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What is the Real Relationship between Cash Holdings and Stock Returns?☆

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Abstract

The literature has provided mixed evidence on the relationship between cash holdings and average stock returns. We empirically verify that the relationship is positive and robust to the adjustment of risk, the construction of cash holdings portfolios, and the weighting scheme of portfolio returns. We further examine a battery of potential channels that can explain the positive relationship. We find that the cash holding effect can be subsumed by accruals-related anomalies and it mainly comes from stocks with low net operating assets. It is stronger among stocks with high limits to arbitrage. Overall, our results indicate that the cash holding effect does not present a new asset-pricing regularity, but that it is a manifestation of existing anomalies closely related to mispricing.

JEL Classification: G12, G14, G32

Keywords: Cash holdings; NOAs; Accruals; Limits to arbitrage; Mispricing; Investor sentiment

1. Introduction

Cash holdings have been widely studied in the corporate finance literature.[1] However, this subject is relatively new to asset-pricing studies. Palazzo (2012) argues that systematically riskier firms, which have higher expected returns, should rationally hold more cash to avoid costly external financing in case their future cash flows run low. Simutin (2010) suggests that firms with high cash holdings possess more risky growth options. As these firms have lower assets in place, their asset base is riskier, and hence they have higher expected returns. Both of these studies suggest a positive relationship between cash holdings and stock returns. In contrast, Ortiz-Molina and Phillips (2014) argue that the asset base of high cash holding firms is less risky because more cash provides them with greater liquidity. Therefore, the expected returns for high cash holding firms are lower. This implies a negative relationship between cash holdings and stock returns.

In this paper, we first comprehensively re-examine whether the association between cash holdings and average stock returns is robustly positive or negative. We then investigate whether the return predictability of cash holdings presents a new return pattern or is simply a manifestation of existing patterns of return predictability. More specifically, we identify and test the possible channels that might be able to explain the positive relationship between cash holdings and average returns.

To re-examine the robustness of the return predictability of cash holdings, we use two approaches: portfolio analysis and regression analysis. In the portfolio approach, we adjust the risk of portfolio returns using the Fama and French (FF, 2015) five-factor model, which adds profitability

[1] For example, Pinkowitz and Williamson (2001) examine the relationship between bank power and corporate cash holdings. Klasa, Maxwell, and Ortiz-Molina (2009) investigate the strategic use of cash holdings in collective bargaining with labor unions. Duchin (2010) studies the relationship between cash holdings and corporate diversification. Frésard (2010) examines the impact of cash holdings on product market performance. Liu and Mauer (2011) analyze the relationship between CEO compensation and cash holdings. Song and Lee (2012) investigate the effect of the 1997 Asian financial crisis on cash holdings.

and investment factors to the three-factor model of Fama and French (1993). Fama and French (2016) show that their new five-factor model is able to explain many anomalies that their earlier three-factor model cannot. Hou, Xue, and Zhang (2015; 2019) find that many anomalies in the literature are not robust; they vanish when portfolios are sorted using NYSE breakpoints and that the returns are value-weighted. We hence examine whether the return predictability of cash holdings survives from the more restrictive portfolio construction scheme. We find that the relationship between cash holdings and average stock returns is positive and robust to the adjustment of risk, the construction of cash holdings portfolios, and the weighting scheme of portfolio returns.

We next use the Fama and MacBeth (1973) firm-level cross-sectional and month-by-month regressions. Bates, Kahle, and Stulz (2009) document that average cash holdings are higher in high tech firms than in manufacturing firms. Based on the 49-industry classification of Fama and French (1997), we also observe in our sample that cash hoardings are substantially higher in some industries than in others.[2] The return predictability of cash holdings might come from the industry level rather than from the stock level. We therefore further control for the industry effect based on the industry classification of Fama and French (1997). We find that the positive relationship continues to hold using the Fama and MacBeth regression approach and is robust to controlling for the industry fixed effect.

We then identify the potential channels that might explain the positive relationship between cash holdings and average stock returns. The various channels can be classified into two main categories: the risk-based story and the behavioral/mispricing story. The risk-based story is the *q*-theory of investment (Cochrane, 1991, 1996; Zhang, 2005; Li, Livdan, and Zhang, 2009; Liu,

[2] We find that firms in the medical equipment, pharmaceutical products, business services, computer hardware, and computer software industries tend to have high cash holdings. In contrast, firms in utilities, petroleum and natural gas, communication, and wholesale industries tend to hold less cash.

Whited, and Zhang, 2009; Titman, Wei, and Xie, 2013; Chen, Sun, Wei, and Xie, 2018). The *q*-theory predicts that corporate investment is negatively related to expected returns and that simultaneously, economic profitability is positively related to expected returns (Lam, Prombutr, and Wei, 2019). We find that the investment and profitability effects together cannot fully explain the cash holding effect.

The second risk-based explanation is the real options story. First, Simutin (2010) argues that firms with high cash holdings are riskier and hence have higher expected returns because they possess a large number of risky growth options. Chan, Martin, and Kensinger (1990), Chan, Lakonishok, and Sougiannis (2001), Chambers, Jennings, and Thompson (2002), and Li (2011), among others, document a positive relationship between R&D spending and future stock returns. As higher R&D spending should lead to a larger number of risky growth options, we test whether the known return predictability of R&D spending subsumes the return predictability of cash holdings. We find that when controlling for R&D spending, the cash holding effect continues to be substantial and robust.

The third risk-based explanation is that high cash holdings might be a proxy for higher exposures to macroeconomic risk and that therefore, high cash holding firms have higher expected returns. On the one hand, Palazzo (2012) argues that systematically riskier firms should rationally hold more cash to avoid costly external financing in case their future cash flows run low. On the other hand, Acharya, Davydenko, and Strebulaev (2012) argue that a firm's asset composition, especially its proportion of cash, depends on its liability status. A firm facing higher default risk raises its cash holdings to increase its liquidity as a precaution against shortfall in its future cash flow.[3] We test whether the macroeconomic factor model of Chen, Roll, and Ross (1986) captures the

[3] These authors focus on cash holdings and bond yields. They show that the market demands larger credit spreads and hence higher yields on the bonds of high cash holding firms.

relationship between cash holdings and average returns. Of the five factors in the model, we expect the default risk to play the largest role in the relationship. We find that the macroeconomic factor model of Chen et al. (1985) can at most reduce the cash holding effect measured by the FF five-factor alpha by only 14%.

On the behavioral/mispricing story, the return predictability of cash holdings may be a manifestation of the well-known return predictability of existing anomaly variables. We find that the cash holding effect is closely correlated with accruals-related anomalies. For example, Hirshleifer, Hou, Teoh, and Zhang (2004) argue that investors with limited attention focus mainly on accounting profitability and neglect cash profitability. Hence, firms with low net operating assets (NOAs) are associated with investors' excessive pessimism provoked by reportedly poor past performance and therefore tend to be temporarily undervalued. When this undervaluation is corrected, firms with low NOAs have higher average returns. We find that cash holdings are significantly negatively correlated with NOAs. Moreover, the cash holding effect mainly comes from stocks with low NOAs and is subsumed by the NOAs effect.

Overall, we find that the association between cash holdings and average stock returns is indeed positive and robust to the adjustment of the FF five-factor model, the construction of cash holdings-sorted portfolios, the weighting scheme of portfolio returns, and the test methods. More importantly, the cash holding effect can be subsumed by the accruals-related effects, especially NOAs effect. These results suggest that the cash holding effect is a surrogate of well-known empirical patterns in the cross-section of stock returns.

We further show that the cash holding effect is stronger for firms with high limits to arbitrage. We also observe that the cash holding effect is slightly stronger, although insignificantly so, following the high sentiment period than following the low sentiment period. More importantly, the short leg of the cash holding hedge portfolio is more profitable following the high sentiment period. All of these findings are consistent with the combined argument of overpricing and short-sales constraints suggested by Stambaugh, Yu, and Yuan (2012). Overall, the evidence suggests that mispricing plays an important role in explaining the cash holding effect and its related anomalies.

2. Variables Description and Sample Selection

This section describes the major firm characteristics and the data used in our analysis. Appendix 1 provides detailed descriptions of the variables of interest.

2.1. Cash holdings

We measure cash holdings (*CH*) by the cash-to-assets ratio at the end of fiscal year *t*. This ratio is the proportion of total assets that the firm holds in cash and cash equivalents. A higher value means that the firm hoards cash more intensively.

2.2. Corporate investment and economic profitability

Similar to Huang, Lam, and Wei (2014), who apply the *q*-theory of investment to explain the external financing anomaly, we use the total asset growth (*TAG*) for fiscal year *t* as the comprehensive measure of corporate investment.[4] We use the total return on assets (*TROA*) in fiscal year *t* as the measure of economic profitability. *TROA* is the return on assets (*ROA*) plus R&D intensity (*RDA*), i.e., the profitability gross of R&D expense.[5] In addition, we use the

[4] The external financing anomaly refers to the negative relationship between net external financing activities and future stock returns (see, e.g., Bradshaw, Richardson, and Sloan, 2006).

