Cash Holdings and Stock Returns: Risk or Mispricing?[☆]

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Cash Holdings and Stock Return: Risks or Mispricing?

Abstract

We examine the precautionary savings explanation and the mispricing explanation of the positive association between cash holdings and average future stock return. (1) As predicted by the optimal corporate cash holdings policy in precautionary savings models, high cash holders have higher systematic default risk than low cash holders. (2) Inconsistent with the asset pricing implication of precautionary savings models, adjusting for default risk and other macroeconomic risks do not explain the positive association and the main culprit is the empirically negative default risk premium. (3) Cash holdings is negatively correlated with a relatively (over)valuation index and, as predicted by the mispricing explanation, the positive association disappears when limits to arbitrage are low, reappears when limits to arbitrage get more severe and is strongest when limits to arbitrage are high. (4) Consistent with the mispricing explanation, the positive association is strongest when high cash holders are undervalued and low cash holders are overvalued, becomes weaker when either high cash holders are less undervalued or low cash holders are less overvalued, and vanishes when high cash holders are least undervalued and low cash holders are least overvalued.

JEL Classification: G12, G14, G32

Keywords: Cash holdings; Cross-section of stock returns; Default risk, Limits to arbitrage; Macroeconomic risks, Misvaluation, Precautionary savings

1. Introduction

We examine two explanations of the positive association between corporate cash holdings and average future stock return. Firstly, Palazzo (2012) argues that riskier firms, whose cash flows correlate more with an aggregate uncertainty, have greater needs of hedging against future cash flow shortfall in states in which they face costly external financing for exercising valuable growth options. As such, these firms optimally hold more cash. In a related precautionary savings study, Archarya, Davydenko, and Strebulaev (2012) provide an optimal cash holdings model to predict that cash holdings is positively correlated with default risk as firms that are more distressed maintain higher cash as a buffer against cash flow shortfall in the future. As high cash holdings firms are subject to higher systematic uncertainty, especially default risk, they should be priced with higher expected stock returns. To test this line of explanation of the positive association between cash holdings and average stock return, we examine the loadings of firms with different cash holdings on the classical macroeconomic factors in Chen, Roll, and Ross (1986) and test whether exposures to these risks, particularly the default risk, capture the positive association.

Secondly, as firms holdings more cash make less investment (see, e.g., Opler, Pinkowtiz, Stulz, and Williamson, 1999; Bates, Kahle, and Stulz, 2009; Simutin, 2010), investors might perceive some of these firms have not performed well recently and expect the inferior performance to continue. Therefore, such firms tend to be out of favor and underpriced (Lakonishok, Shleifer, and Vishny, 1994). On the other hand, firms holdings less cash make more investment and investors might perceive some of these firms have performed well recently and expect the good performance to continue. Hence such firms tend to be glamorous and overpriced. To test if the positive association between cash holdings and average future stock

return might be due to mispricing, we first test whether the positive association between cash holdings and stock return is stronger among firms subject to more severe limits to arbitrage (Shleifer and Vishny, 1997).

Furthermore, we test whether high cash-holdings firms remain associated with high stock return when such firms tend to be ex-ante overvalued. We also test whether low cash-holdings firms remain associated with low stock return when such firms tend to be undervalued. Finally, we test whether the positive association becomes stronger when high cash-holdings firms tend to be ex-ante more undervalued and/or low cash-holdings firms tend to be ex-ante more overvalued. Our measure of ex-ante misvaluation is based on the relative valuation indexing scheme similar to that in Stambaugh, Yu, and Yuan (2012, 2013) and combines 11 signals that the literature has recently documented to predict future stock return in the cross section.

During our sample period from July 1960 to December 2011, future average size and book-to-market adjusted stock return on high cash-holdings firms outperforms that on low cash-holdings firms by 0.62% per month. High cash-holdings firms load more on the industrial production and expected inflation factors but the difference is not statistically significant. On the other hand, high cash-holdings firms load less on the unexpected inflation and term factors. More importantly, as suggested by Archarya, Davydenko, and Strebulaev (2012), we find that firms with higher cash holdings have monotonically higher exposure to the default factor and the difference in such exposure between high cash-holdings firms and low cash-holdings firms is economically and statistically significant.

However, the precautionary savings motive does not explain the positive association between cash holdings and average future stock return. The macroeconomic-risk-factor alpha of the hedge longing high cash-holdings firms and shorting low cash-holdings firms is 0.78% per

month. That is, the average stock return spread between high cash holders and low cash holders not only remains significant but also slightly strengthens after controlling for the macroeconomic risks. The major reason that the macroeconomic factors fail to capture the positive association being the default factor empirically carries a negative premium or essentially the distress risk puzzle documented by Dichev (1998) and Campbell, Hilscher, and Szilagyi (2008), among others.

On the other hand, the positive association between cash holdings and average future stock return responds to limits to arbitrage as predicted by the mispricing explanation. Among low limits to arbitrage stocks, the average return spread between high and low cash holders is economically small and statistically insignificant. The spread turns significant and monotonically increases as limits to arbitrage become more severe. These findings are similar when we measure limits to arbitrage by commonly used proxies including idiosyncratic volatility, inverse of stock price, inverse of dollar trading volume, and the Amihud (2002) illiquidity.

The average return on high cash holders decreases when these firms tend to be ex-ante more overvalued relatively. The return on high cash holders is no longer significantly positive when these firms tend to be relatively overvalued. Furthermore, the return on low cash holders increases when these firms tend to be more undervalued relatively. The return on low cash holders is no longer significantly negative when these firms tend to be relatively undervalued. Consistent with the mispricing explanation, the positive association becomes monotonically stronger when high cash-holdings firms tend to be more undervalued and/or low cash-holdings firms tend to be more overvalued. Finally, the positive association turns economically and statistically insignificant when higher cash holders are relatively overvalued and low cash holders are relatively undervalued.

The remainder of the paper is organized as follows. Section 2 reviews the literature and develops our hypotheses. Section 3 describes the sample and measurements of variables. Section 4 presents summary statistics and the positive association between cash holdings and future average stock return. Section 5 examines the role of macroeconomic risks in the positive association. Section 6 examines the roles of limits to arbitrage and ex-ante misvaluation in the positive association. Section 7 concludes the paper.

2. Literature Review and Hypothesis Development

Simutin (2010) and Palazzo (2012) find that firms with high cash holdings earn significantly higher average subsequent stock return than firms with low cash holdings. The positive association between cash holdings and stock return can neither be explained by the Capital Asset Pricing Model, the Fama and French (1993) three factor model consisting of the market, size, and value factors nor the Hou, Xue, and Zhang (2012) three factor model consisting of the market, investment, and profitability factors.

Palazzo (2012) models the optimal corporate cash holdings policy when a firm's cash flow is correlated with a source of priced aggregate risk and faces costly external financing. As cash savings allow the firm to avoid costly financing to fund the exercise of valuable growth options in the future when the firm experiences a shortfall in cash flow, there is a hedging need of precautionary savings. On one hand, riskier firms save more cash. On the other hand, riskier firms are priced to provide higher expected return. As cash holdings is positively correlated with systematic risk, it is positively correlated with expected return. Furthermore, the model also predicts that the correlation between cash holdings and expected return to be stronger when there is less valuable growth options. When firm value is tied less to growth options and more to assets

in place, expected return on the latter plays a larger role in affecting the overall expected return. Hence a given increase in the risk of the cash flow generated by the asset in place, which is accompanied by a given increase in cash savings, leads to a larger increase in overall expected return. Consistent with this prediction, Palazzo (2012) also show that positive association between cash holdings and stock return is stronger for firms with smaller size, lower profitability, or higher book-to-market equity ratio.

In a related study, Archarya, Davydenko, and Strebulaev (2012) argues that a firm's asset composition, especially cash, depends on the liability structure. When the financially-constrained firm faces higher default likelihood and expects lower future cash flow but higher return, it holds more cash to raise the liquidity of its assets to buffer the potential shortfall in cash flow in the future. As the higher liquidity does not completely overcome the higher default risk, the distressed firm remains more risky. This hedging need of precautionary savings predicts that cash holdings is positively correlated with default risk as well as expected return. As the precautionary-savings theories argue that it is the aggregate economic, particularly default, risk that drives cash holdings and expected returns, we hypothesize the following.

H_1: Higher cash-holdings firms have higher exposures on macroeconomic risks especially the default risk.

H_2: Future average stock return on high cash holders is not higher than that on low cash holders after controlling for macroeconomic risks.

As mentioned in the onset, firms holdings more cash make less investment. Some of these firms might be perceived to have done badly and investors may extrapolate the poor performance into the future and turn overly pessimistic. Hence these out-of-favor stocks get oversold and underpriced (Lakonishok, Shleifer, and Vishny, 1994). On the other hand, firms holdings less cash make more investment. Analogously, some of these firms might be perceived to have done well and investors may extrapolate the good performance into the future and get overly excited. Therefore these glamour stocks get overbought and overpriced.

