0.08	0.75	1.10	−0.12	−0.07	0.69	0.80
t_α	−3.21	0.72	3.08	5.47	−0.97	−0.73	3.54	3.67
β_{MKT}	1.06	1.09	1.01	−0.05	1.01	1.01	1.08	0.07
$t_{\beta_{MKT}}$	32.56	34.83	18.44	−0.76	30.95	38.07	16.81	1.23
β_{SMB}	0.79	0.85	1.21	0.42	−0.03	−0.00	0.28	0.32
$t_{\beta_{SMB}}$	7.48	8.74	11.62	3.17	−0.48	−0.06	2.64	3.27
β_{HML}	0.55	0.43	−0.46	−1.01	0.17	0.17	−0.91	−1.09
$t_{\beta_{HML}}$	6.49	4.91	−4.96	−9.55	2.07	2.63	−9.26	−11.67
	$GRS=6.59$ $p(GRS)=0.00$ $m.a.e=0.32$				$GRS=3.91$ $p(GRS)=0.00$ $m.a.e=0.24$			
Panel D: $r_t^i - r_t^f = \alpha + \beta_{MKT}(MKT_t - r_t^f) + \beta_{INV}INV_t + \beta_{ROE}ROE_t + \varepsilon_t^i$								
α	0.17	0.60	1.44	1.26	−0.10	−0.03	0.80	0.89
t_α	0.84	2.90	3.64	3.63	−0.87	−0.28	2.97	3.19
β_{MKT}	1.05	1.10	1.15	0.11	0.98	0.98	1.20	0.22
$t_{\beta_{MKT}}$	17.92	18.58	16.39	1.48	35.60	45.44	20.00	3.60
β_{INV}	0.14	0.15	−0.19	−0.32	−0.08	−0.01	−0.58	−0.50
$t_{\beta_{INV}}$	1.13	1.38	−1.18	−1.88	−0.91	−0.19	−3.49	−3.16
β_{ROE}	−0.23	−0.32	−0.90	−0.66	0.14	0.07	−0.41	−0.55
$t_{\beta_{ROE}}$	−2.03	−3.45	−4.28	−4.05	1.91	1.02	−2.44	−4.59
	$GRS=7.78$ $p(GRS)=0.00$ $m.a.e=0.68$				$GRS=3.02$ $p(GRS)=0.00$ $m.a.e=0.27$			

book-to-market, with the annual rebalancing performed at the beginning of July of each year.[11]

[11] I follow Davis, Fama, and French (2000) to form book-to-market quintile breakpoints. I use all NYSE companies (excluding the financial and utility sectors) with ordinary common shares and a positive quantity for the book value of equity (as defined as in Section 3.1.1) at time $t-1$. I construct the book-to-market ratio by dividing the book value at time $t-1$ by the market value at the end of December of year $t-1$. The quintiles breakpoints evaluated with the time $t-1$ values are used to sort stocks in book-to-market categories from the beginning of July of year t up to the beginning of June of year $t+1$.

Table 5 reports the results when size is used to proxy for expected profitability. The cash-related excess return is significant only for small firms in the equally weighted case and for small and large firms in the value-weighted case (Panel A). The difference between the cash-related excess return across size categories is negative in both

Table 5

Raw and risk-adjusted equity returns across cash-to-assets and size portfolios.

Portfolios are rebalanced monthly starting in July 1972 and ending in December 2009. I use the quarterly accounting data in month t in portfolios sorts starting at time $t+i+1$ if there has been an earnings announcement (item RDQ) in month $t+i$, where $i=1$, 2, 3. This table reports results for both equally weighted and value-weighted portfolios. CH_1 is the bottom cash-holding quintile, CH_3 is the third cash-holding quintile, CH_5 is the top cash-holding quintile, and ΔCH is the difference between the top and bottom cash-holding quintiles. ME_1 is the bottom size quintile, ME_3 is the third size quintile, ME_5 is the top size quintile, and ΔME is the difference between the top and bottom size quintiles. Panel A reports the average realized equity returns in excess of the risk-free rate and the corresponding t-statistics. Panel B, Panel C, and Panel D report the risk-adjusted equity returns (α) and the factor loadings (βs) with the corresponding t-statistics using the classical capital asset pricing model (Sharpe, 1964; Littner, 1965), the Fama and French (1993) three-factor model, and the Chen, Novy-Marx, and Zhang (2011) three-factor model, respectively. GRS and $p(GRS)$ are the Gibbons, Ross, and Shanken (1989) test statistics and the corresponding p-value, respectively. $m.a.e.$ is the mean absolute error of the risk-adjusted equity returns. The t-statistics are evaluated following Newey and West (1987) and using 12 lags. The t-statistics of the difference in factor loadings between the top and bottom quintiles are evaluated using robust t-statistics.

	Equally weighted								**Value-weighted**							
	CH_1	CH_3	CH_5	ΔCH	CH_1	CH_3	CH_5	ΔCH	CH_1	CH_3	CH_5	ΔCH	CH_1	CH_3	CH_5	ΔCH
Panel A: $r_i^e = E[r_t^i - r_t^f]$																
	Excess returns				**t-statistic**				**Excess returns**				**t-Statistic**			
ME_1	0.58	1.14	1.53	0.95	1.57	3.09	3.41	3.38	0.46	0.95	1.14	0.68	1.37	2.82	2.76	2.28
ME_3	0.51	0.77	0.73	0.22	1.94	2.60	2.08	0.75	0.54	0.78	0.72	0.17	2.07	2.64	2.03	0.59
ME_5	0.38	0.55	0.79	0.41	1.66	2.38	2.11	1.36	0.23	0.40	0.80	0.57	0.92	1.84	2.25	2.19
ΔME	−0.20	−0.59	−0.74	−0.54	−0.72	−2.13	−2.30	−2.47	−0.24	−0.54	−0.35	−0.11	−0.87	−1.88	−0.98	−0.42
Panel B: $r_t^i - r_t^f = \alpha + \beta_{MKT}(MKT_t - r_t^f) + \epsilon_t^i$																
	α				t_α				α				t_α			
ME_1	0.10	0.64	0.98	0.87	0.44	2.46	3.03	3.10	−0.02	0.44	0.58	0.60	−0.09	1.84	1.96	2.03
ME_3	0.03	0.26	0.15	0.11	0.17	1.44	0.58	0.39	0.07	0.26	0.13	0.06	0.34	1.47	0.51	0.22
ME_5	−0.04	0.11	0.22	0.26	−0.32	1.65	1.06	0.91	−0.17	0.02	0.28	0.45	−1.56	0.19	1.47	1.80
ΔME	−0.14	−0.53	−0.76	−0.62	−0.52	−1.92	−2.34	−2.95	−0.15	−0.42	−0.30	−0.15	−0.55	−1.45	−0.86	−0.61
	β_{MKT}				$t_{\beta_{MKT}}$				β_{MKT}				$t_{\beta_{MKT}}$			
ME_1	1.10	1.16	1.29	0.19	13.95	16.55	17.51	1.89	1.13	1.18	1.31	0.18	14.26	16.82	18.00	2.05
ME_3	1.11	1.20	1.37	0.26	16.31	22.84	18.24	3.52	1.11	1.20	1.37	0.26	17.02	23.24	18.19	3.63
ME_5	0.96	1.01	1.32	0.36	21.02	45.98	13.94	5.96	0.92	0.89	1.21	0.29	21.55	25.47	15.59	5.08
ΔME	−0.14	−0.15	0.03		−1.81	−2.10	0.36		−0.20	−0.29	−0.10		−2.83	−4.57	−1.25	
	$GRS=3.06$ $p(GRS)=0.00$ $m.a.e.=0.25$								$GRS=2.58$ $p(GRS)=0.00$ $m.a.e.=0.21$							
Panel C: $r_t^i - r_t^f = \alpha + \beta_{MKT}(MKT_t - r_t^f) + \beta_{SMB}SMB_t + \beta_{HML}HML_t + \epsilon_t^i$																
	α				t_α				α				t_α			
ME_1	−0.39	0.23	0.88	1.27	−2.81	1.66	3.68	5.39	−0.52	0.02	0.54	1.06	−4.34	0.17	2.75	4.32
ME_3	−0.33	−0.02	0.37	0.70	−2.40	−0.23	1.79	2.91	−0.29	−0.02	0.35	0.64	−2.05	−0.18	1.76	2.71
ME_5	−0.17	0.06	0.69	0.87	−1.63	0.89	3.43	3.66	−0.23	0.00	0.78	1.01	−2.23	0.03	4.30	4.79
ΔME	0.21	−0.17	−0.19	−0.40	1.23	−1.16	−0.91	−1.85	0.29	−0.02	0.24	−0.05	2.16	−0.12	1.14	−0.21

