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Is cash-return relation risk induced?

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- **Abstract**: Corporate cash holding is found to be able to predict stock return. Some scholars attribute this to the association of cash with systematic risk with respect to growth options. Others find that the relation is a mispricing effect. In this paper, I try to test whether the relation between cash and return is driven by systematic risk that captured by cash. The empirical results do not support the risk explanation of cash-return relation. First, the risk loading on CASH factor cannot predict returns, which is not consistent with rational frictionless asset pricing models. Second, CASH factor cannot reflect future GDP growth. Third, CASH and its factor loading exhibit no association with implied cost of capital derived from analysts' earnings forecasts. Also, it is found that institutional investors tend to hold more shares of companies whose cash holdings intend to be high in the next period and the return spread by cash in firms with more institutional ownerships is lower than that in firms with less institutional ownerships. Overall, this paper casts doubt on the argument that cash can serve as a proxy of systematic risk in the explanation of cross sectional variation in stock returns, while it supports a mispricing explanation.

JEL: G12, G31

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1. Introduction

In the paper of Palazzo [2012, Cash holdings, risk, and expected returns, Journal of Financial Economics, 104(1), 162-185], a relation between cash holdings and expected return is built based on the precautionary motivation for firms to hold cash. The idea of his paper is that firms save assets as cash to avoid the costly external funding when cash flow is highly positively correlated with aggregate shocks, indicating firms tend to hold cash to hedge on risk (higher correlation between cash flow and aggregate shocks) and hence firms with more cash have higher subsequent returns to compensate on this risk. Empirically he shows the spread return of portfolios sorted by cash cannot be fully explained by Fama French three factors, suggesting that the risk captured by cash holdings is different from market systematic risk, small size risk and low value risk. His paper indicates cash can serve as a risk proxy (Simutin, 2010). However, although the paper does provide evidence that cash holdings can explain cross sectional variations in stock returns, whether this relation is risk induced is not sophisticatedly evidenced.

Besides the rational asset pricing theory, behavior finance is another important strand to explain the variation in stock returns. Researchers have found some anomalies with respect to accounting information, such as accrual anomaly (e.g., Sloan, 1996) and net operating assets (e.g., Hirshlefer et al., 2004), cannot be explained by rational theories. Instead, these anomalies are found to be attributed to mispricing caused by investors' limits of attention on the information contained in these financial numbers. Cash is also a kind of financial information. From perspective of corporate finance, the amount of cash held by firms is subject to two important reasons: financial constraints (Almeida, 2004) and agency problems (Jensen, 1986). The financial constraint story indicates positive impacts of large cash holdings, while the agency problem story indicates negative impacts. If the market participants cannot interpret the information indicated by cash precisely, they would misprice the stock, resulting in anomalies in subsequent periods when the mispricing is corrected.

There are recently two papers trying to explain cash-return relation through mispricing channel. The ideas in these two papers are quite similar: investors overreact on the agency problems captured by high cash holdings and underestimate the stock value, so buying stocks with high cash holdings will get high subsequent stock returns. The first paper is by Li and Luo (2016), finding that cash-return relation is heavily influenced by investor sentiment since the relation is more pronounced after high sentiment periods and that cash-return relation is stronger when limits-to-arbitrage measured by transaction costs, institutional ownership and idiosyncratic volatility is higher. The second paper is the working paper by Lam et al. (2016) who find that cash-return relation is a surrogate for knowing mispricing and support a mispricing channel how cash holdings and stock returns are correlated. First, they find that the return predictability in cash holdings is subsumed by accruals and profitability effects and also by net operating assets effect. Second, they find that the positive relation strengthens when limits to arbitrage is more severe, indicating that cash-return relation is stronger within firms with severe mispricing phenomenon.

The above two papers, especially the latter one, contradict with Palazzo's paper since if cash can serve as a proxy for systematic risk, the predictability of cash on stock return should not be subsumed by any other variables. Therefore, whether returns on high cash holdings are compensation of systematic risk is actually in debate. However there are very few papers to dissect the cash-return relation in the existing literature. Whether cash-return relation is risk induced is still an open empirical question. This paper tries to fill this gap by exploring the ability of cash to serve as a risk proxy using a systematic way that researchers have developed.

The controversy about whether it is the risk or the equity characteristics that explains expected returns for a specific anomaly has been studied since 1990s. For example, Daniel and Titman (1997) argue that it is the size and book-to-market characteristics rather than the loadings on SMB and HML that affect expected returns. Davis et al. (2000) find that risk factors explain expected returns better than characteristics when the sample periods is large and their test covers period from 1926 to 1997, compared to that of Daniel and Titman's (1997) which covers from 1963 to 1997. Core et al. (2008) test whether the accruals quality is a priced risk factor. Mohanram et al. (2009) test whether PIN factor is priced. Hirshleifer et al. (2012) test whether the accrual anomaly is because of risk or mispricing. The methodologies used to test whether a factor is a risk factor are quite mature and systematic.

Following these papers, I use several common used methods to test whether CASH can serve as a risk proxy in explaining the cross sectional variations of stock returns. First, I construct the cash factor, LMS (large amount minus small amount), by taking a long position on firms with large amount of cash holdings and taking a short position on firms with small amount of cash holdings. The mean monthly time-series premium for the LMS of 0.27% and is statistically different from zero with a significance level of 95%.

Then I use a two-stage cross sectional regression method (2SCSR). In the first stage, it estimates factor betas and in the second stage, estimates the factor risk premiums. Under the rational factor pricing explanation of cash holding anomaly, expected returns are determined by a stock's cash factor loadings. If cash affects stock returns because of systematic risk it captures, the risk premium on cash factor loadings should be positive and significant. However, it is found that the coefficient on LMS loadings is positive but is not significant.

In addition to the 2SCSR tests, I also use several other approaches that are used in the literature. One such test is to examine whether LMS can predict future GDP growth. This methodology have been used by Chen (1991), Liew and Vassalou (2000), Chordia and Shivakumar (2006) and Mohanram and Rajgopal (2009) to test whether the Fama–French factors, price momentum and PIN are proxies for risk factors. Since GDP growth contains information of investment opportunities of the whole economy, if a risk factor represents the premium on systematic risk, i.e., compensation on the risk to the whole economy rather than some particular firms or industries, it should have a positive association with future GDP growth rate. However, in the context of this paper, the results show that there's no such association between LMS and GDP growth rate.

Then, I test whether LMS or LMS loadings affect the expected costs of capital. Compare with subsequent realized stock returns, ex-ante expected costs of capital are estimated using existing accounting information. Since ex-ante costs of capital have shown to be positively related to risk, correlation between LMS or LMS loadings and ex-ante costs of equity is a necessary condition to conclude that LMS and LMS loadings reflect systematic risk. Again, I couldn't find empirical evidence of this.

At last, I test whether there are supports of the mispricing explanation of cash-return relation. I first test the trading behavior of institutions pre-anomaly of cash and find that institution investors tend to hold more shares of companies whose cash holdings intend to be high in the next period. Then I compare return spread by cash between portfolio with stocks held by more institutional investors and portfolio with stocks held by less institutional investors. It is found that return spread by cash in firms with more institutional ownerships is lower than that in firms with less institutional ownerships, suggesting that the return spread by cash is due to limited attention of investors on cash information, supporting the mispricing explanation.

Overall, I interpret these results shown in this paper as documenting that based on the tests of rational asset pricing framework, cash cannot serve as a proxy of systematic risk.

This paper shed lights on the literature of cash anomaly. The topic on how cash holdings affect expected returns has drawn considerable attentions in the past several years. Excess cash holdings (Simutin, 2010), the level of cash holdings (Palazzo, 2012) and the change in cash holdings (Sodjahin, 2013) are found to have a positive relation with expected stock returns. Specifically, Simutin (2010) find that as a proxy for unexpected investment growth option, excess cash is positively associated with expected returns. Palazzo (2012) develops a rational model to show the positive relation between cash holdings and expected returns based on its relation with cash flow risk. Sodjahin (2013) argues that the change in cash holding is a proxy of the coming investment opportunity and the high return is a compensation for the risk that accompanies the new investment opportunity. Although they try to explain cash-return relation from a perspective of rational asset pricing theory that firms hold cash for future investment options, they didn't provide solid evidence on this with reasonable asset pricing methods. What's more, there are papers shown that cash-return relation is caused by investors' misinterpretation of the information contained in cash holdings (Li and Luo 2016, Lam et al. 2016). In this study, I explore in further by asking whether there is a pervasive systematic factor with respect to cash holdings directly associated with return variability.

In the next section, I describe the sample and replicate table 4 and table 5 in Palazzo's paper. Section 3 reports the construction of LMS factor and its correlation with existing Fama and French factors. Section 4 shows the results of two-stage cross sectional regressions. Section 5 tests the correlation between cash and future GDP growth. Section 6 reports the relation between ex-ante cost of equity and LMS/LMS loading. Section 7 tests the possible mispricing explanation of cash-return relation. Section 8 concludes.

