Corporate Cash Holdings, Stock Returns, and Firm Expected Uncertainty

Cathy Xuying Cao*
Albers School of Business and Economics
Seattle University
901 12th Avenue, Seattle, WA, 98122
caoc@seattleu.edu

Chongyang Chen
Pacific Lutheran University
12180 Park Ave S, Tacoma, WA 98447
chencb@plu.edu

Jot Yau
Albers School of Business and Economics
Seattle University
901 12th Avenue, Seattle, WA, 98122
jyau@seattleu.edu

*Corresponding author: Cathy Xuying Cao

Corporate Cash Holdings, Stock Returns, and Firm Expected Uncertainty

ABSTRACT

The paper examines the anomaly of the positive relation between cross-sectional stock returns and corporate cash holdings. We hypothesize that the relation is driven by the endogenous nature of cash holdings when firms face expected uncertainty in the presence of external financial constraints. We first use an EGARCH measure to proxy for expected firm-specific risks. We find that the positive relation disappears after controlling for firm expected uncertainty. In addition, we examine how fundamental sources of firm expected risks affect the relation. Specifically, we include three main drivers of firm risks that are identified in previous literature: cash flow volatility, financial constraints, and firm R&D activities in our tests. Consistent with our previous results, the positive relation is no longer significant after controlling for the fundamental sources of expected firm risks. Our results are robust to various alternative specifications. Our study highlights the importance of taking into account the endogeneity of firm fundamentals in asset pricing studies.

Keywords: corporate cash holdings, stock returns, excess cash, expected cash, precautionary saving hypothesis

JEL Classification: G12, G12, G32

EFM Classification Code: 350

Corporate Cash Holdings, Stock Returns, and Firm Expected Uncertainty

1. Introduction

Firms with higher cash holdings are intuitively expected to be "safer". However, seemly counterintuitively, Palazzo (2012) and Simutin (2010) document a cross-sectional cash holdings effect: firms with more cash holdings have higher future stock returns controlling for common risk factors. This finding suggests that one can earn abnormal returns by trading on the information of firms' cash holdings, which seems to pose a formidable challenge to the notion of efficient markets. It appears to be an anomaly for rational investors since they appear to be buying the shares of "safer" firms at discount.

What explains the puzzling cash holdings effect: firms with more cash holdings have higher future stock returns? In this paper, we show empirically that the endogenous nature of cash holdings can induce a spurious positive correlation between equity returns and cash holdings, as both are associated with the underlying firm-specific risks. We argue that riskier firms tend to hoard more cash holdings in the presence of financing constraints.[1] As a result, contrary to the conventional wisdom, larger cash holdings empirically reflect higher, not lower, expected firm risks.

In this paper, we explore the role of firm expected risks in the cash holdings-stock returns relation. We hypothesize that the positive relation is a manifestation of the endogenous nature of cash holdings when firms face expected uncertainty and nontrivial costs of financial distress. To hedge against future adversities, ex ante, firms optimally hold a certain level of cash. At the same time, firm stock returns increase to compensate stockholders for expected uncertainty. Thus cash

[1] There is a stream of papers in corporate finance on the endogenous determination of corporate cash holdings, such as Opler et al. (1999), Almeida, Campello, and Weisbach (2004), Bates, Kahle, and Stulz (2009), and Acharya, Davydenko, and Strebulaev (2012).

holdings and stock returns are jointly determined by the expected uncertainty. Therefore, it is the expected uncertainty, rather than cash holdings, that drives the variation of stock returns across firms.

To test our hypothesis, we first use expected firm-level volatilities estimated from an EGARCH model to proxy for firm expected uncertainty. Specifically, following Fu (2009), we use monthly stock returns to estimate the Fama and French (1993) three-factor model with an error term that follows an EGARCH process. We want to emphasize that the expected firm-level volatility measure in our study is different from the realized idiosyncratic risk measure as the latter is estimated as the standard deviation of the residuals from the regression of daily stock returns on the Fama and French (1993) three-factors. Different from the realized idiosyncratic risk measure, our EGARCH measure, estimated from longer-term and lower-frequency data, is not related to mispricing or arbitrage costs (Peterson and Smedema (2011)).[2] To further mitigate the concern that the expected idiosyncratic volatilities used in our study capture arbitrage costs, we follow Cohen, Diether, and Malloy (2007) to restrict our sample to stocks with lagged price greater than or equal to $5. This ensures that our results are not driven by small and illiquid stocks that tend to be mispriced.[3]

In addition to using a proxy for firm expected uncertainty, we directly examine how the fundamental sources of expected firm risks affect the relation between cash holdings and stock returns. Relying on prior literature, we focus on three main drivers of future firm risks: cash flow

[2] Peterson and Smedema (2011) compare the realized and expected idiosyncratic volatility and show that the expected idiosyncratic volatility estimated from longer-term and lower-frequency data is not related to mispricing or investor sentiment.

[3] Existing studies suggest that low-priced stocks are associated with high trading costs (Dolley (1933), Angel (1997)), low trading volumes (Hong and Stein (2007)), great noise trading (Black (1986)), and high likelihood of over-pricing (Baker, Greenwood, and Wurgler (2009)). In addition, Li, Sullivan, and Garcia-Feijóo (2014) find that the negative relation between stock returns and realized idiosyncratic risks, proxy for limits to arbitrage, disappears after excluding low-priced (under $5) stocks.

volatility (Pastor and Veronesi (2003) and Irvine and Pontiff (2009)), financial constraints (Whited and Wu (2006) and Gomes, Yaron, and Zhang (2006)), and firm R&D activities (Brown and Petersen (2011)). We find consistent results with either the EGARCH measure or the fundamental sources of expected firm risks.

The first sets of our tests explore the relation between cash holdings and future stock returns. We use three measures of cash holdings: raw cash holdings, expected cash holdings, and excess cash holdings. Following Simutin (2010), we measure excess cash as the cash holdings in excess of the level predicted by firm characteristics. We find that the positive cash holdings-stock returns relation is driven by the firm's expected cash holdings, which is determined by firm characteristics such as the firm size, market-to-book ratio, investment needs, and industry uncertainty.

We next show that the positive relation between expected cash holdings and stock returns is no longer significant after including a measure of expected firm-level risks into the regression. The evidence suggests that the positive cash-return relation documented in existing studies simply reflects the latent positive relationship between stock returns and firm's expected risks. Our results are consistent with the precautionary savings motive. Our findings hold even after taking into account foreign income repatriation tax costs[4] and remain robust to both high-tech and non-tech firms.

To further examine the role of firm expected uncertainty in driving the positive cash-return relation, we turn to the fundamental sources of expected firm risks. Specifically, we

[4] One strand of literature explaining the corporate cash hoarding behavior is based on taxes. For example, Foley, Hartzell, Titman, and Twite (2007) find evidence that the magnitude of the US multinationals' cash holdings are, in part, a consequence of the tax cost associated with foreign income repatriation. They report that the higher the repatriation tax, the higher the level of cash held abroad in affiliated companies.

include three main drivers of firm risks: cash flow volatility, financial constraints, and firm R&D activities in our tests. Instead of including EGARCH measure of expected firm-level risks, we control for the fundamental sources of expected firm risks in the regressions. We show that the positive cash holdings-return relation is no longer significant after controlling for the fundamental sources of expected firm risks.

Our paper is related to several studies that document a positive relation between cash holdings and future stock returns (Palazzo (2012) and Simutin (2010)). Simutin (2010) focuses on excess cash. He documents a robust positive relationship between corporate excess cash holdings and future stock returns. Different from Simutin (2010), we exclude firms with stock price lower than $5 and show that the relation is significant and positive between expected cash holdings and stock returns while it is insignificant between excess cash and future stock returns.

Palazzo (2012) models a precautionary savings motive for firms whose cash flows are related to aggregate shocks. The study proposes and empirically shows that the correlation between raw cash holdings and expected equity returns are positive and larger for firms with less profitable growth options. Complementing his paper, our study tests the hypothesis that firm-specific uncertainty is the underlying force behind the positive cash-equity return relation. More importantly, we empirically show that the positive effect becomes insignificant after controlling for either expected firm risks proxied by EGARCH measure of idiosyncratic volatility or the fundamental sources of firm risks, such as cash flow volatility, R&D intensity, and financial constraints.

Our paper contributes to a resolution of the cash holding effect puzzle by empirically examining the role of firm uncertainty in shaping the cash holdings-return relation. To explain the cash holdings effect, Li and Luo (2016) propose that investment sentiment and limit-to-arbitrage affect the strength of the association between cash holdings and future stock returns. Our paper is different from Li and Luo (2016) in several ways. First, Li and Luo (2016) adopt a behavioral interpretation. In particular, Li and Luo (2016) suggest that irrational investors may systematically undervalue firms with high cash holdings. They argue that this investor sentiment, combined with limits-to-arbitrage, leads to the persistent positive relation between cash holdings and stock returns. Our paper offers alternative explanation for the cash holdings effect. We hypothesize and provide empirical evidence that the cash effect is consistent with risk-based explanation, which suggests that the positive association is driven by firm expected risks. In addition, we focus on firms with stock price above $5 that are less susceptible to the limit-to-arbitrage effect.

Second, Li and Luo (2016) show that the cash holding effect is strong when investor sentiment is low and arbitrage costs are high. Their evidence suggests that investor sentiment and arbitrage costs cannot subsume the cash holding effect. In contrast, we show that firm uncertainty totally absorbs the significant effect of cash holding on stock returns. Our results suggest that firm uncertainty explains the cash holding effect.

Third, Li and Luo (2016) use the realized idiosyncratic volatility to proxy for the cost of arbitrage. They estimate the realized idiosyncratic volatility as the standard deviations of residuals from the Fama-French three-factor regression on daily stock returns. Different from their approach, we use expected idiosyncratic volatility, forecasted from a monthly EGARCH model, to proxy for firm uncertainty. As shown in Peterson and Smedema (2011), our measure of idiosyncratic volatility, based on longer-term and lower-frequency data, reflects undiversifiable firm-level risk but is not related to aggregate sentiment or mispricing.