If extreme cash holders are misvalued, the resulting profit opportunities would attract arbitrage activities, which correct the mispricing. When such opportunities are riskless and costless to exploit, misvaluation should be corrected quickly. However, when arbitrage is risky and costly, the correction of misvaluation could slow down, especially when limits to arbitrage are more severe.

De Long, Shleifer, Summers, and Waldmann (1990) suggest that noise trading would cause prices to diverge from fundamental values, causing arbitrage to be risky. Shleifer and Vishny (1997) argue that arbitrageurs are typically capital constrained and might have to prematurely close up arbitrage positions due to margin calls and suffer losses. Liu and Longstaff (2004) show that even optimized trades can still experience loss before prices converge when arbitrage is risky. Pontiff (2006) shows arbitrageurs prefer holdings fewer stocks with higher idiosyncratic volatility. Arbitrageurs are typically under-diversified hence the idiosyncratic risk adds substantially to the total risk of their overall positions. The added risk should be of great concern to arbitrageurs as there is still a debate whether they would be compensated with higher expected return.[1] Transaction costs would be another barrier to arbitrage. Trading expenses obviously

[1] E.g., Fu (2009) show that stock returns are positively associated with idiosyncratic risk but Ang, Hodrick, Xing, and Zhang (2006, 2009) find the opposite.

reduce the profitability of arbitrage trades, which reduces their attractiveness to arbitrageurs. Finally, illiquidity and the risk of short squeezes might make arbitrage opportunities technically harder to exploit.

When arbitrage is riskier, transaction costs are higher or liquidity is lower, arbitrage opportunities provided by the misvaluation of extreme cash holders are less attractive and more difficult to exploit. As arbitrageurs would only gradually correct the misvaluation, we should observe a stronger association between cash holdings and average subsequent stock return when arbitrage is more limited. This argument leads to our third hypothesis.

H_3: The positive association between cash holdings and average future stock return is stronger when limits to arbitrage are more severe.

Furthermore, if dispersion in ex-ante valuation, i.e. firms with higher cash holdings are undervalued while firms with lower cash holdings are overvalued, is the driving force of the positive association between cash holdings and average future stock return, then our final hypothesis is:

H_4: The positive association between cash holdings and future stock return is stronger when high cash holders are ex-ante more undervalued and/or low cash holders are more overvalued.

In the extreme, the positive association should be the strongest among high cash holders that are most undervalued and low cash holders that are most overvalued. On the other hand, the

association should be weakest among high cash holders that are most overvalued and low cash holders that are most undervalued.

3. Variables and Sample Selection

This section overviews the variables used in our tests and describes the sample data. Details of the variables are available in the Appendix.

3.1. Cash holdings and stock returns

We measure a firm's cash holdings (*CH*) by its cash-to-asset ratio, which is cash and short-term investments scaled by total assets at the end of fiscal year *t*. The ratio measures the proportion of total assets that is being held as cash and equivalently liquid items. The higher the ratio, the more intensive the firm hoards cash but less of the asset base is productive.

We identify the positive association between cash holdings and average subsequent stock return by forming decile portfolios at the end of June every calendar year *t*+1 using cash holdings from fiscal year *t*.[2] After forming 25 benchmark portfolios by sorting all available stocks independently into market capitalization (*Size*) and book-to-market equity ratio (*B/M*) quintiles, we measure the returns on a stock (*Ret*) between July of year *t*+1 and June of year *t*+2 as the monthly raw stock returns minus the monthly returns on the benchmark portfolio matched to the stock by *Size* and *B/M* quintile rankings.[3] As cash holdings is negatively correlated with market capitalization and book-to-market equity ratio (see, e.g., Simutin, 2010; Palazzo, 2012), the characteristic-adjusted stock returns control for the influence of the size and book-to-market

[2] The portfolio approach allows us to address econometric issues such as overlapping observations, nonlinearities, and the "bad model issue" discussed in Fama (1998) and Mitchell and Stafford (2000) more easily.
[3] *Size* is stock price multiplied by number of shares outstanding at the end of June of year *t*+1 while *B/M* is the Fama and French (1993) book value of equity divided by the market value of equity at the end of fiscal year *t*.

effects (see, e.g., Fama, French, 1992, 1993) on the identification scheme. Finally we match the monthly characteristic-adjusted returns to the stocks in the cash-holdings decile portfolios and rebalance the portfolios annually.

3.2. Macroeconomic risks

To measure the exposures of the cash-holdings portfolios on macroeconomic risks, we employ the classical macroeconomic risks in Chen, Roll, and Ross (1986) (hereafter CRR) in the following time-series regression:

$$R_{p,t} - R_{ft} = \alpha_p + \beta_{p,MP} R_{MP,t} + \beta_{p,UI} R_{UI,t} + \beta_{p,DEI} R_{DEI,t} + \beta_{p,UTS} R_{UTS,t} + \beta_{p,UPR} R_{UPR,t} + \epsilon_{p,t}, \quad (1)$$

where $R_{p,t}$ is the monthly return on cash-holdings portfolio p and R_{ft} is the risk-free rate in month t. R_{MP}, R_{UI}, R_{DEI}, R_{UTS}, and R_{UPR} are the macroeconomic risk factors proposed by CRR related to the growth rate of industrial production, the unexpected inflation, change in expected inflation, term structure of interest rate, and default risk, respectively. The regression slope coefficient (β) measures the exposure of a cash-holdings portfolio on a particular macroeconomic risk stated above. The regression intercept (α) measures the average return on a cash-holdings portfolio controlling for the macroeconomic risks.

The original risk factors are constructed as follows. *MP* is the growth rate of industrial production and is defined as $MP_t = \log(IP_t/IP_{t-1})$, where IP_t is the index of industrial production in month t from the Federal Reserve Bank of St. Louis. MP_t is led by a month to synchronize with the timing of the stock return. *UI* is the unexpected inflation and is the change in expected inflation (*DEI*) as calculated in CRR and is derived from the total seasonally-adjusted consumer price index (CPI) reported by the Federal Reserve Bank of St. Louis. *UTS* is the term premium

and is the yield spread between the long-term (10-year) and the one-year Treasury bonds published by the Federal Reserve Bank of St. Louis. Finally, *UPR* is the default premium and is the yield spread between Moody's Baa and Aaa bonds, again, reported by the Federal Reserve Bank of St. Louis.

As the explanatory variables in regression equation (1) are return while the risk factors *MP*, *UI*, and *DEI* are not traded assets, we follow the standard asset pricing literature to employ mimicking portfolios to track these factors. Although the risk factors *UTS* and *UPR* are traded assets, as in Chan, Karceski, and Lakonishok (1998) and Cooper and Priestley (2011), we also employ mimicking portfolios to track them for consistency. In order words, we construct mimicking portfolios for all the five CRR risk factors and use the return on the mimicking portfolios in estimating regression equation (1). The basis of the mimicking portfolios consist of 10 equal-weighted book-to-market portfolios, 10 equal-weighted size portfolios, 10 equal-weighted momentum portfolios, and 10 equal-weighted cash-holdings portfolios. The book-to-market, size, and momentum portfolios are from French's internet data library. The 10 cash-holdings portfolios are our cash-holdings deciles described earlier.

Following Lehmann and Modest (1988) and Cooper and Priestley (2011), we construct the pure factor mimicking portfolios as follows. Firstly, we project the monthly returns on each of the 40 basis assets on the five CRR risk factors. In other words, we perform 40 time-series return regressions to estimate a 40 by 5 matrix B of slope coefficients of the five CRR factors. Let V be the 40 by 40 covariance matrix of error terms for these regressions, which are imposed to be orthogonal. It follows that the portfolio weights to track the five CRR factors are given by the 5 by 40 matrix $w = (B'V^{-1}B)^{-1}B'V^{-1}$ and the mimicking portfolios are given by wR', where R is a T by 40 matrix with each column containing the time-series returns on a basis asset over the

sample period. The product *wR'* gives a 5 by *T* matrix, in which each row represents the returns on a mimicking portfolio for a CRR factor over the sample period. The mimicking portfolio constructed this way for a specific CRR factor has a sensitivity of one with respect to that factor and zero sensitivity with respect to the other factors.

3.3 Limits to arbitrage

As in Pontiff (1996), Wurgler and Zhuravskaya (2002), Ali, Hwang, and Trombley (2003), Mashruwala, Rajgopal, and Shevlin (2006), Duan, Hu, McLean (2010), McLean (2010), Lam and Wei (2011), Lipson, Mortal, and Schill (2011), we use idiosyncratic stock return volatility (*IVol*) to measure arbitrage risk. Our measure of transaction costs is the inverse of stock price (1/*Price*). Bhardwaj and Brooks (1992) suggest that stock price is inversely related to bid-ask spread and the brokerage commission. Ball, Kothari, and Shanken (1995) also use stock price as an inverse proxy for bid-ask spread and illiquidity. Stoll (2000) shows that recent stock prices are inversely related to relative bid-ask spread. Our measure of illiquidity is the inverse of dollar trading volume (1/*DVol*), which is related to price pressure and time required to fill an order or to trade a large block of shares (Bhushan, 1994). Another proxy of illiquidity is the Amihud (2002) illiquidity (*Illiquid*), which measures the impact of order flow on stock price. Stocks with higher arbitrage risk, transaction costs, or illiquidity are considered to have more severe limits to arbitrage. Limits to arbitrage variables are measured at the end of June of calendar year *t*+1.