Table 5 (*continued*)

	Equally weighted								Value-weighted							
	CH_1	CH_3	CH_5	ΔCH	CH_1	CH_3	CH_5	ΔCH	CH_1	CH_3	CH_5	ΔCH	CH_1	CH_3	CH_5	ΔCH
	β_{MKT}				$t_{\beta_{MKT}}$				β_{MKT}				$t_{\beta_{MKT}}$			
ME_1	1.04	1.05	1.01	−0.04	22.72	25.68	18.56	−0.47	1.09	1.10	1.02	−0.07	25.50	29.69	20.62	−1.21
ME_3	1.13	1.16	1.06	−0.08	28.98	35.34	23.65	−1.38	1.13	1.17	1.05	−0.07	28.61	34.88	23.42	−1.34
ME_5	1.04	1.04	1.07	0.03	27.86	44.04	18.86	0.56	0.99	0.95	1.03	0.03	27.76	22.23	21.95	0.67
ΔME	−0.00	−0.01	0.06		−0.02	−0.14	0.86		−0.09	−0.15	0.01		−2.01	−3.51	0.18	
	β_{SMB}				$t_{\beta_{SMB}}$				β_{SMB}				$t_{\beta_{SMB}}$			
ME_1	1.12	1.22	1.40	0.28	8.18	11.25	16.23	1.88	1.06	1.14	1.37	0.31	7.82	12.44	20.26	2.33
ME_3	0.57	0.66	1.00	0.43	4.43	5.61	11.42	3.81	0.55	0.64	0.98	0.43	4.16	5.38	11.66	3.87
ME_5	−0.11	−0.04	0.25	0.36	−1.75	−0.88	2.16	3.50	−0.21	−0.20	−0.07	0.14	−4.80	−6.73	−1.06	1.92
ΔME	−1.23	−1.26	−1.15		−11.37	−13.95	−7.98		−1.28	−1.34	−1.44		−12.58	−17.81	−13.07	
	β_{HML}				$t_{\beta_{HML}}$				β_{HML}				$t_{\beta_{HML}}$			
ME_1	0.66	0.50	−0.09	−0.75	5.99	4.99	−0.66	−5.33	0.68	0.53	−0.19	−0.87	6.80	6.26	−2.04	−8.63
ME_3	0.54	0.37	−0.57	−1.11	4.18	3.42	−6.04	−11.33	0.53	0.38	−0.58	−1.11	4.15	3.40	−6.03	−11.42
ME_5	0.26	0.09	−0.88	−1.14	2.90	1.57	−8.12	−13.48	0.15	0.06	−0.88	−1.02	2.23	0.99	−8.37	−12.32
ΔME	−0.39	−0.41	−0.79		−3.83	−4.23	−6.19		−0.54	−0.46	−0.68		−6.23	−6.28	−6.93	
	$GRS=3.88$ $p(GRS)=0.00$ $m.a.e.=0.27$								$GRS=3.81$ $p(GRS)=0.00$ $m.a.e.=0.25$							
Panel D: $r_t^i - r_t^f = \alpha + \beta_{MKT}(MKT_t - r_t^f) + \beta_{INV} INV_t + \beta_{ROE} ROE_t + \epsilon_t^i$																
	α				t_α				α				t_α			
ME_1	0.39	1.03	1.85	1.46	1.46	3.74	4.71	5.58	0.10	0.68	1.33	1.23	0.42	2.77	3.43	4.39
ME_3	−0.00	0.27	0.70	0.71	−0.02	1.61	1.84	2.63	0.03	0.26	0.68	0.65	0.16	1.53	1.81	2.46
ME_5	−0.23	0.09	0.80	1.03	−2.20	1.17	2.63	4.28	−0.38	−0.10	0.69	1.08	−3.36	−0.99	2.69	4.77
ΔME	−0.62	−0.94	−1.04	−0.43	−2.55	−3.48	−3.33	−2.06	−0.49	−0.78	−0.64	−0.16	−1.85	−2.67	−1.81	−0.60
	β_{MKT}				$t_{\beta_{MKT}}$				β_{MKT}				$t_{\beta_{MKT}}$			
ME_1	1.04	1.07	1.09	0.05	13.13	13.14	13.12	0.59	1.10	1.13	1.14	0.04	14.22	15.24	15.14	0.50
ME_3	1.12	1.19	1.25	0.12	20.20	24.66	20.74	1.73	1.11	1.20	1.24	0.13	21.20	25.60	20.96	1.81
ME_5	1.01	1.02	1.18	0.18	42.43	67.97	20.26	3.43	0.97	0.92	1.12	0.15	37.16	37.13	20.85	2.76
ΔME	−0.03	−0.05	0.09		−0.43	−0.79	1.21		−0.13	−0.21	−0.02		−1.88	−3.51	−0.32	
	β_{INV}				$t_{\beta_{INV}}$				β_{INV}				$t_{\beta_{INV}}$			
ME_1	0.22	0.23	−0.05	−0.27	1.26	1.43	−0.26	−1.20	0.28	0.29	0.00	−0.28	1.86	2.25	0.00	−1.42
ME_3	−0.02	0.11	−0.20	−0.18	−0.17	1.28	−1.12	−0.97	−0.02	0.12	−0.21	−0.19	−0.23	1.35	−1.21	−1.01
ME_5	0.02	−0.06	−0.56	−0.58	0.22	−1.06	−3.29	−4.11	0.07	−0.00	−0.54	−0.61	0.97	−0.03	−3.22	−4.21
ΔME	−0.20	−0.29	−0.51		−1.27	−1.91	−2.43		−0.20	−0.29	−0.54		−1.40	−2.24	−2.74	
	β_{ROE}				$t_{\beta_{ROE}}$				β_{ROE}				$t_{\beta_{ROE}}$			
ME_1	−0.47	−0.61	−1.04	−0.57	−3.32	−5.60	−6.42	−3.36	−0.31	−0.46	−0.92	−0.62	−2.28	−4.66	−5.13	−3.96
ME_3	0.06	−0.07	−0.57	−0.63	0.37	−0.78	−2.51	−3.86	0.06	−0.06	−0.56	−0.62	0.40	−0.60	−2.47	−3.89
ME_5	0.23	0.06	−0.40	−0.63	2.58	0.84	−2.00	−5.05	0.22	0.14	−0.21	−0.43	3.97	2.86	−1.50	−4.49
ΔME	0.70	0.67	0.64		6.04	6.64	3.65		0.52	0.60	0.71		4.99	6.80	4.77	
	$GRS=5.03$ $p(GRS)=0.00$ $m.a.e.=0.49$								$GRS=4.07$ $p(GRS)=0.00$ $m.a.e.=0.42$							

cases (-0.54% and -0.11%) and significant only for the equally weighted portfolios. The same pattern emerges when risk-adjusted equity returns are considered. The difference in the cash-related spread is negative and significant only for equally weighted portfolios and equal to -0.62% when the CAPM is used (Panel B), -0.40% when the Fama and French model is used (Panel C), and -0.43% when the Chen, Novy-Marx, and Zhang model is used (Panel D). In the value-weighted case, the data do not support the hypothesis that expected profitability influences the difference in the cash-related spread (Hypothesis 2).

Table 5 also reports the loading on each risk factor used to risk-adjust the excess returns. Similar to the one-way sort case, the significance of the difference in loadings on the market factor weakens substantially when the Fama and French or the Chen, Novy-Marx, and Zhang factor model is used, at the same time, high cash portfolios are significantly less exposed to the sources of risk proxied by the HML and the ROE factors. Panel C shows that the difference in loadings on the HML factor varies between -1.14 (large size portfolio) and -0.75 (small size portfolio), thus generating a substantial spread of -0.19% per month in the cash-related excess return between large and small firms.[12] Panel D shows that, for the large firms category, high cash firms are less exposed to the investment factor and this is expected given that the investment factor has properties similar to the HML factor, as Chen, Novy-Marx, and Zhang (2011) show. In addition, high cash firms have a significant smaller loading on the ROE factor that varies between -0.63 and -0.57 (-0.62 and -0.43) in the equally (value-) weighted case. These results confirm what is found in the one-way sort case. The cash-related risk-adjusted excess returns increase after the sources of risk associated to firms' size, growth opportunities and current profitability are controlled for.