Furthermore, our paper adds new evidence that supports the hypothesis that firm fundamental risks and the precautionary savings motive lead to the positive correlation between cash holdings and stock returns. We show that fundamental sources of firm-level risks, such as cash flow volatility, financial constraints, and firm R&D activities, drive the cash holdings effect.

The rest of the paper is organized as follows. We provide motivation and hypothesis development in Section 2. In Section 3, we present the data and methodology. In section 4, we next presents empirical evidence on the cross-sectional relation between cash holdings and stock returns after we control for expected firm risks. In section 5, we check the robustness our results. We offer concluding remarks in Section 6.

2. Motivation and Hypothesis Development

In this paper, we hypothesize that the positive relation between cash holdings and stock returns is a manifestation of the endogenous nature of cash holdings. Many firms hold cash to hedge against expected uncertainty. Since both cash holdings and stock returns are jointly affected by firm expected uncertainty, such uncertainty can be the underlying factor that induces the cash-returns relation.

Previous literature shows that precautionary motive is a critical determinant of cash holdings. Precautionary motive suggests that firms hold cash to better buffer against adverse shocks when external financing is costly (Keynes (1935)). Consistent with this perspective, a unifying thread in theoretical literature predicts a positive relation between a firm’s risk and its level of cash holdings in presence of financial constraints (Kim, Mauer, and Sherman (1998), Han and Qiu (2007), Riddick and Whited (2009), and Palazzo (2012)). Prior empirical studies also find a positive association between firm risk and cash holdings. For example, existing evidence shows that a firm tends to hold more cash if the firm has riskier cash flows and costlier external capital (Opler, Pinkowitz, Stulz, and Williamson (1999) and Bates, Kahle, and Stulz (2009)), higher credit risk (Acharya, Davydenko, and Strebulaev (2012)), as well as higher refinancing risk (Harford, Klasa, and Maxwell (2014)). In sum, endogenously determined cash holdings, to some extent, reflect expected firm risks.

The discussion above implies the importance of controlling for the endogeneity of cash holdings when examining the cash holdings-return relation. Failure to address the endogeneity concerns can lead to “biased and inconsistent parameter estimates that make reliable inference virtually impossible” (Roberts and Whited (2013)). In our setting, as suggested by prior studies, firm expected uncertainty is both a determinant of stock returns and is correlated with cash holdings. When a measure of firm risks is omitted in a regression, the relation between cash holdings and stock returns is distorted because of the joint correlation between expected firm risks and stock returns and between expected firm risks and cash holdings. We posit that including measures of expected firm risks can mitigate the endogeneity concerns and help reveal the underlying relation between cash holdings and stock returns.

Several studies show that firm fundamentals, such as cash flow volatility, R&D intensity, and financial constraints, not only affect firms’ cash holding decision but also are related to firm risks and therefore equity returns.

Volatile firm cash flows is an important driver of firm risk. Irvine and Pontiff (2009) show that firm cash flow volatility is positively related to idiosyncratic stock-return volatility. In addition, Pastor and Veronesi (2003) show that idiosyncratic volatility is higher for firms with more volatile profitability. Moreover, the fluctuations in cash flows affect stock returns. Vuolteenaho (2002) show that firm-level stock returns are mainly driven by cash-flow news.

In addition, extant literature shows that high R&D intensity leads to an increase in the firm-level risk. Cao, Simin, and Zhao (2009) show that both the level and the variance of growth options are related to firm-level volatility. Similarly, Comin and Philippon (2005) and Bekaert, Hodrick, and Zhang (2012) find a positive link between firm idiosyncratic risks and firms' growth options proxied by firm R&D. In addition, Chan, Lakonishok, and Sougiannis (2001) find a positive relation between stock return volatility and R&D intensity.

Another source of firm risk is firm financial constraints. Financial constraints arise when firms reply on external capital markets to finance investment opportunities to grow or finance temporary liquidity needs. Existing studies show that financial constraints are important sources of risks that explain the cross-section of stock returns (Lamont, Polk, and Saa-Requejo (2001), Whited and Wu (2006), and Gomes, Yaron, and Zhang (2006)). As suggested by Gomes, Yaron, and Zhang (2006), financing constraints introduce a wedge between investment returns and fundamentals such as profitability and thus create an important additional source of variation in investment returns.

If both firms' cash holdings and equity returns are related to fundamental sources of firm risk, the endogenous nature of cash holdings can induce a spurious positive correlation between equity returns and cash holdings, as both affected by the underlying fundamental sources of firm risk. Therefore, we expect that such a positive cash holding effect no longer holds if we take into account the fundamental sources of firm risk such as cash flow volatility, R&D intensity, and financial constraints.

3. Data and Methodology

3.1 Data

The data used in this study are drawn from two primary sources, the COMPUSTAT annual file and the Center for Research in Security Prices (CRSP) monthly return files. Sample data includes stocks traded on the NYSE, AMEX, and NASDAQ for the period from January 1970 to December 2013. We obtained annual cash holdings and other accounting data from Compustat, whereas the stock return data were taken from the CRSP data files. We also collect Fama-French risk factors, such as small-minus-large factor and high-minus-low factor from Ken French website.

We exclude utilities (SIC codes between 4900 and 4999), financial firms (SIC codes between 6000 and 6999), American depository receipts (ADRs), real estate investment trusts (REITs), and units of beneficial interest.[5] Moreover, to mitigate the concern about the potential impact on the firm risk that may arise from the trading anomaly related to low-priced stocks, we exclude firms with stocks with prices lower than $5.

3.2 Variable Construction

A. Construction of Cash Measure

We construct three measures of cash holdings: cash, expected cash, and excess cash. *Cash* is simply the log of the ratio of cash to net assets (total assets less cash). Following Simutin (2010), we construct *Expected cash* in the following way. In each year *t*, we run the following regression:

$$Cash_{i,t} = \gamma_0 + \gamma_1\, MB_{i,t} + \gamma_2\, Size_{i,t} + \gamma_3\, CF_{i,t} + \gamma_4\, NWC_{i,t} + \gamma_5 CAPEX_{i,t} + \gamma_6 LTD_{i,t} + \gamma_7\, R\&D_{i,t} + \gamma_8 \sigma_{i,t}^{IND} + \gamma_8 DIV_{i.t} + \gamma_9 Dummy_{i,t}^{IND} + \varepsilon_{i,t}, \quad (1)$$

[5] Following Foley et al. (2007) and Simutin (2010), financials (and utilities) are excluded since they tend to hold a large (small) proportion of the assets in cash or equivalents to meet statutory capital requirements and other regulations. ADRs, REITs, and units of beneficial interest are excluded to avoid possible confounding effect arising from their peculiar nature.

where i refers to firm i; *Cash* is the log of the ratio of cash to total assets less cash; *MB*, the market-to-book ratio is measured as the book value of assets minus the book value of equity, plus the market value of equity, divided by assets; *Size* is the log of real assets (adjusted by CPI); *CF* is the ratio of cash flow to total assets, where cash flow is computed as the earnings before interest, taxes, depreciation, and amortization (EBITDA) less interest, taxes, and common dividends; *NWC* is the ratio of net working capital calculated without cash to assets; *CAPEX* is the ratio of capital expenditures to assets; *LTD* is leverage, measured by the ratio of the sum of the short-term and long-term debt to net assets.; *R&D* is the ratio of research and development expenditures to sales; σ^{IND}, the industry uncertainty measured by the mean of the standard deviations of *CF* over a 20-year period for firms in the same two-digit SIC industry; the dividend dummy, DIV_t, is set to one if the firm pays a dividend in year t, and set to 0 if it does not[6]; and we define industry dummies, Dummy^{IND}, based on Fama and French's 17-industry classification.

Excess cash, as defined in Simutin (2010), is the residual as of year t from Equation 1, while expected cash is the predicted cash holdings estimated from the regression model.

B. Construction of Risk-adjusted Returns

To test for the positive relationship between stock returns and cash holdings, we employ the cross-sectional risk-adjusted return as the dependent variable in order to purge the spurious correlation caused by systematic risks. If the systematic risks are the main drivers of the positive relation between cash holdings and stock returns, one would expect that there will be no significant correlation between risk-adjusted return and cash holdings after we purge out the impact of the systematic risk on stock returns. Moreover, using the risk-adjusted return as the dependent variable instead of using the estimated factor loadings as the independent variables

[6] Except for the industry and dividend dummies, variables are defined the same as in Opler et al. (1999).

enables us to avoid the errors-in-variable problem (Brennan, Chordia, and Subrahmanyam (1998)).

We use the Fama and French's (1993) three-factor model to adjust returns for risk. As such, the risk-adjusted returns for an individual stock are computed as follows:

$$R_{it}^{adj} = R_{it} - R_{ft} - \hat{\beta}_M R_{Mt} - \hat{\beta}_{SMB} R_{SMBt} - \hat{\beta}_{HML} R_{HMLt}, \tag{2}$$

where R_{it} is the raw return on stock i at t, R_{ft} is the risk-free rate (T-bill rate) at t, and R_M, R_{SMB}, R_{HML} are the three risk factors, respectively: market, size, and market-to-book. We estimate the three factor loadings ($\hat{\beta}_M$, $\hat{\beta}_{SMB}$, and $\hat{\beta}_{HML}$) for each stock using monthly rolling regressions with a 60-month window requiring at least 24 observations of the monthly return in a given window.

C. Estimation of Expected Firm-level Risks

We use firm-specific conditional volatility to proxy for expected future firm-level risks. To capture the time-varying property of the firm-level risk, we follow Fu's (2009) approach by estimating conditional idiosyncratic risks, IV^{EGARCH}, from the Exponential Generalized Autoregressive Conditional Heteroskedasticity (EGARCH) model using monthly stock returns,

$$R_{i,t} - r_{f,t} = \alpha_{i,t} + \beta_{i,t}\left(R_{m,t} - r_{f,t}\right) + s_{i,t}SMB_t + h_{i,t}HML_t + \varepsilon_{i,t},$$

where $\varepsilon_{i,t} \sim i.i.d.\ (0, \sigma_{i,t}^2)$,

$$\text{EGARCH(1,1): } ln\sigma_{i,t}^2 = \theta_{0,i} + \theta_{1,i} ln\sigma_{i,t-1}^2 + \theta_{2,i}\left(\frac{\varepsilon_{i,t-1}}{\sigma_{i,t-1}}\right) + \theta_{3,i}\left(\left|\frac{\epsilon_{i,t-1}}{\sigma_{i,t-1}}\right| - \left(\frac{2}{\pi}\right)^{0.5}\right). \tag{3}$$

We define the $\sigma_{i,t}$ as the expected firm-level risk conditional, IV^{EGARCH}, on currently available information.