3.4 Ex-ante Misvaluation

Our methodology of identifying ex-ante misvaluation shares a similar spirit with Stambaugh,

Yu, and Yuan (2012, 2013). We construct a relative valuation index (*RVI*) by combining the following ten cross-sectional stock return anomalies:

1. Asset growth effect

   Cooper, Gulen, Schill (2008) document that firms that increase their total assets have lower future stock return. They suggest that it is due to overreaction to asset expansions or contractions

2. Accruals effect

   Sloan (1996) document that firms with higher accruals have lower future stock return. He suggests that it is due to overestimation of the persistence of the accrual component of earnings.

3. Net operating asset effect

   Hirshleifer, Hou, Teoh, Zhang (2004) document that firms with higher net operating assets have lower future stock return. They suggest that it is due to limited attention to accounting profitability neglects cash profitability.

4. Capital investment effect

   Titman, Wei, and Xie (2004) document that firms with higher capital investment have lower future stock return. They suggest that it is due to underreaction to the overinvestment by empire-building managers.

5. Financing effect

   Bradshaw, Richardson, Sloan (2006) document that firms that increase their overall external funding have lower future stock return. They suggest that it is due to managers opportunistically issue overvalued securities and retire undervalued securities.

6. Net share issuance effect

Daniel and Titman (2006) document that firms that issue more shares have lower future stock return. They suggest that managers issue (retire) shares in response to favorable (unfavorable) intangible information, which might reflect overvaluation (undervaluation).

7. Earnings and gross profitability effects

   Fama and French (2006) document that firms with higher earnings profitability have higher future stock return. Novy-Marx (2013) document that firms with higher gross profitability have higher future stock return. Lam, Wang, and Wei (2013) find that these effects exist only when market valuations are inconsistent with the profitability and during high sentiment periods while firms with high profitability but low market valuation have higher abnormal earnings announcement return, analyst earnings forecast errors and forecast revisions than firms with low profitability but high market valuation. They suggest that the effects are due to expectation errors.

8. Book-to-market effect

   Piotroski and So (2012) document that firms with higher book-to-market equity ratios but stronger fundamentals have higher future stock return while firms with higher book-to-market equity ratios but weaker fundamentals do not. They suggest that it is due to biased expectations.

9. Financial distress effect

   Dichev (1998) document that firms with higher bankruptcy risk have higher future stock return. Campbell, Hilscher, and Szilagyi (2008) further show that the effect is stronger among firms with more informational frictions and suggest that it is due to misvaluation.

10. Momentum effect

Jegadeesh and Titman (1993, 2001) document that firms with higher previous year stock return have higher future stock return. They suggest that it is due to misreaction to firm information.

While each anomaly might serve as a misvaluation proxy itself, we combine them in order to diversify away the measurement error in each individual effect and produce a more precise measure. The combination also provides a comprehensive measure that reflects misvaluation due to various behavioral reasons. We independently sort stocks into 11 individual quintiles based on a variable reflecting each of the above anomalies, namely total asset growth (*TAG*), accounting accruals (*Ac*), net operating assets (*NOA*), capital investment (*I*/*A*), overall external financing (*XF*), net share issuance (*NSI*), earnings profitability (*ROA*), gross profitability (*GP*), Piotroski and So (2012) misvaluation score (*MSCORE*), Ohlson (1980) bankruptcy risk score (*OSCORE*), and past year stock return (*PRet*). The first ten variables are measured at the end of fiscal year *t* and the last one is measured at the end of June of calendar year *t*+1. For each of the sort we assign a quintile rank to each stock such that the highest rank is associated with the lowest average future stock return, i.e., the highest relative degree of overpricing according to the given anomaly. We then take the simple average of these 11 rankings on each stock and the relative valuation index (*RVI*) is the tercile ranking of the average. As the relative valuation index is purely cross sectional, it only measures relative misvaluation. Stocks with a higher *RVI* are associated with lower average future stock return hence higher *RVI* proxies for higher relative overvaluation or lower relative undervaluation. Stocks with a lower *RVI* are associated with higher return hence lower *RVI* proxies for lower relative overvaluation or higher relative undervaluation.

3.5. Sample selection

Our data contains firms traded on the NYSE, Amex, and Nasdaq exchanges. Their annual financial statements and monthly stock data are from the Compustat and the Center for Research in Security Prices (CRSP), respectively. The observed CRR factors are from Liu and Zhang (2008).[4] The baseline sample covers annual firm financials from 1959 to 2011, and monthly stock returns from the end of July of 1960 to the end of November of 2011. The return sample used for tests involving the relative valuation index (*RVI*) begins at the end of July 1972 when the data needed to calculate the Piotroski and So (2012) misvaluation score (*MSCORE*) becomes available. Like Fama and French (1992, 1993), certificates, American depositary receipts (ADRs), shares of beneficial interest (SBIs), unit trusts, closed-end funds, real estate investment trusts (REITs), and financial firms are excluded. Firms in our sample have appeared on Compustat for at least two years hence the selection and backfilling bias is alleviated. We also delete firms which we do not have the necessary information to compute the variables in a year. Delisting returns are further used to mitigate the survivorship bias.[5]

4. Summary Statistics and the Positive Association between Cash Holdings and Stock Return

Table 1 reports summary statistics and sample correlations. The average cash holdings is 12.38% of total assets. The minimum cash holdings is only 3% while the maximum cash holdings is 85.21%. The standard deviation of cash holdings is 14.47% hence there is a meaningful variation of cash holdings in the cross section. Cash holdings is negatively correlated with the relative valuation

[4] We thank Laura Liu for sharing the updated data.

[5] Shumway (1997) suggests that stocks delisted due to poor performance (delisting codes 500 and 520 to 584) usually have missing delisting returns. We use raw returns of –30% for these stocks when delisting returns are missing. We use raw returns of 0% for other firms when delisting returns are not available.

index. Consistent with the mispricing hypothesis, firms that hold more cash tend to be relatively undervalued and vice versa. As expected, the limits to arbitrage measures are all significantly positively correlated.

Table 2 presents the cash-holdings decile portfolios. On average 2647 firms go into the sorting and there are about 265 stocks in each cash-holdings decile per year in the full sample. The cash holdings in the low decile (1) is 0.94% while the cash holdings in the high decile (10) is 49.42%. The difference in cash holdings between high and low cash holdings amounts to a substantial 48.48%. Consistent with the literature, firms with higher cash holdings are smaller by market capitalization and have lower book-to-market equity ratio. The association between cash holdings and average future stock return could be driven by the size effect in which smaller firms have higher stock return. On the other hand, the association might be concealed by the book-to-market effect in which firms with lower book-to-market equity ratios have higher stock return. As discussed in the previous section, we use the size and book-to-market characteristic-adjusted stock return to identify the positive association between cash holdings and stock return more precisely.

The average characteristic-adjusted stock return on the low cash-holdings decile is -0.18% per month and is significant at the 1% level. The return is almost monotonically increasing as cash holdings increases. The average adjusted stock return on the high cash-holdings decile is -0.44% per month and is significant at the 1% level. The difference in the return between high and low cash-holdings deciles is 0.63% per month and is significant at the 1% level. Consistent with the literature, we observe a substantial and significant positive association between cash holdings and average subsequent stock return.

5. The Roles of Macroeconomic Risks in the Association between Cash Holdingss and Stock Return

Table 3 reports the average premiums on the five CRR macroeconomic risks or essentially the average return on the mimicking portfolios tracking the five risk factors. Like Liu and Zhang (2008) and Cooper and Priestley (2011), we find a significantly positive premium on the *MP* (growth rate of industrial production) factor. Similar to Cooper and Priestley (2011), we also find insignificant premiums on the *UI* (unexpected inflation) and *DEI* (change in expected inflation) factors, a significantly positive premium on the *UTS* (term structure) factor, and a significantly negative premium on the *UPR* (default risk) factor. In our sample, the average premiums on the MP, UTS, and UPR factors are 1.22%, 1.10%, and -0.25% per month, respectively. The magnitudes of these premiums are very close to those in Cooper and Priestley (2011). Although the negative premium on the default factor seems absurd, it is indeed consistent with the distress risk puzzle, i.e. firms with higher distress risk have higher average future stock return, documented by Dichev (1998), Campbell, Hilscher, and Szilagyi (2008), and many others.

Table 4 presents the test results on Hypotheses 1 and 2. The exposure or loading of low cash-holdings firms on the *MP* factor (β_{MP}) is 0.00 and insignificant. The exposure seems to slightly rise and stay rather flat as cash holdings increases. The exposure of high cash-holdings firms on the *MP* factor is 0.09 and significant at the 5% level. The difference in the exposure on the *MP* factor between high and low cash-holdings firms is 0.09 but not significant at the 10% level. The case on the *DEI* factor is similar. The exposure of low cash-holdings firms (β_{DEI}) is -1.20 and significant at the 5% level. The exposure seems to rise as cash holdings increases. The exposure of high cash-holdings firms on the *DEI* factor is 0.84 and significant at the 5% level. The difference in the exposure on the *DEI* factor between high and low cash-holdings firms is

economically large at 2.04 yet not significant at the 10% level probably due to the high standard error of the coefficient estimate.