Tables 6 and 7 report the outcome of the two-way sorts on cash-to-assets and book-to-market and cash-to-assets and return on equity, respectively. The results are very similar to the ones described for the cash-to-assets and size-sorted portfolios. When the book-to-market ratio is used to proxy for expected profitability, more support is found for the hypothesis that expected profitability influences the difference in the cash-related spread because the spread is now positive and significant for both equally weighted (1.28% per month) and value-weighted (0.75% per month) portfolios. Panel C and Panel D of Table 6 show that the high cash portfolios are significantly less exposed to the value and the profitability risk factors, but they still earn a significantly larger excess return than low cash portfolios.

Using a third proxy for expected profitability, I get a significantly larger cash-related spread (0.87% per month) only for low ROE portfolios in the equally weighted case (Table 7, Panel A). As in the previous two cases and in the one-sort case, high cash firms have larger factor loadings on the value and profitability factors (Table 7, Panel C and Panel D). It is worth highlighting that high ROE firms are significantly less exposed to the size risk factor when I control for the cash-to-assets ratio. This finding does not come as a surprise given that firms with higher profitability tend also to be larger firms.[13]

The CAPM model produces the smaller mean absolute error for the intercepts when I sort according to cash holdings and size and when I sort according to cash holdings and ROE (value-weighted returns case). The Fama and French three-factor model produces the smaller mean absolute error for the intercepts when I sort according to cash holdings and book-to-market and when I sort according to cash holdings and ROE (equally weighted returns case). All the proposed linear factor models are rejected at the 10% level.

Overall, the portfolio analysis provides supportive evidence only for the hypothesis that expected equity returns and firm cash holdings are positively related (Hypothesis 1). Firms with higher cash holdings have on average higher excess equity returns. The evidence supporting the hypothesis that expected profitability influences the difference in the cash-related spread (Hypothesis 2) is weaker because more profitable firms produce a smaller spread almost exclusively when equally weighted portfolios are considered.

4. Conclusion

This paper explores an additional source of corporate precautionary savings driven by the correlation between cash flows and aggregate risk. Using a model that assumes costly access to external financing, I show that the higher the correlation between cash flows and an aggregate shock (i.e., the riskier the firm), the more the firm hoards cash as a hedge against the risk of a future cash flow shortfall (i.e., the higher the savings). The model also generates testable predictions regarding the correlation between corporate cash holdings and expected equity returns. Under the assumption that the ex-dividend value of the firm is decreasing in the riskiness of the firm's assets in place, the model predicts that the correlation between cash holdings and expected equity returns should be positive and larger for firms with less profitable growth options.

I test the model's predictions using two measures of expected equity returns. When I use an accounting-based proxy, the data show that this variable positively affects changes in cash holding policies, thus providing robust evidence in support of precautionary savings motives at the firm level being driven by expected equity returns. In addition, the data show support for the hypothesis that the marginal effect of expected equity returns on cash

[12] The average value of the HML factor over the period that starts in July 1972 and ends in December 2009 is equal to 0.47%. The different exposure to the value factor generates a difference in returns between high cash and low cash firms equal to $-0.75\times0.47=-0.35\%$ ($-1.14\times0.47=-0.54\%$) for small (large) size firms. The implied difference in the cash-related spread between large (more profitable) and small (less profitable) firms is equal to -0.54% $-(-0.35)\%=-0.19\%$.

[13] I do not report the firms' characteristics across the two-way sorted portfolios. These results are available upon request.

Table 6
Raw and risk-adjusted equity returns across cash-to-assets and book-to-market portfolios.

Portfolios are rebalanced monthly starting in July 1972 and ending in December 2009. I use the quarterly accounting data for cash holdings in month t in portfolios sorts starting at time $t+i+1$ if there has been an earnings announcement (item RDQ) in month $t+i$, where $i=1$, 2, 3. I follow Davis, Fama, and French (2000) to form book-to-market quintile breakpoints. Specifically, I use all NYSE companies (excluding the financial and utility sectors) with ordinary common shares and a positive quantity for the book value of equity (as defined in Section 3.1.1) at time $t-1$. I construct the book-to-market ratio by dividing the book value at time $t-1$ by the market value at the end of December of year $t-1$. The quintiles breakpoints evaluated with the time $t-1$ values are used to sort stocks in book-to-market categories from the beginning of July of year t up to the beginning of June of year $t+1$. This table reports results for both equally weighted and value-weighted portfolios. CH_1 is the bottom cash-holding quintile, CH_3 is the third cash-holding quintile, CH_5 is the top cash-holding quintile, and ΔCH is the difference between the top and bottom cash-holding quintiles. MB_1 is the bottom book-to-market quintile, MB_3 is the third book-to-market quintile, MB_5 is the top book-to-market quintile, and ΔBM is the difference between the top and bottom book-to-market quintiles. Panel A reports the average realized equity returns in excess of the risk-free rate and the corresponding t-statistics. Panel B, Panel C, and Panel D report the risk-adjusted equity returns (α) and the factor loadings (βs) with the corresponding t-statistics using the classical capital asset pricing model (Sharpe, 1964; Littner, 1965), the Fama and French (1993) three-factor model, and the Chen, Novy-Marx, and Zhang (2011) three-factor model, respectively. GRS and $p(GRS)$ are the Gibbons, Ross, and Shanken (1989) test statistics and the corresponding p-value, respectively. $m.a.e.$ is the mean absolute error of the risk-adjusted equity returns. The t-statistics are evaluated following Newey and West (1987) and using 12 lags. The t-statistics of the difference in factor loadings between the top and bottom quintiles are evaluated using robust t-statistics.