D. Construction of Other Control Variables

In our empirical tests, we also control for stock illiquidity, where illiquidity is measured as the average of the daily Amihud illiquidity measures, which is equal to the absolute value of the daily return divided by the daily volume (in million dollars) (Amihud (2002)). In addition, we also compute the coefficient of variation, $CV^{Illiquid}$, of the daily Amihud illiquidity measures over the past 250 days as an alternative measure of illiquidity. We also control for stocks' past cumulative returns measured as the compounded rate of return from month $t - 12$ to $t - 2$.

We follow Titman, Wei, and Xie (2004) to estimate a firm's cash flows, which is scaled by total assets, as operating income before depreciation minus interest expenses, taxes, preferred dividends, and common dividends. We then estimate cash flow volatility as the standard deviation of a firm's cash flows over the past ten years.

To identify firms with financial constraints, we construct a financial constraint index following Hadlock and Pierce (2010). As in Dai, Shackelford, Zhang, and Chen (2013), we classify a firm categorized as financially constrained if its financial constraint index among the top two-thirds it is considered financially unconstrained.

To test how the US taxation of foreign income affects the relation between stock returns and cash holdings, we estimate repatriation tax costs of repatriating foreign income, Domestic Income/Net Assets, and Foreign Income/Net Assets following Foley et al. (2007). Tax costs of repatriating foreign income is computed by first subtracting foreign taxes paid from the product of a firm's foreign pre-tax income and its marginal effective tax rate as calculated in Graham

(1996b). Then the maximum of this difference or zero is scaled by total firm assets. Net asset equals the total asset minus cash holdings. Domestic Income/Net Assets and Foreign Income/Net Assets are ratios of domestic and foreign pre-tax income to net assets, respectively.

To identify high-tech industries, we follow prior studies (e.g., Brown, Fazzari, and Petersen (2009), King et al. 2008, and Certo et al. 2001) that have identified seven high-tech industries based on the two-digit SIC codes: chemicals (28), computer equipment (35), electronics (36), aerospace (transportation: 37), instruments (38), communications (48), and software (business services: 73). Following Brown, Fazzari, and Petersen (2009), we exclude aerospace as the high-tech part of SIC 37 since it has very few firms and much of its R&D is funded by the U.S. government. It is noted that including aerospace in the sample does not change the results qualitatively.

3.3 Characteristics of Firms with Different Cash Holding Groups

Table 1 presents the descriptive statistics for the top (High) and the bottom (Low) decile cash-holdings portfolios for the period from 1970 to 2013. Using the Fama and French (1993) portfolio approach, we sort stocks in June of each year t into deciles based on the measures of cash holdings over the fiscal year ending in year $t-1$. Specifically, we use cash, expected cash, and excess cash measures defined in the appendix. High (low) cash-holdings portfolios refer to portfolios with cash holdings in the top (bottom) decile.

In Table 1, we notice significant differences between firms with high- and low- cash holdings in several aspects. For example, high-cash holding firms tend to have smaller market capitalization, low book-to-market ratios, and larger firm specific uncertainty. In addition, high-cash holding firms, on average, have more intensive R&D activities and larger cash flow volatilities and are more likely to be financially constrained. Thus it is important to control for the heterogeneity in firm fundamentals in order to cleanly test the relation between cash holdings and stock returns.

4 Stock Returns, Cash Holdings, and Firm Uncertainty

In this section, we first re-examine the positive relation between stock return and firm cash holdings documented in prior studies. Next, we investigate whether such relation is driven by firm uncertainty, proxied by expected idiosyncratic risk estimated from the EGARCH model.

4.1 Univariate Test on the Relation Between Cash Holdings and Stock Returns

We first examine the relation between cash holdings and stock returns by sorting with ten cash-holding portfolios. Specifically, we sort stocks in June of each year t into deciles on the measures of cash holdings over the fiscal year $t - 1$. We keep the portfolio composition constant over July of year t to June of year $t + 1$. We calculate average monthly returns for each portfolio period from 1970 to 2013.

Table 2 reports the equal-weighted and value-valued average monthly risk-adjusted returns for decile cash-holdings portfolios ranked by cash/net assets, expected cash, and excess cash from 1970 to 2013. Panel A reports monthly raw returns for the cash-holdings portfolios. Panel B reports monthly risk adjusted returns for cash-holdings portfolio. From Table 2, we observe that the average equal-weighted returns for decile portfolios in general increase with the level of all three cash holdings measure, whereas the difference in equally-weighted portfolio returns between the top (High) and the bottom (Low) deciles are all significant at the 1% level. For example, the equally-weighted returns increases from 0.78% per month for the low cash-to-asset decile to 1.36% for the high cash-to-asset decile with a spread of 0.58% ($t = 3.56$) per month.

The similar pattern on the return-cash holdings relation does not exist when we measure portfolio returns using value-weighted portfolios.[7] The relation documented in the univariate test can be affected by other factors. In the next section, we formally examine the relation between stock returns and cash holdings using cross-sectional Fama-MacBeth regressions, controlling for possible determinants of stock returns.

4.2 Cross-sectional Tests on the Relation between Cash Holdings and Stock Returns

To confirm the positive relation between cash holdings and stock returns, we start our empirical analysis by replicating the main results in prior studies. We run Fama and MacBeth (1973) regressions of monthly stock returns on various firm characteristics as well as cash holding measures over year 1970 and 2013. Specifically, for each month in the sample period, we run the following cross-sectional regression:

$$R_{it}^{adj} = \alpha_i + \beta_0 ln(ME)_{i,t-1} + \beta_1 \left(\frac{BE}{ME}\right)_{i,t-1} + \beta_2 R_{i,t-12,t-2} + \beta_3 \ln(Illiquidity)_{i,t-1}$$
$$+ \beta_4 \ln\left(CV^{Illiquid}\right)_{i,t-1} + \beta_5 R_{i,t-1} + \beta_6 Cash_{i,t-1} + \varepsilon_{i,t}, \tag{4}$$

where $R_{i,t}$ is the realized risk-adjusted return on stock *i* in month *t*. In the regression, we include the explanatory variables of cross-sectional expected returns such as beta, size, book-to-market ratio, and illiquidity measures. Following Fama and French (1992), we use size (the market capitalization, *ME*) in June to explain the returns of the following 12 months and use BE/ME of year t to explain the returns for the months from July of year t+1 to June of year t+2. The time

[7] When stocks with prices lower than \$5 and stocks of utility firms were included in the sample, we also observe that a positive and significant spread between the value-weighted returns for top and bottom decile portfolios. This result is similar to that of previous studies.

gap between BE/ME and returns ensures that the information on BE/ME is available to the public prior to the returns. Liquidity is another important factor that has an impact on cross-sectional returns (for example, see Amihud (2002), and Pastor and Stambaugh (2003)). We use Amihud illiquidity measure, *Illiquid* , and coefficient of variation of Amihud illiquidity measure, $CV^{Illiquid}$, to control for liquidity risk.

In addition, to control for the momentum effects documented in Jegadeesh and Titman (1993), we construct a past return variable, $R_{i,t-12,t-2}$, which is the compound gross return from month *t*-12 to month *t*-2 assuming the current month is *t*. We also control for return reversal effect (Jegadeesh (1990)), we control for return of prior month, $R_{i,t-1}$.

Following previous literature (Opler et al (1999)), we define cash as the log value of total cash holdings over net assets. In addition to examining the relation between stock returns and total cash holdings, we further study the relation between stock returns and expected cash as well as excess cash following Simutin (2010). Prior studies show that corporate cash holding policy is determined by various factors, such in firm size, market-to-book ratio, financial leverage, profitability, industry risks (see Opler et al. (1999)). If the level of cash holdings is optimally determined by a firm's operational and financial characteristics, we expect that only the endogenously determined cash reserve, i.e. expected cash holdings, to be positively associated with future stock returns.

Table 3 presents the regression results between cash holdings and stock returns. In model 1, 2 and 3, we regress monthly risk-adjusted stock returns on measures of cash-to-net-asset ratio, expected cash, and excess cash, respectively. In model 4, we regress risk-adjusted returns on both expected cash and excess cash.

Consistent with previous studies, we find that stocks with small capitalization, high book-to-market ratio, and high past returns have high risk-adjusted returns. In addition, stocks that have high liquidity risks tend to have high return.

We find positive relation between risk-adjusted returns and total cash holdings. In model 1, the coefficient estimate of cash-to-net asset is 0.061 with a t-value of 2.49. In addition, consistent with our expectation, we show in model 2 that the positive relation between returns and total cash holdings is driven by the expected cash holdings. Specifically, the coefficient estimate of expected cash is 0.269 with a t-value of 3.49, suggesting a significant and positive relation between expected cash and stock returns. More importantly, the relation between expected cash and stock return is economically and statistically stronger than that between cash and stock return. In contrast, we document an insignificant relation between excess cash and stock return.[8] If we include both expected cash and excess cash, the relation between excess cash and stock return stays insignificant. However, the relation between expected cash and stock return remains economically and statistically significant. The results therefore suggest that expected cash holding is an important factor that drives stock return. This confirms our first hypothesis that expected cash holdings is positively and significantly related to stock returns. In addition, there is no correlation between excess cash holdings and stock returns. We next test whether there is a significant relation between cash holdings and stock returns

4.3 Cash Holdings, Stock Returns, and Uncertainty

[8] This finding is different from that in Simutin (2010). Using portfolio approach, Simutin (2010) shows a positive alpha for portfolios comprised of longing stocks in the top excess cash holdings decile and shorting those in the low excess cash holdings group. Different from Simutin (2010), we examine the relation between stock returns and cash holdings at firm levels, controlling for various firm/stock characteristics. In addition, we exclude stocks with stock price less than $5.