[5] The *q*-theory models true economic profitability rather than accounting earnings. As accounting earnings expense R&D expenditures, which are associated with higher future economic profitability, accounting earnings do not

investment-to-capital ratio (*I*/*K*) at the end of fiscal year *t* to measure capital investment (e.g., Xing, 2008; Mao and Wei, 2016). We also use accruals (*Acc*) in fiscal year *t* to measure working capital investment (e.g., Wu, Zhang, and Zhang, 2010).

2.3. R&D intensity and macroeconomic risk factors

We measure R&D intensity by the ratio of R&D spending to total assets (*RDA*) for fiscal year *t*. Similar to Liu, Whited, and Zhang (2006) and Cooper and Priestley (2011), we construct the macroeconomic risk factors using returns on portfolios, tracking industrial production, unexpected inflation, the term structure of the interest rate, the change in expected inflation, and the default risk. Appendix 2 discusses the construction of these tracking portfolios.

2.4. Net operating assets

Following Hirshleifer, Hou, Teoh, and Zhang (2004), we measure the NOAs at the end of fiscal year *t* as the difference between operating assets and operating liabilities scaled by lagged total assets. NOAs are the assets of a firm directly related to its operations and can be used to measure the firm's performance independently of its financing activities. NOAs are also the cumulative difference between operating income and free cash flow.

2.5. Sample selection

Our sample contains all of the firms listed on the NYSE, Amex, and NASDAQ. We obtain annual financial statements from Compustat and monthly stock information from the Center for

represent true economic profitability. Given that cash holdings are positively correlated with R&D spending, measurement error in accounting earnings could undermine the power of *q*-theory to explain the return predictability of cash holdings. The measure of the total profitability gross of R&D expenditures should reduce the measurement error and enhance the statistical power of the *q*-theory test.

Research in Security Prices (CRSP). Like Fama and French (1992, 1993), we exclude certificates, American depositary receipts (ADRs), shares of beneficial interest (SBIs), unit trusts, closed end funds, real estate investment trusts (REITs), and financial firms. Following common practice, we match monthly stock returns from July of calendar year *t*+1 to June of calendar year *t*+2 to financial statements for fiscal year *t*. We delete firms for which we do not have the data to compute all of the necessary firm characteristics in a year. We also use the delisting returns to mitigate the survivorship bias.[6] The sample covers annual firm characteristics from fiscal years 1962 to 2013 and monthly stock returns from the end of July 1963 to the end of December 2014.

3. Empirical Findings on the Relationship between Cash Holdings and Average Stock Returns

Panel A of Table 1 presents the summary statistics of cash holdings and the firm characteristics of interest. The average firm holds 15% of its total assets in cash. The standard deviation of cash holdings in the cross section is 17%. The 10th percentile of cash holdings is 1%, and the 90th percentile of cash holdings is 41%.

Panel B of Table 1 reports the sample correlations between cash holdings and firm characteristics. Cash holdings are negatively correlated with market capitalization (*Size*), the book-to-market equity ratio (*B*/*M*), accruals (*Acc*), and net operating assets (*NOAs*). These correlations are significant at the 5% level, and the correlation with *NOAs* is rather substantial at –0.40. In other words, high cash holding firms tend to be small growth firms (measured by *Size* and *B/M*). They tend to have

[6] Shumway (1997) suggests that the returns of stocks delisted for poor performance (delisting codes 500 and 520 to 584) are usually unavailable. Following Shumway and Warther (1999), when the return is missing for an available CRSP month date, we use the delisting return. When the delisting return is not available, we use –30% for poor performance delisting and 0% for other cases.

less investment in working capital (measured by *Acc*) and to have very weak reported performance (measured by *NOAs*).

In addition, cash holdings are positively correlated with total asset growth (*TAG*), the capital-to-investment ratio (*I*/*K*), total return on assets (*TROA*), and R&D spending (*RDA*). All of the correlations are significant at the 5% level. In other words, high cash holding firms tend to slightly experience overall and fixed asset expansions, to have higher economic profitability, and to invest more in R&D.

3.1. The relationship between cash holdings and future stock returns: Portfolio analysis

Panel A of Table 2 reports the decile portfolios sorted by cash holdings at the end of June each year.[7] Low cash holding firms (decile 1) hold 1% of their total assets in cash. High cash holding firms (decile 10) hold 54% of their total assets in cash. High cash holding firms hold 53% more of their total assets as cash than low cash holding firms. As shown in Table 1, cash holdings are correlated with firm size (*Size*) and book-to-market equity (*B/M*). Fama and French (1992) find that *Size* and *B/M* are associated with future stock returns. We therefore control for these existing return predictors. We follow Daniel, Grinblatt, Titman, and Wermers (1997), Daniel and Titman (1997), and Daniel, Titman, and Wei (2001) to compute the characteristics-adjusted returns on portfolios sorted by cash holdings. More specifically, the characteristics-adjusted return on a stock is its monthly return minus the return on the benchmark portfolio matched to the stock. The benchmarks are the five-by-five portfolios sorted by market capitalization at the end of June of calendar year t+1 and book-to-market equity at the end of fiscal year t. All of the t-statistics are based on Newey

[7] Palazzo (2012) uses quarterly data and form monthly portfolios on non-financial and non-utility firms from calendar year 1972. We use annual data and form yearly portfolios on non-financial firms. Our strategy requires much less frequent rebalancing and considers more firms. Our sample of holding period returns, which starts from calendar year 1963, is more comparable to studies on return predictability in financial statement variables.

and West (1987) standard errors. The average monthly characteristics-adjusted return (*aRet*) is –0.20% for low cash holding firms and 0.26% for high cash holding firms. High cash holding firms significantly outperform low cash holding firms (i.e., [10–1]) by 0.46% (*t*-stat = 2.60). That is, there is a positive relationship between cash holdings and future abnormal stock returns when controlling for the characteristic risk of size and book-to-market equity.

In addition to the characteristics-adjusted returns, for robustness checks, we also estimate the Fama and French (2015) five-factor risk-adjusted return (i.e., intercept or alpha) of the following monthly time-series regression:

$$Ret_{p,t} - R_{ft} = \alpha_{p,FF5} + \beta_{p,MKT}MKT_t + \beta_{p,SMB}SMB_t + \beta_{p,HML}HML_t + \beta_{p,RMW}RMW_t + \beta_{p,CMA}CMA_t + \epsilon_{p,t}, \quad (1)$$

where $Ret_{p,t}$ is the monthly return on cash holding decile portfolio *p* in month *t* and R_{ft} is the risk-free rate. *MKT* is the market factor, *SMB* is the small-minus-size size factor, *HML* is the high-minus-low B/M value factor, *RMW* is the robust-minus-weak profitability factor, and *CMA* is the conservative-minus-aggressive investment factor.[8] The last column in Panel A of Table 2 reports the FF five-factor alpha (α_{FF5}). The FF five-factor alpha is –0.07% for low cash holding firms and 0.71% for high cash holding firms. The risk-adjusted return spread between the two extreme cash holding deciles is 0.78% (*t*-stat = 4.37), indicating a significantly positive relationship between cash holdings and future average returns when controlling for the FF five-factor model. The *t*-statistic is also higher than the 3.00 threshold recommended by Harvey, Liu, and Zhu (2016).

We switch to portfolios sorted by NYSE breakpoints and value-weighted returns reported in Panel B of Table 2. The characteristics-adjusted return is –0.13% for low cash holding firms and 0.14% for high cash holding firms. High cash holders outperform low cash holders by 0.27% (*t*-stat

[8] See Fama and French (2015) for the detailed construction of these factors. We obtain the risk-free rate and the risk factors from Kenneth French's internet data library.

= 2.32). The FF five-factor alpha is 0.09% for low cash holding firms and 0.56% for high cash holding firms. The difference in the FF five-factor alphas is significantly positive, with a value of 0.46% (*t*-stat = 3.33). Although the positive spreads in abnormal returns are reduced by this portfolio construction scheme and the use of value-weighted returns, they remain highly significant.

3.2. The cash holding effect: The Fama and MacBeth regression approach

To check the robustness of the above results, we examine the return predictability of cash holdings by estimating the Fama and MacBeth (1973) cross-sectional regression month by month as follows:

$$Ret_{i,t+1} = \sum_{j=1}^{49} a_j Industry_{i,j,t} + b_1 CH_{i,t} + b_2 RDA_{i,t} + b_3 Ln(Size_{i,t}) + b_4 B/M_{i.t} + \varepsilon_{i,t+1}, \qquad (2)$$

where $Ret_{i,t+1}$ is the monthly stock return on firm *i* from July of calendar year *t*+1 to June of calendar year *t*+2. $Industry_{i,j,t}$ is the set of industry dummies, each of which equals one if firm *i* belongs to industry *j* at the end of fiscal year *t* according to the 49-industry classification of Fama and French (1997), and zero otherwise.[9] *CH* is cash holdings and *RDA* is R&D spending in fiscal year *t*. *Ln*(*Size*) is the natural logarithm of market capitalization at the end of June of calendar year *t*+1.[10] *B*/*M* is the book-to-market equity ratio at the end of fiscal year *t*.