On the *UI* factor, the exposure (β_{UI}) of low cash-holdings firms is 0.31 and significant at the 5% level. The exposure tends to drop as cash holdings increases. The exposure of high cash-holdings firms on the *UI* factor is -0.09 and insignificant. The difference in the exposure on the *UI* factor between high and low cash-holdings firms is -0.40 and significant at the 10% level. The case on the *UTS* factor is similar. The exposure (β_{UTS}) of low cash-holdings firms is 0.00 and insignificant. The exposure seems stay flat and drop as cash holdings increases. The exposure of high cash-holdings firms on the *UTS* factor is -0.06 and significant at the 5% level. The difference in the exposure on the *UTS* factor between high and low cash-holdings firms is -0.06 and is significant at the 5% level.

As high cash-holdings firms do no have higher exposures on the *MP* and *DEI* factors while they have lower exposures on the *UI* and *UTS* factors than low cash-holdings firms, the findings are not consistent with Hypothesis. However, the case for the default risk is consistent with Hypothesis 1. The exposure of low cash-holdings firms (β_{UPR}) is -0.35 and significant at the 5% level. The exposure almost monotonically rises as cash holdings increases. The exposure of high cash-holdings firms on the *UPR* factor is 0.56 and significant at the 5% level. The difference in the exposure on the *UPR* factor between high and low cash-holdings firms is economically substantial at 0.91 and significant at the 1% level. Higher cash-holdings firms do have higher exposure on the default risk and this finding is consistent with the role of systematic default risk in optimal corporate cash holdings policy in the precautionary savings models of Archarya, Davydenko, and Strebulaev (2012) and Palazzo (2012).

Controlling for the macroeconomic risks, the average stock return on low cash-holdings

firms remain negative at -0.26 per month and significant at the 5% level. The return almost monotonically increases as cash holdings increases. The return on high cash-holdings firms is again positive at .52% per month. The difference in the return between high and low cash-holdings firms is 0.78% per month and significant at the 1% level. The return difference not only remains significant, it also gets somewhat larger after the macroeconomic-risk adjustments. This finding is inconsistent with Hypothesis 2. The main reason that the adjustment fails to capture but strengthens the positive association between cash holdings and stock return is mainly due to the negative premium on the default factor. Although the *MP* factor offers a large positive premium, the positive difference in exposures between high and low cash-holdings firms on this factor is rather small. Again, the *UTS* factor offers a substantial positive premium. However, the difference in exposures between high and low cash-holdings firms on this factor is negative yet rather small. On the other hand, the *UI* and *DEI* factors do not offer significant premiums in order to contribute to the adjustment meaningfully. Overall, it does not seem that the positive association between cash holdings and stock return is a manifestation of the positive relation between cash holdings and expected return predicted by the precautionary savings models.

6. The Roles of Limits to Arbitrage and Ex-ante Misvaluation in the Association between Cash Holdingss and Stock Return

This section reports the test results on Hypotheses 3 and 4 regarding the mispricing explanation.

6.1. The roles of limits to arbitrage

Table 5 presents the test results on Hypothesis 3. Panel A reports the results when the specific limits to arbitrage is arbitrage risk and is measured by idiosyncratic volatility (*IVol*). The distribution of cash holdings among firms with low arbitrage risk subsample is very similar to that among all firms in the full sample. Cash holdings of low cash-holdings firms is 0.96% while that of high cash-holdings firms is 40.39%. The difference in cash holdings between high and low cash-holdings firms is 39.43%. However, high cash-holdings firms no longer have higher average subsequent stock return than low cash-holdings firms. The return on low cash-holdings firms is -0.06% per month and insignificant and the return on high cash-holdings firms is -0.04% per month and insignificant. The difference in return is just 0.02% per month and is insignificant.

The distribution of cash holdings among firms with medium arbitrage risk remains similar. Cash holdings of low cash-holdings firms is 1.02% while that of high cash-holdings firms is 41.81%. The difference in cash holdings between high and low cash-holdings firms is 40.79%. When a medium level of arbitrage risk is present, high cash-holdings firms have higher average subsequent stock return than low cash-holdings firms. The return on low cash-holdings firms is -0.10% per month and insignificant and the return on high cash-holdings firms is 0.34% per month and significant at the 1% level. The difference in return is 0.44% per month and is significant at the 2% level.

Among firms with high arbitrage risk, the distribution of cash holdings again remains similar. Cash holdings of low cash-holdings firms is 0.92% while that of high cash-holdings firms is 45.42%. The difference in cash holdings between high and low cash-holdings firms is 44.50%. The positive association between cash holdings and stock return becomes strongest when a high level of arbitrage risk is present. The return on low cash-holdings firms is -0.24% per month and marginally significant at the 15% level and the return on high cash-holdings firms

is 0.49% per month and significant at the 1% level. The difference in return is 0.73% per month and is significant at the 2% level. Arbitrage risk significantly strengthens the positive association between cash holdings and stock return. The difference in the return difference between high and low cash-holdings firms between high and low arbitrage-risk environment is 0.72% per month and is significant at the 2% level.

Panel B reports the results when the specific limits to arbitrage is transaction costs and is measured by inverse of stock price (1/*Price*). Again, the distribution of cash holdings among firms with low transaction costs subsample is very similar to that among all firms in the full sample. Cash holdings of low cash-holdings firms is 1.01% while that of high cash-holdings firms is 41.12%. The difference in cash holdings between high and low cash-holdings firms is 40.11%. Similarly, high cash-holdings firms no longer have higher average subsequent stock return than low cash-holdings firms. The return on low cash-holdings firms is 0.02% per month and insignificant and the return on high cash-holdings firms is 0.17% per month and insignificant. The difference in return is just 0.15% per month and is insignificant.

The distribution of cash holdings among firms with medium transaction costs is similar. Cash holdings of low cash-holdings firms is 0.97% while that of high cash-holdings firms is 43.05%. The difference in cash holdings between high and low cash-holdings firms is 42.08%. When a medium level of transaction cost is present, the positive association between cash holdings and stock return reemerges. The return on low cash-holdings firms is -0.19% per month and significant at the 5% level and the return on high cash-holdings firms is 0.13% per month although not significant. The difference in return is 0.32% per month and is significant at the 10% level.

Among firms with high transaction costs, the distribution of cash holdings also remains similar. Cash holdings of low cash-holdings firms is 0.94% while that of high cash-holdings firms is 44.94%. The difference in cash holdings between high and low cash-holdings firms is 44.01%. The positive association between cash holdings and stock return also becomes strongest when a high level of transaction costs is present. The return on low cash-holdings firms is -0.16% per month though not significant and the return on high cash-holdings firms is 0.62% per month and significant at the 1% level. The difference in return is 0.79% per month and is significant at the 1% level. Transaction costs also substantially strengthen the positive association between cash holdings and stock return. The difference in the return difference between high and low cash-holdings firms between high and low transaction-costs environment is 0.63% per month and is significant at the 2% level.

Panel C and D report the results when the specific limits to arbitrage is illiquidity and is measured by inverse of dollar volume (1/*DVol*) and the Amihud (2000) illiquidity (*Illiquid*), respectively. The distribution of cash holdings among firms with low illiquidity subsample is also very similar to that among all firms in the full sample. E.g., when the measure is 1/*DVol*, cash holdings of low cash-holdings firms is 1.00% while that of high cash-holdings firms is 41.57%. The difference in cash holdings between high and low cash-holdings firms is 40.57%. Similarly, high cash-holdings firms do not have higher average subsequent stock return than low cash-holdings firms. The return on low cash-holdings firms is -0.02 per month and insignificant and the return on high cash-holdings firms is 0.09% per month and insignificant. The difference in return is just 0.10% per month and is insignificant.

Again, the distribution of cash holdings among firms with medium illiquidity remains similar. E.g., when the measure is *Illiquid*, cash holdings of low cash-holdings firms is 1.00%

while that of high cash-holdings firms is 43.56%. The difference in cash holdings between high and low cash-holdings firms is 42.56%. When a medium level of illiquidity is present, the positive association between cash holdings and stock return again reemerges. The return on low cash-holdings firms is -0.13% per month and marginally significant at the 15% level and the return on high cash-holdings firms is 0.39% per month and significant at the 1% level. The difference in return is 0.52% per month and is significant at the 2% level.

Among firms with high illiquidity, the distribution of cash holdings again remains similar. E.g., when the measure is 1/*DVol*, cash holdings of low cash-holdings firms is 0.95% while that of high cash-holdings firms is 43.88%. The difference in cash holdings between high and low cash-holdings firms is 42.93%. Similarly, the positive association between cash holdings and stock return becomes strongest when a high level of illiquidity is present. The return on low cash-holdings firms is -0.20% per month and marginally significant at the 10% level and the return on high cash-holdings firms is 0.55% per month and significant at the 1% level. The difference in return is 0.75% per month and is significant at the 1% level. Illiquidity significantly strengthens the positive association between cash holdings and stock return as well. The difference in the return difference between high and low cash-holdings firms between high and low illiquidity environment is 0.64% per month and is significant at the 1% level.