Precautionary demand for cash theory predicts that firms adjust corporate cash holding policy not only in response to past and current firm condition but also in anticipation of firm uncertainty (Kim, Mauer, and Sherman (1998) and Riddick and Whited (2009)). Under the theories, firms hold cash to hedge against adverse cash flow shocks. In addition, Irvine and Pontiff (2009) show that the increase in firm specific risk mirrors an increase in cash flow volatility. Bates, Kahle, and Stulz (2009) show that firms with a higher idiosyncratic risk entails a greater precautionary demand for corporate cash holdings. Additionally, stock returns are positively associated with expected firm specific risks (Fu (2009)). We hypothesize that the documented positive relation between cash holdings and stock returns reflects the joint correlation of stock returns and cash holdings with expected firm specific risks. As such, cash holdings are not directly related to stock returns. Rather, cash holdings and stock returns are both driven by expected firm specific risks.

Motivated by papers by Engle (1982), Nelson (1991), and Fu (2009), we employ conditional idiosyncratic risks to proxy for expected firm specific risks. Following Fu (2009), we estimate conditional idiosyncratic risks, IV^{EGARCH}, from the Exponential Generalized Autoregressive Conditional Heteroskedasticity (EGARCH) model using monthly stock returns.

To test our hypothesis, we include the measure of expected firm specific risks, or conditional idiosyncratic risks, in our regression of stock returns on cash holdings:

$$R_{it}^{adj} = \alpha_i + \beta_0 ln(ME)_{i,t-1} + \beta_1 \left(\frac{BE}{ME}\right)_{i,t-1} + \beta_2 R_{i,t-12,t-2} + \beta_3 \ln(Illiquidity)_{i,t-1} + \beta_4 \ln\left(CV^{Illiquid}\right)_{i,t-1} + \beta_5 R_{i,t-1} + \beta_6 IV_{i,t-1}^{EGARCH} + \beta_7 Cash_{i,t-1} + \varepsilon_{i,t}. \quad (5)$$

Table 4 reports the results of regressions of monthly stock returns on three measures of cash holdings controlling for the expected firm-level risks. Results in Table 4 show that after controlling for the expected idiosyncratic risks, the significant positive cash holdings-stock returns relationship disappears for all model specifications. For example, in the regression of returns on cash-to-net assets ratio (in Column 1), the t-value of coefficient is only 0.28. Similarly, in the regression of returns on both expected cash and excess cash (in Column 4), the coefficients of these two cash measures are both insignificant after controlling for firm expected risks, IV^{EGARCH}.

The results in Table 4 support our hypothesis that the expected firm specific risks drive the spurious positive relationship between cash holdings and stock returns. As shown in Table 4, there is a strong and positive relation between stock returns and firm specific risks. Specifically, the coefficients of the measure of expected firm specific risks, IV^{EGARCH}, are positive and significant for all different model specifications. More importantly, after we control for the expected firm specific risks into our regression, the previously documented positive relation between stock returns and cash holdings in Table 3 becomes insignificant for different measures of cash holdings. For example, in Model 1 the coefficient of cash-to-net assets ratio is 0.006 with t value of 0.28. Similarly, in Model 4, the coefficient for expected cash holdings is 0.107 with t-value of 1.54. Our evidence suggests that cash holdings are not the main driver of high stock returns. The positive association between cash holdings and stock returns in Table 3 reflects the joint correlations between firm specific risks and cash holdings and between firm specific risks and stock returns.

4.4 Fundamental Factors of Idiosyncratic Risks, Cash Holdings, and Stock Returns

To shed more light on the sources of the significant relation between expected firm specific risks and stock returns, we resort to the literature to identify firm fundamental characteristics that affect expected firm specific risks. Although the literature suggests plenty of factors, we focus on three main drivers of expected firm specific risks: firm cash flow volatility, firm financial constraints, and firm R&D activities.

After identifying the main drivers of firm specific risks, we next empirically examine the relation between stock returns and cash holdings after controlling for the possible sources of firm specific risks by estimating the following regression. Specifically, we add the factors to the right hand side of the following equation:

$$\begin{aligned} R_{it}^{adj} = \alpha_i + \beta_0 ln(ME)_{i,t-1} + \beta_1 \left(\frac{BE}{ME}\right)_{i,t-1} + \beta_2 R_{i,t-12,t-2} + \beta_3 \ln(Illiquidity)_{i,t-1} \\ + \beta_4 \ln\left(CV^{Illiquid}\right)_{i,t-1} + \beta_5 R_{i,t-1} + \beta_6 \left(D^{Financial\ Constraints}\right)_{i,t-1} \\ + \beta_7 CF\ Volatility_{i,t-1} + \beta_8 \left(\frac{R\&D}{Sales}\right)_{i,t-1} + \beta_9 Cash_{i,t-1} + \varepsilon_{i,t}, \end{aligned} \tag{6}$$

where β_6 is the coefficient to firm financial constraints, β_7 is the coefficient to firm cash flow volatility, and β_8 is the coefficient to firm R&D expense ratio, respectively. In table 5, we regress risk-adjusted stock returns on cash-to-net-asset ratio, expected cash, excess cash, and on both expected cash and excess cash in model 1 to 4, respectively, controlling for firm cash flow volatility, financial constraints, and R&D activities.

Table 5 presents the estimation results. We show that none of the cash holdings measures is significantly associated with risk adjusted stock returns after controlling for the sources of firm specific expected risks, namely, the financial constraints, cash flow volatility, and R&D

activities. More importantly, the significant relationships between stock returns and cash-to-net-asset ratio (model 1) and expected cash (model 2 and 4) in Table 3 do not hold any more. In contrast, the coefficients before the variables financial constraints, cash flow volatility, and R&D intensity are all positively significantly associated with risk adjusted returns. The results suggest that firms that have higher cash flow volatility, have higher R&D intensity, or are more financially constrained tend to have higher risk adjusted returns. At the same time, these firm characteristics also suggest that the firms have higher expected firm risks, which require firms to have higher expected cash. As a result, the significant relation between risk adjusted stock returns and expected cash does not hold after we include the proxies for expected firm risks. In sum, Table 5 shows that the previous positive relation between expected cash and firm stock returns is actually driven by expected firm risks.

5 Robustness

5.1 Foreign Income repatriation costs, Idiosyncratic Risks, Cash Holdings, and Stock Returns

Previous studies on corporate cash holdings suggest a tax motivation for a firm to hold cash. For example, Foley, Hartzell, Titman, and Twite (2007) find that firms facing higher repatriation taxes hold higher levels of cash abroad, and in affiliates that enjoy low corporate tax rates. It is therefore possible that the empirical relation between stock returns and cash holdings varies across firms facing different tax consequences on foreign incomes.

To investigate the possible tax effects on the return-cash holdings relation, we group our sample into firms facing potential repatriation tax costs and firms without every year. We then re-estimate the expected cash holdings and excess cash holdings by incorporating repatriation tax affects for firms with and without foreign incomes. Specifically, motivated by Foley, Hartzell, Titman, and Twite (2007), we use the following regression model to estimate expected and excess cash holdings:

$$Cash_{i,t} = \gamma_0 + \gamma_1\, MB_{i,t} + \gamma_2\, Size_{i,t} + \gamma_3\, CF_{i,t} + \gamma_4\, NWC_{i,t} + \gamma_5 CAPEX_{i,t} + \gamma_6 LTD_{i,t} + \gamma_7\, R\&D_{i,t}$$
$$+ \gamma_8 \sigma_{i,t}^{IND} + \gamma_8 DIV_{i,t} + \gamma_9 Dummy_{i,t}^{IND} + \gamma_{10} Tax_{i,t}^{Repatriation} + \gamma_{11} DIncome_{i,t}$$
$$+ \gamma_{12} FIncome_{i,t} + \varepsilon_{i,t}. \tag{7}$$

If repatriation tax influences the relation among stock returns, cash holdings, and expected future firm specific risks, then we should see different empirical results between the groups of firms with different repatriation tax costs.

Table 6 reports the regression results of stock returns on cash holdings and expected firm specific risks for firms with different repatriation tax costs. Models 1 and 2 show results for firms with positive foreign income and Models 3 and 4 for firms without. In addition, we do not control for expected firm specific risks in Models 1 and 3, but control for the risks in Models 2 and 4. The results show that repatriation tax costs does not affect our previous findings.

Consistent with our main findings in Table 4, we find that there is a significant and positive relation between stock returns and expected cash for both groups of firms (i.e., firms with or without positive foreign income) without controlling for expected firm specific risks in the regression. For example, for firms with positive foreign incomes, the coefficient of expected cash is 0.189 with a t value of 1.74 (in Model 1). Similarly, as shown in Model 3, for firms without positive foreign incomes, the coefficient estimate of expected cash is 0.262 with a t-value of 3.20.

However, once we include the expected firm specific risks, proxied by the expected volatility (IV^{EGARCH}), in the regression, the positive relation between the expected cash holdings and stock returns becomes insignificant for both groups of firms. In contrast, we document a strong and positive relation between stock returns and expected firm specific risks. For example, in Model 2, for firms with positive foreign incomes, the coefficient estimate of firm specific risks is 0.133with a t-value of 5.72, while the coefficient of expected cash is 0.044 with a t value of 0.46. We find similar results for firms without positive foreign income. The evidence suggests that our findings are not driven by foreign Income repatriation costs.

5.2 High-tech Firms, Idiosyncratic Risks, Cash Holdings, and Stock Returns

High-technology companies tend to have higher R&D activities, create more growth options, and experience larger return volatility (Schwert (2002), Cao, Simin, and Zhao (2009), and Brown, Fazzari, and Petersen (2009)) than other firms. In addition, High-technology firms tend to have their high-technology production facilities abroad and hold an increasing portion of earnings offshore to avoid US taxation over recent years (Hufbauer and Assa (2007) and Thurm and Linebaugh (2013)). It is possible that the relation among firm cash holdings, stock returns, and firm expected volatility only exists for high-technology firms.