2. Replication and extension of Palazzo's paper

2.1 Data and variables

Stock price, stock return and shares of common outstanding are taken from Center for Research in Securities Prices (CRSP) monthly return file; quarterly financial data are obtained from Compustat Quarterly; monthly risk-free interest rate, the three Fama French factors (R_M-R_F, SMB, and HML) and momentum factor returns (UMD) are gotten through Kenneth French's website. The sample is based on all NYSE/AMEX and NASDAQ firms with available data from both CRSP and Compustat quarterly with a period from July 1972 to December 2015. I filter and merge the datasets following the criteria below, most of which is borrowed from Palazzo's paper (Plazzo, 2012): 1) the data from CRSP and Compustat Quarterly are merged by PERMNO; 2) the first six digits of Compustat Committee on Uniform Security Identification Procedures (CUSIP) must be same with the first six digits of the CRSP CUSIP code or the CRSP name CUSIP (NCUSIP) code; 3) only ordinary common shares (share codes 10 and 11 in CRSP) are considered; 4) observations related to suspended, halted, or non-listed shares (exchange codes lower than 1 and higher than 3 are excluded; 5) stocks in the sample should have reported returns for at least 24 months in 5 years prior to portfolio formation; 6) utility firms (SIC codes between 4900 and 4949) and financial firms (SIC codes between 6000 and 6999) are excluded; 7) observations with a negative book-to-market ratio or a negative cash-to-assets ratio are excluded from the sample.

For the measurements, cash holding is calculated as cash and short term investments (item CHE) over total assets (item AT). Size is the market value of stock at portfolio formation. Book equity is stockholder's equity (item SEQQ), or common equity (item CEQQ) plus preferred stock par value (item PSTKQ), or asset (item ATQ) minus liabilities (item LTQ)) plus balance sheet deferred taxes and investment tax credit(item TXDITCQ) minus the book value of preferred stock (item PSTKRQ, or PSTKQ if PSTKRQ is not available). The book to-market ratio is calculated by dividing book equity by market capitalization measured at portfolio formation. Return is adjusted using delisting return on delisting day.

2.2 Replication of Palazzo's paper

To make this study comparable to Palazzo's, in this section, I replicate the results of the portfolio characteristics and spread of return by one-way sort (table 3 and table 4) in his paper. Palazzo (2012) shows that cash holdings could explain the cross sectional variation in excess return that cannot be explained by existing models such as classic capital asset pricing model (CAPM), Fama and French (1992) three factor model.

In particular, in table 3, Palazzo uses data over the periods from July 1972 to December 2009 and classifies the sample into 10 deciles in each month based on cash over total assets. In table 4, for portfolio construction, instead of rebalancing annually with annual accounting data, he constructs the portfolios based on quarterly accounting data. Following his paper, I use the quarterly accounting data available in month t in portfolio sorts starting at time t+i+1 if there has been an earnings announcement (item RDQ) in month t+i. For example, the first fiscal quarterly financial report (end in March) is announced on May 20, year t, then these data are used to form portfolios starting from June, year t. I don't require i to be 1, 2 or 3 in order to make the sample more continuous in monthly frequency. For example, the first fiscal quarterly financial report (end in March) is announced on July 20, year t, then these data are used to form portfolios starting from August, year t, although the interval between March to August is 5 months. If RDQ is missing, I use the accounting data from the latest fiscal quarter that at least six months prior to portfolio formation. If financial reports of two consecutive quarters are announced in the same month, I will use the latest quarter to sort the portfolio. For example, the financial reports of the first and second fiscal quarter in year t are announced on July 5, year t and July 20, year t, then I'll use the information of the second quarter to sort the portfolio which starts in August, year t.

I first show the results based on a period exactly same with Palazzo's, i.e. from July 1972 to December 2009. Then I extend the sample period to 2015 since more data are available now and moreover this also could test the robustness and pervasiveness of the positive relation between return and cash holdings.

[Insert table 1 here]

Table 1 presents the results of the summary statistics of firm characteristics. Columns from (1) to (5) are over period from July 1972 to December 2009. Compared to Palazzo's paper, all the statistics are quite similar. In particular, book to market ratio, market value are decreasing with cash holdings, while post-rank market beta is increasing with cash holdings. This is also consistent with intuition that firms with more growth options, smaller size and more risk exposure tend to hold more cash. Columns from (6) to (10) report the summary over period from July 1972 to December 2015. The correlations between cash and book to market ratio, market value, post-rank beta are identical across these two different time windows.

[Insert table 2 here]

Table 2 presents the results of the difference in excess and risk adjusted returns between top and bottom deciles for both the equally weighted and value-weighted portfolios. Panel A reports the results over period from July 1972 to December 2009. Panel A.1, A.2 and A.3 report excess return, excess returns adjusted by CAPM model and excess return adjusted by Fama and French (1992) three factor model respectively.

The results are similar to Palazzo's paper in all respects. Firstly, the difference in excess returns, excess return adjusted by CAPM model and excess return adjusted by Fama and French (1992) three factor model between the top and bottom cash-to-assets deciles are all positive. For equally weighted portfolios, all return spreads are statistically significant, but for value weighted portfolios, only Fama French three-factor adjusted return spread is statistically significant. The magnitudes are also similar to his paper. For example, panel A.1 shows that the excess return is 0.796% per month for equally weighted and 0.331% for value weighted, comparable to 0.69% and 0.38% respectively in palazzo's paper. Secondly, differences in loadings on market size, growth options which is reported in panel A.3 are positive and significantly different from zero for both the equally weighted and the value-weighted portfolios. When the sample is extended to December 2015, all results remain similar.

3. Construction and summary statistics for the factor returns

So far, I have replicated palazzo's paper and shown that the results are quite similar to theirs', indicating that the following results are comparable and suggestive to his arguments. In this section, I construct the cash factor using the same sample obtained in the section 2.

3.1 The construction of LMS

Following the construction approach of Fama and French three factors, I create the cash-based factor which I call LMS (large amount minus small amount) as a zero-investment factor-mimicking portfolio. LMS is formed based on cash and size groups via independent sorts. In particular, in each month, all stocks with non-missing size, non-missing cash and positive book equity value are assigned into two size groups (S or B) based on whether the value of size is smaller or larger than the median value of their NYSE breakpoints. Also in each month, all stocks are sorted independently into three cash portfolios (S, M, or L) based on the 30% and 70% NYSE breakpoints. Taking intersections of two size portfolios and three cash portfolios, I form six portfolios which are called S/S, S/M, S/L, B/S, B/M, and B/L. The value-weighted monthly returns of these six portfolios are calculated for each month. The cash factor 'LMS' (large amount-small amount) is the difference between the weighted average of the returns on the two large amounts of cash portfolios (S/L and B/L) and the equal-weighted average of the returns on the two small amounts of cash portfolios (S/S and B/S): (S/L + B/L)/2+ (S/S + B/S)/2.

[Insert table 3 here]

3.2 Summary statistics of LMS and Fama and French factors

The summary statistics of Fama French factors and cash factor is reported in panel A of table 3. The sample consists of 522 monthly time-series return over period of July 1972 to December 2015. The mean monthly time-series return to LMS is 0.27%, indicating a mean annual risk premium of about 3.24%. The return to LMS is different from zero with a significance level of 95%. The modest significance of risk premium does not provide strong evidence that cash is priced (Shanken and Weinstein, 2006).

Panel B of Table 3 reports the correlations between Fama French 5 factors, momentum factor and cash factor. The correlation table shows that the cash factor, i.e. LMS is positively related to market risk factor and size factor and negatively correlated with market to book ratio factor, investment factor and profitability factor. As for the magnitude, LMS is highly correlated with HML(r=-0.633) and RMW (r=-0.570), modestly correlated with SMB and CMA, and have low correlations with market risk premium(r=0.208) and UMD (r=0.123).

3.3 Time-series regression of LMS on Fama and French factors

Note that statistically significant spreads on cash are not sufficient evidence that cash is a priced risk factor since LMS may be subsumed by the existing Fama–French risk factors. Therefore, I test whether LMS is subsumed by regressing LMS on Fama and French 3 factors, 4 factors and 5 factors respectively. The idea is that if LMS can be fully explained by other factors, the estimated intercept which represents the unexplained part should be insignificant. Specifically, the model is as following:

$$\mathrm{LMS}_t = \alpha + \beta(R_m - R_f)_t + s\mathrm{SMB}_t + h\mathrm{HML}_t + m\mathrm{UMD}_t + r\mathrm{RMW}_t + c\mathrm{CMA}_t + \varepsilon_t.$$

The results are reported in Panel C, table 3. Overall, Panel C provides several implications. First, the intercept is significant in all model specifications, suggesting LMS can explain the variation in stock return that cannot be captured by existing factors. Second, UMD has little to do with LMS since the coefficient of UMD is insignificant and the adjusted R-square doesn't increase at all when UMD is augmented. Third, LMS is highly correlated with HML and RMW both in magnitude and in significance. This is consistent with the argument from corporate perspective, that, firms higher investment opportunity (lower book to market ratio), less profitability (more financial constraints) tend to hold more cash. Fourth, the explanation power increased from 44.4% of regression of LMS on Fama and French 3 factors to 60.7% of regression of LMS on Fama and French 5 factors.

3.4 Factor loadings in three-factor and five-factor asset-pricing models

From the last subsection, we know that LMS has little correlation to do with UMD, so in the rest tests, I use Fama and French 3 factor model and 5 factor model instead of the four factor model.