Overall, the association between cash holdings and stock return does not appear in the low limits to arbitrage environment. The positive association reappears in the medium limits to arbitrage environment and becomes strongest in the high limits to arbitrage environment. Thus the findings are highly consistent with Hypothesis 3 and supports the mispricing explanation.

6.2. The role of ex-ante misvaluation

Table 6 presents the test results on Hypothesis 4. The stock return on low and high cash holdings firms are influenced by ex-ante misevaluation, as measured by the relative valuation index (*RVI*) in a way expected by the mispricing explanation. Among firms that are relatively undervalued (*RVI*=low), the average future stock return on low cash-holdings firms is 0.06% per month and is insignificant. Low cash-holdings firms do not have particularly low return when they are relatively undervalued or not much overvalued relatively. Among firms that are not as relatively undervalued or slightly overvalued relatively (*RVI*=mid), the return on low cash-holdings firms is lower at -0.19% per month and is marginally significantly at the 15% level. Low cash-holdings firms have lowest return when they are relatively overvalued. Among firms that are that relatively overvalued (*RVI*=high), the return on low cash-holdings firms is -0.47% per month and is marginally significantly at the 1% level. These findings are consistent with the idea that low cash-holdings firms have low stock return because they are overvalued.

On the other hand, among firms that are relatively overvalued, the return on high cash-holdings firms is 0.21% per month and is insignificant. High cash-holdings firms do not have particularly high return when they are relatively overvalued or not much undervalued relatively. Among firms that are not as relatively overvalued or more undervalued relatively, the return on high cash-holdings firms is higher at 0.51% per month and is significantly at the 1% level. High cash-holdings firms have largest return when they are relatively undervalued. Among firms that are that relatively undervalued, the return on low cash-holdings firms is 0.58% per month and is significantly at the 1% level. These findings are consistent with the idea that high cash-holdings firms have high stock return because they are undervalued.

The difference in cash holdings between high and low cash-holdings firms stays between 44.23% and 47.39% as the relative valuations of these firms change. The positive association

between cash holdings and stock return weakens as low cash-holdings firms are more undervalued relatively. The return difference between high cash-holdings firms that are relatively undervalued and low cash-holdings firms decreases from 1.05% per month (significant at the 1% level), to 0.77% per month (significant at the 1% level), to 0.51% per month (significant at the 10% level) when low cash-holdings firms gets more undervalued relatively. The return difference between high cash-holdings firms that are less relatively undervalued and low cash-holdings firms decreases from 0.98% per month (significant at the 1% level), to 0.70% per month (significant at the 1% level), to 0.44% per month (significant at the 10% level) when low cash-holdings firms gets more undervalued relatively. The return difference between high cash-holdings firms that are relatively overvalued and low cash-holdings firms decreases from 0.69% per month (significant at the 2% level), to 0.40% per month (marginally significant at the 15% level), to 0.15% per month (insignificant) when low cash-holdings firms gets more undervalued relatively.

On the other hand, the positive association between cash holdings and stock return weakens as high cash-holdings firms are more overvalued relatively. The return difference between high cash-holdings firms and low cash-holdings firms that are relatively overvalued decreases from 1.05% per month (significant at the 1% level), to 0.98% per month (significant at the 1% level), to 0.69% per month (significant at the 2% level) when high cash-holdings firms gets more overvalued relatively. The return difference between high cash-holdings firms and low cash-holdings firms that are less relatively overvalued decreases from 0.77% per month (significant at the 1% level), to 0.70% per month (significant at the 1% level), to 0.40% per month (marginally significant at the 15% level) when high cash-holdings firms gets more overvalued relatively. Finally, the return difference between high cash-holdings firms and low cash-holdings firms that

are relatively undervalued decreases from 0.51% per month (significant at the 10% level), to 0.4% per month (marginally significant at the 10% level), to 0.15% per month (insignificant) when high cash-holdings firms gets more undervalued relatively.

Overall, the association between cash holdings and stock return is stronger when high cash-holdings firms are relatively more undervalued and/or low cash-holdings firms are relatively more overvalued. These findings are highly consistent with Hypothesis 4 and again support the mispricing explanation. Specifically, the positive association does not appear when high cash-holdings firms are relatively overvalued and low cash-holdings firms are relatively undervalued, i.e., high cash-holdings firms do not have higher average future stock return than low cash-holdings firms without the accompanied by the necessary misvaluation suggested by the mispricing explanation.

7. Conclusions

We test two hypotheses regarding the precautionary savings explanation as well as two hypotheses regarding the mispricing explanation of the positive association between cash holdings and average subsequent stock return. We find that high cash holders do have higher systematic default risk than low cash holder as predicted by the optimal corporate cash holdings policy in precautionary savings models. However, we find that adjusting for default risk as well as other macroeconomic risks do not explain the positive association. The main culprit is the negative average premium on the default risk in the data. It seems the evidence is inconsistent with the asset pricing implication of precautionary savings models.

Cash holdings is negatively correlated with a relatively (over)valuation index and the evidence from the other two tests is positive on the mispricing explanation. The positive

association disappear when limits to arbitrage are low, reappears when limits to arbitrage gets more severe and is strongest when limits to arbitrage are high. Furthermore, the positive association is strongest when high cash holders are undervalued and low cash holders are overvalued. The association becomes weaker when either high cash holders are less undervalued or low cash holders are less overvalued. The association vanishes when high cash holders are least undervalued and low cash holders are least overvalued.

References

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

Amihud, Y., 2002. Illiquidity and stock returns: cross-section and time-series effects. Journal of Financial Markets 5, 31-56.

Ang, A., Hodrick, R.J., Xing, Y., Zhang, X., 2006. The cross-section of volatility and expected returns. Journal of Finance 61, 259-299.

Ang, A., Hodrick, R.J., Xing, Y., Zhang, X., 2009. High idiosyncratic volatility and low returns: international and further U.S. evidence. Journal of Financial Economics, 91, 1-23.

Archarya, V., Davydenko, S.A., Strebulaev, I.A., 2012. Cash holdings and credit risk. Review of Financial Studies, 25, 3572-3609.

Ball, R., Kothari, S.P., Shanken, J., 1995. Problems in measuring portfolio performance: an application to contrarian investment strategies. Journal of Financial Economics 38, 79-107.

Bates, T.W., Kahle, K.T., Stulz, R., 2009. Why do U.S. firms hold so much more cash than they used to ? Journal of Finance 65. 1985-2021.

Bhardwaj, R.K., Brooks, L.D., 1992. The January anomaly: effects of low share price, transaction costs and bid-asked bias. Journal of Finance 47, 553-575.

Bhushan, R., 1994. An informational efficiency perspective on the post-earnings announcement drift. Journal of Accounting and Economics 18, 45-66.

Bradshaw, M.T., Richardson, S.A., Sloan, R.G., 2006. The relation between corporate financing activities, analysts' forecasts and stock returns. Journal of Accounting and Economics 42, 53-85.

Campbell, J.Y., Hilscher, J., Szilagyi, J., 2008. In search of distress risk. Journal of Finance 63, 2899-2939.

Chan., L., Karceski, J., Lakonishok, J., 1998. The risk and returns from factors. Journal of Financial and Quantitative Analysis 33, 159-188.

Chen, N-F., Roll, R., Ross, S., 1986. Economic forces and the stock market. Journal of Business 59, 383-403.

Cooper, M.J., Gulen, H., Schill, M.J., 2008. Asset growth and the cross-section of stock returns. Journal of Finance 63, 1609-1651.

Cooper, I., Priestley, R., 2011. Real investment and risk dynamics Journal of Financial Economics 101. 182-205.

Daniel, K., Titman, S., 2006. Market reactions to tangible and intangible information. Journal of Finance 61, 1605-1643.

De Long, B.J., Shleifer, A., Summers, L.H., Waldmann, R.J., 1990. Noise trader risk in financial markets. Journal of Political Economy 98, 703-738.

Dichev, T.D., 1998. Is the risk of bankruptcy a systematic risk? Journal of Finance 53 1131-1147.

Duan, Y., Hu, G., McLean, R.D., 2010. Costly arbitrage and idiosyncratic risk: evidence from short sellers. Journal of Financial Intermediation 19, 564-579.

Fama, E.F., 1998. Market efficiency, long-term returns, and behavioral finance. Journal of Financial Economics 49, 283-306.

Fama, E.F., French, K.R., 1992. The cross-section of expected stock returns. Journal of Finance 47, 427-465.

Fama, E.F., French, K.R., 1993. Common risk factors in the returns and bonds. Journal of Financial Economics 33, 3-56.

Fama, E.F., French, K.R., 2006. Profitability, investment and average returns. Journal of Financial Economics 82, 491-518.