To test this possibility, we separate firms into high-tech firms and non-high-tech firms and examine the relation among firm cash holdings, stock returns, and firm expected volatility for the two groups of firms.

Table 7 reports the regression results. Models 1 and 2 show results for high-tech firms and Models 3 and 4 show results for non-high-tech firms. In addition, we do not control for expected firm specific risks in Models 1 and 3, but control for the risks in Models 2 and 4. For the sample of high-tech firms, the estimation results are consistent with our previous findings. We document a positive relation between stock returns and firm expected cash holdings in

Model 1 but such positive association disappears after we control for expected firm uncertainty in Model 2.

More importantly, Table 7 shows similar findings for the sample of non-high-tech firms. The results in Model 3 show that for non-high-tech firms, there is a positive relation between stock returns and firm expected cash holdings but an insignificant relation between stock returns and firm excess cash holdings in Model 4. For example, the coefficients for expected cash and excess cash are 0.172 and -0.001 with t-values of 2.03 and -0.07, respectively. Similar to the results on high-tech firms, for non-high-tech firms, there is no significant relation between stock returns and expected as well as excess cash holdings after we include a measure of expected uncertainty in the regression. As shown in Model 4, the coefficient for expected cash becomes 0.084 with a t-value of 1.00.

In sum, our findings on the relation among firm cash holdings, stock returns, and firm expected volatility are robust to both high-tech firms and non-high-tech firms.

6 Conclusion

In this paper, we examine the anomaly of the positive relation between cross-sectional stock returns and corporate cash holdings. We propose that such a cash-return relation arises because of the endogeneity of cash holdings: firms optimally adjust their cash holdings in anticipation of expected uncertainty and liquidity shortfalls in the presence of external financial constraints.

We first show that there is a positive relation between stock returns and the firm's expected cash holdings. Using the EGARCH model to model the firm's expected uncertainty, we show that the positive cash holdings-stock returns relation disappears. It suggests that the previously documented positive relationship between stock returns and cash holdings is induced by the firm's conditional volatility.

To further examine the role of firm expected uncertainty in driving the positive cash-return relation, we study how fundamental sources of expected firm-level risks affect the relation. We show that the positive relation between stock returns and measures of cash holdings disappears after controlling for the sources of firm specific expected risks: the financial constraints, cash flow volatility, and R&D activities.

We ran several robustness tests to demonstrate that indeed the expected conditional volatilities drive the positive relationship between cash holdings and stock returns. Our results are robust to both high-tech and non-high tech firms as well as for firms with or without positive foreign income.

Our major findings are that once the conditional volatilities or the sources of firm expected uncertainty are controlled for, there is no positive relationship between stock returns and cash holdings. Results of this study provide strong evidence that cash holdings is a proxy for the firm's expected uncertainty, which drives the positive relationship between stock returns and cash holdings. Our findings highlight the importance of taking into account the endogeneity of firm fundamentals in asset pricing studies of the firm.

References

Acharya, V. V., Almeida, H., and Campello, M., (2007). "Is cash negative debt? A hedging perspective on corporate financial policies," *Journal of Financial Intermediation*, 16(4), 515-554.

Acharya, V., Davydenko, S. A., & Strebulaev, I. A. (2012). Cash holdings and credit risk. *Review of Financial Studies*, *25*(12), 3572-3609.

Ali, A., Hwang, L. S., & Trombley, M. A. (2003). Arbitrage risk and the book-to-market anomaly. *Journal of Financial Economics*, *69*(2), 355-373.

Almeida, H., Campello, M., and Weisbach, M., (2004). "The cash flow sensitivity of cash," *Journal of Finance*, 59(4), 1777-1804.

Amihud, Yakov, (2002). "Illiquidity and stock returns: Cross-section and time-series effects," *Journal of Financial Markets* 5, 31–56.

Angel, J. J. (1997). Tick size, share prices, and stock splits. *The Journal of Finance*, *52*(2), 655-681.

Baker, M., Greenwood, R., & Wurgler, J. (2009). Catering through nominal share prices. *The Journal of Finance*, *64*(6), 2559-2590.

Barinov, Alexander, 2006, "Idiosyncratic volatility, growth options, and the cross section of returns", Working paper, University of Rochester.

Bates, Thomas W., Kathleen M. Kahle, and Rene M. Stulz, (2009). "Why do U.S. firms hold so much more cash than they used to?" *Journal of Finance*, 64 (5), 1985-2021.

Bekaert, G., Hodrick, R. J., & Zhang, X. (2012). Aggregate idiosyncratic volatility. *Journal of Financial and Quantitative Analysis*, *47*(06), 1155-1185.

Black, F. (1986). Noise. *The journal of finance*, *41*(3), 528-543.

Brennan, M.J., T. Chordia, and A. Subrahmanyam, (1998). "Alternative factor specifications, security characteristics, and the cross-section of expected stock returns," *Journal of Financial Economics*, 49, 345-373.

Brown, J. R., Fazzari, S. M. and Petersen, B. C. (2009), "Financing Innovation and Growth: Cash Flow, External Equity, and the 1990s R&D Boom," *Journal of Finance,* 64: 151–185.

Brown, James R., and Bruce C. Petersen, (2011). "Cash holdings and R&D smoothing," *Journal of Corporate Finance*, 17 (3), 694-709

Campello, M., Graham, J. R., & Harvey, C. R. (2010). The real effects of financial constraints: Evidence from a financial crisis. *Journal of Financial Economics*, *97*(3), 470-487.

Cao, Charles, Tim Simin, and Jing Zhao, (2008). "Can growth options explain the trend in idiosyncratic risk?" *Review of Financial Studies,* 21, 2599-2633.

Certo, S. T., Covin, J. G., Daily, C. M., & Dalton, D. R. (2001). Wealth and the effects of founder management among IPO-stage new ventures. *Strategic Management Journal*, *22*(6-7), 641-658.

Chan, Louis K. C., Josef Lakonishok, and Theodore Sougiannis, (2001). "The stock market valuation of research and development expenditures," *Journal of Finance*, 56 (6), 2431-2456.

Cohen, L., Diether, K. B., & Malloy, C. J. (2007). Supply and demand shifts in the shorting market. *The Journal of Finance*, *62*(5), 2061-2096.

Comin, D. A., & Philippon, T. (2006). The rise in firm-level volatility: Causes and consequences. In *NBER Macroeconomics Annual 2005, Volume 20* (pp. 167-228). MIT Press.

Dai, Z., Shackelford, D. A., Zhang, H. H., & Chen, C. (2013). Does financial constraint affect the relation between shareholder taxes and the cost of equity capital?. *The Accounting Review*, *88*(5), 1603-1627.

Denis, David J., and Valeriy Sibilkov, (2010). "Financial constraints, investment, and the value of cash holdings," *Review of Financial Studies*, 23 (1), 247-269.

Dolley, J. C. (1933). Common stock split-ups—Motives and effects. *Harvard Business Review*, *12*(1), 70-81.

Engle, R. F. (1982). Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica: Journal of the Econometric Society*, 987-1007.

Fama, E. F., & French, K. R. (1992). The cross-section of expected stock returns. *the Journal of Finance*, *47*(2), 427-465.

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of financial economics*, *33*(1), 3-56.

Fama, E. F., & MacBeth, J. D. (1973). Risk, return, and equilibrium: Empirical tests. *The Journal of Political Economy*, 607-636.

Foley, C.F., Hartzell, C.F., Titman, S., and Twite, G., (2007). "Why do firms hold so much cash? A tax-based explanation," *Journal of Financial Economics*, 86, 579-607.

Fu, Fangjian, (2009). "Idiosyncratic risk and the cross-section of expected stock returns," *Journal of Financial Economics*, 91, 24-37.

Gomes, J. F., Yaron, A., & Zhang, L. (2006). Asset pricing implications of firms' financing constraints. *Review of Financial Studies*, *19*(4), 1321-1356.

Graham, J. R. (1996). Proxies for the corporate marginal tax rate. *Journal of Financial Economics*, *42*(2), 187-221.

Hadlock, C.J. and J.R. Pierce, (2010). "New evidence on measuring financial constraints: moving beyond the KZ Index," *Review of Financial Studies*, 23(5), 1909-1940.

Han, S., & Qiu, J. (2007). Corporate precautionary cash holdings. *Journal of Corporate Finance*, *13*(1), 43-57.

Harford, J., Klasa, S., & Maxwell, W. F. (2014). Refinancing risk and cash holdings. *The Journal of Finance*, *69*(3), 975-1012.

Hong, H., & Stein, J. C. (2007). Disagreement and the stock market. *The Journal of Economic Perspectives*, *21*(2), 109-128.

Hufbauer, Gary C. and Ariel Assa, (2007). *US Taxation of Foreign Income*, Peterson Institute for International Economics.

Irvine, P. J., & Pontiff, J. (2009). Idiosyncratic return volatility, cash flows, and product market competition. *Review of Financial Studies*, *22*(3), 1149-1177.

Jegadeesh, N. (1990). Evidence of predictable behavior of security returns. *The Journal of Finance*, *45*(3), 881-898.

Jegadeesh, N., & Titman, S. (1993). Returns to buying winners and selling losers: Implications for stock market efficiency. *The Journal of finance*, *48*(1), 65-91.

Keynes, J. M. (1935). *General theory of employment, interest and money*. Atlantic Publishers & Dist.

Kim, C.-S., Mauer, D. C., and Sherman, A. E., (1998). “The determinants of corporate liquidity: Theory and evidence,” *Journal of Financial and Quantitative Analysis*, 33 (3), 335–359.

King, D., R. Slotegraaf, I. Kesner. (2008). “Performance implications of firm resource interactions in the acquisition of R&D-intensive firms,” *Organization Science*, 19(2) 327-340.

Lamont, O., Polk, C., & Saaá-Requejo, J. (2001). Financial constraints and stock returns. *Review of financial studies*, *14*(2), 529-554.