Panel C of Table 2 reports the results. In Model 1, we estimate the slope (b_1) on cash holdings, controlling only for market capitalization and the book-to-market equity ratio. The estimated slope coefficient is significantly positive (coeff = 0.821; *t*-stat = 2.56). The positive estimate mirrors the positive spread of the characteristics-adjusted returns on the two extreme decile portfolios in Panel A

[9] We obtain the updated industry classification from Kenneth French’s internet data library. As we exclude financial firms, i.e., classifications 45 to 48, our sample covers 45 industries.
[10] We take the natural logarithm of firm size to alleviate the effect of its skewness in the linear regression.

of Table 2. As discussed at the onset, because there is substantial heterogeneity in cash holdings across industries, the cash holding effect can be attributed to the industry effect. To test this hypothesis, in Model 2, we estimate the slope coefficient on cash holdings, controlling for the industry dummies. Although the magnitude of the estimated slope coefficient is reduced by 28%, it is still highly significantly positive, with a value of 0.591 (*t*-stat = 2.52). The result suggests that the industry effect can explain 28% of the cash holding effect, but the return predictability of cash holdings is not entirely an industry-level phenomenon. We also observe that the small size and book-to-market effects are both highly significant.

3.3. Investor sentiment and the cash holding effect

Behavioral theory suggests that speculative demand, which is more prevalent during periods of high investor sentiment (e.g., Baker and Wurgler, 2006), drives the mispricing of stocks that are sensitive to subjective valuation. Stambaugh, Yu, and Yuan (2012) find that anomalies are stronger following periods with high investor sentiment and that the overpricing of the short leg of an anomaly-based trading strategy is more profitable following the high sentiment period. Specifically, Bates, Kahle, and Stulz (2009), Simutin (2010), and Palazzo (2012) show that stocks with high cash holdings are likely to be speculative stocks, while those with low cash holdings are likely to be safe stocks.

We test whether the cash holding effect is consistent with speculative overpricing. Following Stambaugh, Yu, and Yuan (2012), we classify a month as a high (low) sentiment month if the Baker and Wurgler (2006) investor sentiment index is above (below) the sample median. Panel D of Table 2 shows that the return spread is 0.94% following the high sentiment period, which is slightly larger, although insignificantly so, than the return spread of 0.77% following low sentiment period. More importantly, we find that the short leg of the cash holding trading strategy is more profitable following the high sentiment period (-0.41%; *t*-stat = -2.77) than following the low sentiment period (0.04%; *t*-stat = 0.36). This evidence partially supports the mispricing explanation of the cash holding effect.[11]

In summary, Table 2 shows that the relationship between cash holdings and average stock returns is positive. Moreover, this positive relationship is robust to the adjustment of risks, the construction of portfolios sorted by cash holdings, the weighting scheme of portfolios returns, and the control of industry effects.

4. Potential Channels for the Positive Relationship between Cash Holdings and Average Stock Returns

In this section, we identify several channels from the literature that have the potential to explain the above-documented positive association between cash holdings and average stock returns. In addition to the risk-based story based on the FF five-factor model and the characteristics-based model used to compute the risk-adjusted returns reported in Table 2, we identify three additional risk-based explanations: the q-theory of investment, the real options theory, and the macroeconomic factor risk model. We also identify the behavioral story associated with the mispricing of accruals and NOAs.

4.1. The risk-based explanation: the q-theory and real option theory

[11] Our results using the consumer sentiment index from the University of Michigan are similar. Our finding stands in contrast to that of Li and Luo (2017), who find that the cash holding effect is significantly more pronounced following the low investor sentiment period. Our robustness checks (untabulated) show that the significant difference in the cash holding effects between the high and low sentiment periods disappears (i) when controlling for the profitability (RMW) and investment (CMA) factors or (ii) when using another proxy for cash holdings, such as the excess cash holdings in Opler, Pinkowitz, Stulz, and Williamson (1999).

The q-theory of investment suggests that average stock returns are negatively associated with corporate investment and positively associated with economic profitability. The negative relationship between investment and expected return works through the following channel. First, firms invest more when their marginal q, i.e., the net present value (NPV) of future cash flows generated from one additional unit of investment, is higher. Other things being equal, low expected returns imply high marginal q and therefore high investment, and vice versa. Second, stock returns are equal to (levered) investment returns in equilibrium. Decreasing returns to scale or increasing marginal adjustment costs implies that more investment leads to lower investment returns, and hence to lower expected stock returns in equilibrium. The positive relationship between profitability and expected returns works through the following channel. All else being equal, high expected profitability implies high marginal future cash flows from investment and therefore high investment returns. As stock returns are equal to (levered) investment returns, high profitability is associated with higher expected returns. Wu, Zhang, and Zhang (2010) extend the q-theory to consider working capital investment as a corporate investment decision variable and use accounting accruals as a measure of working capital investment.

The real options theory argues that when firms invest, they replace risky growth options with safer assets in place (e.g., Berk, Green, and Naik, 1999). As a result, risk falls and the expected return is reduced, which generates a negative relationship between investment and average returns. We argue that firms with high cash holdings are riskier because they possess high numbers of risky growth options (Simutin, 2010).

To test the q-theory or real options theory explanation for the cash holding effect, we estimate the Fama and MacBeth (1973) cross-sectional regression month by month as follows:

$$Ret_{i,t+1} = a + b_1 CH_{i,t} + b_2 Investment_{i,t} + b_3 Profitability_{i,t} \\ + b_4 Ln\left(Size_{i,t}\right) + b_5 B/M_{i.t} + \varepsilon_{i,t+1}, \quad (3)$$

where *Investment* is corporate investment and *Profitability* is economic profitability for fiscal year t. Table 3 reports the results. Models 1 and 4, Models 2 and 5, and Models 3 and 6 use total asset growth (*TAG*), the investment-to-capital ratio (*I/K*), and accruals (*Acc*) to measure *Investment*, respectively. For robustness checks to measure *Profitability*, Models 1-3 use the total return on assets (*TROA*) and Models 4-6 use its components: return on assets (*ROA*) and R&D spending (*RDA*) simultaneously. The estimated slope coefficients on *Investment* (b_2) in Models 1, 2, and 3 are all significantly negative, with slope coefficients of –0.488 (t-stat = –5.56), –1.808 (t-stat = –3.77), and –0.148 (t-stat = –3.87), respectively. The estimated slope coefficients on *Investment* in Models 4, 5, and 6 are also significantly negative. These results indicate that consistent with the literature, different measures of corporate investment are negatively related to future average returns. The estimated slope coefficients on *Profitability* (b_3) measured by *TROA* in Models 1, 2, and 3 are all significantly positive, with slope coefficients of 1.429 (t-stat = 4.22), 2.062 (t-stat = 4.94), and 1.328 (t-stat = 4.28), respectively. The estimated slope coefficients on *Profitability* (b_3) proxied by *ROA* and *RDA* in Models 4, 5, and 6 are also all significantly positive. The results reveal that consistent with the literature, all of the measures of economic profitability are positively associated with future stock returns.

The estimated slopes on cash holdings (b_1) in Models 7 and 8 are both significantly positive even when controlling for *TAG* or *I/K* as a measure of investment and *TROA* as a measure of profitability, which have slope coefficients of 0.754 (t-stat = 2.23) and 0.823 (t-stat = 2.48), respectively. The result shows that the cash holding effect does not decrease substantially, even when controlling for *TAG* and *TROA* or *I/K* and *TROA*. Moreover, the estimated slopes on cash holdings (b_1) in Models 10 and 11 are still significantly positive, with slope coefficients of 0.706 (t-stat = 2.28) and 0.824 (t-stat = 2.72), respectively. The results suggest that cash holdings are still positively related to future returns even when controlling for *TAG*, *ROA*, and *RDA* or *I*/*K*, *ROA*, and *RDA*.

In contrast, the estimated slopes on cash holdings (b_1) in Models 9 and 12 are statistically insignificant, with slope coefficients of 0.237 (*t*-stat = 0.63) and 0.267 (*t*-stat = 0.79), respectively, when we include Accruals (*Acc*) in the regression along with the other control variables. Our results suggest that the cash holding effect cannot be explained by capital investment and profitability as suggested by the traditional q-theory or by R&D intensity as suggested by the real options theory. In contrast, it can be fully subsumed by the existing accruals anomaly when controlling for profitability, size, and book-to-market equity.