Fu, F., 2009. Idiosyncratic risk and the cross-section of expected stock return. Journal of Financial Economics, 91, 24-37.

Hirshleifer, D., Hou, K., Teoh, S.H., Zhang, Y., 2004. Do investors overvalue firms with bloated balance sheets? Journal of Accounting and Economics 38, 297-331.

Hou, K., Chen, X., Zhang, L., 2012. Digesting anomalies: an investment approach. Working paper.

Jegadeesh, N, Titman, S., 1993. Return to buying winners and selling losers: implications for stock market efficiency. Journal of Finance 48, 65-91.

Jegadeesh, N., Titman, S., 2001. Profitability of momentum strategies: an evaluation of alternative explanations. Journal of Finance 56, 699-720.

Lakonishok, J., Shleifer A., Vishny R.W., 1994. Contrarian investment, extrapolation, and risk. Journal of Finance 49, 1541-1578.

Lam, F.Y.E.C., Wei, K.C.J., 2011. Limits-to-arbitrage, investment frictions, and the asset growth anomaly. Journal of Financial Economics 102, 127-149.

Lam, F.Y.E.C., Wang, S., Wei, K.C.J., 2014. The profitability premium: macroeconomic risks or expectation errors? Working paper.

Lehmann, B., Modest, D., 1988. The empirical foundations of the arbitrage pricing theory. Journal of Financial Economics 21, 213-154.

Lipson, M.L., Mortal, S., Schill, M.J., 2011. On the scope and drivers of the asset growth effect. Journal of Financial and Quantitative Analysis 46, 1651-1682.

.

Liu, J., Longstaff, F.A., 2004. Losing money on arbitrage: optimal dynamic portfolio choice in markets with arbitrage opportunities. Review of Financial Studies, 17, 611-641.

Liu, L,. Zhang, L., 2009. Momentum profits, factor pricing, and macroeconomic risk. Review of Financial Studies 21, 2417-2448.

Mashruwala, C., Rajgopal, S., Shevlin, T., 2006. Why is the accrual anomaly not arbitraged away? The role of idiosyncratic risk and transaction costs. Journal of Accounting and Economics 42, 3-33.

McLean, R.D., 2010. Idiosyncratic risk, long-term reversal, and momentum. Journal of Financial and Quantitative Analysis, 45, 883-906.

Mitchell, M.L., Stafford, E., 2000. Managerial decisions and long-term stock price performance. Journal of Business 73, 287-329.

Newey, W.K., West, K.D., 1987. A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. Econometrica 55, 703-708.

Novy-Marx, R., 2013. The other side of value: the gross profitability premium. Journal of Financial Economics 108, 1-28.

Opler, T.L., Pinkowitz, R., Stulz, R., Williamson, R., 1999. The determinants and implications of cash holdings. Journal of Financial Economics 52, 3-46.

Palazzo, B., 2012. Cash holdings, risk, and expected returns. Journal of Financial Economics 104, 162-185.

Piotroski, J.D., So, E.C., 2012. Identifying expectation errors in value/glamour strategies: a fundamental analysis approach. Review of Financial Studies 25, 2841-2875.

Pontiff, J., 1996. Costly arbitrage: evidence from closed-end funds. Quarterly Journal of Economics 111, 1135-1152.

Shleifer, A., Vishny, R.W., 1997. The limits of arbitrage. Journal of Finance 52, 35-55.

Shumway, T., 1997. The delisting bias in CRSP data. Journal of Finance 52, 327-340.

Simutin, M., 2010. Excess cash and stock returns. Financial Management 39, 1197-1222.

Sloan, R.G., 1996. Do stock prices fully reflect information in accruals and cash flows about future earnings. Accounting Review 3, 289-315.

Stambaugh, R.F., Yu, J., Yuan, Y., 2012, The short of it: investor sentiment and anomalies. Journal of Financial Economics 104, 288-302.

Stambaugh, R.F., Yu, J., Yuan, Y., 2013, Arbitrage asymmetry and the idiosyncratic volatility puzzle. Working paper.

Stoll, H.R., 2000. Friction. Journal of Finance 55, 1479-1514.

Titman, S., Wei, K.C.J., Xie, F., 2004. Capital investments and stock returns. Journal of Financial and Quantitative Analysis 39, 677-700.

Wurgler, J., Zhuravskaya, E., 2002. Does arbitrage flatten demand curves for stocks? Journal of Business 75, 583-608.

Appendix
Variable definition

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

IVol: Idiosyncratic stock return volatility, measured as the standard deviation of the residual values from the following 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 S&P 500 index. The model is estimated with 36 months of return ending in June and requires a full 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. 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. Data source: CRSP.

Illiquid: The Amihud (2002) illiquidity measure, which is defined as the time-series average of absolute daily return divided by daily dollar trading volume over the past one year ending in June. Data source: CRSP.

TAG: Growth in book value of total assets, calculated as the change in total assets (item AT) over a fiscal year scaled by beginning total assets. Data source: Compustat Annual.

Acc: Accounting 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 a fiscal year scaled by beginning total assets. Data source: Compustat Annual.

NOA: Net operating assets, calculated as the change in operating assets and operating liabilities over a fiscal year scaled by beginning total assets. Operating assets is total assets minus cash and short-term investments (item CHE). Operating liabilities 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.

I/A: Investment-to-asset ratio, calculated as the change in inventories (item INVT) and gross property, plant, and equipment (item PPEGT) over a fiscal year scaled by beginning total assets. Data source: Compustat Annual.

XF: Net cash flow from external financing, calculated as the sum of ΔE and ΔD. ΔE is net cash flow from equity financing, measured as the cash proceeds from sales of common and preferred stocks (COMPUSTAT item SCSTKC plus item SPSTKC) less the cash payments for purchases of common and preferred stocks (item PRSTKCC

plus PRSTKPC) less cash payments for dividends (item CDVC) over a fiscal year scaled by beginning total assets. ΔD is net cash flow from debt financing, measured as the cash proceeds from issuance of long-term debt (Compustat item DLTIS) less the cash payments for long-term debt reductions (item DLTR) plus changes in current debt (item DLCCH, set to zero if it is missing) over a fiscal year scaled by beginning total assets.[6] Data source: Compustat Annual.

NSI: Net share issuance, calculated as the natural logarithm of the ratio of split-adjusted shares (item CSHO multiplied by item ADJEX_C) outstanding at the end of a fiscal year to that at the beginning of the year. Data source: Compustat Annual.

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

GP: Gross profitability, calculated as the gross profit (item GP) over a fiscal year scaled by beginning total assets. Data source: Compustat Annual.

FSCORE: A financial strength measure of Piotroski (2000) and is calculated as the sum of nine dummies, each equals one if a given condition holds and zero otherwise.[7] The conditions are: (1) income before extraordinary items (Compustat item IB) for a fiscal year is positive; (2) cash flow from operations for a fiscal year as defined below is positive; (3) the change in return on assets, defined as income before extraordinary items over a fiscal year divided by beginning total assets, is positive; (4) cash flow from operations exceeds income before extraordinary items for a fiscal year; (5) the change in leverage, defined as long-term debt (items DLTT and DD1) divided by assets at the end of a fiscal year, is negative; (6) the change in liquidity, defined as current assets (item ACT) divided by current liabilities (item LCT) at the end of a fiscal year, is positive; (7) the change in gross margin, defined as one minus the ratio of the cost of goods sold (item COGS) to sales (item REVT) for a fiscal year, is positive; (8) the change in asset turnover, defined as sales for a fiscal year divided by beginning total assets, is positive; and (9) the company has a positive cash flow from the sale of common and preferred stock (item SSTK) for a fiscal year. The changes above are measured between a fiscal year and the lagged fiscal year. If Compustat indicates that the company reports a statement of cash flows (format code 7), cash flow from operations is net cash from operating activities (OANCF). If the company reports a statement of working capital (format code 1), cash flow from operations equals funds from operations (*Op*), minus other changes in working capital (item WCAPC), if available. For other format codes, cash flow from operations is funds

[6] Setting a missing value in item DLCCH to zero provides us with a much larger sample.

[7] The nine financial binary signals measure three different aspects of a firm's financial condition, namely profitability, changes in financial leverage/liquidity, and changes in operational efficiency It measures the overall improvement or deterioration in a firm's recent financial health. Firms with a low *FSCORE* of 3 or below are considered to have deteriorated the most in fundamentals or weak financial performance. Firms with a high *FSCORE* of 7 or above are considered to have improved the most or strong financial performance. Finally, firms with a medium *FSCORE* falling between 4 and 6 are considered to have no substantial deterioration or improvement hence medium financial performance.

from operations plus other changes in working capital, if available. *Op* is income before extraordinary items (item IB) plus income statement deferred tax (item TXDI), if available, plus equity's share of depreciation expenses for a fiscal year, which is depreciation expenses (item DP) multiplied by market value of equity and divided by total assets minus book value of equity plus market value of equity at the end of a fiscal year. Data source: Compustat.