Li, X., & Luo, D. (2016). Investor Sentiment, Limited Arbitrage and the Cash Holding Effects. *Review of Finance*, Forthcoming.

Li, X., Sullivan, R. N., & Garcia-Feijóo, L. (2014). The limits to arbitrage and the low-volatility anomaly. *Financial analysts journal*, *70*(1), 52-63.

Nelson, D. B. (1991). Conditional heteroskedasticity in asset returns: A new approach. *Econometrica: Journal of the Econometric Society*, 347-370.

Opler, Tim, Lee Pinkowitz, René Stulz, and Rohan Williamson, (1999). “The determinants and implications of cash holdings,” *Journal of Financial Economics*, 52, 3-46.

Ortiz-Molina, H., & Phillips, G. M. (2014). Real asset illiquidity and the cost of capital. *Journal of Financial and Quantitative Analysis*, 48, 1-32.

Palazzo, Berardino, (2012). “Cash holdings, risk, and expected returns,” *Journal of Financial Economics*, 104 (1), 162–185.

Pastor, L., Stambaugh, R., 2003. Liquidity risk and expected stock returns. Journal of Political Economy 111, 642-685.

Peterson, D. R., & Smedema, A. R. (2011). The return impact of realized and expected idiosyncratic volatility. *Journal of Banking & Finance*, *35*(10), 2547-2558.

Pontiff, J. (2006). Costly arbitrage and the myth of idiosyncratic risk. *Journal of Accounting and Economics*, *42*(1), 35-52.

Pástor, Ľ., & Veronesi Pietro (2003). Stock valuation and learning about profitability. *The Journal of Finance*, *58*(5), 1749-1790.

Riddick, L.A., and Whited, T. M., (2009). "The corporate propensity to save," *Journal of Finance*, 64 (4), 1729-1766.

Schwert, G. W. (2002). Stock volatility in the new millennium: how wacky is Nasdaq?. *Journal of Monetary Economics*, *49*(1), 3-26.

Simutin, Mikhail, (2010). "Excess cash and stock returns," *Financial Management*, 39 (3), 1197–1222.

Stambaugh, R. F., Yu, J., & Yuan, Y. (2015). Arbitrage asymmetry and the idiosyncratic volatility puzzle. *The Journal of Finance*, *70*(5), 1903-1948.

Thurm, S., & Linebaugh, K. (2013). More US Profits Parked Abroad, Saving on Taxes. *Wall Street Journal*, *10*.

Titman, S., Wei, K. J., & Xie, F. (2004). Capital investments and stock returns. *Journal of financial and Quantitative Analysis*, *39*(04), 677-700.

Whited, T. M., & Wu, G. (2006). Financial constraints risk. *Review of Financial Studies*, *19*(2), 531-559.

Table 1: Average monthly returns for cash-holdings portfolios from 1970 to 2013

This table reports the average monthly risk-adjusted returns for cash-holdings portfolios from 1970 to 2013. We report the averages for 10 portfolios sorted on *total cash* holdings ln(Cash/Net Assets), 10 portfolios sorted on Opler, Pinkowitz, Stulz, and Williamson's [1999] *expected cash* holdings, and 10 portfolios sorted on Simutin's [2010] *excess cash* holdings. We form portfolios in June of year *t* based on the three cash holdings measures at the fiscal year-end of $t-1$. The portfolio sortings are effective from July of year *t* to June of year $t+1$. *High* (*Low*) cash-holdings portfolios refer to portfolios with cash holdings in the top (bottom) 10% percentile. Our sample includes non-financial and non-utility common stocks listed on NYSE, AMEX, and NASDAQ firms, with prices more than $5. The variable definitions are provided in Appendix. *, **, and *** indicate significance at 10, 5, and 1% levels, respectively, for a two-tailed test. The t-statistics are adjusted for heteroscedasticity and autocorrelations. All entries except for the t-statistics are in percent.

The *Expected cash holdings* is the predicted value from the cross-sectional regressions of Cash on Market-to-Book (MB), Market Size (Size), Cash Flow/Net Assets (CF), Net working Capital/Net Assets (NWC), Capital Expenditure/Net Assets (CAPEX), Leverage (LTD), R&D/Sales (R&D), Industry Sigma (σ^{IND}), Dividend dummy (DIV), and Industry dummy (Dummy^{IND}).

$$Cash_t = \gamma_0 + \gamma_1\, MB_t + \gamma_2\, Size_t + \gamma_3\, CF_t + \gamma_4\, NWC_t + \gamma_5 CAPEX_t + \gamma_6 LTD_t + \gamma_7\, R\&D_t + \gamma_8 \sigma_t^{IND} + \gamma_8 DIV_t + \gamma_9 Dummy_t^{IND} + \varepsilon_t$$

MB ratio is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. *Size* is the market capitalization at the end of June year *t*. *CF* is defined as earnings before interest and taxes, but before depreciation and amortization, less interest, taxes, and common dividends. *NWC* is calculated without cash. *LTD* is the sum short-term debt plus long-term debt divided by net assets. Industry sigma is the mean of standard deviations of cash flow over assets over 20 years, for firms in the same industry, as defined by 2-digit SIC code. Dividend dummy is a variable set to one if the firm paid a dividend in the year, and set to zero if it did not. Industry dummies are constructed for each industry, based on French's 17 industry definitions. The *Excess cash* holdings for firm in year *t* is defined as the residual estimated from the cross-sectional regression. Using the three-factor model of Fama and French (1993) as the benchmark model for risk-adjustment, we define the risk-adjusted return for individual stocks as follows: $R_{it}^{adj} = R_{it} - R_{ft} - \hat{\beta}_M R_M - \hat{\beta}_{SMB} R_{SMB} - \hat{\beta}_{HML} R_{HML}$, where R_{it} is the raw return on stock *i* at *t*, R_{ft} is the risk-free rate (T-bill rate) at t, and R_M, R_{SMB}, R_{HML} represent the three Fama-French factors (market, size, and book-to-market). We estimate the factor loadings ($\hat{\beta}_M$, $\hat{\beta}_{SMB}$, and $\hat{\beta}_{HML}$) for individual stocks using monthly rolling regressions with a 60-month window every month requiring at least 24 monthly return observations in a given window.

	Cash/Net Asset		Expected Cash		Excess Cash	
	Equal-weighted Return	Value-weighted Return	Equal-weighted Return	Value-weighted Return	Equal-weighted Return	Value-weighted Return
Low	0.78	0.17	0.68	0.20	0.81	0.12
2	0.73	-0.02	0.66	0.23	0.81	0.10
3	0.68	0.19	0.71	0.13	0.75	0.09
4	0.72	0.08	0.74	0.13	0.75	0.03
5	0.80	0.08	0.83	0.18	0.82	0.15
6	0.79	0.20	0.87	0.25	0.88	0.24
7	0.85	0.17	1.00	0.24	0.85	0.31
8	0.93	0.36	1.02	0.12	0.98	0.32
9	1.05	0.41	1.13	0.18	0.95	0.24
High	1.36	0.31	1.22	0.31	0.98	0.14
High-Low	0.58	0.14	0.54	0.10	0.17	0.02
t-value (dif)	3.65	0.76	2.94	0.55	2.04	0.18

Table 2: Characteristics of the top and the bottom decile cash-holdings portfolios for the period 1970-2013.

This table presents descriptive statistics for our cash-holdings portfolios over the period from January 1970 to December 2013. The sample consists of non-financial stocks that are traded in the NY SE, AMEX, or NASDAQ, with prices more than $5. We form portfolios in June of year t based on the three cash holdings measures at the fiscal year-end of t −1. The portfolio sortings are effective from July of year t to June of year t + 1. High (Low) cash-holdings portfolios refer to portfolios with cash holdings in the top (bottom) decile.The variable definitions are provided in Appendix.

	Cash/Net Assets Portfolio			Expected-Cash Portfolio			Excess-Cash Portfolio		
Variables	Low	High	p-value (Diff)	Low	High	p-value (Diff)	Low	High	p-value (Diff)
Return from July year t to June year T+1	0.138	0.146	0.384	0.146	0.099	0.000	0.124	0.169	0.000
Market Size	1195.754	751.567	0.000	2253.742	1071.888	0.000	1003.364	930.848	0.435
Book-to-Market	1.056	0.582	0.000	1.213	0.397	0.000	0.945	0.851	0.000
$R_{t-2,t-12}$	0.213	0.290	0.000	0.205	0.319	0.000	0.235	0.253	0.056
Illiquidity	16.867	13.915	0.000	11.111	10.533	0.338	18.698	18.702	0.997
$CV^{Illiquid}$	1.674	1.680	0.703	1.518	1.647	0.000	1.726	1.697	0.088
Expected Volatility	0.110	0.142	0.000	0.110	0.145	0.000	0.115	0.123	0.000
R&D/Net Assets	0.012	0.676	0.000	0.006	0.712	0.000	0.100	0.083	0.229
Cashflow Volatility	0.046	0.134	0.000	0.040	0.164	0.000	0.060	0.071	0.000
Dummy for Financial Constraint	0.275	0.638	0.000	0.110	0.710	0.000	0.370	0.390	0.001

Table 3: Regressions of cross-sectional stock returns on three measures of cash holdings

This table reports the results of the Fama-MacBeth regressions of cross-sectional stock returns on measures of cash holdings over the period from January 1970 to December 2013. Our sample includes non-financial and non-utility common stocks listed on NYSE, AMEX, and NASDAQ firms, with prices more than $5. We estimate the following model:

$$R_{it}^{adj} = \alpha_i + \beta_0 \ln(ME)_{i,t-1} + \beta_1 \left(\frac{BE}{ME}\right)_{i,t-1} + \beta_2 R_{i,t-12,t-2} + \beta_3 \ln(Illiquidity)_{i,t-1} + \beta_4 \ln(CV^{Illiquid})_{i,t-1} + \beta_5 R_{i,t-1} + \beta_6 Cash_{i,t-1} + \varepsilon_{i,t}$$

Dependent variables are monthly risk-adjusted stock returns. The variable definitions are provided in Appendix. All variables (except returns) are winsorized at the 0.5% level. Robust Newey-West (1987) t-statistics are reported in parentheses.