In this subsection, I investigate the effects of cash on contemporaneous equity returns, as manifest in the factor loadings and explanatory power of three-factor (the market risk premium, size premium, and value premium) and five-factor (the market risk premium, size premium, value premium, profitability premium and investment premium) asset-pricing models augmented with LMS. The models are illustrated as below:

$$R_{i,t} - R_{f,t} = \alpha + \beta\left(R_{m,t} - R_{f,t}\right) + sSMB_t + hHML_t + lLMS_t + \varepsilon_t$$

$$R_{i,t} - R_{f,t} = \alpha + \beta(R_{m,t} - R_{f,t}) + sSMB_t + hHML_t + cCMA_t + rRMW + lLMS_t + \varepsilon_t.$$

I begin by estimating the above two models for each of the 10565 firms with at least 18 monthly returns between July 1972 and December 2015. Then I take means of coefficient estimates and t-statistics for the 10565 regressions. If LMS proxy for new factor premium, it should have a significant effect on explaining the variations in returns. The coefficient of LMS should be positive and significant, and the explanatory power should be enhanced after LMS is augmented into these models.

[Insert table 4 here]

Table 4 presents the estimates of time-series regressions of stock excess returns on contemporaneous factor returns on firm level. Column (1) reports the estimates of Fama and French three-factor model. Column (3) reports the estimates of Fama and French five-factor model. Column (2) and column (4) are results when LMS is included.

The estimates under all model specifications show that all the Fama French factor loadings are significant at 99% level. For explanatory power, column (1) and column (3) show that the three factors and five factors explain an average of 19.2% and 23% of the total variation in the sample firms' excess returns. The rest columns report the mean coefficient estimates and statistics for regressions when LMS is included. Column (2) shows that the coefficient of LMS is negative with t-statistics of -1.35. Column (4) shows that the coefficient of LMS is negative with t-statistics of -2.4. What's more, the coefficients of other factors do not change much, and for explanatory power, when LMS is included, the figure of both models increases by around 2%. All these indicate LMS provides limited information in explaining stock return.

4. The two-stage cross-sectional regression (2SCSR)

So far, I have shown that the cash premium 'LMS' is positive and marginally significant; LMS is not subsumed to other factors; LMS have limited power in explaining the variations in stock return time serially. In this section, I test whether the LMS is a priced risk factor using a two-stage cross-sectional regression approach (2SCSR). This method has been applied by previous papers to test whether a candidate variable is a priced risk factor. For example, Daniel and Titman (1997) use this method to test whether size and book to market ratio are priced; Core and Guay (2008) use this approach to test whether accrual quality is priced; Mohanram et al. (2009) use this approach to test whether PIN is priced. To apply this method, I first estimate factor loadings for LMS and other risk factors. Then I run a cross-sectional regression of returns on factor loadings to test whether the factor loadings can predict returns. Since Fama and French (1992) show that the estimated factor loadings for individual stocks are noisy, and it will cause bias if use noisy factor loadings in Fama–Macbeth regression. To mitigate this concern, following previous studies (Khan, 2008), I do the tests at portfolio level instead of firm level.

4.1 The first stage: estimate factor loadings

In the first stage, I estimate factor loading by regression the excess return of a portfolio on Fama and French factors and LMS. LMS is defined as the equally weighted average of the value-weighted hedge returns (high CASH–low CASH) for two size groups. I conduct this analysis both for the Fama–French 3-factor model (Rm–Rf, SMB, HML) augmented with LMS, as well as for the Fama–French 5-factor model (Rm–Rf, SMB, HML, RMW, CMA) augmented with LMS. Specifically, the models are shown below.

$$R_{P,t} - R_{F,t} = b_0 + b_{q,R_{M,t}-R_{F,t}}(R_{M,t} - R_{F,t}) + b_{p,SMB}SMB_t + b_{p,HML}HML_t + b_{p,LMS} + LMS_t + \varepsilon_{p,t};$$

$$R_{P,t} - R_{F,t} = b_0 + b_{q,R_{M,t}-R_{F,t}}(R_{M,t} - R_{F,t}) + b_{p,SMB}SMB_t + b_{p,HML}HML_t + b_{p,RMW}RMW_t + b_{p,CMA}CMA_t + b_{p,LMS}LMS_t + \varepsilon_{p,t}.$$

[Insert table 5 here]

Table 5 reports the average estimates of the coefficients and their t-statistics, along with the adjusted R^2. In a paper with similar research methodology, Core and Guay (2008) claim that if the portfolios do not generate enough cross sectional variations in the factor to be tested, it would have systematically bias and show lower statistical power when testing whether the factor is a priced risk factor. To address this concern, I use four different sets of portfolios to make sure the results are robust: 9 size-cash groups (3*3), 10 size groups, 30 size-cash groups (10*3), and finally 27 size-cash-LMS groups (3*3*3). 9 size-cash groups are sorted based on the P30 and P70 NYSE breakpoints of size and cash. 10 size groups are sorted based on the NYSE decile breakpoints of size. 30 size-cash groups are based on NYSE decile breakpoints of size and the P30 and P70 NYSE breakpoints of cash. For 27 size-cash-lms groups, 9 size-cash groups are firstly sorted based on the P30 and P70 NYSE breakpoints of size and cash. Then each size-cash group is further sorted by the value of P30 and P70 of firm-level LMS loadings. All size groups and cash groups are sorted independently. Then for each portfolio, I compute the value weighted return within each month, getting 522 monthly returns over the period of July 1972 to December 2015.

Panel A of table 5 presents summary results of the time-series regressing of excess stock returns on Fama and French 3 factors and LMS at portfolio level. The first and second columns of the table present the average of estimates of 9 time-series regressions for the 9-size-cash portfolio. Similarly, the third and fourth columns are for the 10-size portfolio;

the fifth and sixth columns are for 30-size-cash portfolio; the last two columns are for the 27-Size-Cash-LMS portfolio. The results show that both the magnitude and significance of the coefficients of FF factors are consistent with previous studies. The average loadings on the market risk premium, size premium and value premium is around 1, 0.6 and 0.2 respectively for all portfolio classifications. When LMS is added to the models, the coefficients of market factor and size factor are almost the same as estimates of models without LMS while the coefficient of HML changes a lot. This is consistent with previous results of this paper that LMS has a high correlation with HML, so LMS and HML explain overlapping variations in stock return. The coefficient of LMS is negative and statistically significant only for 10-size portfolio and 30-size-cash portfolio, indicating cash affects stock return strongly conditional on size. The Fama and French factors explain an average of 88%, 91%, 81% and 77% of the time-series return variation in the four sets of portfolio returns. LMS factor contribute an increase in the explanatory power of the models with a range from 0.2% to 4.7%. Panel B of table 5 reports summary results of regressions of excess stock return on Fama and French 5 factors and LMS factor at portfolio level. From this table, we get similar information as for LMS.

4.2 The second stage: Fama-Macbeth regressions

In the second stage, I conduct monthly Fama and MacBeth (1973) cross-sectional regressions of value weighted excess returns on factor loadings to ascertain whether LMS factor loadings predict returns within each of the four sets of portfolios. The model as below is estimated over period from July 1972 to December 2015:

$$\overline{R_{P,t}}-\overline{R_{F,t}}=\gamma_0+\gamma_1 b_{p,R_{M,t}-R_{F,t}}+\gamma_2 b_{p,\mathrm{SMB}}+\gamma_3 b_{p,\mathrm{HML}}+\gamma_4 b_{p,\mathrm{LMS}}+\varepsilon_{p,t}.$$

[Insert table 6 here]

The cross-sectional regressions are run for each of the 522 months from July 1972 to December 2015, and the parameters are averaged and t-statistics estimated using the Fama and MacBeth (1973) procedure. Table 6 presents Fama Macbeth regression results. Including different Fama-French factors produces similar results for different. To save place, I tabulated only the results using the Fama-French 3-factor model (R_m-R_f, SMB, and HML) augmented with LMS. To show consistence over the tests, in the following tests, I also show estimates of regressions on the three Fama–French factors. To make sure the empirical approach correct, I replicate Table V, Petkova (2006) first. The first two rows of Panel A of Table 6 present results of the second stage in Petkova's (2006) with a sample period of July 1963 to December 2001 and the second two rows show my replication over the same period. The results are quite similar in that, the market loading is negative and marginally significant, the size (SMB) loading is positive but insignificant, and the book-to-market (HML) loading is positive and significant. This is also consistent with the literature.

Panels from B to E of Table 6 present the second stage results for 4 sets of portfolios: 9 size-cash portfolios, 10 size portfolios, 30 size-cash portfolios, 27 size-cash-LMS_loading portfolios. In each panel, the estimates for Fama–French 3-factor model are presented in the first two rows, followed by the results for Fama–French 3-factor model augmented with LMS. If LMS were a risk factor, it would be expected to have a positive coefficient. However, the estimated coefficients on the LMS beta are negative and not statistically significant from zero in all of the models. The estimated coefficients on the market are positive and significant when portfolios are sorted based on size and cash, indicating that size-cash portfolios create the most variation in market risk premium.

