Back to the Beginning: Does Investor Diversification Affect the Firm's Cost of Equity?*

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Abstract

We test whether the diversification of marginal investor affects the underlying firm's cost of equity. We use institutional investor holdings data to identify the marginal investor. We measure institutional investor diversification as the goodness of fit of a benchmark asset pricing model with respect to the investor portfolio returns. We find that firms with less diversified investors have a higher cost of equity and lower real investment. These findings are not driven by firm size, idiosyncratic volatility, institutional ownership, liquidity, investor stock selectivity, or behavioral biases. Collective evidence leans toward the market incompleteness explanation (Merton, 1987).

Keywords: Institutional Investors; Marginal Investor; Investor Diversification; Cost of Equity

JEL Classifications: G11; G12; G2

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1. Introduction

Classic asset pricing theories assume that investors hold diversified and identical portfolios. However, empirically, the majority of investors, whether individuals or institutional investors, hold rather heterogeneous and under-diversified portfolios. In an influential paper, Merton (1987) suggests that under-diversified investors would demand higher returns for bearing firm-specific risks. Surprisingly, the empirical analyses that directly test this important implication are rare in the literature.

In this paper, we use institutional investor holdings data to identify the marginal investor (by definition, marginal investor represents the collective beliefs of investors who are trading a stock and hence determines the equilibrium stock price), and test whether investor diversification affects the underlying firm's cost of equity. Consistent with Merton (1987)'s prediction, we find that firms with less diversified institutional investors have higher cost of equity (i.e., the under-diversification discounts) and lower real investment. We further show that such under-diversification discounts are likely driven by market incompleteness, instead of investor stock selectivity or behavioral attributions.

Recent literature on financial intermediaries, e.g., He and Krishnamurthy (2013), models financial intermediaries as the marginal investor. Similarly, we use institutional investors instead of individual investors to proxy for the marginal investor, because institutional investors are much larger and more sophisticated, dominating individual investors in trading activities. For example, institutional investors account for 79% of average stock trading volume in our sample period 1981-2013. Therefore, the average institutional investor is arguably more likely to be the firm's marginal investor.

Yet, the literature suggests that even institutional investors may not be well diversified and that they demonstrate great heterogeneity of diversification in their portfolios. Institutional

investors may be under-diversified due to transaction costs (Constantinides, 1986), market segmentations (Merton, 1987), fiduciary responsibilities and investment mandates (Del Guercio, 1996; He and Xiong, 2013), monitoring costs (Smith, 1996), background risks (Heaton and Lucas, 2000), investment style constraints (Abarbanell, Bushee and Raedy, 2003; Bushee, 2001), preferences for skewness or rank dependence (Polkovnichenko, 2005; Mitton and Vorkink, 2007; Barberis and Huang, 2008), information acquisitions (Van Nieuwerburgh and Veldkamp, 2009, 2010), joint liquidation risks (Wagner, 2011), ambiguity (Boyle, Garlappi, Uppal, and Wang, 2012), or behavioral biases (Tversky and Kahneman, 1981, 1986; Barberis and Huang, 2001).

In this paper, we attempt to investigate the consequences of investors' under-diversification. We measure an institutional investor's diversification as how well common risk factors capture its holding-based portfolio returns. Specifically, we use the goodness of fit of a benchmark asset pricing model (e.g., the CAPM, Fama-French 3-factor model, Fama-French 5-factor model, or Carhart 4-factor model) with respect to the investor's returns, i.e., the portfolio R^2. Thus, 1- R^2 measures the institutional investor's portfolio under-diversification. We find that institutional investors are generally under-diversified and their portfolio diversification varies greatly across different investors. For example, relative to the CAPM (Fama-French 3-factor, Carhart 4-factor) model, those pricing factors only capture approximately 79% (83%, 84%) of the institutional investor return variations, with a large standard deviation of 22% (20%, 19%). Moreover, the investor's under-diversification is highly persistent, with an average first-order autocorrelation coefficient of 0.83.