4.2. Macroeconomic risk

As discussed at the outset, Palazzo (2012) argues that high cash holdings may proxy for high risk. The rationale is that systematically riskier firms should rationally hold more cash to avoid costly external financing in case their future cash flows fall short. That is, cash holding may proxy for macroeconomic risks, especially default risk. To check this possibility, we estimate the alpha (i.e., intercept or $\alpha_{p,CRR}$) of the Chen, Roll, and Ross (1986) macroeconomic factor model using the following monthly time-series regression model:

$$Ret_{p,t} - R_{ft} = \alpha_{p,CRR} + \beta_{p,MP} Ret_{MP,t} + \beta_{p,UI} Ret_{UI,t} + \beta_{p,UTS} Ret_{UTS,t} + \beta_{p,DEI} Ret_{DEI,t} + \beta_{p,URP} Ret_{URP,t} + \epsilon_{p,t}, \quad (4)$$

where Ret_{MP}, Ret_{UI}, Ret_{UTS}, Ret_{DEI}, and Ret_{URP} are the monthly returns on the portfolios tracking the industrial production factor (*MP*), the unexpected inflation factor (*UI*), the factor pertaining to the term structure of the interest rate (*UTS*), the factor pertaining to change in expected inflation (*DEI*), and the default risk factor (*URP*), respectively.

Panel A of Table 4 presents the average returns on the tracking portfolios. These are the estimated risk premiums on the macroeconomic factors. Consistent with Liu and Zhang (2008), the industrial production factor has a positive premium (1.23%; *t*-stat = 8.07). Similar to Cooper and Priestley (2011), the unexpected inflation factor and the factor pertaining to the change in expected inflation do not have significant premiums. The factor pertaining to the term structure of the interest rate has a positive premium (1.11%; *t*-stat = 2.71), while the default risk factor has a negative premium (–0.23%, *t*-stat = –2.18). The magnitudes of the estimated premiums on the industrial production factor, the factor pertaining to the term structure of the interest rate, and the default risk factor are similar to those reported in Cooper and Priestley (2011).

Panel B of Table 4 reports the estimates of regression (4). The estimated exposures of low and high cash holding firms to the industrial production factor (β_{MP}) are –0.005 and –0.009, respectively. The difference in the exposures is –0.004 (*t*-stat = –0.06). The estimated exposures of low and high cash holding firms to the factor pertaining to the term structure of the interest rate (β_{UTS}) are 0.000 and –0.045, respectively. The difference in the exposures is –0.045 (*t*-stat = –1.90). Most importantly, the exposures of low and high cash holding firms to the default risk factor (β_{URP}) are –0.325 and 0.355, respectively. The difference in the exposures is 0.680 (*t*-stat = 4.78). High cash holding firms are subject to higher default risk than low cash holding firms, which seems to be consistent with the default risk story for high cash holding firms.

However, the macroeconomic factor alpha (α_{CRR}) is –0.26% for low cash holding firms and 0.41% for high cash holding firms. High cash holding firms outperform low cash holding firms by 0.67% (*t*-stat = 4.97), which is slightly lower than the FF five-factor alpha (α_{FF5}) of 0.78% (*t*-stat = 4.37) reported in Table 2. The *t*-statistic is still higher than the 3.00 threshold recommended by Harvey, Liu, and Zhu (2016). The macroeconomic factor model can only explain 14% of the cash holding effect measured by the FF five-factor alpha.

As many macroeconomic factors are not priced on average, the unconditional version of the macroeconomic factor model may not be powerful enough to capture the cross-sectional variation in returns. Following Shen, Yu, and Zhao (2017), we partition our sample into periods of low and high investor sentiment. As before, we classify a month as a high (low) sentiment month if the Baker and Wurgler (2006) investor sentiment index is above (below) the sample median. Then, we compare the Chen, Roll, and Ross (1986) alphas for the cash holding portfolios following high and low sentiments. Panel C of Table 4 shows the results. We find that the alphas of the cash holding trading strategy are still significantly positive across both high and low sentiment periods. The return spread is 0.68% following the high sentiment period, which is slightly larger, although insignificantly so, than the return spread of 0.42% following the low sentiment period. Overall, the results show that macroeconomic risks do not explain the cash holding effect following high or low sentiment periods. Moreover, the effect is weakly stronger following the high sentiment period, which supports the mispricing story.

4.3. The NOAs effect

NOAs are defined as the cumulative difference between operating income and free cash flow. This suggests that high cash holding firms tend to have low NOAs, and as shown in Table 1, there is a highly negative correlation of -0.40 between the two variables. Hirshleifer, Hou, Teoh, and Zhang (2004) find that firms with high NOAs have lower average returns than do firms with low NOAs, which they attribute to investors' limited attention. More specifically, investors tend to focus on accounting profitability and to neglect cash profitability. As firms with low NOAs have poorly reported accounting profits in the past, they are associated with investors' excessive pessimism and are therefore temporarily undervalued, which generates the NOAs effect.

We next examine whether the NOAs effect can explain the cash holding effect. Panel A of Table 5 presents the averages of NOAs and its components of operating assets (OA) and operating liabilities (OL), scaled by lagged total assets, for each of cash holding decile portfolios. The averages of NOAs are 0.82 and 0.32 for low and high cash holding firms, respectively, confirming our correlation analysis that NOAs are negatively associated with cash holdings. The difference in NOAs between the low and high cash holding firms mainly comes from operating assets (1.06 versus 0.54), with little accounted for by operating liabilities (0.25 versus 0.20). This suggests that high cash holding firms have much lower operating income relative to free cash flow than do low cash holding firms, which indicates that high cash holding firms have more poorly reported accounting performance in the past.

Panel B of Table 5 reports the returns on portfolios sorted by the cash holding deciles and net operating asset terciles. It is evident that among the three groups of NOAs, the spreads in cash holdings between high and low cash holding firms (0.44, 0.46, and 0.50) are similar to the spread among all firms (0.53). However, the differences in abnormal returns between high and low cash holding firms are substantially different among these three NOAs groups. More specifically, among firms with low NOAs, the return spreads are 0.87% (*t*-stat = 2.78), 1.28% (*t*-stat = 3.74), and 1.47% (*t*-stat = 5.53) for the characteristics-adjusted return (*aRet*), the FF five-factor alpha (α_{FF5}), and the macroeconomic factor alpha (α_{CRR}), respectively. The relationship between cash holdings and future returns is significantly positive when NOAs is low.

Among firms with medium NOAs, however, the differences in the corresponding risk-adjusted returns between high and low cash holding firms are all small and insignificant, with values of –

0.04% (*t*-stat = –0.12), 0.11% (*t*-stat = 0.41) and 0.29% (*t*-stat = 1.06). Among firms with high NOAs, the differences in the corresponding abnormal returns between high and low cash holding firms are also all small and insignificant, with values of –0.33% (*t*-stat = –0.68), –0.38% (*t*-stat = –0.75), and –0.19% (*t*-stat = –0.34). The results suggest that when NOAs are not low, there is no relationship between cash holdings and average returns. The cash holding effect only exists among firms with low NOAs, which have poorly reported past accounting performance.

We note that high cash holding firms with high NOAs do not outperform low cash holding firms with low NOAs. More specifically, the differences in the corresponding abnormal returns between these two groups, i.e., [(10, high NOA) – (1, low NOA)], are –0.20% (*t*-stat = –0.39), –0.06% (*t*-stat = –0.04), and 0.45% (*t*-stat = 0.93). In contrast, high cash holding firms with low NOAs significantly outperform low cash holding firms with low NOAs. Specifically, the differences in the corresponding abnormal returns between high cash holding firms with low NOAs and low cash holding firms with high NOAs, i.e., [(10, low NOA) – (1, high NOA)], are 0.74% (*t*=3.71), 0.96% (*t*=4.82), and 0.83% (*t*=4.97). When high cash holdings firms have high NOAs, they do not outperform low cash holding firms with high NOAs. However, when high cash holding firms have low *NOAs*, they outperform low cash holding firms with high NOAs.

These observations suggest that low NOAs among high cash holding firms are the driving force behind the positive relationship between cash holdings and future returns. This is probably because of the low spread in NOAs among the cash holding deciles of this low NOAs group compared to the other two NOAs groups, which suggests that the cash holding effect could be due to the NOAs effect. To formally test this hypothesis, we estimate the following Fama and MacBeth (1973) cross-sectional regression month by month:

$$Ret_{i,t+1} = a + b_1 CH_{i,t} + b_2 NOA_{i,t} + b_3 Ln(Size_{i,t}) + b_4 B/M_{i.t} + \varepsilon_{i,t+1}. \tag{5}$$

Panel C of Table 5 reports the result. In Model 1, the slope coefficient on *NOA* (b_2) is –0.552 (*t*-stat = –5.39). Consistent with the literature, *NOA* is negatively related to future stock returns. More importantly, when both *NOA* and *CH* are included in the regression, as shown in Model 2, the slope coefficient on cash holdings (b_1) is no longer significant (coeff = 0.344; *t*-stat = 1.08). In contrast, the slope coefficient on *NOA* continues to be highly significant (*t*-stat = -5.62), although the magnitude is reduced slightly from -0.552 to -0.498. That is, the NOAs effect subsumes the return predictability of cash holdings.