	Equally weighted								**Value-weighted**							
	CH_1	CH_3	CH_5	ΔCH	CH_1	CH_3	CH_5	ΔCH	CH_1	CH_3	CH_5	ΔCH	CH_1	CH_3	CH_5	ΔCH
Panel A: $r_i^e = E[r_t^i - r_t^f]$																
	Excess returns				***t*-Statistic**				**Excess returns**				***t*-Statistic**			
BM_1	−0.02	0.21	0.59	0.61	−0.06	0.64	1.39	2.08	0.21	0.22	0.59	0.38	0.82	0.88	1.69	1.30
BM_3	0.42	0.80	1.33	0.91	1.51	2.60	3.51	3.89	0.27	0.69	1.06	0.79	1.10	2.72	3.41	2.85
BM_5	0.93	1.56	2.83	1.90	2.44	4.10	5.17	5.73	0.58	0.85	1.70	1.12	1.90	2.61	3.83	2.99
ΔBM	0.95	1.35	2.23	1.28	3.91	5.40	5.46	4.69	0.37	0.63	1.11	0.75	1.48	2.24	3.13	2.31
Panel B: $r_t^i - r_t^f = \alpha + \beta_{MKT}(MKT_t - r_t^f) + \epsilon_t^i$																
	α				t_α				α				t_α			
BM_1	−0.52	−0.30	−0.01	0.51	−2.97	−1.68	−0.02	1.76	−0.19	−0.18	0.07	0.26	−1.18	−1.48	0.34	0.94
BM_3	−0.02	0.31	0.79	0.81	−0.11	1.67	3.22	3.66	−0.14	0.26	0.52	0.65	−0.95	2.03	2.32	2.34
BM_5	0.47	1.06	2.31	1.85	1.82	3.90	5.43	5.62	0.12	0.37	1.17	1.05	0.59	1.63	3.68	2.84
ΔBM	0.98	1.36	2.32	1.34	4.02	5.44	5.64	4.89	0.31	0.56	1.10	0.79	1.27	1.97	3.10	2.44
	β_{MKT}				$t_{\beta_{MKT}}$				β_{MKT}				$t_{\beta_{MKT}}$			
BM_1	1.16	1.18	1.40	0.24	21.25	29.68	20.40	3.85	0.95	0.94	1.22	0.27	12.85	16.43	15.89	4.10
BM_3	1.03	1.13	1.26	0.23	20.93	25.78	18.71	3.46	0.95	0.99	1.26	0.31	22.33	26.88	17.60	5.43
BM_5	1.08	1.16	1.20	0.12	12.69	14.12	13.45	1.15	1.08	1.12	1.24	0.17	18.08	16.33	16.28	2.16
ΔBM	−0.08	−0.02	−0.20		−0.96	−0.27	−2.16		0.12	0.18	0.02		1.79	2.55	0.30	
	$GRS=5.11$ $p(GRS)=0.00$ $m.a.e.=0.51$								$GRS=1.45$ $p(GRS)=0.08$ $m.a.e.=0.30$							
Panel C: $r_t^i - r_t^f = \alpha + \beta_{MKT}(MKT_t - r_t^f) + \beta_{SMB}SMB_t + \beta_{HML}HML_t + \epsilon_t^i$																
	α				t_α				α				t_α			
BM_1	−0.63	−0.30	0.28	0.92	−3.88	−2.47	1.21	3.59	−0.16	−0.03	0.57	0.73	−0.93	−0.22	3.04	2.90
BM_3	−0.32	0.05	0.74	1.06	−2.24	0.53	4.34	4.99	−0.33	0.09	0.61	0.94	−2.20	0.72	3.09	3.80
BM_5	−0.07	0.54	2.03	2.10	−0.42	3.12	5.35	6.81	−0.24	−0.09	0.99	1.23	−1.23	−0.38	3.46	3.57
ΔBM	0.56	0.84	1.74	1.18	2.78	4.18	4.76	4.35	−0.07	−0.06	0.42	0.49	−0.32	−0.25	1.45	1.62
	β_{MKT}				$t_{\beta_{MKT}}$				β_{MKT}				$t_{\beta_{MKT}}$			
BM_1	1.05	1.04	1.07	0.02	24.90	36.14	21.73	0.39	0.97	0.92	1.00	0.03	15.18	19.96	22.67	0.59
BM_3	0.99	1.07	1.04	0.04	20.46	32.51	20.54	0.81	1.02	1.06	1.09	0.07	24.08	21.82	18.21	1.23

BM_5	1.09	1.13	1.05	−0.03	21.76	22.95	12.20	−0.33	1.16	1.23	1.14	−0.02	25.44	12.91	16.40	−0.28
ΔBM	0.04	0.09	−0.02		0.58	1.53	−0.20		0.19	0.31	0.14		3.05	4.40	2.00	
	β_{SMB}				$t_{\beta_{SMB}}$				β_{SMB}				$t_{\beta_{SMB}}$			
BM_1	0.68	0.63	0.93	0.25	9.62	9.82	7.57	2.16	−0.13	−0.18	0.07	0.20	−2.28	−3.44	1.02	2.47
BM_3	0.69	0.75	1.06	0.38	5.99	10.56	14.42	3.55	0.03	0.02	0.59	0.56	0.41	0.23	6.58	6.00
BM_5	0.93	1.04	1.16	0.24	7.91	7.63	7.85	1.40	0.25	0.34	0.77	0.52	2.38	2.76	7.57	3.90
ΔBM	0.25	0.41	0.24		2.33	3.40	1.37		0.38	0.52	0.71		3.67	4.96	6.03	
	β_{HML}				$t_{\beta_{HML}}$				β_{HML}				$t_{\beta_{HML}}$			
BM_1	0.08	−0.11	−0.69	−0.77	0.95	−1.24	−7.73	−8.30	−0.03	−0.25	−0.90	−0.87	−0.26	−2.27	−9.22	−8.94
BM_3	0.40	0.32	−0.12	−0.52	3.41	4.27	−1.42	−5.53	0.34	0.29	−0.27	−0.61	3.65	3.53	−3.49	−6.20
BM_5	0.78	0.72	0.29	−0.49	7.25	5.85	1.45	−2.67	0.58	0.74	0.17	−0.40	5.53	4.83	1.28	−2.98
ΔBM	0.70	0.83	0.98		6.18	7.06	5.73		0.61	0.99	1.07		5.58	8.22	8.51	
	$GRS=4.60$ $p(GRS)=0.00$ $m.a.e.=0.41$								$GRS=2.01$ $p(GRS)=0.00$ $m.a.e.=0.26$							

Panel D: $r_t^i - r_t^f = \alpha + \beta_{MKT}(MKT_t - r_t^f) + \beta_{INV} INV_t + \beta_{ROE} ROE_t + \epsilon_t^i$

	α				t_α				α				t_α			
BM_1	−0.46	−0.18	0.61	1.07	−2.40	−0.99	1.64	3.99	−0.54	−0.42	0.48	1.02	−4.00	−3.38	1.82	4.54
BM_3	−0.05	0.42	1.35	1.41	−0.27	2.14	4.33	7.16	−0.31	0.29	0.97	1.28	−1.84	1.97	3.06	4.72
BM_5	0.76	1.46	3.13	2.37	2.55	4.62	6.78	7.92	0.28	0.43	1.82	1.54	1.06	1.58	5.81	4.63
ΔBM	1.22	1.64	2.52	1.30	5.15	6.85	6.36	4.72	0.82	0.84	1.34	0.52	3.84	3.33	4.14	1.64
	β_{MKT}				$t_{\beta_{MKT}}$				β_{MKT}				$t_{\beta_{MKT}}$			
BM_1	1.14	1.15	1.26	0.12	18.31	21.66	21.17	1.67	1.03	0.99	1.13	0.10	23.83	24.76	22.09	1.65
BM_3	1.04	1.11	1.14	0.10	20.08	20.86	17.35	1.42	0.99	0.99	1.16	0.17	29.50	26.32	19.81	2.90
BM_5	1.01	1.07	1.02	0.00	14.38	14.02	12.31	0.03	1.04	1.11	1.10	0.06	20.14	18.28	21.63	0.81
ΔBM	−0.13	−0.08	−0.24		−1.72	−1.15	−2.76		0.01	0.12	−0.03		0.15	1.83	−0.42	
	β_{INV}				$t_{\beta_{INV}}$				β_{INV}				$t_{\beta_{INV}}$			
BM_1	−0.05	−0.07	−0.27	−0.22	−0.31	−0.68	−1.86	−1.30	−0.05	−0.11	−0.53	−0.48	−0.40	−1.35	−3.25	−3.11
BM_3	0.11	0.18	0.02	−0.09	0.86	1.86	0.11	−0.53	0.14	0.05	−0.13	−0.27	1.39	0.52	−0.63	−1.57
BM_5	0.26	0.27	0.04	−0.22	1.71	1.79	0.17	−0.86	0.03	0.50	−0.00	−0.04	0.27	3.11	−0.03	−0.20
ΔBM	0.31	0.35	0.31		1.68	2.06	1.25		0.08	0.61	0.52		0.56	3.60	2.60	
	β_{ROE}				$t_{\beta_{ROE}}$				β_{ROE}				$t_{\beta_{ROE}}$			
BM_1	−0.05	−0.10	−0.61	−0.56	−0.47	−0.90	−2.51	−3.55	0.45	0.34	−0.22	−0.66	11.53	7.61	−1.44	−6.67
BM_3	−0.02	−0.23	−0.70	−0.68	−0.31	−3.55	−6.91	−6.66	0.14	−0.06	−0.48	−0.62	1.47	−0.71	−5.21	−6.31
BM_5	−0.50	−0.64	−1.02	−0.52	−3.24	−4.68	−9.78	−3.02	−0.21	−0.34	−0.79	−0.58	−1.41	−1.73	−10.79	−4.18
ΔBM	−0.46	−0.55	−0.41		−3.49	−4.11	−2.14		−0.66	−0.69	−0.58		−5.82	−5.79	−4.54	
	$GRS=11.13$ $p(GRS)=0.00$ $m.a.e.=0.76$								$GRS=4.88$ $p(GRS)=0.00$ $m.a.e.=0.52$							

Table 7
Raw and risk-adjusted equity returns across cash-to-assets and return on equity (ROE) portfolios.