This is also consistent with table 1 that cash holdings are increasing when firm risk increases. The coefficients on size and book-to-market factor betas are insignificant in these specifications. Previous studies show that the coefficient on HML beta is positive, but in this paper, it is not the case, which may because of the variation in the beta loadings of HML factor is not significant since portfolios are not sorted based on book-to-market ratio in this paper.

Overall, the results from the two-stage cross-sectional regressions are consistent with previous tables/studies and cast doubt on whether LMS is a priced risk factor.

5. **LMS and Future GDP growth rate**

In this section, I will discuss the relation between LMS and GDP growth rate. Chen (1991) shows that in intertemporal market equilibrium, the state variables that are priced are those that can forecast changes in the investment and consumption opportunity sets. The predictive power of the proposed new factor on future GDP growth has been used by various scholars to test whether there is a risk effect of cash on stock returns. For example, Liew and Vassalou (2000) use this approach to examine whether there is low value risk and small size risk; Chordia and Shivakumar (2006) use this approach to evident earnings momentum is a risk factor; Mohanram(2009) use this approach to examine whether PIN is a priced risk factor. In this paper, if LMS is a risk factor in an inter-temporal asset-pricing model such as Merton (1973), it would have a positive relation with GDP growth rate.

Following Chen (1991) and Liew and Vassalou (2000), I regress future GDP growth on lagged values of the Fama–French factors as well as LMS. The specific model is shown below:

$$\text{GDPGrowth}_{t+1,t+12} = \alpha + \beta(R_M - R_F)_{t-11,t} + sSMB_{t-11,t} + hHML_{t-11,t} + mUMD_{t-11,t} + lLMS_{t-11,t} + \varepsilon_t.$$

The dependent variable is the continuously compounded growth in real GDP over months from t+1 to t+12 and the explanatory variables include the value-weighted excess market return(R_m-R_f), SMB, HML, UMD and LMS, all of which are compounded over months t-11 to t. GDP data is available from the U.S. Bureau of Economic Analysis. Since data of GDP growth rates are available at quarterly frequency, consecutive annual growth rates have three overlapping quarters, inducing serial correlation in the residuals of our regressions. To address this concern, I use the Newey and West (1987) estimator and set the parameter q equal to three.

[Insert table 7 here]

Table 7 presents the results. Because GDP growth rates are observed at quarterly frequencies, the regressions use quarterly data. The time series sample is constituted with 173 quarters over period December 1972 to December 2015. Panel A reports the replication results of table 6, Mohanram et al. (2009) over period December 1984 to December 2002. I get very similar results to theirs that only the coefficient of HML is significantly different from zero. Panels from B to E show the results using four different portfolios with LMS included in the model. Under all sample sets, I find that the coefficients on LMS are positive but not significant. Further, the adjusted-R^2 of the regression is only about -0.5% when LMS is included by itself. FF factors can explain around 12% variations in GDP growth rate and this figure increases by only about 1% when LMS is augmented. These results suggest that LMS fails a macro-economic test of whether it is a risk factor.

6. LMS and ex-ante expected cost of equity

Another possible way to assess whether LMS is a priced risk factor is to examine whether a higher LMS is associated with a higher ex ante cost of capital (i.e., implied cost of capital, ICOE). Because of their nature as proxies for expected returns, ICOE can be used as the risk-related compensation. If the relation between LMS and future return is attributable to market mispricing, then the relation between LMS and the ICOE would not be pronounced. On the contrary, if LMS is a priced risk factor, then we would expect a higher LMS to be associated with higher ICOE. In particular, I use the following model to conduct the firm-level regressions of ante cost of capital measures on CASH and the control variables:

$$RP_{i,t} = \alpha + \beta\, Beta_{i,t} + sLSIZE_{i,t} + bLBM_{i,t} + dLDM_{i,t} + cCASH_{i,t} + \varepsilon_{i,t} \ ,$$

where RP represents the risk premium, calculated as ICOE minus risk free rate; Beta represents the market risk loadings calculated over period from July 1972 to December 2015; LSIZE is calculated as the natural log of market value; LBM is the natural log of book to market ratio; LDM is the natural log of 1 plus long-term debt over market value; CASH is cash and short-term investments over total assets.

Following Ohlson and Juettner-Nauroth (2005) model, I estimate ICOE with the following model:

$$r_e = A + \sqrt{A^2 + \frac{eps_1}{P_0}(g_2 - (\gamma - 1))}\ ,$$

Where $A = \frac{1}{2}(\gamma - 1) + \frac{dps_1}{P_0}$ and $g_2 = \frac{eps_2 - eps_1}{eps_1}$, eps_1 and eps_2 are consensus estimates of 1-year-ahead and 2-year-ahead annual eps, g_2 is the average of short-term growth rate (eps_2/eps_1-1), dps_1 is the estimated dividend in the next period assuming historical payout and g is the estimate of the long run economy-wide growth rate. (γ-1) is set as R_f -3%, where R_f is the yield on 10-year notes.

Since the estimated ICOE is in an annually frequency, I do this tests using annual data. The annual accounting data is obtained from compustat annual industrial. EPSs are obtained from I/B/E/S Summary. 10-year notes yield is obtained from CRSP Index. After merging all the variables together, I keep only firms that are used in previous tests in order to make the sample firms consistent in all tests. The final sample is constructed with 70805 firm-year observations from fiscal year 1974 to fiscal year 2015. The accounting variables are all winsorized at 1% and 99% level in each fiscal year.

[Insert table 8 here]

Panel A of Table 8 presents the mean value of key variables. The mean value of RP, Beta, LSIZE, LDM, LBM and CASH is around 15.59%, 1.157, 5.94, 0.234, -0.685 and 0.145 respectively. Panel B shows the correlations between these variables. It is shown that RP is positively related to Beta, long-term leverage, book to market ratio, and negatively related to size and cash. Panel C shows the estimates of Fama Macbeth regression. The coefficient of CASH is negative and is not significantly different from zero, indicating that there is no association between CASH and ICOE. The inconsistent relationship between CASH and ex-ante risk provide extra evidence that CASH cannot be considered a reliable proxy of systematic risk. As for the coefficients of other variables, market beta, book to market ratio, long-term debt increase the cost of equity, while size decreases it. This is consistent with previous studies (Mohanram, 2009), and also consistent with the intuition that firms with higher systematic risk, lower growth options, higher leverage tend to have higher costs of equity, while firms with bigger size tend to have lower costs of equity.

6.1 LMS loadings and ex-ante expected cost of equity

Since LMS loading represents the risk exposure to LMS, and ex-ante costs of equity is also proxy for the expected risk, we should see a positive correlation between LMS loading and ex-ante costs of equity if LMS is the risk compensation on large amount of cash. To test this argument, I run the cross-sectional Fama Macbeth regressions following the model as:

$$RP_{i,t} = \alpha + \gamma_1 b_{i,R_m-R_f} + \gamma_2 b_{i,\mathrm{SMB}} + \gamma_3 b_{i,\mathrm{HML}} + \gamma_4 b_{i,\mathrm{LMS}} + \varepsilon_{i,t},$$

where the independent variables are firm-level factor loadings calculated over full sample period from July 1972 to December 2015 for firms with at least 18 months during this period.

[Insert table 9 here]

Panel A, table 9 presents the correlation between RP and the factor loadings, suggesting a positive correlation of RP and the factor loadings. Panel B, table 9 reports the estimates of the Fama-Macbeth cross-sectional regression. The coefficients of market loading, SMB loading and HML loading is positive and significant, while the coefficient of LMS loading is not significant. This test does not support that LMS is a risk factor, indicating that cash-return relation is not because of systematic risk captured by cash. And high cash level cannot suggest high systematic risk.

7 The potential Mispricing Explanation of Cash-return Relation

So far, I have provided evidence that cash-return relation is not due to the systematic risk related to cash holdings. In this chapter, I will explore the potential behavior explanation.

As mentioned, the cash-return relation may due to the limited attention of investors on cash information. The investors may interpret firms with higher cash holdings as firms with more agency problems since managers in firms with more agency problems tend to hold more cash to get private perquisites. In this case investors tend to undervalue the stock prices of firms with more cash holdings. And hence stocks of firms with more cash holdings tend to get higher subsequent return. I'll use two methods to provide evidences of mispricing explanation by using institutional investors as sophisticated investors. The first is to test the trading behaviour of institutions in relation to cash. The second is to test the differences in return spread by cash between firms with more institutional investors and less institutional investors.

7.1 Trading Behaviour of Institutions pre-anomaly of Cash

Institutional investors are proved to be sophisticated investors. Sophisticated investors have the ability to predict stock return and they would sell a stock if it is overpriced and buy it if it gets undervalued. So I first test whether there are more institutional investors invest on long leg of pre-anomaly portfolios. If institutional investors increased before cash anomalies are formed, the cash holding anomaly is more likely to be because of the mispricing effect. In this test, two measures of institutional investors are considered. The first is the number of institutional investors. The second is the number of shares held by institutional investors. The data of institutional investors are available at quarterly frequency and are obtained in file s34 in Thomson Reuters.