	Model 1	Model 2	Model 3	Model 4
Ln(ME)	-0.702***	-0.687***	-0.714***	-0.684***
	(-7.92)	(-7.99)	(-7.76)	(-8.00)
Ln(BE/ME)	0.172***	0.259***	0.140**	0.258***
	(2.75)	(4.43)	(2.13)	(4.43)
$RET_{t-2,t-12}$	-0.291	-0.304	-0.286	-0.304
	(-1.17)	(-1.22)	(-1.15)	(-1.23)
Ln(Illiquid)	-0.320***	-0.323***	-0.322***	-0.322***
	(-4.20)	(-4.20)	(-4.20)	(-4.18)
$Ln(CV^{Illiquid})$	1.012***	1.010***	1.003***	1.015***
	(5.56)	(5.55)	(5.56)	(5.55)
RET_{t-1}	-0.059***	-0.059***	-0.059***	-0.059***
	(-10.07)	(-10.13)	(-10.00)	(-10.13)
Cash/Net Asset	0.061**			
	(2.49)			
Expected Cash		0.269***		0.268***
		(3.49)		(3.49)
Excess Cash			0.021	0.017
			(1.16)	(0.97)
R-Squared	0.031	0.032	0.030	0.032
No. of Obs.	1907	1907	1907	1907

Table 4: Regressions of cross-sectional stock returns on three measures of cash holdings and expected conditional volatility

This table reports the results of the Fama-MacBeth regressions of monthly stock return on measures of cash holdings and on expected conditional volatility over the period from January 1970 to December 2013. Our sample includes non-financial and non-utility common stocks listed on NYSE, AMEX, and NASDAQ firms, with prices more than $5. We estimate the following model:

$$R_{it}^{adj} = \alpha_i + \beta_0 \ln(ME)_{i,t-1} + \beta_1 \left(\frac{BE}{ME}\right)_{i,t-1} + \beta_2 R_{i,t-12,t-2} + \beta_3 \ln(Illiquidity)_{i,t-1} + \beta_4 \ln\left(CV^{Illiquid}\right)_{i,t-1} + \beta_5 R_{i,t-1} + \beta_6 IV_{i,t-1}^{EGARCH} + \beta_7 Cash_{i,t-1} + \varepsilon_{i,t}$$

Dependent variables are monthly risk-adjusted stock returns. Following Fu (2009), *Expected Volatility* (IV^{EGARCH}) is estimated by EGARCH on the Fama-French three factor model using monthly information up to last month. The variable definitions are provided in Appendix. All variables (except returns) are winsorized at the 0.5% level. Robust Newey-West (1987) t-statistics are reported in parentheses.

	Model 1	Model 2	Model 3	Model 4
Ln(ME)	-0.171***	-0.165***	-0.172***	-0.165***
	(-3.15)	(-3.06)	(-3.14)	(-3.06)
Ln(BE/ME)	0.396***	0.435***	0.396***	0.432***
	(6.21)	(6.77)	(6.20)	(6.73)
$RET_{t-2,t-12}$	-0.327	-0.337	-0.324	-0.336
	(-1.41)	(-1.45)	(-1.38)	(-1.45)
Ln(Illiquid)	-0.047	-0.049	-0.047	-0.050
	(-0.81)	(-0.83)	(-0.81)	(-0.84)
$Ln(CV^{Illiquid})$	0.751***	0.752***	0.749***	0.755***
	(4.57)	(4.54)	(4.57)	(4.55)
RET_{t-1}	-0.059***	-0.060***	-0.059***	-0.060***
	(-9.82)	(-9.86)	(-9.76)	(-9.86)
IV^{EGARCH}	0.219***	0.219***	0.218***	0.219***
	(10.91)	(11.05)	(10.74)	(11.08)
Cash/Net Assets	0.006			
	(0.28)			
Expected Cash		0.108		0.107
		(1.54)		(1.54)
Excess Cash			-0.005	-0.007
			(-0.31)	(-0.43)
R-Squared	0.038	0.039	0.037	0.039
No. of Obs.	1802	1802	1802	1802

Table 5: **Regressions of cross-sectional stock returns on three measures of cash holdings and factors of cashflow uncertainty**

This table reports the results of the Fama-MacBeth regressions of monthly stock returns on three measures of cash holdings and on factors related to cashflow uncertainty over the period from January 1970 to December 2013. Our sample includes non-financial and non-utility common stocks listed on NYSE, AMEX, and NASDAQ firms, with prices more than $5.The *dummy for financial constraint* is set to one for firms with financial constraints index among the top 67%. Financial constraints index is constructed following Hadlock and Pierce (2010).

$$R_{it}^{adj} = \alpha_i + \beta_0 ln(ME)_{i,t-1} + \beta_1 \left(\frac{BE}{ME}\right)_{i,t-1} + \beta_2 R_{i,t-12,t-2} + \beta_3 \ln(Illiquidity)_{i,t-1} + \beta_4 \ln\left(CV^{Illiquid}\right)_{i,t-1} + \beta_5 R_{i,t-1} + \beta_6 \left(D^{Financial\ Constraints}\right)_{i,t-1} + \beta_7 CF\ Volatility_{i,t-1} + \beta_8 \left(\frac{R\&D}{NetAssets}\right)_{i,t-1} + \beta_9 Cash_{i,t-1} + \varepsilon_{i,t}$$

Dependent variables are monthly risk-adjusted stock returns. The variable definitions are provided in Appendix. All variables (except returns) are winsorized at the 0.5% level. Robust Newey-West (1987) t-statistics are reported in parentheses.

	Model 1	Model 2	Model 3	Model 4
Ln(ME)	-0.495***	-0.495***	-0.495***	-0.494***
	(-4.68)	(-4.63)	(-4.69)	(-4.64)
Ln(BE/ME)	0.400***	0.407***	0.402***	0.404***
	(6.50)	(6.12)	(6.81)	(6.09)
$R_{t-2,t-12}$	-0.338	-0.337	-0.336	-0.338
	(-1.33)	(-1.34)	(-1.32)	(-1.34)
Ln(Illiquidity)	-0.256**	-0.254**	-0.256**	-0.255**
	(-2.49)	(-2.46)	(-2.50)	(-2.45)
Ln($CV^{Illiquid}$)	0.954***	0.946***	0.956***	0.951***
	(4.32)	(4.31)	(4.32)	(4.31)
R_{t-1}	-0.055***	-0.055***	-0.055***	-0.055***
	(-7.63)	(-7.60)	(-7.64)	(-7.60)
Dummy_Constraint	1.121***	1.119***	1.116***	1.118***
	(8.57)	(9.06)	(8.36)	(9.13)
Cashflow Volatility	4.254***	4.150***	4.224***	4.152***
	(4.85)	(4.78)	(4.78)	(4.79)
R&D / Net Asset	1.504***	1.406***	1.494***	1.408***
	(3.01)	(2.78)	(2.96)	(2.79)
Cash/Net Assets	-0.011			
	(-0.71)			
Expected Cash		0.002		0.001
		(0.03)		(0.01)
Excess Cash			-0.003	-0.004
			(-0.24)	(-0.28)
R-Squared	0.038	0.038	0.037	0.038
No. of Obs.	1762	1762	1762	1762

Table 6: **Robustness Tests: Regressions of cross-sectional stock returns on three measures of cash holdings for firms with and without repatriation tax costs of foreign income**

This table reports the results of the Fama-MacBeth regressions of monthly stock returns on three measures of cash holdings controlling for firm expected conditional volatility for firms with and without foreign incomes, respectively, over the period from January 1970 to December 2010. Our sample includes non-financial and non-utility common stocks listed on NYSE, AMEX, and NASDAQ firms, with prices more than \$5. We estimate the following model:

$$R_{it}^{adj} = \alpha_i + \beta_0 \ln(ME)_{i,t-1} + \beta_1 \left(\frac{BE}{ME}\right)_{i,t-1} + \beta_2 R_{i,t-12,t-2} + \beta_3 \ln(Illiquidity)_{i,t-1} + \beta_4 \ln\left(CV^{Illiquid}\right)_{i,t-1} + \beta_5 R_{i,t-1} + \beta_6 Cash_{i,t-1} + \varepsilon_{i,t}$$

Expected cash holdings is the predicted value from the cross-sectional regressions of Cash/Net Assets on Market-to-book, Size, Cash Flow/Net Assets, Net working Capital/Net Assets, Capital Expenditure/Net Assets, Leverage (Long-term Debt/Net Asset), R&D/Sales, Industry Sigma, Dividend dummy, Industry dummy, tax costs of repatriating foreign income ($Tax_t^{Repatriation}$), Domestic Income/Net Assets ($DIncome_t$), and Foreign Income/Net Assets ($FIncome_t$). We estimate tax costs of repatriating foreign income, foreign income, Domestic Income/Net Assets, and Foreign Income/Net Assets following Foley et al. (2007). *Tax costs of repatriating foreign income* is computed by first subtracting foreign taxes paid from the product of a firm's foreign pre-tax income and its marginal effective tax rate as calculated in Graham (1996b). Then the maximum of this difference or zero is scaled by total firm assets. Net asset equals the total asset minus cash holdings. *Domestic Income/Net Assets* and *Foreign Income/Net Assets* are ratios of domestic and foreign pre-tax income to net assets, respectively.

For firms with repatriation costs, we use the following model to estimate their expected and excess cash holdings.

$$Cash_t = \gamma_0 + \gamma_1 MB_t + \gamma_2 Size_t + \gamma_3 CF_t + \gamma_4 NWC_t + \gamma_5 CAPEX_t + \gamma_6 LTD_t + \gamma_7 R\&D_t + \gamma_8 \sigma_t^{IND} + \gamma_8 DIV_t + \gamma_9 Dummy_t^{IND} + \gamma_{10} Tax_t^{Repatriation} + \gamma_{11} DIncome_t + \gamma_{12} FIncome_t + \varepsilon_t$$

For firms without reported foreign incomes, we use the following model to estimate their expected and excess cash holdings.

$$Cash_t = \gamma_0 + \gamma_1 MB_t + \gamma_2 Size_t + \gamma_3 CF_t + \gamma_4 NWC_t + \gamma_5 CAPEX_t + \gamma_6 LTD_t + \gamma_7 R\&D_t + \gamma_8 \sigma_t^{IND} + \gamma_8 DIV_t + \gamma_9 Dummy_t^{IND} + \varepsilon_t$$

The dependent variable is the monthly risk-adjusted stock return. The variable definitions are provided in Appendix. All variables (except returns) are winsorized at the 0.5% level. Robust Newey-West (1987) t-statistics are reported in parentheses.