M/B: Market-to-book equity ratio, calculated as the market value of equity divided by the book value of equity at the end of a fiscal year.[8] As in Fama and French (1993), book equity is total assets (Compustat item AT) minus liabilities (item LT), 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 and CRSP.

MSCORE: A misevaluation score in Piotroski and So (2012) and is calculated by comparing the rank of the financial strength measure *FSCORE* with the rank of the market-to-book equity ratio *M*/*B*. When a firm's financial performance is strong (high *FSCORE*) and its earnings expectation is weak (low *M/B*), expectation error is set to 1 and indicates a high potential for undervaluation. When financial performance is strong (high *FSCORE*) and earnings expectation is medium (medium *M/B*) or when financial performance is medium (medium *FSCORE*) and earnings expectation is weak (low *M/B*), *MSCORE* is set to 2 and indicates a mild potential for undervaluation. Likewise, with medium *FSCORE* and high *M/B* or low *FSCORE* and medium *M/B*, *MSCORE* is set to 4 and indicates a mild potential for overvaluation. With low *FSCORE* and high *M/B*, *MSCORE* is set to 5 and indicates a high potential for overvaluation. For the rest, *MSCORE* is set to 3 and indicates a low potential for misvaluation. Data source: Compustat and CRSP.

OSCORE: Bankruptcy risk score suggested by Ohlson (1980), which is calculated as

$$-4.07\times Ln(A) + 6.03\times(L/A) - 1.43\times(CA - CL)/TA + 0.0757\times CL/CA - 2.37\times NI/TA + 0.285\times Loss - 1.72\times NegBook - 0.521\times\Delta NI - 1.83\times Op/TL,$$

where $Ln(A)$ is the natural logarithm of total assets, L is liabilities CA is current assets (item ACT), and CL is current liabilities (item LCT) at the end of a fiscal year. NI is net income (item NI) for the lagged fiscal year. $Loss$ is equal to one if net income for both a fiscal year and the lagged fiscal year is negative and zero otherwise. $NegBook$ is equal to one if L is greater than A and zero otherwise. ΔNI is the change in net income between a fiscal year and the lagged fiscal year scaled by the sum of the absolute values of the net income for the two years. *Op*, funds from operations, is defined as that in *FSCORE*. Data source: Compustat.

[8] According to Fama and French (2003), this ratio measures the valuation of a firm's equity and could proxy for investor expectation of the firm's future earnings. Earnings expectation is regarded as weak, medium, and strong if the tercile ranking of *M/B* is low, medium, and high, respectively.

PRet: Prior-one-year stock return at the end of June, calculated by compounding the 11 monthly raw stock return since the end of previous June. Data source: CRSP.

Table 1
Summary statistics and sample correlations

Panel A reports the pooled-sample summary statistics of cash holdings or cash-to-asset ratio (*CH*) and idiosyncratic volatility (*IVol*) in % as well as stock price (*Price*), dollar trading volume (*DVol*), Amihud (2002) illiquidity (*Illiquid*), and the relative valuation index (*RVI*). Min is the minimum, Med is the median, Max is the maximum, and Stdev is the standard deviation. Panel B reports the time-series average of the cross-section correlations among these variables and those that are significant at 5% level are in bold.

	CH	*IVol*	*Price*	*DVol*	*Illiquid*	*RVI*
Panel A: Summary statistics						
Min	0.03	2.76	0.44	1.00E+04	4.93E-11	1.00
Med	6.59	10.35	15.59	2.29E+07	3.65E-08	2.00
Max	85.21	70.91	479.30	2.06E+10	1.45E-04	1.99
Mean	12.38	11.70	20.89	2.27E+08	6.10E-07	3.00
Stdev	14.67	6.32	24.43	9.01E+08	4.91E-06	0.82
Panel B: Sample Correlations						
IVol	**0.17**					
Price	**-0.03**	**-0.38**				
DVol	**0.02**	**-0.17**	**0.40**			
Illiquid	**0.01**	**0.20**	**-0.14**	**-0.06**		
RVI	**-0.13**	**0.13**	**-0.12**	**-0.06**	-0.01	

Table2
The relation between cash holdingss and subsequent stock return

This table reports time-series averages of firm characteristics at portfolio formation and monthly stock return in % from July of year *t*+1 to June of year *t*+2 on portfolios sorted and rebalanced annually by deciles of cash holdings or cash-to-asset ratio at the end of fiscal year *t*. *N* is the number of firms. *CH* is the median cash-to-asset ratio in %. *Size* is the median market value of equity at the end of June of calendar year *t*+1. *B/M* is the book-to-market equity ratio using Fama and French (1993) book value at the end of fiscal year *t*. *Ret* is the equal-weighted characteristic-adjusted return, which are the stock return minus the return on a benchmark portfolio matched to the stocks at the end of June of year *t*+1 by market value of equity and the book-to-market equity ratio. [10–1] is the difference in characteristic or return between the high (10) and the low (1) cash-holdings deciles. The *t*-statistics *t* for the return are based on Newey and West (1986) standard error with autocorrelations up to 12 lags.

	N	*CH*	*Size*	*B/M*	*Ret*	*t*
1 (low)	264	0.94	1.24E+08	0.88	-0.18	-2.92
2	265	1.96	1.58E+08	0.89	-0.11	-1.98
3	265	3.06	1.81E+08	0.86	-0.12	-2.32
4	264	4.55	1.73E+08	0.85	-0.13	-2.36
5	264	6.62	1.49E+08	0.81	-0.02	-0.38
6	265	9.62	1.38E+08	0.77	0.01	0.28
7	265	13.81	1.24E+08	0.72	0.10	2.24
8	265	20.08	1.14E+08	0.66	0.15	2.82
9	265	29.77	9.81E+07	0.58	0.22	3.23
10 (high)	265	49.42	7.42E+07	0.48	0.44	3.67
[10-1]		48.48	-4.96E+07	-0.40	0.62	3.15

Table 3
Macroeconomic-risk premiums

This table reports the average monthly return in % and the corresponding *t*-statistics *t* based on Newey and West (1986) standard error with autocorrelations up to 12 lags on five portfolios mimicking the Chan, Roll, and Ross (1986) macroeconomic-risk factors. Ret_{MP} is the return that tracks the growth rate of industrial production (*MP*). Ret_{UI} is the return that tracks the unexpected inflation (*UI*). Ret_{DEI} is the return that tracks the change in expected inflation (*DEI*). Ret_{UTS} is the return that tracks the term premium (*UTS*). Ret_{UPR} is the return that tracks the default premium (*URP*).

	Ret_{MP}	Ret_{UI}	Ret_{DEI}	Ret_{UTS}	Ret_{UPR}
Average	1.22	-0.06	-0.01	1.10	-0.25
t	8.23	-0.75	-0.41	2.44	-2.21

Table 4
The relation between cash holdingss and subsequent stock return: macroeconomic risk analysis

This table reports the estimated parameters of the following time-series regression:
$Ret_{p,t} - Ret_{ft} = \alpha_{p,CRR} + \beta_{p,MP}Ret_{MP,t} + \beta_{p,UI}Ret_{UI,t} + \beta_{p,DEI}Ret_{DEI,t} + \beta_{p,UTS}Ret_{UTS,t} + \beta_{p,URP}Ret_{URP,t} + \epsilon_{p,t}$,
where $Ret_{p,t}$ is the characteristics-adjusted monthly return on a cash-holdings decile portfolio or the return spread [10–1] between the highest and the lowest cash-holdings deciles while Ret_{ft} is the risk-free rate in month *t*. Regression parameter estimates that are significant in 5% level are in bold. The *t*-statistics *t* for the [10-1] spreads in regression parameters are based on Newey and West (1986) standard error with autocorrelations up to 12 lags.

	β_{MP}	β_{UI}	β_{DEI}	β_{UTS}	β_{UPR}	α_{CRR}
1 (low)	0.00	**0.31**	**-1.20**	0.00	**-0.35**	**-0.26**
2	**0.07**	0.01	**-0.79**	**0.02**	**-0.12**	**-0.25**
3	0.02	**0.08**	**-0.75**	**0.02**	**-0.13**	**-0.19**
4	**0.06**	0.03	**-0.61**	**0.03**	**-0.12**	**-0.27**
5	**0.05**	0.03	**-0.41**	**0.03**	**-0.09**	**-0.14**
6	-0.01	-0.05	0.14	**0.02**	**-0.07**	-0.01
7	-0.02	**-0.15**	**0.58**	**0.02**	**0.09**	**0.13**
8	**-0.03**	**-0.14**	**0.88**	0.01	**0.14**	**0.22**
9	**-0.10**	**-0.17**	**1.75**	**-0.02**	**0.22**	**0.43**
10 (high)	**0.09**	-0.09	**0.84**	**-0.06**	**0.56**	**0.52**
[10–1]	0.09	-0.40	2.04	**-0.06**	**0.91**	**0.78**
t	1.50	-1.78	1.43	-2.21	7.47	4.76

Table 5
The relation between cash holdingss and subsequent stock return across limits-to-arbitrage subgroups

This table reports time-series averages of cash holdings at portfolio formation and monthly stock return in % from July of year *t*+1 to June of year *t*+2 on portfolios independently sorted and rebalanced annually by tercile of a limits-to-arbitrage (*LTA*) measure and decile of cash-to-asset ratio at the end of fiscal year *t*. ([10-1],high-low) is the difference in the [10–1] spread of cash holdings or return between firms with high limits to arbitrage (*LTA*=high) and firms with low limits to arbitrage (*LTA*=low). The *t*-statistics *t* for the return are based on Newey and West (1986) standard error with autocorrelations up to 12 lags. In Panel A limits to arbitrage is measured by idiosyncratic volatility (*IVol*). In Panel B limits to arbitrage is measured by inverse of stock price (1/*Price*). In Panel C limits to arbitrage is measured by inverse of dollar trading volume (1/*DVol*). In Panel D limits to arbitrage is measured by the Amihud (2002) illiquidity (*Illiquid*). Limits to arbitrage variables are measured at the end of June of year *t*+1.