[Insert table 10 here]

Table 10 reports the results of the change of institutions pre-anomaly. Panel A is the summary statistics of institutions and change in institutions. It's shown that averagely there are around 83 institution investors per firm. The shares held by institutions account for around 41% of the total shares. Panel B shows the changes in institutional investors for cash holding anomaly stocks. I first sort the sample into three portfolios based on cash over total assets in quarter q. Then I calculate the change in institutions from the beginning of quarter q to the end of quarter q. The zero-investments on long in high cash portfolio and short in low cash portfolio earn an average return of 0.6%. Both change in number of institutions and change in shares of institutions show monotonically decreasing from the long leg of cash portfolio to short leg of cash portfolio, suggesting that the institutions tend to invest more on high cash portfolio to get higher subsequent return.

7.2 Comparison of Return Spread by Cash between HIO and LIO

If the cash prediction of returns is due to the mispricing caused by investors' limited attention of the cash implications on firm performance, it should be expected that there would be less cash mispricing for firms held by more institutional investors who are more informed and sophisticated in reading accounting information. This mechanism has been used to test the accrual mispricing due to investors' limited attention by Collins, Gong and Hribar (2003). I use institutional ownership to proxy for institution investors. I divide the sample into 25 (5*5) portfolios based on cash and institutional ownership and aim to find the differences in abnormal returns spread by cash between high institutional investor group (i.e., HIO) and low institutional investor group (i.e., LIO).

[Insert table 11 here]

Table 11 reports the results showing how institutional investors affect the return spread across cash holding quintiles. LIO indicates the group with lowest quintile of institutional investors. MIO indicates the group with medium quintile of institutional investors. HIO indicates the group with highest quintile of institutional investors. The abnormal returns include excess return, excess return adjusted by market risk and excess return adjusted by Fama French 3 factors. In the LIO, these three variables get values of 1.096%, 0.992% and 1.189% respectively with significance at 99% level. While in the HIO, they are 0.314%, 0.079% and 0.560% and are not statistically significant. The values in MIO are in between the respective values in HIO and LIO. Panel D shows the differences in abnormal return spread by cash between HIO and LIO. The differences are all statistically significant; indicating that return spread by cash in firms with more institutional ownerships is lower than that in firms with less institutional ownerships. These results suggest that the return spread by cash is due to a mispricing effect due to limited attention of investors on cash information.

8 Conclusion

This paper tries to test whether cash-return relation is caused by systematic risk. Palazzo (2012) finds a positive correlation between cash and equity return. He claims that cash holdings have a link with systematic risk, and therefore, firms with more cash have higher stock return for compensation on the systematic risk embedded within them. This argument is interpreted in the paper of Simutin(2010) that cash could serve as a proxy of systematic risk. However, none of them empirically verify this argument with the methodology used in the literature. Recently, there are papers studying the cash-return relation from behaviour finance perspective, finding evidence supporting a mispricing explanation story and also casting doubt on whether the relation between cash and return really exists. So this paper tries to follow the systematic methodology in the literature to test whether cash could be proxy for systemic risk in explaining the variations in stock returns. First, the two-stage cross-sectional regression show that LMS loading is not priced. Second, LMS is not correlated with the macro-economy growth rate, which is not consistent with the intertemporal asset pricing theory. Third, both cash and LMS loading are not associated with the implied costs of equity, which typically have a positive correlation with systematic risk. I further explore the potential mispricing explanation and find supporting evidences. First, it is found that sophisticated investors tend to buy in more stocks in firms with more cash than stocks in firms with less cash, consistent with the argument that sophisticated investors get can earn higher return by recognizing mispriced stocks. Second, it is found that the cash-return relation in firms with more sophisticated investors are less pronounced than in firms with less sophisticated investors, consistent with the view that sophisticated investors help correct mispricing effect.

References

Almeida, Heitor, Murillo Campello, and Michael S. Weisbach. 2004. "The Cash Flow Sensitivity of Cash." *The Journal of Finance* 59 (4): 1777–1804.

Chen, Nf. 1991. "Financial Investment Opportunities and the" 46 (2): 529–54.

Chen, L., Novy-Marx, R., and Zhang, L. 2011. "An alternative three-factor model." *Available at SSRN 1418117*.

Chordia, Tarun, and Lakshmanan Shivakumar. 2006. "Earnings and Price Momentum." *Journal of Financial Economics* 80 (3): 627–56.

Core, John E., Wayne R. Guay, and Rodrigo Verdi. 2008. "Is Accruals Quality a Priced Risk Factor?" *Journal of Accounting and Economics* 46 (1): 2–22.

Collins, D.W., Gong, G. and Hribar, P., 2003. Investor sophistication and the mispricing of accruals. *Review of Accounting Studies*, *8*(2), pp.251-276.

Daniel, Kent, and Sheridan Titman. 1997. "Evidence on the Characteristics of Cross Sectional Variation in Stock Returns." *Journal of Finance* 52 (1): 1–33.

Davis, James L., Eugene F. Fama, and Kenneth R. French. 2000. "Characteristics, Covariances, and Average Returns: 1929 to 1997." *Journal of Finance* 55 (1): 389–406.

Fama, Eugene F., and James D. Macbeth. 1973. "Risk, Return, and Equilibrium: Empirical Tests." *Journal of Political Economy* 81 (3): 607–36.

F.Y. Eric C. Lam, Tai Ma, Shujing Wang, and Kuo-Chiang (John) Wei. 2016. "What is the Real Relation between Cash Holdings and Stock Returns?" *WP*.

Hirshleifer, D., Hou, K., Teoh, S. H., and Yinglei Zhang. 2004. "Do Investors Overvalue Firms with Bloated Balance Sheets?" *Journal of Accounting and Economics* 38: 297–331.

Hirshleifer, D., Hou, K., and Teoh, S. H. 2012. "The accrual anomaly: risk or mispricing?" *Management Science*, 58(2), 320-335.

Jensen, Michael. 1986. "Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers." *The American Economic Review* 76 (2): 323.

Khan, Mozaffar. 2008. "Are Accruals Mispriced? Evidence from Tests of an Intertemporal Capital Asset Pricing Model." *Journal of Accounting and Economics* 45 (1): 55–77.

Liew, Jimmy, and Maria Vassalou. 2000. "Can Book-to-Market, Size and Momentum Be Risk Factors That Predict Economic Growth?" *Journal of Financial Economics* 57 (2): 221–45.

Li, Xiafei, and Di Luo. 2016. "Investor Sentiment, Limited Arbitrage, and the Cash Holding Effect." *Review of Finance,* rfw031.

Mohanram, Partha, and Shiva Rajgopal. 2009. "Is PIN Priced Risk?" *Journal of Accounting and Economics* 47 (3): 226–43.

Palazzo, Berardino. 2012. "Cash Holdings, Risk, and Expected Returns." *Journal of Financial Economics* 104 (1): 162–85.

Shanken, Jay, and Mark I. Weinstein. 2006. "Economic Forces and the Stock Market Revisited." *Journal of Empirical Finance* 13 (2): 129–44.

Simutin, Mikhail. 2010. "Excess Cash and Stock Returns." *Financial Management* 39 (3): 1197–1222.

Sloan, Richard G. 1996. "Do Stock Prices Fully Reflect Information in Accruals and Cash Flows about Future Earnings?" *The Accounting Review* 71 (3): 289–315.

Sodjahin, William. 2013. "Change in Cash-Holding Policies and Stock Return Predictability in the Cross Section." *Financial Analysts Journal* 69 (1): 53–70.

Table 1 Characteristics of the ten cash-to-assets portfolios

This table reports the average and median value (in the squared brackets) of the time series value of cross sectional mean values of firm characteristics across the ten portfolios which are rebalanced monthly based on cash over total assets. Column (1) to column (5) is summary statistics over periods from July 1972 to December 2009, which is the same as the time window in Palazzo's paper. Column (6) to column (10) is the statistics of the period from July 1972 to December 2015. For the portfolio construction, I use the quarterly accounting data available in month t in portfolio sorts starting at time t+i+1 if there has been an earnings announcement (item RDQ) in month t+i. N is the average firm number contained in each portfolio. CAR is cash over total assets. Market size is the market value of stock at portfolio formation. Book equity is stockholder's equity (item SEQQ), or common equity (item CEQQ) plus preferred stock par value (item PSTKQ), or asset (item ATQ) minus liabilities (item LTQ)) plus balance sheet deferred taxes and investment tax credit(item TXDITCQ) minus the book value of preferred stock (item PSTKRQ, or PSTKQ if PSTKRQ is not available). The BM (book to-market ratio) is calculated by dividing book equity by market capitalization measured at portfolio formation. Beta is the post-rank beta which is calculated with full period sample. Beta is the post-rank beta following Fama and French (1992).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Portfolio	Palazzo's paper: Jul. 1972 to Dec. 2009					My statistics: Jul. 1972 to Dec. 2015				
	N	CAR	BM	Market Size	Beta	N	CAR	BM	Market Size	Beta
1	244	0.00	1.13	832.79	1.01	234	0.00	1.09	1132.63	1.02
		0.00	1.00	587.62	0.97		0.00	0.98	759.53	1.02
2	244	0.01	1.11	1320.81	1.03	234	0.01	1.07	2079.96	1.04
		0.01	1.02	577.24	1.01		0.01	0.97	1083.30	1.04
3	244	0.02	1.10	1525.62	1.04	234	0.03	1.05	2427.21	1.06
		0.02	0.98	921.98	1.02		0.02	0.93	1491.52	1.05
4	244	0.04	1.07	1415.38	1.07	234	0.04	1.02	2136.87	1.08
		0.03	0.96	749.23	1.04		0.03	0.90	958.81	1.08