4.4. The effect of limits to arbitrage on return predictability in cash holdings

In Section 4.3, we found that the NOAs effect can subsume the cash holding effect and that the NOA effect is attributed to the behavioral bias story proposed by Hirshleifer et al. (2004). A natural extension is to explore the role of limits to arbitrage.[12]

We examine portfolios sorted by cash holding deciles and limits to arbitrage terciles. Limits to arbitrage (*LTA*) is a composite index consisting of arbitrage risk, trading costs, and transaction liquidity at the end of June of calendar year *t*+1.[13] Panel A of Table 6 reports the results. Among

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[12] To exploit profitable opportunities due to mispricing, arbitrageurs should trade the mispricing away quickly if arbitrage risk and costs are low. However, De Long, Shleifer, Summers, and Waldmann (1990) suggest that noise traders may cause prices to diverge from fundamentals even further, adding risk to arbitrage. Shleifer and Vishny (1997) argue that arbitrageurs are typically capital constrained and might be forced to close arbitrage positions prematurely due to margin calls and suffer significant losses. Pontiff (1996, 2006) document that arbitrageurs are typically under-diversified and that idiosyncratic risk hence adds substantially to the total risk of their overall positions. Arbitrageurs would be concerned about this extra risk because it is unclear whether it would bring higher expected returns (e.g., Ang, Hodrick, Xing, and Zhang, 2006, 2009; Stambaugh, Yu, and Yuan, 2015). Trading costs would be another barrier to arbitrage. Trading expenses will obviously reduce the profitability of arbitrage trades, lowering their attractiveness to arbitrageurs. Finally, the lack of trading liquidity might increase the technical difficulty of exploiting arbitrage opportunities. Therefore, the correction of mispricing would be delayed when arbitrage is riskier and costlier.

[13] We use idiosyncratic stock return volatility (*IVol*) to measure arbitrage risk following Pontiff (1996, 2006), Wurgler and Zhuravskaya (2002), Ali, Hwang, and Trombley (2003), Mashruwala, Rajgopal, and Shevlin (2006), Duan, Hu, McLean (2010), McLean (2010), Lam and Wei (2011), and Lipson, Mortal, and Schill (2011). As arbitrageurs typically hold undiversified positions, they prefer to exploit the mispricing of stocks with lower idiosyncratic risk. Our measure of trading costs is the inverse of stock price (1/*Price*), which is related to the bid–ask spread and brokerage commission (see, e.g., Bhardwaj and Brooks, 1992). Ball, Kothari, and Shanken (1995) also use stock price as an inverse proxy for the bid–ask spread. Furthermore, Stoll (2000) shows that recent stock prices are inversely related to the relative bid–ask spread. Our measure of transaction liquidity is the dollar trading volume (*DVol*), which

firms with low *LTA*, the differences in abnormal returns between high and low cash holdings firms are all positive but insignificant, with values of 0.14% (*t*-stat = 0.92), 0.24% (*t*-stat = 0.49), and 0.20% (*t*-stat = 1.26) for the characteristics-adjusted return (*aRet*), the FF five-factor alpha (α_{FF5}), and the macroeconomic factor alpha (α_{CRR}), respectively. Among firms with medium *LTA*, the corresponding differences in the abnormal returns between high and low cash holding firms are all significantly positive, with values of 0.38% (*t*-stat = 2.01), 0.63% (*t*-stat = 3.70), and 0.50% (*t*-stat = 3.01). Among firms with high *LTA*, the corresponding differences in the abnormal returns between high and low cash holding firms are even more positive and significant, with values of 0.89% (*t*-stat = 3.21), 1.18% (*t*-stat = 4.33), and 1.26% (*t*-stat = 5.32). The corresponding differences in the abnormal returns between high and low cash holding firms across high and low *LTA* ([high–low] of [10–1]) are 0.75% (*t*-stat = 2.86), 0.94% (*t*-stat = 3.03), and 1.06% (*t*-stat = 4.38), indicating that the cash holding effect is more pronounced when limits to arbitrage are more severe.

To formally test the argument, we estimate the Fama and MacBeth (1973) cross-sectional regression as follows:

$$Ret_{i,t+1} = a + b_1 CH_{i,t} + b_2 LTA_{i,t} + b_3 CH_{i,t} \times LTA_{i,t}$$
$$+ b_4 Ln\left(Size_{i,t}\right) + b_5 B/M_{i.t} + \varepsilon_{i,t+1}, \quad (6)$$

where *CH*×*LTA* is the interaction term between cash holdings and *LTA*. The slope coefficient of interest is b_3, and we predict it to be positive. Panel B of Table 6 reports the results. In Model 1, the slope coefficient on *LTA* (b_2) is negative but insignificant, with a value of –0.104 (*t*-stat = –0.85), suggesting that *LTA* itself is not related to future stock returns. In Model 2, the slope on cash

is inversely related to price pressure and the time required to fill an order or to transact a large block of shares (see, e.g., Bhushan, 1994). Stocks with higher arbitrage risk, higher trading costs, and lower transaction liquidity have more severe limits to arbitrage. We compute the three measures for each firm at the end of June of calendar year *t*+1 and sort the firms independently into terciles based on each of the measures. We then average out the rankings on each firm to obtain an overall measure of limits to arbitrage for a firm.

holdings (b_1) is negative but insignificant, with a value of –0.242 (t-stat = –0.42). There is no relationship between cash holdings and future returns when controlling for *LTA* and the interaction term. The slope on the interactive term (b_3) is significantly positive, with a value of 0.410 (t-stat = 1.77). The result suggests that the cash holding effect is stronger when limits to arbitrage are more severe. The results in Tables 6 and 8 combined appear to suggest that the return predictability of cash holdings is consistent with the behavioral story.

5. Conclusions

The literature has provided mixed evidence of the relationship between cash holdings and future stock returns. We empirically confirm that the empirical relationship is positive and robust to how we adjust for risk, how we construct cash holdings portfolios, and how we weigh portfolio returns. All of these results fail to support the risk-based explanations for the cash holding effect.

The cash holding effect is closely related to accruals-related anomalies. We find that high cash holding firms tend to have lower NOAs. Hirshleifer, Hou, Teoh, and Zhang (2004) suggest that investors with limited attention focus mainly on accounting profitability but neglect cash profitability and that NOAs are positively related to accounting earnings but negatively related to cash profitability. The limited attention story suggests that firms with low NOAs tend to be undervalued and therefore earn high average returns. We find that consistent with the limit-attention story, the NOAs effect subsumes the return predictability of cash holdings.

Moreover, we find that the cash holding effect strengthens when limits to arbitrage is more severe. We also test whether the cash holding effect is consistent with speculative overpricing. We show that the cash holding effect exists in both the high and low sentiment periods. However, the effect is slightly stronger, although insignificantly so, following high sentiment periods rather than low sentiment periods. More importantly, the short leg of the cash holding trading strategy is more profitable following high sentiment periods rather than low sentiment periods. All of this evidence is consistent with the combined argument of overpricing and short-sales constraints suggested by Stambaugh, Yu, and Yuan (2012).

Overall, our findings suggest that the positive relationship between cash holdings and average stock returns does not present a new asset-pricing regularity. The cash holding effect appears to be a manifestation of accruals-based anomalies, which is closely related to mispricing and limits to arbitrage. More specifically, the cash holding effect mainly comes from the stocks of firms with low NOAs.

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Appendix 1

CH: Cash-to-assets ratio, calculated as cash and short term investments (item CHE) scaled by total assets (item AT) at the end of fiscal year *t*. Data source: Compustat Annual.

Size: Market capitalization, calculated as the closing stock price multiplied by the number of shares outstanding at the end of June of calendar year *t*+1. Data source: CRSP.

B/M: Book-to-market equity ratio, calculated as the book value of equity divided by the market capitalization at the end of a fiscal year *t*. Book equity is total assets minus total liabilities, plus balance sheet deferred taxes (item TXDB) and investment tax credits (item ITCI), minus preferred stock liquidation value (item PSTKL) if available, or redemption value (item PSTKRV) if available, or carrying value (item PSTK) if available. Data source: Compustat Annual and CRSP.

TAG: Total asset growth, calculated as the change in total assets (item AT) over fiscal year *t* scaled by beginning total assets. Data source: Compustat Annual.

I/K: Investment-to-capital ratio, calculated as capital expenditures (Compustat item CAPX) for fiscal year *t* scaled by beginning net book value of property, plant, and equipment (item PPENT). Data source: Compustat.