Portfolios are rebalanced monthly starting in July 1972 and ending in December 2009. I use the quarterly accounting data in month t in portfolios sorts starting at time $t+i+1$ if there has been an earnings announcement (item RDQ) in month $t+i$, where $i=1$, 2, 3. This table reports results for both equally weighted and value-weighted portfolios. CH_1 is the bottom cash-holding quintile, CH_3 is the third cash-holding quintile, CH_5 is the top cash-holding quintile, and ΔCH is the difference between the top and bottom cash-holding quintiles. ROE_1 is the bottom ROE quintile, ROE_3 is the third ROE quintile, ROE_5 is the top ROE quintile, and ΔROE is the difference between the top and bottom ROE quintiles. Panel A reports the average realized equity returns in excess of the risk-free rate and the corresponding t-statistics. Panel B, Panel C, and Panel D report the risk-adjusted equity returns (α) and the factor loadings (βs) with the corresponding t-statistics using the classical capital asset pricing model (Sharpe, 1964; Littner, 1965), the Fama and French (1993) three-factor model, and the Chen, Novy-Marx, and Zhang (2011) three-factor model, respectively. GRS and $p(GRS)$ are the Gibbons, Ross, and Shanken (1989) test statistics and the corresponding p-value, respectively. $m.a.e.$ is the mean absolute error of the risk-adjusted equity returns. The t-statistics are evaluated following Newey and West (1987) and using 12 lags. The t-statistics of the difference in factor loadings between the top and bottom quintiles are evaluated using robust t-statistics.

	Equally weighted								Value-weighted							
	CH_1	CH_3	CH_5	ΔCH	CH_1	CH_3	CH_5	ΔCH	CH_1	CH_3	CH_5	ΔCH	CH_1	CH_3	CH_5	ΔCH
Panel A: $r_i^e=E[r_t^i-r_t^f]$																
	Excess returns				***t*-Statistic**				**Excess returns**				***t*-Statistic**			
ROE_1	−0.32	0.62	1.04	1.36	−0.68	1.33	2.02	4.10	−0.66	0.14	0.17	0.83	−1.40	0.29	0.40	2.05
ROE_3	0.70	0.94	1.01	0.31	2.49	3.32	3.11	1.26	0.43	0.29	0.69	0.27	1.94	1.17	1.82	0.86
ROE_5	0.93	1.28	1.44	0.51	2.90	4.13	4.13	2.09	0.45	0.64	0.88	0.43	1.53	2.54	2.50	1.40
ΔROE	1.25	0.66	0.40	−0.85	3.85	1.96	1.47	−3.17	1.11	0.50	0.71	−0.40	2.92	1.23	2.65	−1.06
Panel B: $r_t^i-r_t^f=\alpha+\beta_{MKT}(MKT_t-r_t^f)+\epsilon_t^i$																
	α				t_α				α				t_α			
ROE_1	−0.86	0.03	0.42	1.28	−2.80	0.09	1.09	3.79	−1.23	−0.46	−0.42	0.80	−3.77	−1.49	−1.51	1.97
ROE_3	0.25	0.48	0.49	0.25	1.33	2.46	2.40	1.02	0.02	−0.15	0.12	0.10	0.19	−1.16	0.51	0.34
ROE_5	0.44	0.79	0.88	0.44	2.24	4.38	4.44	1.79	0.02	0.24	0.35	0.33	0.12	1.77	1.86	1.10
ΔROE	1.30	0.76	0.46	−0.85	4.10	2.27	1.69	−3.15	1.25	0.70	0.78	−0.47	3.42	1.84	2.91	−1.26
	β_{MKT}				$t_{\beta_{MKT}}$				β_{MKT}				$t_{\beta_{MKT}}$			
ROE_1	1.25	1.37	1.44	0.19	14.36	15.51	15.03	1.51	1.31	1.40	1.38	0.07	19.58	14.59	13.64	0.76
ROE_3	1.05	1.08	1.19	0.14	16.95	20.25	19.73	2.20	0.95	1.01	1.34	0.39	23.13	31.61	11.28	4.73
ROE_5	1.13	1.14	1.31	0.18	18.25	18.58	23.28	2.89	0.99	0.93	1.23	0.23	14.20	15.69	19.07	3.76
ΔROE	−0.12	−0.23	−0.13		−1.25	−2.57	−1.38		−0.32	−0.46	−0.16		−4.44	−5.85	−1.84	
	$GRS=4.74$ $p(GRS)=0.00$ $m.a.e.=0.45$								$GRS=1.77$ $p(GRS)=0.01$ $m.a.e.=0.20$							
Panel C: $r_t^i-r_t^f=\alpha+\beta_{MKT}(MKT_t-r_t^f)+\beta_{SMB}SMB_t+\beta_{HML}HML_t+\epsilon_t^i$																
	α				t_α				α				t_α			
ROE_1	−1.31	−0.27	0.41	1.72	−5.41	−1.08	1.19	5.97	−1.44	−0.49	−0.27	1.17	−4.53	−1.81	−1.12	3.22
ROE_3	−0.11	0.14	0.53	0.63	−0.95	1.26	3.68	3.17	−0.10	−0.31	0.51	0.61	−0.88	−2.22	2.08	2.46
ROE_5	0.16	0.56	1.01	0.85	1.00	4.72	7.86	4.19	−0.01	0.21	0.81	0.82	−0.08	1.44	4.43	2.98
ΔROE	1.47	0.83	0.60	−0.87	4.50	2.59	2.29	−3.35	1.43	0.71	1.08	−0.35	3.98	1.86	4.58	−0.96
	β_{MKT}				$t_{\beta_{MKT}}$				β_{MKT}				$t_{\beta_{MKT}}$			
ROE_1	1.15	1.18	1.07	−0.08	16.36	16.26	13.04	−0.70	1.30	1.33	1.08	−0.22	20.98	15.21	15.17	−2.52
ROE_3	1.05	1.05	0.98	−0.06	30.96	32.94	20.61	−1.38	1.00	1.05	1.07	0.07	25.30	23.61	15.84	1.14
ROE_5	1.09	1.09	1.08	−0.02	24.35	25.54	33.94	−0.38	1.03	0.95	1.05	0.02	19.53	17.79	24.12	0.35
ΔROE	−0.06	−0.09	0.00		−0.69	−1.16	0.02		−0.27	−0.39	−0.03		−3.70	−4.57	−0.45	

	β_{SMB}				$t_{\beta_{SMB}}$				β_{SMB}				$t_{\beta_{SMB}}$			
ROE_1	1.25	1.38	1.63	0.38	10.50	12.15	9.52	1.87	0.44	0.33	1.06	0.62	4.18	3.28	9.96	4.09
ROE_3	0.67	0.75	0.86	0.19	6.45	8.61	15.83	2.13	−0.01	0.08	0.49	0.50	−0.17	1.16	4.92	4.76
ROE_5	0.67	0.63	0.79	0.12	4.44	4.63	12.97	1.10	−0.09	−0.01	−0.02	0.06	−1.05	−0.12	−0.41	0.72
ΔROE	−0.58	−0.75	−0.84		−3.80	−4.99	−4.94		−0.53	−0.34	−1.08		−3.83	−2.60	−9.87	
	β_{HML}				$t_{\beta_{HML}}$				β_{HML}				$t_{\beta_{HML}}$			
ROE_1	0.57	0.27	−0.28	−0.85	3.60	1.53	−1.41	−4.04	0.30	−0.01	−0.47	−0.76	2.46	−0.08	−3.21	−5.02
ROE_3	0.50	0.46	−0.22	−0.72	6.08	5.25	−3.81	−9.57	0.21	0.28	−0.78	−0.99	3.47	3.98	−5.23	−6.76
ROE_5	0.39	0.28	−0.37	−0.76	2.80	2.19	−6.11	−9.07	0.08	0.04	−0.80	−0.88	0.62	0.36	−9.25	−9.11
ΔROE	−0.18	0.01	−0.09		−1.13	0.10	−0.58		−0.22	0.05	−0.33		−1.62	0.39	−2.78	
	$GRS=8.91$ $p(GRS)=0.00$ $m.a.e.=0.42$								$GRS=3.20$ $p(GRS)=0.00$ $m.a.e.=0.33$							