5	244	0.06	1.01	1430.08	1.08	234	0.07	0.97	2097.51	1.10
		0.05	0.92	858.42	1.06		0.05	0.87	1071.79	1.11
6	244	0.09	0.96	1581.96	1.11	234	0.10	0.91	2372.43	1.12
		0.08	0.89	755.40	1.08		0.08	0.84	1134.17	1.12
7	244	0.14	0.88	1274.50	1.16	234	0.15	0.84	2076.74	1.17
		0.13	0.80	733.26	1.11		0.13	0.76	888.96	1.14
8	244	0.21	0.82	999.07	1.20	234	0.22	0.79	1485.63	1.20
		0.20	0.72	569.60	1.11		0.21	0.69	683.50	1.13
9	244	0.32	0.74	885.47	1.25	234	0.33	0.71	1308.09	1.25
		0.31	0.65	481.64	1.12		0.32	0.61	616.92	1.16
10	244	0.55	0.66	459.47	1.28	234	0.58	0.62	762.25	1.29
		0.59	0.60	332.78	1.16		0.60	0.56	372.24	1.26

Table 2 Equity returns and risk-adjusted returns across the ten cash-to-assets portfolios

This table reports average monthly excess returns (Ret-R_f), average monthly market risk adjusted return (Alpha), and average monthly Fama French three-factor alphas (Alpha) of equal-weighed and value-weighted cash holding decile portfolios. Each month, all common stocks are sorted into deciles using the cash holding breakpoints of the NYSE stock sample. Panel A reports results within a period from July 1972 to December 2009 which are comparable to Palazzo (2012). Panel B are the estimates within a more recent period that is within a period from January 1980 to December 2015, which is also the sample period for the later tests. The portfolios are held for one month. Returns and alphas are in percentage terms.

Panel A Equity returns and risk-adjusted returns across the ten cash-to-assets portfolios during July 1972 to Dec. 2009

	Equally Weighted				**Value-weighted**			
	CH1	CH5	CH10	ΔCH	CH1	CH5	CH10	ΔCH
Panel A.1 Excess return								
r_i^e	0.527	0.944	1.323	0.796	0.421	0.470	0.752	0.331
$t_{r_i^e}$	1.79	3.06	3.4	3.22	1.72	1.88	1.97	1.11
Panel A.2 Market risk adjusted return								
α	0.078	0.452	0.762	0.684	0.002	0.030	0.158	0.156
t_α	0.38	2.42	2.45	2.24	0.02	0.34	0.62	0.54
β_{MKT}	1.040	1.141	1.301	0.261	0.973	1.021	1.378	0.405
$t_{\beta_{\mathrm{MKT}}}$	15.37	18.6	18.22	2.46	27.89	21.2	15.49	3.64
Panel A.3 FF three factor risk adjusted return								
α	-0.346	0.120	0.857	1.203	-0.059	-0.066	0.574	0.633
t_α	-2.79	1.14	3.48	4.21	-0.43	-0.77	2.9	2.59
β_{MKT}	1.017	1.068	0.971	-0.046	1.004	1.048	1.063	0.059
$t_{\beta_{\mathrm{MKT}}}$	27.84	29.26	17.79	-0.63	32.01	23.42	17.23	0.72

β_{SMB}	0.888	0.940	1.290	0.402	-0.029	0.056	0.622	0.650
$t_{\beta_{\text{SMB}}}$	8.4	9.27	13.51	2.19	-0.37	0.84	7.63	4.48
β_{HML}	0.588	0.415	-0.408	-0.996	0.113	0.159	-0.856	-0.969
$t_{\beta_{\text{HML}}}$	6.74	5.28	-4.36	-6.72	1.47	2.77	-11.87	-7.77

Panel B equity returns and risk-adjusted returns across the ten cash-to-assets portfolios during Jan. 1980 to Dec. 2015

	Equally Weighted				**Value-weighted**			
	CH1	CH5	CH10	ΔCH	CH1	CH5	CH10	ΔCH
Panel B.1 Excess return								
r_i^e	0.592	0.965	1.330	0.737	0.470	0.578	0.806	0.336
$t_{r_i^e}$	2.2	3.47	3.77	3.27	2.12	2.54	2.35	1.26
Panel B.2 Market risk adjusted return								
α	0.042	0.368	0.653	0.611	-0.037	0.041	0.097	0.134
t_α	0.22	2.19	2.38	2.24	-0.33	0.54	0.43	0.52
β_{MKT}	1.054	1.143	1.296	0.242	0.971	1.027	1.358	0.387
$t_{\beta_{\text{MKT}}}$	17.31	20.73	20.26	2.55	30.81	23.75	16.95	3.87
Panel B.3 FF three factor risk adjusted return								
α	-0.300	0.118	0.759	1.059	-0.095	-0.030	0.459	0.553
t_α	-2.54	1.29	3.5	4.08	-0.78	-0.39	2.53	2.49
β_{MKT}	1.016	1.055	0.972	-0.044	1.000	1.048	1.065	0.066
$t_{\beta_{\text{MKT}}}$	30.54	31.13	19.44	-0.66	34.88	25.96	19.02	0.88
β_{SMB}	0.876	0.914	1.296	0.420	-0.017	0.046	0.628	0.645
$t_{\beta_{\text{SMB}}}$	8.97	9.62	14.17	2.45	-0.23	0.73	8.1	4.68
β_{HML}	0.593	0.393	-0.408	-1.001	0.124	0.143	-0.851	-0.975
$t_{\beta_{\text{HML}}}$	7.25	5.29	-4.64	-7.21	1.69	2.57	-12.3	-8.22

Table 3 Time series relationship between cash factor (LMS) and Fama-French factors

The table documents summary statistics (Panels A), the correlations among the three Fama and French (1993) factors and the cash factor (LMS) (Panels B) and time series relationship between LMS and Fama-French five factors computed at the monthly level from July 1972 to December 2015. R_m-R_f is the excess return on the market portfolio. SMB is the return to size factor-mimicking portfolio. HML is the return to book-to-market factor-mimicking portfolio. RMW is return to operating profitability factor-mimicking portfolio. CMA is return to investment factor-mimicking portfolio. UMD is return to momentum factor-mimicking portfolio. LMS is the return to the cash holding factor-mimicking portfolio. The construction of the cash holding portfolio is explained in the text. The returns in Panel A are shown in percentages. Panel B contains the time-series correlations between the factor portfolios over the sample period. Figures below (above) the diagonal are Pearson (Spearman rank-order) correlations. Panel C presents the time series relationship between LMS and Fama-French five factors and also momentum factor.

Panel A summary statistics

Factor	N	Mean	Std Dev	t Value
R_m-R_f	522	0.522	4.577	2.61
SMB	522	0.165	3.124	1.21
HML	522	0.368	2.986	2.81
RMW	522	0.262	2.363	2.53
CMA	522	0.344	1.980	3.97
UMD	522	0.699	4.449	3.59
LMS	522	0.274	2.884	2.17

Panel B Correlations

	R_m-R_f	SMB	HML	RMW	CMA	UMD	LMS
mkt_rf	1	0.259	-0.330	-0.232	-0.339	-0.107	0.196
		<.0001	<.0001	<.0001	<.0001	0.0147	<.0001
SMB	0.271	1	-0.150	-0.297	-0.120	-0.014	0.164
	<.0001		0.0006	<.0001	0.006	0.7461	0.0002
HML	-0.318	-0.235	1	-0.091	0.686	-0.101	-0.536
	<.0001	<.0001		0.0371	<.0001	0.0205	<.0001
RMW	-0.256	-0.450	0.206	1	-0.153	0.149	-0.216
	<.0001	<.0001	<.0001		0.0004	0.0007	<.0001
CMA	-0.389	-0.125	0.700	0.040	1	-0.002	-0.351
	<.0001	0.0043	<.0001	0.3593		0.9681	<.0001
UMD	-0.143	-0.005	-0.166	0.094	0.019	1	0.073
	0.0011	0.9162	0.0001	0.0309	0.6569		0.095
LMS	0.208	0.357	-0.633	-0.570	-0.391	0.123	1
	<.0001	<.0001	<.0001	<.0001	<.0001	0.005	

Panel C Time-series regression of Cash Factor on other factors

Model $LMS=\alpha+\beta(r_m-r_f)+s\,SMB+h\,HML+m\,UMD+r\,RMW+c\,CMA+\varepsilon_i$

Model	α	β	s	h	m	r	c	Adj. R^2 (%)

3-factor	0.464	-0.027	0.212	-0.572				0.444
	4.82	-1.2	6.67	-16.96				
4-factor	0.451	-0.024	0.212	-0.567	0.014			0.444
	4.58	-1.05	6.66	-16.39	0.62			
5-factor	0.664	-0.065	0.023	-0.526		-0.579	-0.043	0.607
	7.98	-3.31	0.82	-13.71		-15.28	-0.72	

Table 4 Firm specific regressions of contemporaneous excess return on factor returns

This table reports average coefficient estimates and average R^2 of 10491 time-series regressions of monthly contemporaneous firm level excess stock returns (stock return minus the risk-free rate) on the Fama–French factors and LMS (the cash factor). The first two columns are the estimates of Fama French 3 factors and cash factor, and the last two columns are the estimates of Fama French 5 factors and cash factor. R_m-R_f is the excess return on the market portfolio. SMB is the return to size factor-mimicking portfolio. HML is the return to book-to-market factor-mimicking portfolio. RMW is return to operating profitability factor-mimicking portfolio. CMA is return to investment factor-mimicking portfolio. UMD is return to momentum factor-mimicking portfolio. LMS is the return to the cash holding factor-mimicking portfolio. The data period is from July 1972 to December 2015. The firms included in the sample need to have at least 18 months data during the whole period.