Next, we compute the average under-diversification level of a firm's institutional investors, weighted by the institutional investor buy-orders of the firm to capture the under-diversification of the marginal investor.[1] We find that the firm level institutional under-diversification varies

[1] Because trading is required to identify the marginal investor (by definition), we only consider institutional investors that have a change of holdings of the stock during a quarter. It is reasonable to

significantly across firms. For example, when the Carhart 4-factor model is used, the average institutional under-diversification is 0.085 with a standard deviation of 0.102. We find strong evidence that firms with less diversified institutional investors have a higher cost of equity (expected return), i.e., the under-diversification discount. A zero-cost portfolio that longs stocks in the quintile of the least diversified investors and shorts stocks in the quintile of the most diversified investors generates a Carhart alpha of 0.52% (equally-weighted) or 0.73% (value-weighted) per month during the period 1981-2013.

The above results are robust to the usual suspects that affect the cross-section of stock returns, such as market capitalization, book-to-market ratio, idiosyncratic volatility, liquidity, analyst coverage, and institutional ownership. Nonetheless, the presence of institutional under-diversification discounts requires further justifications. There are three major explanations. First, market incompleteness could result in institutional under-diversification (Merton, 1987). Frictions such as taxation, information acquisition costs, transaction costs, investment style constraints, or uninsurable labor income shocks, hinder market completeness and generate market segmentations. Thus, the under-diversified marginal investors require higher expected returns for bearing firm-specific (idiosyncratic) risks. Such idiosyncratic risks, not captured by the existing pricing factors but impounded through our under-diversification measure, would appear to be seemingly missing factors and thus generate excess returns relative to the commonly used benchmark models.

Second, institutional under-diversification may be driven by institutional investor stock picking ability or their information advantage. Firms with higher institutional under-diversification outperform because less diversified investors possess private information or have

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assume that buyers are more likely to be the marginal investor that determines the required rate of return than sellers because selling may be due to liquidation or even fire sale reasons. Therefore, in our main specification, we focus on the buy-order weighted under-diversification measure, while for robustness checks, we also construct the buy-order and sell-order weighted as well as the ownership weighted under-diversification measures.

better stock selection skills (Titman and Tiu, 2011; Amihud and Goyenko, 2013).[2] Third, behavioral biases may induce investors to choose less diversified portfolios (Tversky and Kahneman, 1981, 1986; Barberis and Huang, 2001, 2008), and hence, firms with higher institutional under-diversification may be mispriced due to greater noise trading driven by investor sentiment (Kumar, 2009; Stambaugh, Yu and Yuan, 2012).

Our collective evidence leans towards the market incompleteness explanation. First, employing the Fama-MacBeth regression, we show that less diversified investors require higher returns for stocks with higher idiosyncratic risk, which is consistent with Merton (1987). Second, the under-diversification discounts are robust after directly controlling for institutional investor's selectivity. Third, the under-diversification discounts are also robust after excluding stocks which are likely to have higher information asymmetry (small-cap stocks) or associated with the likely informed investors (short-term, transient investors). Last, the under-diversification discounts are stronger when we only consider large investors in the construction of the under-diversification measure. Those investors are more likely to be the marginal investor and are less subject to behavioral biases. Moreover, we find that the under-diversification discounts are actually weaker during the period of high investor sentiment, further challenging the behavioral bias explanation.

We provide a series of additional tests to strengthen the previous results on institutional under-diversification discounts. First, instead of using realized returns, we take a different approach and follow the recent accounting literature to estimate the implied cost of equity, because realized stock returns may be a noisy proxy for the expected returns (Elton, 1999). We follow Hou, Van Dijk, and Zhang (2012) or Li and Mohanram (2014) to estimate the risk-

[2] Titman and Tiu (2011) and Amihud and Goyenko (2013) examine the performance of hedge funds and mutual funds, respectively. Instead, to identify the marginal investor of stocks, we focus on the broader universe of institutional investors with various types (banks, insurance companies, independent investment advisors, pension funds, university endowments, etc.). The heterogeneities of portfolio choices among these investors are arguably more likely to be driven by different investment styles or investment mandates of institutions (He and Xiong, 2013).

adjusted implied cost of equity and find similar under-diversification discounts. Second, we examine the real effects of investors' under-diversification discounts on the firm operating activities, e.g., corporate investment. As predicted by the Q-theory, we show that investors' under-diversification leads to lower corporate investment.