Panel D: $r_t^i - r_t^f = \alpha + \beta_{MKT}(MKT_t - r_t^f) + \beta_{INV} INV_t + \beta_{ROE} ROE_t + \epsilon_t^i$

	α				t_α				α				t_α			
ROE_1	−0.08	1.01	1.66	1.74	−0.24	2.78	3.52	5.14	−0.70	0.18	0.46	1.16	−1.89	0.80	1.68	2.87
ROE_3	0.24	0.52	0.91	0.67	1.23	2.65	3.82	3.17	−0.07	−0.18	0.77	0.84	−0.59	−1.22	3.01	3.22
ROE_5	0.34	0.68	1.19	0.85	1.74	4.18	4.53	3.86	−0.26	−0.04	0.60	0.85	−1.67	−0.34	2.31	3.32
ΔROE	0.42	−0.33	−0.47	−0.89	1.95	−1.61	−2.13	−3.26	0.44	−0.22	0.13	−0.31	1.39	−0.92	0.48	−0.80
	β_{MKT}				$t_{\beta_{MKT}}$				β_{MKT}				$t_{\beta_{MKT}}$			
ROE_1	1.08	1.15	1.16	0.08	13.18	13.27	12.31	0.84	1.19	1.25	1.18	−0.01	19.12	22.95	14.52	−0.11
ROE_3	1.06	1.07	1.10	0.04	18.50	20.39	23.58	0.70	0.97	1.01	1.19	0.22	24.80	35.64	15.65	2.98
ROE_5	1.15	1.17	1.24	0.08	21.02	20.40	21.83	1.30	1.06	1.00	1.17	0.11	27.01	26.06	23.78	1.94
ΔROE	0.08	0.01	0.08		0.89	0.18	0.94		−0.14	−0.26	−0.01		−1.89	−4.28	−0.16	
	β_{INV}				$t_{\beta_{INV}}$				β_{INV}				$t_{\beta_{INV}}$			
ROE_1	1.08	1.15	1.16	0.08	13.18	13.27	12.31	0.84	1.19	1.25	1.18	−0.01	19.12	22.95	14.52	−0.11
ROE_3	1.06	1.07	1.10	0.04	18.50	20.39	23.58	0.70	0.97	1.01	1.19	0.22	24.80	35.64	15.65	2.98
ROE_5	1.15	1.17	1.24	0.08	21.02	20.40	21.83	1.30	1.06	1.00	1.17	0.11	27.01	26.06	23.78	1.94
ΔROE	0.08	0.01	0.08		0.89	0.18	0.94		−0.14	−0.26	−0.01		−1.89	−4.28	−0.16	
	β_{ROE}				$t_{\beta_{ROE}}$				β_{ROE}				$t_{\beta_{ROE}}$			
ROE_1	−0.96	−1.22	−1.40	−0.44	−5.99	−9.84	−5.85	−1.94	−0.41	−0.76	−0.99	−0.58	−3.77	−8.78	−6.11	−3.50
ROE_3	−0.10	−0.20	−0.52	−0.43	−1.04	−2.55	−4.79	−4.55	0.04	−0.04	−0.56	−0.60	0.73	−0.43	−3.88	−4.54
ROE_5	0.09	0.10	−0.29	−0.38	0.92	1.26	−2.42	−3.75	0.39	0.33	−0.10	−0.48	5.28	6.39	−0.78	−5.06
ΔROE	1.05	1.32	1.11		6.46	9.00	5.82		0.80	1.09	0.90		5.85	9.41	6.68	
	$GRS=3.79$ $p(GRS)=0.00$ $m.a.e.=0.67$								$GRS=1.93$ $p(GRS)=0.00$ $m.a.e.=0.30$							

holdings should be stronger across firms with more profitable growth options when I use market size and ROE as proxies for expected profitability. The data are less supportive when I perform a portfolio analysis using average realized returns. I obtain a sizable and significant excess return of high cash-to-assets portfolios over low cash-to-assets portfolios, which is larger for firms with less profitable growth options, mainly when I consider equally weighted equity returns.

An interesting result that stems from the portfolio analysis is that high cash firms have more growth opportunities and lower current profitability and, as a consequence, they are less exposed to the sources of risk proxied by the value, investment, and profitability factors. At the same time, these firms earn a larger and significant risk-adjusted return over firms with a low cash-to-assets ratio suggesting the presence of a source of risk related to cash-holdings that is not captured by the Fama and French (1993) and the Chen, Novy-Marx, and Zhang (2011) three-factor models.

Appendix A

In this appendix, I provide the proofs of the results discussed in Section 2.

A.1. Existence and uniqueness of the optimal savings policy

Proposition A.1. A unique interior solution to the firm's problem exists if the marginal benefit of saving cash evaluated at $S_1 = 0$ is larger than the marginal cost, namely,

$$\frac{1}{R} + \frac{\pi\lambda}{R}\Phi(\zeta_0) > \frac{1}{\widehat{R}}, \tag{13}$$

where $\Phi(\cdot)$ is the cumulative distribution function of a standard normal random variable and

$$\zeta_0 = \frac{-\mu + 0.5\sigma_x^2 + \beta_{xm}}{\sigma_x}. \tag{14}$$

Proof. Rewrite the firm's problem as

$$\max_{S_1 \geq 0} C_0 - \frac{S_1}{\widehat{R}} + (1-\pi)E_0[M_1(e^{x_1} + S_1)] + \pi E_0[M_1(1+\lambda\chi_1)(e^{x_1} + S_1 - 1)] + \pi e^{-2r}C_2. \tag{15}$$

Let $\kappa = \log(1 - S_1)$. Then, $\pi E_0[M_1(1+\lambda\chi_1)(e^{x_1} + S_1 - 1)]$ can be rewritten as

$$\pi E_0[M_1(1+\lambda)(e^{x_1} + S_1 - 1)|x_1 < \kappa]\Phi\left(\frac{\kappa - \mu + 0.5\sigma_x}{\sigma_x}\right) + \pi E_0[M_1(e^{x_1} + S_1 - 1)|x_1 \geq \kappa]\left(1 - \Phi\left(\frac{\kappa - \mu + 0.5\sigma_x}{\sigma_x}\right)\right). \tag{16}$$

The above expression can be further simplified using the following two results.

Lemma A.1. Let X and Y be two correlated normal random variables. X has mean μ_x and variance σ_x, and Y has mean μ_y and variance σ_y. Let ρ be their correlation coefficient. Then,

$$E[e^Y|X \leq \overline{x}] = e^{\mu_y + \sigma_y^2/2}\left(\frac{\Phi\left(\frac{\overline{x} - \mu_x}{\sigma_x} - \rho\sigma_y\right)}{\Phi\left(\frac{\overline{x} - \mu_x}{\sigma_x}\right)}\right),$$

where Φ is the cumulative distribution function of a standard normal variable.

Lemma A.2. Let X and Y be two correlated normal random variables. X has mean μ_x and variance σ_x, and Y has mean μ_y and variance σ_y. Let σ_{xy} be the their covariance. Then,

$$E[e^X e^Y|X \geq \overline{x}] = e^{\mu_y + \mu_x + (\sigma_y^2 + \sigma_x^2 + 2\sigma_{xy})/2}\left(\frac{1 - \Phi\left(\frac{\overline{x} - \mu_x - \sigma_x^2 - \sigma_{xy}}{\sigma_x}\right)}{1 - \Phi\left(\frac{\overline{x} - \mu_x}{\sigma_x}\right)}\right),$$

where Φ is the cumulative distribution function of a standard normal variable.