	(1)		(2)		(3)		(4)	
	3 factor model augmented with LMS				5 factor model augmented with LMS			
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Intercept	-0.086	-2.8	-0.087	-2.65	0.123	3.25	0.101	2.49
R_m-R_f	1.017	108.03	0.991	101.53	0.945	84.26	0.933	81.49
SMB	1.016	73.66	0.994	71.1	0.967	63.84	0.958	62.37
HML	0.111	6.84	0.139	7.12	0.097	4.4	0.097	4
RMW					-0.316	-11.89	-0.310	-11.17
CMA					-0.106	-3.31	-0.095	-2.92
LMS			-0.030	-1.35			-0.055	-2.4
R^2	0.192		0.212		0.230		0.248	
N	10565		10565		10565		10565	

Table 5 Portfolio time-series regressions of contemporaneous excess returns on factor returns

This table presents average coefficient estimates and average R^2 of time-series regressions. Panel A is for regressions of monthly contemporaneous portfolio value weighted excess stock returns (stock return minus the risk-free rate) on the three Fama–French factors and the LMS (Cash factor). Panel B is for regressions of monthly contemporaneous portfolio excess stock returns (stock return minus the risk-free rate) on the five Fama–French factors and the LMS (Cash factor). The first two columns consist of 9 (3*3) size and cash portfolios and 10 size portfolios; the next two columns consist of 30 (10*3) size and cash portfolios, and 27 (3*3*3) size, cash and LMS portfolios. R_m-R_f is the excess return on the market portfolio. SMB is the return to size factor-mimicking portfolio. HML is the return to book-to-market factor-mimicking portfolio. RMW is return to operating profitability factor-mimicking portfolio. CMA is return to investment factor-mimicking portfolio. LMS is the return to the cash holding factor-mimicking portfolio. T-statistics are computed based on the standard error of the portfolio-specific coefficient estimates.

Panel A: Fama French 3 factor model augmented with cash factor

	9 size-cash		10 size		30 size-cash		27 size-cash-lms loading	
Intercept	-0.024	0.068	0.030	0.063	-0.021	0.080	-0.043	0.055
	-0.32	1.82	1.33	2.18	-0.46	2.98	-0.92	1.11
R_m-R_f	1.065	1.060	1.077	1.075	1.084	1.078	1.070	1.064
	67.21	69.47	70	72.26	113.88	117.4	74.49	71.12
SMB	0.527	0.569	0.665	0.680	0.610	0.656	0.541	0.586
	2.92	3.16	4.51	4.61	7.27	8.01	5.33	6.03
HML	0.181	0.067	0.119	0.078	0.214	0.089	0.204	0.083
	1.59	1.11	2.61	1.62	3.59	2.72	2.89	1.84
LMS		-0.199		-0.071		-0.218		-0.211
		-1.39		-2.64		-2.84		-1.58
R^2	0.884	0.912	0.907	0.909	0.808	0.834	0.768	0.815

Panel B: Fama French 5 factor model augmented with cash factor

	9 size-cash		10 size		30 size-cash		27 size-cash-cash loading	
Intercept	-0.055	0.040	0.046	0.082	-0.050	0.057	-0.078	0.024
	-0.56	0.89	4.38	3.62	-0.83	1.99	-1.18	0.45
R_m-R_f	1.073	1.063	1.076	1.072	1.091	1.080	1.078	1.068
	72.11	93.39	73.94	80.89	104.41	122.73	87.16	87.29
SMB	0.578	0.581	0.675	0.676	0.664	0.668	0.596	0.599
	3.35	3.36	4.74	4.74	8.45	8.49	6.43	6.46
HML	0.094	0.019	0.028	-0.001	0.120	0.035	0.113	0.032
	0.88	0.32	0.77	-0.02	2.11	1.03	1.7	0.74
RMW	0.114	0.031	-0.024	-0.056	0.114	0.021	0.122	0.033
	1.1	0.46	-0.61	-1.3	1.85	0.59	1.42	0.7
CMA	0.015	0.009	0.012	0.010	0.003	-0.004	0.016	0.010
	0.46	0.27	0.56	0.44	0.17	-0.18	0.58	0.33
LMS		-0.143		-0.054		-0.161		-0.153
		-1.03		-2.03		-2.35		-1.14
R^2	0.902	0.920	0.914	0.915	0.828	0.842	0.792	0.824

Table 6 Cross-sectional portfolio regressions of excess returns on factor betas

This table presents the Fama Macbeth estimates and R^2 of cross sectional regressions of value weighted monthly excess returns on Fama and French (1992) three factor loadings and cash holding factor loadings. Panel A presents the replication of Petkova (2006)'s estimates of regressing average 25 Size-BM portfolio excess returns on factor loadings. Panel B, C and D are estimates based on 9 Size-Cash portfolios, 10 Size portfolios, 30 Size-Cash portfolios and 27 Size-Cash-LMS portfolios respectively over period of July 1972 and December 2015. All the factor loadings are calculated with full-period data on a multivariate time-series regression of portfolio returns on the respective factors during the period of July 1972 and December 2015. b_{Rm-Rf} is the portfolio beta related to the RM_RF factor. b_{SMB} is the portfolio beta related to the SMB factor. b_{HML} is the portfolio beta related to the HML factor. b_{LMS} is the portfolio beta related to the CASH factor. T statistics are based on newy-west tests.

Panel A: 25 size and book to market portfolios
Replication of Petkova (2006) over period July 1963 to December 2001

	Intercept	b_{Rm-Rf}	b_{SMB}	b_{HML}	Adj R^2
Petkova's estimate	1.15	-0.65	0.16	0.44	0.71
FM t-stat	3.3	-1.6	1.04	3.09	
My Estimate	1.020	-0.529	0.180	0.475	0.55
FM t-stat	3.203	-1.509	1.096	2.888	

	Intercept	b_{Rm-Rf}	b_{SMB}	b_{HML}	b_{LMS}	Adj R^2
Panel B: 9 size and cash holdings portfolios						
My estimate over the period July 1972 to December 2015						
Estimate	-2.075	2.597	0.124	-0.387		0.71
FM t-stat	-1.765	2.254	0.692	-1.838		
Estimate	-2.098	2.631	0.096	-0.301	0.190	0.78
FM t-stat	-1.808	2.323	0.499	-0.909	1.312	
Panel C: 10 size portfolios						
My estimate over the period July 1972 to December 2015						
Estimate	-0.440	1.062	0.004	0.336		0.63
FM t-stat	-0.589	1.422	0.016	0.660		
Estimate	-0.370	0.991	0.012	0.321	-0.248	0.71
FM t-stat	-0.392	1.025	0.056	0.611	-0.456	
Panel D: 30(10*3) size and cash holding portfolios						
My estimate over the period July 1972 to December 2015						
Estimate	-0.646	1.221	0.199	-0.350		0.41
FM t-stat	-1.129	2.133	1.199	-1.686		
Estimate	-0.920	1.523	0.099	-0.096	0.252	0.44
FM t-stat	-1.635	2.650	0.611	-0.409	1.715	
Panel E: 30(10*3) size and cash holding portfolios						
My estimate over the period July 1972 to December 2015						
Estimate	0.833	-0.215	0.207	-0.175		0.46
FM t-stat	1.556	-0.378	1.209	-0.727		
Estimate	0.927	-0.324	-0.353	0.160	0.274	0.52
FM t-stat	1.835	-0.601	-1.823	1.080	1.653	

Table 7 Future GDP Growth on Fama–French factors and the CASH factor.

This table presents the regression coefficients from regressing real GDP growth on the Fama–French factors and the CASH factor. GDP growth is the future 12-month-ahead compounded growth rate. R_m-R_f is the excess return on the market portfolio. SMB is the return to size factor-mimicking portfolio. HML is the return to book-to-market factor-mimicking portfolio. UMD is return to momentum factor-mimicking portfolio. LMS is the return to the cash holding factor-mimicking portfolio. All these factors are annually compounded from the monthly factors over month t-11 and month t. Since data on GDP is reported quarterly, the regressions are based on quarterly data. GDP data is obtained from the US Bureau of Economic Analysis. Since the calculation of compounded factors need data of previous 11 months data. The final sample used of this test is from December 1972 (Q4, 1972) to December 2015 (Q4, 2015). Panel A is the replicate of Mohanram et al.'s respective results over December 1984 to December 2002. Panel B is the main estimates of this test in this paper. Since the regressions use overlapping data, the t-statistics, which are reported in parentheses, are based on Newey–West standard errors.