Acc: Accruals, calculated as the change in non-cash assets (item AT less item CHE) less the change in non-debt liabilities (item LT less item DLTT less item DLC) over fiscal year *t* scaled by beginning total assets. Data source: Compustat Annual.

ROA: Return on assets, calculated as operating income before extraordinary items (item IB) over a fiscal year *t* scaled by beginning total assets. Data source: Compustat Annual.

RDA: R&D spending, calculated as R&D expenditures (item XRD, set to zero if missing) over fiscal year *t* scaled by beginning total assets. Data source: Compustat.

NOA: Net operating assets, calculated as operating assets (*OA*) at the end of fiscal year *t* minus operating liabilities (*OL*) at the end of fiscal year *t*, scaled by beginning total assets. *OA* is total assets minus cash and short term investments (item CHE). *OL* is total assets less current liabilities (item DLC), long term debt (item DLTT), minority interests (item MIB), preferred stocks (item PSTK), and common equity (item CEQ). Data source: Compustat Annual.

IVol: Idiosyncratic stock return volatility, measured as the standard deviation of the residual values from the time series market model

$$R_{i,t} = b_{i0} + b_{i1} R_{M,t} + e_{i,t},$$

where R_i is the monthly stock return and R_M is the monthly return on the S&P 500 index. The model is estimated with 36 months of returns ending in June of calendar year *t*+1, requiring a complete 36-month history. Data source: CRSP.

Price: Share price, measured as the closing stock price (the average of bid and ask prices if the closing price is not available) at the end of June of calendar year *t*+1. Data source: CRSP.

DVol: Dollar trading volume, defined as the time series average of monthly share trading volume multiplied by the monthly closing price over the past one year ending in June of calendar year *t*+1. Data source: CRSP.

Appendix 2

The macroeconomic factors in Chen, Roll, and Ross (1986) are as follows. The growth rate of industrial production *MP* is the leaded logarithm of the gross rate of change in the industrial production index. Unexpected inflation *UI* and the change in expected inflation *DEI* is estimated from the total seasonally adjusted consumer price index. The term premium *UTS* is the yield spread between 10-year and one-year Treasury bonds. The default premium *URP* is the yield spread between Moody's Baa and Aaa bonds.[14]

As the factors *MP*, *UI*, and *DEI* are not traded assets, we follow Chan, Karceski, and Lakonishok (1998) and Cooper and Priestley (2011) to use pure tracking portfolios to mimic all factors for consistency. The basis assets for tracking consist of equal weighted book-to-market equity decile portfolios, equal weighted size decile portfolios, equal weighted momentum decile portfolios, and equal weighted cash holdings decile portfolios. Like Lehmann and Modest (1988) and Cooper and Priestley (2011), we first project the monthly returns on each of the 40 basis assets in excess of the risk free rate on the five factors. That is, we perform 40 time-series regressions to estimate a 40×5 matrix *B* of the slopes of the excess returns on the five factors. Let *V* be the 40×40 covariance matrix of regression errors, which are restricted to be orthogonal. The portfolio weights to track the five factors is the 5×40 matrix $w=(B'V^{-1}B)^{-1}B'V^{-1}$ and the returns on the tracking portfolios are wR', where *R* is a *T*×40 matrix with each column containing the time series returns on a basis in the sample period. The product wR' gives a 5×*T* matrix, in which each row represents the returns on a tracking portfolio for a factor in the sample period. The tracking portfolio constructed this way for a factor has a sensitivity of one with respect to that particular factor and zero with respect to other factors.

[14] We thank Laura Liu for providing the updated series of the macroeconomic factors used in Liu and Zhang (2008).

Table 1. Summary statistics and sample correlations

Panel A reports the time-series averages of descriptive statistics. SD is the standard deviation. 10p, 25p, 75p, and 90p are the 10^{th}, 25^{th}, 75^{th}, and 90^{th} percentiles, respectively. *CH* is cash holdings at the end of fiscal year *t*. *Size* is market capitalization in $\times 10^9$ at the end of June of calendar year *t*+1. *B/M* is the book-to-market equity ratio using the Fama and French (1993) book value at the end of fiscal year *t*. Total asset growth (*TAG*), the investment-to-capital ratio (*I*/*K*), accruals (*Acc*), total return on assets (*TROA*), R&D spending (*RDA*), and net operating assets (*NOA*) are at the end of or for fiscal year *t*. Panel B reports the time series averages of the cross sectional correlations between cash holdings and the characteristics.

Panel A. Summary statistics

	Mean	SD	10p	25p	Median	75p	90p
CH	0.15	0.17	0.01	0.03	0.08	0.22	0.41
Size	1.40	6.71	0.01	0.04	0.15	0.62	2.28
B/*M*	0.93	1.26	0.23	0.41	0.72	1.15	1.73
TAG	0.17	0.87	–0.10	–0.01	0.08	0.20	0.44
I/*K*	0.11	0.39	–0.04	0.02	0.07	0.14	0.26
Acc	–0.03	0.10	–0.12	–0.07	–0.03	0.02	0.08
TROA	0.03	0.92	–0.09	0.01	0.05	0.10	0.17
RDA	0.04	0.10	0.00	0.00	0.00	0.04	0.11
NOA	0.72	0.58	0.39	0.56	0.71	0.83	0.99

Panel B. Sample correlations with cash holdings

Size	*B*/*M*	*TAG*	*I*/*K*	*Acc*	*TROA*	*RDA*	*NOA*
–0.04	–0.15	0.05	0.06	–0.06	0.07	0.27	–0.40

Table 2. The positive relation between cash holdings and future abnormal stock returns

Panel A reports the time-series averages of portfolio characteristic at formation and monthly equal-weighted returns in % during the holding period from July of calendar year *t*+1 to June of calendar year *t*+2 on deciles sorted annually at the end of June of calendar year *t*+1 by cash holdings (*CH*) at the end of fiscal year *t*. Portfolio cash holdings are the median value in the group. The *aRet* is the characteristics-adjusted return, which is the stock returns minus the returns on a five-by-five benchmark portfolio matched to the firm by *Size* at the end of June of calendar year *t*+1 and *B*/*M* at the end of fiscal year *t*. The α_{FF5} is the Fama and French (2015) five-factor alpha, which is the estimated intercept of the following monthly time-series regression

$$Ret_{p,t} - R_{ft} = \alpha_{p,FF5} + \beta_{p,MKT}MKT_t + \beta_{p,SMB}SMB_t + \beta_{p,HML}HML_t + \beta_{p,RMW}RMW_t + \beta_{p,CMA}CMA_t + \epsilon_{p,t},$$

where Ret_p is the monthly return on cash holdings portfolio *p*, and R_f is the risk free rate. *MKT* is the market factor, *SMB* is the size factor, *HML* is the value factor, *RMW* is the profitability factor, and *CMA* is the investment factor. [10–1] is the difference in cash holdings or abnormal returns between the high and low cash holdings deciles. The *t*-statistics are based on the Newey and West (1987) standard errors. Panel B reports the cash holdings and value-weighted returns on cash holdings deciles sorted by NYSE breakpoints. Panel C reports the averages of estimated coefficients (Coeff) from the following Fama and MacBeth (1973) cross-sectional regressions month by month:

$$Ret_{i,t+1} = \sum_{j=1}^{49} a_j Industry_{i,j,t} + b_1 CH_{i,t} + b_2 Ln(Size)_{i,t} + b_3 B/M_{i,t} + \epsilon_{i,t},$$

where Ret_i is the monthly stock return on firm *i* in % from July of calendar year *t*+1 to June of calendar year *t*+2. *Industry* is the set of 49 Fama and French (1997) industry dummies, each of which equals one if firm *i* belongs to industry *j* at the end of fiscal year *t* and zero otherwise. Panel D reports the Fama and French (2015) five-factor alpha on the *CH* decile portfolios across high and low investor sentiment periods. A month is of high (low) sentiment when the Baker and Wurgler (2006) sentiment index in the previous month is above (below) the sample median.