These two results can be derived using any standard statistics textbook (e.g., Casella and Berger, 2002). Lemmas A.1 and A.2 allow me to rewrite $E_0[M_1(\pi(1+\lambda\chi_1)(e^{x_1} + S_1 - 1))]$ as

$$\frac{\pi}{R}[(1 + \Phi(\zeta - \sigma_x)\lambda)e^{\mu - \beta_{xm}} + (S_1 - 1)(1 + \Phi(\zeta)\lambda)], \tag{17}$$

where $\zeta = (\kappa - \mu + 0.5\sigma_x^2 + \beta_{xm})/\sigma_x$ and $\beta_{xm} = \sigma_x\sigma_z\sigma_{x,z}$. The firm's problem becomes

$$\max_{S_1 \geq 0}\left\{C_0 - \frac{S_1}{\widehat{R}} + \frac{1}{R}[e^{\mu - \beta_{xm}} + S_1] + \frac{\pi}{R}\left[\lambda(e^{\mu - \beta_{xm}}\Phi(\zeta - \sigma_x) + S_1\Phi(\zeta)) - I(1 + \lambda\Phi(\zeta)) + \frac{C_2}{R}\right]\right\}, \tag{18}$$

and the first-order condition with respect to S_1 is

$$\frac{1}{\widehat{R}} + \phi = \frac{1-\pi}{R} + \frac{\pi}{R}\left(\frac{e^{\mu - \beta_{xm}}\lambda\Phi'(\zeta - \sigma_x)}{\sigma_x(S_1 - 1)} + (1 + \Phi(\zeta)\lambda) + \frac{(S_1 - 1)\lambda\Phi'(\zeta)}{\sigma_x(S_1 - 1)}\right), \tag{19}$$

where ϕ is the Lagrange multiplier on the non-negativity constraint for S_1. Because $\Phi'(\zeta - \sigma_x) = \Phi'(\zeta)e^{-0.5\sigma_x^2 + \sigma_x\zeta}$, the first-order condition for an interior solution reduces to

$$\frac{1}{\widehat{R}} = \frac{1}{R} + \frac{\pi\lambda}{R}\Phi(\zeta). \tag{20}$$

$\Phi(\zeta)$ is decreasing in S_1 and converges to zero as S_1 approaches one, implying that the marginal benefit of saving cash, $1/R + (\pi\lambda/R)\Phi(\zeta)$, is a decreasing function of S_1 and it reaches its maximum value when S_1 is equal to zero. It follows that having the marginal benefit of savings when $S_1 = 0$ above the marginal cost, $1/\widehat{R}$, is sufficient to guarantee the existence and uniqueness of an interior solution. □

A.2. Optimal savings policy and risk

Proposition A.2. The optimal savings policy is increasing in the firm's riskiness.

Proof. The total differential of Eq. (20) with respect to S_1^* and σ_{xz} is

$$0 = -\left(\frac{\Phi'(\zeta)}{\sigma_x(1 - S_1^*)}\right)dS_1^* + \left(\frac{\Phi'(\zeta)\sigma_x\sigma_z}{\sigma_x}\right)d\sigma_{xz}, \tag{21}$$

and the sensitivity of the optimal savings choice to a change in risk, as measured by $\sigma_{x,z}$, is

$$\frac{dS_1^*}{d\sigma_{x,z}} = \frac{\left(\frac{\Phi'(\zeta)\sigma_x\sigma_z}{\sigma_x}\right)}{\left(\frac{\Phi'(\zeta)}{\sigma_x(1-S_1^*)}\right)} = \sigma_x\sigma_z(1-S_1^*). \tag{22}$$

The above quantity is always positive because the firm never chooses S_1^* greater than or equal to one. □

A.3. Expected returns and risk

*Proposition A.3. If the firm's ex-dividend value at time*0 *is decreasing in* $\sigma_{x,z}$, *then the firm's expected return is increasing in* $\sigma_{x,z}$.

Proof. To assess how a change in riskiness affects expected equity returns, take the first derivative of $E[R^e_{0,1}]$ with respect to σ_{xz}, where $E[R^e_{0,1}]$ is the ratio of the sum of the expected dividends in periods 1 and 2 over the ex-dividend value of the firm in period 0. To simplify the notation, I write the expected equity return as $E[R^e_{0,1}] = f/g$. Applying the quotient rule gives

$$\frac{dE[R^e_{0,1}]}{d\sigma_{xz}} = \frac{g(f_{\sigma_{xz}}-(f/g)g_{\sigma_{xz}})}{g^2}, \tag{23}$$

where $f_{\sigma_{xz}}$ and $g_{\sigma_{xz}}$ are the derivatives of f and g with respect to σ_{xz}. The sum of the expected dividends in periods 1 and 2 is equal to

$$f = (1-\pi)E_0[e^{x_1}+S_1^*]+\pi E_0[(1+\lambda\chi_1)(e^{x_1}+S_1^*-1)]+\frac{\pi C_2}{R}$$
$$= e^{\mu}+S_1^*-\pi+\pi\lambda E_0[\chi_1(e^{x_1}+S_1^*-1)]+\frac{\pi C_2}{R} > 0, \tag{24}$$

and the derivative with respect to σ_{xz} is

$$f_{\sigma_{xz}} = \left(1+\pi\lambda\Phi\left(\zeta-\frac{\beta_{xm}}{\sigma_x}\right)\right)\frac{dS_1^*}{d\sigma_{xz}}. \tag{25}$$

Given that $dS_1^*/d\sigma_{xz} > 0$, $f_{\sigma_{xz}}$ is a positive quantity, then having a negative $g_{\sigma_{xz}}$ (i.e., assuming that the firm's ex-dividend value at time 0 is decreasing in $\sigma_{x,z}$) is sufficient to generate a positive relation between a firm's expected return and σ_{xz}.[14] □

Proposition A.4. The sensitivity of expected returns to $\sigma_{x,z}$ *is decreasing in the profitability of the investment opportunity* C_2.

Proof. I need to show that the quantity $dE[R^e_{0,1}]/d\sigma_{xz}$ is a decreasing function of C_2. Using the same notation as in the proof of Proposition A.3, I can write the sensitivity of expected returns to $\sigma_{x,z}$ as

$$\frac{dE[R^e_{0,1}]}{d\sigma_{xz}} = \frac{f_{\sigma_{xz}}g-fg_{\sigma_{xz}}}{g^2}. \tag{26}$$

$f_{\sigma_{xz}}$ and $g_{\sigma_{xz}}$ do not depend on C_2. The derivative of the above quantity with respect to C_2 is thus equal to

$$\frac{dE[R^e_{0,1}]}{d\sigma_{xz}dC_2} = \frac{(\pi e^{-2r}f_{\sigma_{xz}}-\pi e^{-r}g_{\sigma_{xz}})g^2-(gf_{\sigma_{xz}}-fg_{\sigma_{xz}})2g\pi e^{-2r}}{g^4}$$
$$= \frac{\pi e^{-2r}g^2[-f_{\sigma_{xz}}-g_{\sigma_{xz}}(e^r-2f/g)]}{g^4}. \tag{27}$$

The quantity $-f_{\sigma_{xz}}$ is negative because $f_{\sigma_{xz}} > 0$ (see the proof of Proposition A.3) and the quantity $-g_{\sigma_{xz}}(e^r-2f/g)$ is also negative because by assumption $g_{\sigma_{xz}} < 0$ and $(e^r-2f/g) < 0$, where the latter value is the return on the risk-free asset minus twice the expected equity return $E[R^e_{0,1}]$.[15] It follows that the numerator of $dE[R^e_{0,1}]/d\sigma_{xz}dC_2$ is negative. The sensitivity of expected returns to $\sigma_{x,z}$ is decreasing in C_2. □

A.4. Optimal savings policy: additional properties

Proposition A.5. The optimal savings policy is decreasing in the mean of the cash flow process μ; *decreasing in the risk-free rate* R; *increasing in the probability of getting an investment opportunity* π; *and increasing in the cost of external financing* λ.