	With Repatriation Costs		Without Repatriation Costs	
	Model 1	Model 2	Model 3	Model 4
Ln(ME)	-0.463***	-0.149**	-0.846***	-0.264***
	(-4.22)	(-2.03)	(-5.09)	(-2.73)
Ln(BE/ME)	0.078	0.111	0.306***	0.529***
	(0.81)	(1.07)	(5.15)	(7.60)
$RET_{t-2,t-12}$	-0.731	-0.678	-0.184	-0.244
	(-1.33)	(-1.41)	(-0.98)	(-1.28)
Ln(Illiquid)	-0.259**	-0.079	-0.350***	-0.044
	(-2.14)	(-0.92)	(-2.90)	(-0.55)
$Ln(CV^{Illiquid})$	0.918***	0.689***	0.931***	0.65^{9***}
	(3.34)	(2.66)	(4.23)	(3.34)
RET_{t-1}	-0.055***	-0.054***	-0.057***	-0.058***
	(-6.45)	(-6.48)	(-7.78)	(-7.32)
IV^{EGARCH}		0.133***		0.241***
		(5.72)		(8.79)
Expected Cash	0.189*	0.044	0.262***	0.096
	(1.74)	(0.46)	(3.20)	(1.36)
Excess Cash	0.025	-0.013	0.010	-0.015
	(0.90)	(-0.50)	(0.57)	(-0.88)
R-Squared	0.037	0.045	0.034	0.042
No. of Obs.	453	434	1454	1368

Table 7: **Robustness Tests: Regressions of cross-sectional stock returns on three measures of cash holdings for high-tech firms and non-high-tech firms**

This table reports the results of the Fama-MacBeth regressions of monthly stock returns on three measures of cash holdings controlling for firm expected conditional volatility for high-tech firms and non-high-tech firms, respectively, over the period from January 1970 to December 2010. Our sample includes non-financial and non-utility common stocks listed on NYSE, AMEX, and NASDAQ firms, with prices more than $5. We estimate the following model:

$$R_{it}^{adj} = \alpha_i + \beta_0 \ln(ME)_{i,t-1} + \beta_1 \left(\frac{BE}{ME}\right)_{i,t-1} + \beta_2 R_{i,t-12,t-2} + \beta_3 \ln(Illiquidity)_{i,t-1} + \beta_4 \ln\left(CV^{Illiquid}\right)_{i,t-1} + \beta_5 R_{i,t-1} + \beta_6 Cash_{i,t-1} + \varepsilon_{i,t}$$

The dependent variable is the monthly risk-adjusted stock return. *High-tech industry* is defined following Brown, Fazzari, and Petersen (2009) using two-digit SIC. The *Dummy for High-tech firm* equals to one if the firm belongs to the two-digit SIC industries of 28, 35, 36, 37, 38, or 73; and zero otherwise. The variable definitions are provided in Appendix. All variables (except returns) are winsorized at the 0.5% level. Robust Newey-West (1987) t-statistics are reported in parentheses.

	High-Tech Firms		Non-High-Tech Firms	
	Model 1	Model 2	Model 3	Model 4
Ln(ME)	-0.863***	-0.234***	-0.601***	-0.125**
	(-6.11)	(-2.72)	(-5.11)	(-1.97)
Ln(BE/ME)	0.271***	0.459***	0.244***	0.421***
	(3.96)	(5.22)	(3.38)	(5.00)
$RET_{t-2,t-12}$	-0.410*	-0.449*	-0.183	-0.218
	(-1.74)	(-1.92)	(-0.75)	(-0.96)
Ln(Illiquid)	-0.429***	-0.089	-0.249**	-0.007
	(-3.38)	(-0.98)	(-2.47)	(-0.11)
$\text{Ln}(CV^{Illiquid})$	1.078***	0.775***	0.897***	0.660***
	(3.76)	(2.97)	(4.32)	(3.56)
RET_{t-1}	-0.058***	-0.057***	-0.054***	-0.056***
	(-8.24)	(-7.52)	(-7.60)	(-7.79)
IV^{EGARCH}		0.243***		0.204***
		(10.03)		(8.93)
Expected Cash	0.281***	0.029	0.172**	0.084
	(2.93)	(0.31)	(2.03)	(1.00)
Excess Cash	0.020	-0.023	-0.001	-0.013
	(0.61)	(-0.80)	(-0.07)	(-0.95)
R-Squared	0.039	0.047	0.034	0.041
No. of Obs.	834	779	1074	1023

Appendix A: Definition of Key Variables

Risk-adjusted Return:

The risk-adjusted return for an individual stock is defined as follows:

$R_{it}^{*} = R_{it} - R_{ft} - \hat{\beta}_M R_M - \hat{\beta}_{SMB} R_{SMB} - \hat{\beta}_{HML} R_{HML}$, where R_{it} is the return on stock *i* at *t*, R_{ft} is the risk-free rate (T-bill rate) at t, and R_M, R_{SMB}, R_{HML} represent the three Fama-French factors (market, size, and book-to-market). We estimate the factor loadings ($\hat{\beta}_M$, $\hat{\beta}_{SMB}$, and $\hat{\beta}_{HML}$) for individual stocks using monthly rolling regressions with a 60-month window every month requiring at least 24 monthly return observations in a given window.

Past cumulative returns ($R_{t-12,\, t-2}$)

The compounded rate of return from month $t - 12$ to $t - 2$.

Cash:

The ratio of cash plus marketable securities to net assets (i.e., book value of total assets minus cash plus marketable securities).

Expected cash holdings and excess cash holdings

The *Expected cash holdings* is the predicted value from the cross-sectional regressions of Cash on Market-to-Book (MB), Market Size (Size), Cash Flow/Net Assets (CF), Net working Capital/Net Assets (NWC), Capital Expenditure/Net Assets (CAPEX), Leverage (LTD), R&D/Sales (R&D), Industry Sigma (σ^{IND}), Dividend dummy (DIV), and Industry dummy ($Dummy^{IND}$).

$$Cash_t = \gamma_0 + \gamma_1\, MB_t + \gamma_2\, Size_t + \gamma_3\, CF_t + \gamma_4\, NWC_t + \gamma_5 CAPEX_t + \gamma_6 LTD_t + \gamma_7\, R\&D_t + \gamma_8 \sigma_t^{IND} + \gamma_8 DIV_t + \gamma_9 Dummy_t^{IND} + \varepsilon_t$$

MB ratio is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. *Size* is the market capitalization at the end of June year *t*. *CF* is defined as earnings before interest and taxes, but before depreciation and amortization, less interest, taxes, and common dividends. *NWC* is calculated without cash. *LTD* is the sum short-term debt plus long-term debt divided by net assets. Industry sigma is the mean of standard deviations of cash flow over assets over 20 years, for firms in the same industry, as defined by 2-digit SIC code. Dividend dummy is a variable set to one if the firm paid a dividend in the year, and set to zero if it did not. Industry dummies are constructed for each industry, based on French's 17 industry definitions. The *Excess cash* holdings for firm in year *t* is defined as the residual estimated from the cross-sectional regression.

Expected volatility (IV^{EGARCH})

It is the conditional idiosyncratic volatility. Following Fu (2009), it is estimated byEGARCH in the Fama-French three factor model and using monthly information up to last month.

Market-to-book ratio (MB ratio)

The market-to-book ratio is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets.

Book-to-Market ratio

The book-to-market ratio is estimated using the book equity value of the fiscal year ending in year *t-1* divided by the market capitalization of the stock at the end of December year *T-1*. Observations with a negative book equity value are excluded.

Size

The size in real terms is the natural log of net assets, deflated using the CPI to 2000 dollars.

Cash Flow (*CF*)

Cash flow is as the earnings before interest and taxes, but before depreciation and amortization, less interest, taxes, and common dividends, divided by net assets.

Net working Capital/ Net Assets (NWC)

The ratio of the net working capital without cash to net assets.

C*apital Expenditure/Net Assets (CAPEX)*

The ratio of capital expenses to net assets.

Total leverage (LEV)

The sum short-term debt plus long-term debt divided by net assets.

R&D/Sales (R&D)

The ratio of research and development (R&D) expense to sales. It is set to zero when R&D expense is missing.

Industry sigma (σ^{IND})

The mean of standard deviations of cash flow over assets over 20 years, for firms in the same industry, as defined by the two-digit SIC code.

Dividend dummy (DIV)

DIV is set to one if the firm pays a dividend in the year, and zero if it does not.

Industry dummy (Dummy^{IND})

This dummy variable is constructed for each industry, based on French's 17 industry definitions. Details are available athttp://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

Illiquidity

The average of the daily Amihud illiquidity measures, which is equal to the absolute value of the daily return divided by daily volume (in million dollars), and

Variation of Illiquidity (CV^{Illiquid})

The coefficient of variation of the daily Amihud illiquidity measures over the past 250 days.

Dummy for financing constraints

This dummy is set to one for firms with financing constraint index among the top 67%. *Financing constraint index* is constructed following Hadlock and Pierce (2010).

High-tech firm

High-tech firm is defined as in Brown, Fazzari, and Petersen (2009) using the two-digit SIC code. It equals one if the firm belongs to the two-digit SIC industries of 28, 35, 36, 37, 38, or 73; and zero otherwise.

Cash flow Volatility

We follow Titman, Wei, and Xie (2004) to estimate a firm's cash flows, which is scaled by total assets, as operating income before depreciation minus interest expenses, taxes, preferred dividends, and common dividends. The cash flow volatility is defined as the standard deviation of a firm's cash flows over the past ten years.