	CH	*aRet*	α_{FF5}
Panel A. Decile portfolios sorted by cash holdings (all firm breakpoints and equal weighed returns)			
1 (low)	0.01	–0.20	–0.07
2	0.02	–0.14	–0.10
3	0.03	–0.12	–0.09
4	0.05	–0.11	–0.07
5	0.07	–0.01	0.02
6	0.10	0.01	0.13
7	0.15	0.11	0.32
8	0.22	0.14	0.41
9	0.32	0.17	0.53
10 (high)	0.54	0.26	0.71
[10–1]		0.46	0.78
(*t*-stat)		(2.60)	(4.37)
Panel B. Decile portfolios sorted by cash holdings (NYSE break points and value-weighted returns)			
1 (low)	0.01	–0.13	0.09
2	0.02	–0.17	–0.12
3	0.02	–0.19	–0.16
4	0.03	–0.05	–0.13
5	0.05	–0.04	–0.15
6	0.06	–0.12	–0.14
7	0.09	–0.09	–0.01
8	0.12	0.08	–0.09
9	0.18	–0.03	0.13
10 (high)	0.37	0.14	0.56
[10–1]		0.27	0.46
(*t*-stat)		(2.32)	(3.33)

Table 2 – continued

Panel C. Slope coefficients of returns against cash holdings controlling for industry dummies

Model		Industry dummies	*CH* (b_1)	*Ln*(*Size*) (b_2)	*B*/*M* (b_3)
1	Coeff	No	0.821	–0.109	0.220
	(*t*-stat)		(2.56)	(–2.65)	(3.95)
2	Coeff	Yes	0.591	–0.116	0.213
	(*t*-stat)		(2.52)	(–3.06)	(4.73)

Panel D. Investor sentiment, cash holdings, and portfolio returns (all firm breakpoints and equal weighed returns)

1 (low)	2	3	4	5	6	7	8	9	10 (high)	[10–1]
High sentiment period										
-0.41	-0.24	-0.27	-0.27	-0.09	0.04	0.20	0.35	0.48	0.53	0.94
(-2.77)	(-1.86)	(-2.01)	(-2.11)	(-0.64)	(0.27)	(1.22)	(1.65)	(2.53)	(2.33)	(4.65)
Low sentiment period										
0.04	-0.01	0.04	0.09	0.18	0.18	0.37	0.35	0.50	0.82	0.77
(0.36)	(-0.10)	(0.44)	(0.78)	(2.00)	(1.93)	(3.92)	(3.96)	(4.55)	(5.26)	(4.98)
High minus low sentiment										
-0.45	-0.259	-0.31	-0.36	-0.27	-0.22	-0.17	0.00	-0.02	-0.29	0.17
(-2.60)	(-1.94)	(-2.25)	(-2.97)	(-2.38)	(-1.51)	(-1.97)	(-0.75)	(-0.59)	(-1.23)	(0.75)

Table 3. The *q*-theory and real options theory of investment and the positive relation between cash holdings and average returns

This table reports the estimated slope coefficients of the monthly Fama and MacBeth (1973) cross sectional regression

$$Ret_{i,t+1} = a + b_1 CH_{i,t} + b_2 Investment_{i,t} + b_3 Profitability_{i,t} + b_4 Ln(Size)_{i,t} + b_5 B/M_{i,t} + \epsilon_{i,t},$$

where *Investment* is corporate investment and *Profitability* is economic profitability for fiscal year *t*. Total asset growth (*TAG*) measures overall corporate investment. The investment-to-capital ratio (*I*/*K*) measures capital investment. Accruals (*Acc*) measures working capital investment. Total return on assets (*TROA*) measures true economic profitability, which is equal to the sum of profitability net of R&D spending or return on assets (*ROA*) and R&D spending (*RDA*). The *t*-statistics in parentheses are based on the Newey and West (1987) standard errors.

			Investment (b_2)			*Profitability* (b_3)				
Model		*CH* (b_1)	*TAG*	*I*/*K*	*Acc*	*TROA*	*ROA*	*RDA*	*Ln*(*Size*) (b_4)	*B*/*M* (b_5)
1	Coeff		–0.488			1.429			–0.134	0.198
	(*t*-stat)		(–5.56)			(4.22)			(–3.22)	(3.18)
2	Coeff			–0.148		1.328			–0.137	0.175
	(*t*-stat)			(–3.87)		(4.28)			(–3.27)	(3.17)
3	Coeff				–1.808	2.062			–0.154	0.343
	(*t*-stat)				(–3.77)	(4.94)			(–3.40)	(3.26)
4	Coeff		–0.485				1.241	2.812	–0.129	0.203
	(*t*-stat)		(–5.38)				(3.25)	(3.82)	(–3.17)	(3.42)
5	Coeff			–0.155			1.113	2.801	–0.133	0.177
	(*t*-stat)			(–4.35)			(3.19)	(3.83)	(–3.22)	(3.35)
6	Coeff				–1.788		0.981	3.421	–0.148	0.288
	(*t*-stat)				(–3.65)		(1.71)	(3.64)	(–3.34)	(3.00)
7	Coeff	0.754	–0.472			1.245			–0.124	0.218
	(*t*-stat)	(2.23)	(–5.40)			(3.64)			(–3.06)	(3.76)
8	Coeff	0.823		–0.158		1.131			–0.127	0.194
	(*t*-stat)	(2.48)		(–4.55)		(3.58)			(–3.09)	(3.72)
9	Coeff	0.237			–0.175	2.116			–0.145	0.381
	(*t*-stat)	(0.63)			(–3.75)	(4.53)			(–3.27)	(3.75)
10	Coeff	0.706	–0.463				0.949	2.774	–0.122	0.218
	(*t*-stat)	(2.28)	(–5.13)				(2.40)	(3.91)	(–3.03)	(3.80)
11	Coeff	0.824		–0.157			0.804	2.701	–0.125	0.193
	(*t*-stat)	(2.72)		(–4.54)			(2.19)	(3.81)	(–3.06)	(3.75)
12	Coeff	0.267			–1.732		0.962	3.429	–0.141	0.316
	(*t*-stat)	(0.79)			(–3.64)		(1.85)	(3.60)	(–3.24)	(3.56)

Table 4. Macroeconomic risks and the positive relation between cash holdings and expected returns

Panel A reports the average monthly returns in % and the corresponding t-statistics (t) on five traded portfolios tracking the Chen, Roll, and Ross (1986) macroeconomic risk factors. Ret_{MP} is the return on the portfolio that tracks the growth rate of industrial production (MP). Ret_{UI} is the return on the portfolio that tracks the unexpected inflation (UI). Ret_{UTS} is the return on the portfolio that tracks the term premium (UTS). Ret_{DEI} is the return on the portfolio that tracks the change in expected inflation (DEI). Ret_{URP} is the return on the portfolio that tracks the default premium (URP). Panel B reports the estimated parameters of the monthly time series regression

$$Ret_{p,t} - R_{ft} = \alpha_{p,CRR} + \beta_{p,MP}Ret_{MP,t} + \beta_{p,UI}Ret_{UI,t} + \beta_{p,UTS}Ret_{UTS,t} + \beta_{p,DEI}Ret_{DEI,t} + \beta_{p,URP}Ret_{URP,t} + \epsilon_{p,t},$$

where Ret_p is the size and book-to-market adjusted return on cash holding decile p and R_f is the risk-free rate. Panel C reports the alphas with respect to the Chen, Roll, and Ross (1986) macroeconomic risk factors on the CH decile portfolios across high and low investor sentiment periods. A month is of high (low) sentiment when the Baker and Wurgler (2006) sentiment index in the previous month is above (below) the sample median. The t-statistics in parentheses are based on the Newey and West (1987) standard errors.

Panel A. Average risk premiums on macroeconomic risk factors

	Ret_{MP}	Ret_{UI}	Ret_{UTS}	Ret_{DEI}	Ret_{URP}
Average	1.23	–0.08	1.11	–0.01	–0.23
(t-stat)	(8.07)	(–0.94)	(2.71)	(–0.52)	(–2.18)

Panel B. Estimated parameters of the time-series regressions

	α_{CRR}	β_{MP}	β_{UI}	β_{UTS}	β_{DEI}	β_{URP}
1 (low)	–0.26	–0.005	0.313	0.000	–1.359	–0.325
2	–0.26	0.049	0.066	0.018	–0.835	–0.147
3	–0.20	0.020	0.078	0.019	–0.931	–0.115
4	–0.23	0.053	0.039	0.019	–0.655	–0.120
5	–0.11	0.037	0.015	0.029	–0.486	–0.086
6	–0.01	–0.013	–0.073	0.012	0.246	–0.061
7	0.15	–0.013	–0.076	0.001	0.363	0.105
8	0.22	–0.039	–0.050	–0.002	0.554	0.127
9	0.35	–0.075	–0.115	–0.033	1.387	0.203
10 (high)	0.41	–0.009	–0.141	–0.045	1.960	0.355
[10–1]	0.67	–0.004	–0.454	–0.045	3.319	0.680
(t-stat)	(4.97)	(–0.06)	(–3.59)	(–1.90)	(3.04)	(4.78)

Panel C. Decile portfolios sorted by cash holdings (all firm breakpoints and equal weighed returns)

1 (low)	2	3	4	5	6	7	8	9	10 (high)	[10–1]
High sentiment period										
-0.30	-0.16	-0.16	-0.15	-0.03	0.04	0.19	0.28	0.36	0.38	0.68
(-5.69)	(-3.94)	(-4.25)	(-4.23)	(-0.90)	(1.28)	(5.80)	(6.07)	(7.18)	(4.52)	(5.58)
Low sentiment period										
-0.16	-0.09	-0.01	-0.05	0.05	0.06	0.18	0.21	0.27	0.26	0.42
(-3.21)	(-2.18)	(-0.27)	(-1.28)	(1.57)	(1.87)	(5.07)	(4.14)	(4.05)	(3.43)	(3.74)
High minus low sentiment										
-0.14	-0.07	-0.15	-0.11	-0.08	-0.02	0.00	0.07	0.09	0.12	0.26
(-1.43)	(-1.09)	(-1.42)	(-2.61)	(-2.19)	(-0.47)	(-1.09)	(0.65)	(1.02)	(0.35)	(0.85)