Proof. Consider the first-order condition when an interior solution exists and evaluate the total differential with respect to S_1^* and μ:

$$0 = \left(\frac{\Phi'(\zeta)}{\sigma_x(S_1^*-1)}\right)dS_1^* + \left(-\frac{\Phi'(\zeta)}{\sigma_x}\right)d\mu$$
$$\Rightarrow \frac{dS_1^*}{d\mu} = -\frac{\left(-\frac{\Phi'(\zeta)}{\sigma_x}\right)}{\left(\frac{\Phi'(\zeta)}{\sigma_x(S_1^*-1)}\right)} = (S_1^*-1) < 0. \tag{28}$$

The optimal savings policy is decreasing in the mean of the cash flow process μ because the firm never chooses S_1^* greater than or equal to one. The total differential with respect to R and S_1^* implies that the optimal savings policy is decreasing in the risk-free rate R:

$$\frac{1}{\hat{R}}\,dR = \lambda\pi\left(\frac{\Phi'(\zeta)}{\sigma_x(S_1^*-1)}\right)dS_1^* \Rightarrow \frac{dS_1^*}{dR} = \left(\frac{\sigma_x}{\lambda\pi\hat{R}}\right)\left(\frac{S_1^*-1}{\Phi'(\zeta)}\right) < 0. \tag{29}$$

The total differential with respect to π and S_1^* implies that the optimal savings policy is increasing in the probability of investing π:

$$0 = \Phi(\zeta)d\pi+\pi\left(\frac{\Phi'(\zeta)}{\sigma_x(S_1^*-1)}\right)dS_1^* \Rightarrow \frac{dS_1^*}{d\pi}$$
$$= -\frac{\Phi(\zeta)}{\Phi'(\zeta)}\frac{\sigma_x(S_1^*-1)}{\pi} > 0. \tag{30}$$

The total differential with respect to λ and S_1^* implies that the optimal savings policy is increasing in the cost of

[14] The positive correlation between σ_{xz} and expected returns is a robust result. The sufficient condition $g_{\sigma_{xz}} < 0$ implies the restriction

$$\frac{(1-S_1^*)}{e^{\mu-\beta_{xm}}} < \frac{1+\pi\lambda\Phi(\zeta-\sigma_x)}{1+\pi\lambda\Phi(\zeta)},$$

which is satisfied for a wide range of plausible values for the model's parameters. The calculations are available upon request.

[15] By Proposition A.3, $E[R^e_{0,1}]$ is increasing in σ_{xz} and converges to e^r as σ_{xz} converges to zero. It follows that when I assume risk (i.e., $\sigma_{xz} > 0$) I obtain $e^r-2f/g < 0$ because $2f/g = 2E[R^e_{0,1}] > E[R^e_{0,1}] > e^r$.

external financing λ:

$$0=\Phi(\zeta)d\lambda+\lambda\left(\frac{\Phi'(\zeta)}{\sigma_x(S_1^*-1)}\right)dS_1^*\Rightarrow\frac{dS_1^*}{d\lambda}=-\frac{\Phi(\zeta)}{\Phi'(\zeta)}\frac{\sigma_x(S_1^*-1)}{\lambda}>0.\quad\square \tag{31}$$

Appendix B

In this appendix, I describe how to build the proxy for expected equity returns used in Section 3.1.

B.1. Measuring the equity cost of capital

Using a simple accounting identity implied by the clean surplus approach, I can rewrite Eq. (12) as

$$P_t=\sum_{i=1}^{\infty}\frac{E_t(B_{t-1+i}+NI_{t+i}-B_{t+i})}{(1+r_e)^i}=B_t+\sum_{i=1}^{\infty}\frac{E_t(NI_{t+i}-r_eB_{t+i-1})}{(1+r_e)^i}, \tag{32}$$

where B_{t+i} is the book value of equity at time $t+i$ and NI_{t+1} is the net income for period $t+i$. By dividing both sides by B_t, I end up with

$$\frac{P_t}{B_t}=1+\sum_{i=1}^{\infty}\frac{E_t(ROE_{t+i}-r_e)\frac{B_{t+i-1}}{B_t}}{(1+r_e)^i}, \tag{33}$$

where ROE_{t+1} is the return on equity in period $t+i$, defined as the ratio of NI_{t+i} over B_{t+i-1}. Gebhardt, Lee, and Swaminathan (2001) suggest truncating the summation at time T and using as a terminal value the last term in the summation evaluated as a perpetuity:

$$\frac{P_t}{B_t}=1+\sum_{i=1}^{T-1}\frac{E_t(ROE_{t+i}-r_e)\frac{B_{t+i-1}}{B_t}}{(1+r_e)^i}+\frac{E_t(ROE_{t+T}-r_e)\frac{B_{t+T-1}}{B_t}}{r_e(1+r_e)^T}. \tag{34}$$

The proxy for the expected equity return at time t is the value of r_e that satisfies Eq. (34).[16] The latter is also subject to the law of motion for the book value of equity implied by the clean surplus approach,

$$B_{t+i+1}=B_{t+i}+NI_{t+i+1}-D_{t+i+1}\Rightarrow\frac{B_{t+i+1}}{B_{t+i}}=1+ROE_{t+i+1}-\frac{D_{t+i+1}}{B_{t+i}}. \tag{35}$$

Gebhardt, Lee, and Swaminathan (2001) use earnings forecasts from the Institutional Brokers' Estimate System (I/B/E/S) to construct a measure of expected profitability (ROE_{t+i}). Wu and Zhang (2011) point out, however, that earnings forecasts have important limitations, the most important being that analyst forecasts mainly cover large and well established public companies. For this reason, I follow their approach and estimate values of ROE_{t+i} up to three years in the future using the Fama and MacBeth cross-sectional regression methodology suggested by Fama and French (2006). Wu and Zhang (2011) suggest the following specification to maximize the number of available observations:

$$ROE_{t+k}=\frac{Y_{t+k}}{B_{t+k-1}}=\alpha_0+\alpha_1\log\left(\frac{B_t}{M_t}\right)+\alpha_2\log MC_t+\alpha_3 NEGY_t+\alpha_4\left(\frac{Y_t}{B_t}\right)+\alpha_5AG_t+\varepsilon_{t+k}, \tag{36}$$

where $k=1,2,3$. The data used in the estimation of Eq. (36) come from Compustat Annual, and, as in the rest of the paper, I exclude from the data set utilities (SIC codes between 4900 and 4949) and financial companies (SIC codes between 6000 and 6999). Return on equity in year $t+k$ is defined as Y_{t+k}/B_{t+k-1}, where Y_{t+k} (profitability) is income per share in year $t+k$ (item IB divided by item CSHO) and B_{t+k-1} is book equity per share in year $t+k-1$. Book equity is defined as in Davis, Fama, and French (2000) (see Section 3.1.1 for a detailed description). Book equity per share (B_{t+k-1}) is book equity divided by the total number of shares outstanding (item CSHO) Observations with a negative book equity are excluded from the data set.[17] Book-to-market is the ratio of book equity per share over the fiscal year-end price per share (item PRCC_F). Market capitalization (MC_t) is the fiscal year-end price per share (item PRCC_F) times the total number of shares outstanding (item CSHO). NEG Y_t is a dummy variable that takes the value of one if income per share is negative. Asset growth is $AG_t=(a_t-a_{t-1})/a_{t-1}$, where a_t is total assets (item AT) divided by the total number of shares outstanding (item CSHO). As suggested by Wu and Zhang (2011), I use a ten-year rolling window to avoid look-ahead bias.

I use Eq. (36) to assign to each firm in the data set the corresponding predicted values for ROE_{t+1}, ROE_{t+2}, and ROE_{t+3}, while values of ROE_{t+i} with $i=4,5,\ldots,12$ are evaluated using a simple linear interpolation between ROE_{t+3} and ROE_{t+12}. The latter value is given by the median industry ROE evaluated at time t using only positive values for the past ROEs in the previous ten years (at least five years) and the 48-industry classification of Fama and French. I then use Eq. (35) to recursively generate future book values using the estimated values for ROE_{t+i} and setting $D_{t+i+1}/B_{t+i}=\kappa ROE_{t+i+1}$, where κ is the time t dividend payout ratio.[18]

[16] In this paper, I assume $T=12$.

[17] I also exclude observations with future negative book values as implied by Eq. (35) because I am not aware of a reliable method to evaluate return on equity when the book value is negative. This filter results in the loss of 2,449 out of 140,443 observations.

[18] The dividend payout ratio is the ratio of the total amount of dividends (item DVT) over income before extraordinary items (item IB). As in Gebhardt, Lee, and Swaminathan (2001), if income is negative then the dividend payout ratio is the ratio of the total amount of dividends (item DVT) over 0.06 times total assets (item AT). Moreover, κ is equal to zero (one) if the dividend payout ratio takes values smaller than zero (larger than one). Under the assumption of a constant dividend payout ratio, Eq. (35) can be rewritten as

$$\frac{B_{t+i+1}}{B_{t+i}}=1+ROE_{t+i+1}(1-\kappa).$$

In the empirical analysis, I set $\kappa=0$ when $ROE_{t+i+1}\leq 0$; the results are not sensitive to such a modification.

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