Model: $GDPGrowth_{t+1,t+12}= \alpha + \beta(R_m-R_f)_{t-11,t} + sSMB_{t-11,t} + hHML_{t-11,t} + mUMD_{t-11,t} + lLMS_{t-11,t} + \varepsilon_t$

Panel A: Replicate Mohanram et al.(2009) over period December 1984 to December 2002

	α	β	s	h	m		Adj R^2
Fama-French 3 factor	0.148	0.204	-0.111	0.097			0.162
	7.84	2.65	-0.83	1.32			
Fama-French 4 factor	0.175	0.195	-0.058	0.049	-0.157		0.231
	15.49	2.81	-0.6	0.71	-2.2		

Panel B: My estimates over period December 1972 to December 2015

	α	β	s	h	m	l	Adj R^2
Fama-French 3 factor	0.117	0.207	0.132	0.190			0.123
	6.96	2.91	1.15	2.3			
Fama-French 4 factor	0.120	0.203	0.130	0.184	-0.018		0.118
	5.79	2.73	0.94	1.84	-0.24		
LMS	0.145					0.031	-0.005
	7.3					0.4	
Fama-French 3 factor	0.108	0.212	0.119	0.268		0.136	0.134
and LMS	4.7	2.83	0.83	1.71		0.82	
Fama-French 4 factor	0.113	0.204	0.113	0.264	-0.042	0.152	0.133
and LMS	4.62	2.63	0.8	1.68	-0.59	0.99	

Table 8 Regression of RP on cash

This table presents the estimates of regressions of RP on cash and control variables. The sample period is from fiscal year 1974 to fiscal year 2015. Implied Cost of Capital estimates are calculated using stock prices and earnings forecasts as of the end of the previous year, based on the Ohlson and Juettner-Nauroth (2005) OJ model. Risk Premia, RP, are calculated from implied cost of capital estimates by subtracting out the risk free rate. LSIZE is calculated as the natural log of market value; LBM is the natural log of book to market ratio; LDM is the natural log of 1 plus long-term debt over market value; CASH is cash and short-term investments over total assets. Panel A presents mean value of RP, beta, log of size, log of long term debt, log of book-to-market ratio and cash over total assets. Panel B presents the correlations of these variables. Panel C presents the estimates of cross-sectional Fama-Macbeth regression of RP on risk factors.

Panel A: Mean of RP and Risk Factors

	RP(%)	Beta	LSIZE	LDM	LBM	CASH
	15.593	1.157	5.942	0.243	-0.685	0.145

Panel B: Correlation of RP and Risk Factors

	RP	Beta	LSIZE	LDM	LBM	CASH
RP	1	0.072	-0.314	0.197	0.190	-0.054
		<.0001	<.0001	<.0001	<.0001	<.0001
Beta	0.078	1	0.036	-0.043	-0.107	0.217
	<.0001		<.0001	<.0001	<.0001	<.0001
LSIZE	-0.342	0.040	1	-0.142	-0.361	0.004
	<.0001	<.0001		<.0001	<.0001	0.3339
LDM	0.153	-0.077	-0.051	1	0.456	-0.378
	<.0001	<.0001	<.0001		<.0001	<.0001
LBM	0.227	-0.083	-0.356	0.469	1	-0.330
	<.0001	<.0001	<.0001	<.0001		<.0001
CASH	-0.065	0.192	0.022	-0.551	-0.309	1
	<.0001	<.0001	<.0001	<.0001	<.0001	

Panel C: Regression of RP and risk factors

	Intercept	Beta	LSIZE	LDM	LBM	CASH	Adj R^2
Annual FM	20.367	1.702	-1.283	4.347	0.892	-0.399	0.159
	26.34	12.99	-15.7	23.32	3.98	-0.91	

Table 9 regressions of RP on risk factor loadings

This table presents the estimates of regressions of RP on factor loadings. The sample period is from fiscal year 1974 to fiscal year 2015. Implied Cost of Capital estimates are calculated using stock prices and earnings forecasts as of the end of the previous year, based on the Ohlson and Juettner-Nauroth (2005) OJ model. Risk Premium, RP, are calculated from implied cost of capital estimates by subtracting out the risk free rate. LMKT, LSMB, LHML, LLMS are the firm-level factor loadings with regard to market risk premium, SMB, HML, LMS. Thet are the coefficients estimates of regressing excess return on these factors over full period for firms with at least 18 months observations. Panel A presents the correlations between RP and factor loadings. Panel B presents the estimates of cross-sectional Fama-Macbeth regression of RP on risk factor loadings.

Panel A: Correlation of RP with factor loadings

	RP	LMKT	LSMB	LHML	LLMS
RP	1	0.051	0.154	0.046	0.024
		<.0001	<.0001	<.0001	<.0001
LMKT	0.062	1	0.055	0.169	-0.013
	<.0001		<.0001	<.0001	0.0005
LSMB	0.181	0.071	1	0.059	-0.060
	<.0001	<.0001		<.0001	<.0001
LHML	0.074	0.140	0.091	1	0.472
	<.0001	<.0001	<.0001		<.0001
LLMS	0.007	-0.019	-0.077	0.335	1
	0.0802	<.0001	<.0001	<.0001	

Panel B: Regression of RP on factor loadings

	Intercept	LMKT	LSMB	LHML	LLMS	Adj R^2	N
Annual FM	12.832	1.011	2.092	0.644	0.127	0.058	42 years
	16.6	4.45	12.37	3.56	1.26		

Table 10 Summary of change of institutional investments pre-anomaly

The table reports the changes of institutional invests and the difference between long and short leg based on cash holdings during the calendar quarter prior to anomaly portfolio formation over the period of July 1980 to December 2015. Panel A presents the summary statistics of four institutional ownership variables including the number of institutional investors (#inst(q)), the percentage of institutional shares (%inst(q)), the change in the number of institutional shareholders (Δ#inst(q-1 to q), calculated as number at the end divided by the number at the beginning of period minus one) and the change in percentage of institutional shares (Δ%inst(q-1 to q), calculated as end of period percentage minus beginning). The institutional investor variables are winsorized at the 1% level in both tails. Panel B reports the changes in institutional investor base for cash holding anomaly strategy. The statistics of panel C are the time-series mean and t-statistics.

Panel A: Summary statistics for institutional ownership pre-anomaly

	Mean	Std.	P25	Median	P75
#inst(q)	83.2	128.9	11.0	35.0	105.0
%inst(q)	40.9%	29.4%	14.3%	37.2%	64.9%
Δ#inst(q-1 to q)	4.0%	21.6%	-5.9%	0.0%	9.4%
Δ%inst(q-1 to q)	0.2%	5.9%	-1.6%	0.0%	2.1%

Panel B: Changes in institutional investor base for cash holding anomaly stocks

	Che/at(q)	Δ#inst(q-1 to q)	Δ%inst(q-1 to q)	Excess retun(monthly)
Long	0.40	4.77%	0.30%	1.31
Neut	0.09	3.83%	0.12%	1.03
Short	0.02	3.35%	0.04%	0.70
L-S	0.38***	1.43%***	0.25%***	0.60***

Table 11 Institutional investors and return spread across cash holding quintiles

This table reports cash holdings, excess return and risk adjusted return on portfolios sorted by cash holdings quintiles and institutional quintiles independently. 'Diff (5-1)' represents the difference in cash holdings and abnormal returns between highest quintile cash holdings firms and lowest quintile cash holding firms. Panel A, Panel B and Panel C reports the average value of cash and abnormal return across cash holding quintiles in firms with lowest quintile, medium quintile and highest quintile of institutional investors respectively. 'Difflow-Diffhigh' is the Difference in abnormal returns spread by cash between HIO and LIO.

Quintiles	Cash	$Ret-R_f$	α_{mkt}	$\alpha_{3factor}$
Panel A Lowest quintile of Institutional Investors (LIO)				
1	0.008	0.564	0.065	-0.096
2	0.034	0.619	0.077	-0.022
3	0.090	1.232	0.692	0.563
4	0.209	1.300	0.708	0.683
5	0.513	1.660	1.057	1.093
Diff(5-1)		1.096	0.992	1.189
T-statistics		5.17	3.87	4.9
Panel B Medium quintile of Institutional Investors (MIO)				
1	0.008	0.506	-0.172	-0.464
2	0.034	0.831	0.115	-0.188
3	0.088	0.997	0.280	0.052
4	0.214	1.131	0.385	0.348
5	0.523	1.262	0.475	0.591
Diff(5-1)		0.756	0.647	1.055
T-statistics		2.98	1.98	3.65
Panel C Highest quintile of Institutional Investors (HIO)				
1	0.009	0.703	0.058	-0.129
2	0.035	0.855	0.204	0.059
3	0.091	0.826	0.150	0.044
4	0.203	0.954	0.193	0.237
5	0.446	1.017	0.137	0.430
Diff(5-1)		0.314	0.079	0.560
T-statistics		1.18	0.24	2.34
Difference in abnormal returns spread by cash between HIO and LIO				
$Diff_{low}-Diff_{high}$		0.782	0.914	0.630
T-statistics		2.99	2.85	2.39