Panel A: Limits to arbitrage proxied by *IVol*

LTA=low	*CH*	*Ret*	*t*
1	0.96	-0.06	-0.61
2	1.92	-0.14	-1.70
3	2.97	0.04	0.48
4	4.34	-0.02	-0.28
5	6.17	-0.03	-0.36
6	8.72	0.09	1.05
7	12.34	0.12	1.42
8	17.56	0.06	0.72
9	25.87	0.04	0.44
10	40.39	-0.04	-0.34
[10-1]	39.43	0.02	0.17
LTA=mid			
1	1.02	-0.10	-1.11
2	1.94	-0.01	-0.06
3	2.97	-0.07	-0.74
4	4.33	0.02	0.20
5	6.19	0.09	1.07
6	8.86	0.13	1.60
7	12.49	0.23	3.16
8	17.83	0.29	3.26
9	26.04	0.28	3.42
10	41.81	0.34	3.41
[10-1]	40.79	0.44	2.35
LTA=high			
1	0.92	-0.24	-1.59
2	1.96	-0.19	-1.42
3	2.94	-0.17	-1.29
4	4.34	-0.05	-0.38
5	6.16	0.04	0.31
6	8.87	0.01	0.07
7	12.51	0.26	2.08
8	17.78	0.24	1.87
9	26.15	0.12	1.01
10	45.42	0.49	3.66
[10-1]	44.50	0.73	2.55
([10-1],high-low)	5.07	0.72	2.51

Table 5 - continued

Panel B: Limits to arbitrage proxied by 1/*Price*

LTA=low	*CH*	*Ret*	*t*
1	1.01	0.02	0.18
2	1.91	-0.03	-0.33
3	2.95	0.08	1.07
4	4.31	0.07	0.95
5	6.13	0.05	0.76
6	8.81	0.11	1.59
7	12.35	0.12	1.84
8	17.71	0.15	2.28
9	25.80	0.22	2.84
10	41.12	0.17	1.52
[10-1]	40.11	0.15	0.82
LTA=mid			
1	0.97	-0.19	-2.07
2	1.94	-0.21	-2.48
3	2.95	-0.07	-0.84
4	4.35	-0.06	-0.77
5	6.21	0.10	1.24
6	8.83	0.10	1.25
7	12.55	0.17	2.31
8	17.80	0.15	1.76
9	26.03	0.09	1.08
10	43.05	0.13	1.29
[10-1]	42.08	0.32	1.71
LTA=high			
1	0.93	-0.16	-1.22
2	1.95	-0.16	-1.41
3	2.92	-0.20	-1.64
4	4.34	-0.01	-0.13
5	6.20	-0.02	-0.14
6	8.83	0.00	0.01
7	12.43	0.30	2.66
8	17.77	0.29	2.51
9	26.19	0.19	1.61
10	44.94	0.62	4.52
[10-1]	44.01	0.79	2.77
([10-1],high-low)	3.90	0.63	2.40

Table 5 - continued

Panel C: Limits to arbitrage proxied by 1/*DVol*

LTA=low	*CH*	*Ret*	*t*
1	1.00	-0.02	-0.21
2	1.93	-0.16	-2.16
3	2.97	0.00	0.01
4	4.33	0.00	0.01
5	6.17	0.05	0.70
6	8.76	0.01	0.19
7	12.47	0.13	1.90
8	17.78	0.11	1.20
9	25.94	0.14	1.45
10	41.57	0.09	0.72
[10-1]	40.57	0.10	0.51
LTA=mid			
1	0.97	-0.09	-0.98
2	1.96	-0.10	-1.20
3	2.96	-0.11	-1.32
4	4.31	-0.04	-0.51
5	6.18	0.07	0.81
6	8.85	-0.01	-0.09
7	12.48	0.17	2.26
8	17.68	0.22	2.73
9	26.08	0.18	2.04
10	43.38	0.41	3.46
[10-1]	42.41	0.50	2.26
LTA=high			
1	0.95	-0.20	-1.65
2	1.94	-0.13	-1.31
3	2.92	-0.07	-0.62
4	4.35	0.01	0.11
5	6.20	0.14	1.19
6	8.79	0.19	1.75
7	12.45	0.29	2.73
8	17.80	0.33	3.07
9	26.09	0.16	1.52
10	43.88	0.55	4.36
[10-1]	42.93	0.75	3.09
([10-1],high-low)	2.36	0.64	2.96

Table 5 - continued

Panel D: Limits to arbitrage proxied by *Illiquid*

LTA=low	*CH*	*Ret*	*t*
1	1.00	0.01	0.14
2	1.93	-0.09	-1.22
3	2.96	0.01	0.18
4	4.34	0.02	0.23
5	6.17	0.06	0.95
6	8.79	0.03	0.44
7	12.48	0.19	2.97
8	17.75	0.06	0.80
9	25.82	0.21	2.28
10	41.07	0.14	1.26
[10-1]	40.07	0.13	0.73
LTA=mid			
1	1.00	-0.13	-1.47
2	1.94	-0.14	-1.62
3	2.95	-0.08	-1.04
4	4.32	0.03	0.30
5	6.18	0.03	0.31
6	8.83	0.07	0.89
7	12.51	0.18	2.56
8	17.67	0.24	3.01
9	26.06	0.20	2.26
10	43.56	0.39	3.31
[10-1]	42.56	0.52	2.33
LTA=high			
1	0.93	-0.17	-1.39
2	1.95	-0.15	-1.37
3	2.92	-0.08	-0.72
4	4.34	-0.11	-1.07
5	6.20	0.14	1.17
6	8.82	0.09	0.82
7	12.44	0.25	2.36
8	17.83	0.31	2.83
9	26.20	0.09	0.79
10	44.16	0.56	4.73
[10-1]	43.23	0.74	2.72
([10-1],high-low)	3.16	0.61	2.41

Table 6
The relation between cash holdingss and subsequent stock return across ex-ante misvaluation subgroups

This table reports time-series averages of cash holdings at portfolio formation and monthly stock return in % from July of year *t*+1 to June of year *t*+2 on portfolios independently sorted and rebalanced annually by tercile of the relative valuation index (*RVI*) and decile of cash-to-asset ratio at the end of fiscal year *t*. [low,10-high,1] is the difference in cash holdings or return between firms with low relative valuation (*RVI*=low) and high cash holdings and firms with high relative valuation (*RVI*=low) and low cash holdings. The other differences are defined analogously. The *t*-statistics *t* for the return are based on Newey and West (1986) standard error with autocorrelations up to 12 lags.

RVI=low	*CH*	*Ret*	*t*
1	0.53	0.06	0.42
2	1.29	0.09	0.77
3	2.23	0.09	0.91
4	3.54	0.15	1.46
5	5.43	0.25	2.57
6	8.19	0.22	2.18
7	12.10	0.42	4.32
8	18.25	0.30	3.14
9	27.72	0.29	2.94
10	44.76	0.58	4.20
RVI=mid			
1	0.45	-0.19	-1.54
2	1.27	0.08	0.74
3	2.20	0.00	-0.04
4	3.52	0.14	1.27
5	5.41	0.10	0.84
6	8.11	0.28	2.40
7	12.23	0.10	0.96
8	18.33	0.37	3.21
9	27.94	0.37	2.69
10	46.83	0.51	4.01
RVI=high			
1	0.46	-0.47	-3.78
2	1.26	-0.29	-2.45
3	2.20	-0.38	-3.33
4	3.49	-0.55	-4.49
5	5.38	-0.25	-2.13
6	8.21	-0.22	-1.72
7	12.24	-0.05	-0.29
8	18.19	-0.45	-2.96
9	27.38	-0.03	-0.16
10	47.84	0.21	1.09
[low,10-high,1]	44.29	1.05	4.50
[mid,10-high,1]	46.37	0.98	4.40
[high,10-high,1]	47.37	0.69	2.36
[low,10-mid,1]	44.31	0.77	3.16
[mid,10-mid,1]	46.38	0.70	3.09
[high,10-mid,1]	47.39	0.40	1.47
[low,10-low,1]	44.23	0.51	1.74
[mid,10-low,1]	46.30	0.44	1.80
[high,10-low,1]	47.31	0.15	0.50