Table 5. Mispricing of NOAs and the positive relation between cash holdings and expected returns

Panel A reports average net operating assets (*NOA*) and its components operating assets (*OA*) and operating liabilities (*OL*) at the end of fiscal year *t*, scaled by lagged total assets, of decile portfolios sorted by cash holdings. Panel B reports cash holdings and abnormal returns on portfolios sorted by cash holdings deciles and NOA teciles. [(10, high NOA) – (1, low NOA)] is the difference in abnormal return between high cash holdings firms with high NOAs and low cash holdings firms with low NOAs. [(10, low NOA) – (1, high NOA)] is the difference in abnormal return between high cash holdings firms with low NOAs and low cash holdings firms with high NOAs. Panel C reports the averages of the estimated slope coefficients of the Fama and MacBeth (1973) month by month cross-sectional regressions:

$$Ret_{i,t+1} = a + b_1 CH_{i,t} + b_2 NOA_{i,t} + b_3 Ln(Size)_{i,t} + b_4 B/M_{i,t} + \epsilon_{i,t}.$$

The *t*-statistics in parentheses are based on the Newey and West (1987) standard errors.

Panel A. Net operating assets (NOAs), operating assets (OA), and operating liabilities (OL) of cash holdings deciles

	NOAs	*OA*	*OL*
1 (low *CH*)	0.82	1.06	0.25
2	0.80	1.05	0.25
3	0.78	1.04	0.26
4	0.77	1.02	0.26
5	0.74	1.00	0.26
6	0.71	0.97	0.26
7	0.67	0.93	0.25
8	0.61	0.86	0.25
9	0.52	0.76	0.24
10 (high *CH*)	0.32	0.54	0.20
[10–1]	-0.50	-0.52	-0.050

Table 5 – continued

Panel B. Portfolios sorted by cash holdings (CH) and net operating assets (NOAs)

	CH	*aRet*	α_{FF5}	α_{CRR}
NOAs = low				
1 (low *CH*)	0.01	–0.34	–0.39	–0.87
2	0.02	–0.03	0.10	–0.30
3	0.03	0.31	0.48	0.10
4	0.05	0.07	0.20	–0.18
5	0.07	0.23	0.26	0.01
6	0.10	0.37	0.51	0.22
7	0.14	0.25	0.35	0.18
8	0.20	0.37	0.59	0.35
9	0.30	0.35	0.70	0.48
10 (high *CH*)	0.45	0.52	0.90	0.60
[10–1]	0.44	0.87	1.28	1.47
(*t*-stat)		(2.78)	(3.74)	(5.53)
NOAs = medium				
1 (low *CH*)	0.01	–0.12	–0.01	–0.19
2	0.02	0.12	0.17	–0.01
3	0.03	0.04	0.01	–0.07
4	0.05	0.06	0.11	–0.10
5	0.07	0.17	0.21	0.10
6	0.10	0.09	0.17	0.08
7	0.15	0.24	0.41	0.25
8	0.21	0.17	0.39	0.23
9	0.29	0.21	0.50	0.36
10 (high *CH*)	0.47	–0.16	0.10	0.09
[10–1]	0.46	–0.04	0.11	0.29
(*t*-stat)		(–0.12)	(0.41)	(1.06)
NOAs = high				
1 (low *CH*)	0.01	–0.22	–0.07	–0.23
2	0.02	–0.25	–0.24	–0.32
3	0.03	–0.27	–0.23	–0.30
4	0.05	–0.32	–0.30	–0.37
5h	0.07	–0.27	–0.23	–0.31
6	0.10	–0.19	–0.11	–0.20
7	0.15	–0.10	0.06	0.01
8	0.22	–0.42	–0.19	–0.28
9	0.31	–0.50	–0.22	–0.18
10 (high *CH*)	0.51	–0.55	–0.45	–0.41
[10–1]	0.50	–0.33	–0.38	–0.19
(*t*-stat)		(–0.68)	(–0.75)	(–0.34)
[(10, high NOA) – (1, low NOA)]		–0.20	–0.06	0.45
(*t*-stat)		(–0.39)	(–0.04)	(0.93)
[(10, low NOA) – (1, high NOA)]		0.74	0.96	0.83
(*t*-stat)		(3.71)	(4.82)	(4.97)

Table 5 – continued

Panel C. Average slopes of return against cash holdings (CH) controlling for net operating assets (NOAs)

Model		*CH* (b_1)	*NOA* (b_2)	*Ln*(*Size*) (b_3)	*B*/*M* (b_4)
1	Coeff		–0.552	–0.121	0.197
	(*t*-stat)		–5.39	–2.69	3.16
2	Coeff	0.344	–0.498	–0.119	0.209
	(*t*-stat)	1.08	–5.62	–2.67	3.57

Table 6. Limits to arbitrage and the relation between cash holdings and expected returns

Panel A reports cash holdings and abnormal returns on portfolios sorted by cash holdings deciles and terciles of limits to arbitrage (LTA) at the end of June of calendar year t+1. ([high–low] of [10–1]) is the difference in the difference in abnormal return between high cash holding firms and low cash holding firms across high and low limits to arbitrage. Panel B reports the estimated slope coefficients of the monthly Fama and MacBeth (1973) cross sectional regression

$$Ret_{i,t} = a + b_1 CH_{i,t} + b_2 LTA_{i,t} + b_3 CH_{i,t} \times LTA_{i,t} + b_4 Ln(Size) + b_5 B/M_{i,t} + \epsilon_{i,t},$$

where *CH*×*LTA* is the interaction term between cash holdings and limits to arbitrage. The *t*-statistics in parentheses are based on the Newey and West (1987) standard errors.

Panel A. Portfolios sorted by cash holdings and limits to arbitrage

	CH	*aRet*	α_{FF5}	α_{CRR}
LTA = low				
1 (low *CH*)	0.01	–0.01	0.08	0.08
2	0.02	–0.08	–0.14	–0.12
3	0.03	0.02	–0.06	0.01
4	0.04	0.02	–0.09	–0.06
5	0.06	0.04	–0.11	–0.07
6	0.09	0.07	0.00	0.01
7	0.13	0.15	0.08	0.12
8	0.19	0.08	0.06	0.08
9	0.28	0.24	0.33	0.34
10 (high *CH*)	0.46	0.13	0.32	0.28
[10–1]		0.14	0.24	0.20
(*t*-stat)		(0.92)	(0.49)	(1.26)
LTA = medium				
1 (low *CH*)	0.01	–0.22	–0.20	–0.23
2	0.02	–0.13	–0.17	–0.24
3	0.03	–0.03	–0.11	–0.13
4	0.04	–0.07	–0.15	–0.18
5	0.06	–0.02	–0.07	–0.12
6	0.09	0.08	0.04	–0.01
7	0.13	0.08	0.09	0.10
8	0.19	0.09	0.16	0.10
9	0.28	0.13	0.34	0.28
10 (high *CH*)	0.46	0.16	0.43	0.27
[10–1]		0.38	0.63	0.50
(*t*-stat)		(2.01)	(3.70)	(3.01)
LTA = high				
1 (low *CH*)	0.01	–0.28	–0.03	–0.64
2	0.02	–0.17	0.12	–0.46
3	0.03	–0.17	0.16	–0.37
4	0.04	–0.16	0.16	–0.34
5 *LTA*=high	0.06	0.13	0.44	–0.10
6	0.09	0.00	0.27	–0.12
7	0.13	0.35	0.74	0.26
8	0.19	0.26	0.68	0.18
9	0.28	0.14	0.52	0.17
10 (high *CH*)	0.50	0.61	1.15	0.63
[10–1]		0.89	1.18	1.26
(*t*-stat)		3.21	4.33	5.32
([high–low] of [10–1])		0.75	0.94	1.06
(*t*-stat)		(2.86)	(3.03)	(4.38)

Table 6 - Continued

Panel B. The averages of slopes of returns against cash holdings controlling for limits to arbitrage

Model		*CH* (b_1)	*LTA* (b_2)	*CH*×*LTA* (b_3)	*Ln*(*Size*) (b_4)	*B*/*M* (b_5)
1	Coeff		–0.104		–0.170	0.169
	(*t*-stat)		(–0.85)		(–4.26)	(3.05)
2	Coeff	–0.242	–0.234	0.410	–0.163	0.191
	(*t*-stat)	(–0.42)	(–1.42)	(1.77)	(–5.01)	(3.46)