Finally, we provide additional robustness checks to all of the previous results, by using alternative measures of institutional under-diversification. First, we consider alternative benchmark asset pricing models when computing investor portfolio under-diversification, e.g., the Fama-French 3-factor model, the Fama-French 5-factor model, or the CAPM model. Second, we consider alternative weighting schemes when computing the under-diversification measure at the firm level. We calculate the buy- and sell-trading weighted investor under-diversification and use the absolute amount of trading as the weight. We also use institutional ownership as the weight to compute institutional under-diversification among investors who have traded the stock. The results based on these alternative measures are consistent with the previous ones.

Our paper contributes to several lines of the literature. First, at the stock level, there is a growing body of literature on idiosyncratic risks, examining whether and how idiosyncratic risks are priced (e.g., Campbell, Lettau, Malkiel and Xu, 2001; Goyal and Santa-Clara, 2003; Ang, Hodrick, Xing, and Zhang, 2006, 2009; Bali and Cakici, 2008; Guo and Savickas, 2008; Huang, Liu, Rhee and Zhang, 2010; Boyer, Mitton and Vorkink, 2010; Fu, 2009; Bali, Cakici and Whitelaw, 2011; Chen and Petkova, 2012; Stambaugh, Yu and Yuan, 2015). Merton (1987) suggests that the firm-specific risks will be priced only if its marginal investors are under-diversified. However, the direct tests of Merton (1987) are rare, as the existing literature typically connects the idiosyncratic risk and stock returns directly, neglecting the investors' diversification. Our study complements this literature by investigating the impacts of institutional investors' diversification on the pricing of the idiosyncratic risks.

Second, this paper belongs to the recent literature on institutional investors in the financial markets. Traditional asset pricing theories often view financial intermediaries as a reflection of clients so that the representative household is the marginal investor in the securities markets. Recent financial crisis, e.g., the 2007–2009 subprime crisis and the 1998 LTCM crisis, revive the asset pricing role of financial intermediaries. He and Krishnamurthy (2013) model financial intermediaries as the marginal investor and evaluate the impacts of equity capital constraint on the risk premia. Our paper also uses the institutional investor to proxy for the marginal investor, but concerns the portfolio diversification of institutional investors. In addition, the diversification measure adopted in this paper, i.e., the portfolio R^2, has been used to measure the fund manager's ability or information advantage. For example, Titman and Tiu (2011) find that low R^2 hedge funds have better future performances, while Amihud and Goyenko (2013) find similar results for mutual funds. Sun, Wang and Zheng (2012) use a similar correlation measure to identify the strategy distinctiveness of hedge funds. Unlike these studies, we focus on the universe of institutional investors and take the portfolio R^2 as the direct and first-order proxy for institutional investor diversification and study its impacts on the underlying firm's cost of equity instead of investor performances.

Last, a large body of literature investigates investor diversification, using survey or brokerage account data. This line of literature mainly focuses on portfolio diversification of individual investors and explores its causes and impacts on investors' performances.[3] Little attention has been paid to the effect of investors' diversification on the underlying stocks. Only Kumar (2007) investigates the effects of investor diversification on stock returns from the behavioral perspective. He uses a small subset of individual investors from a brokerage house during the period 1991-1996. However, individual investors are either not representative of the

[3] For example, Blume and Friend (1975); Kelly (1995); Barber and Odean (2000); Grinblatt and Keloharju (2000, 2001); Dorn and Huberman (2005); Polkovnichenko (2005); Campbell (2006); Calvet, Campbell and Sodini (2007); Mitton and Vorking (2007); Goetzmann and Kumar (2008); Ivkovic, Sialm and Weisbenner (2008); Bodnaruk and Ostberg (2009); Kumar (2009).

whole investor population or unlikely to be the marginal investor. Thus, individual investor diversification may not be important for the underlying firm's cost of equity because it is the marginal investor who determines the stock prices. Moreover, individual investors more likely suffer from behavioral biases than institutional investors. Our paper examines the general diversification outcomes of institutional investors, in particular as the marginal investor, on the cost of equity of underlying firms and directly tests the predictions of Merton (1987).

The rest of the paper is organized as follows. Section 2 describes the data and main variables. Section 3 presents our main results of institutional under-diversification discounts. Section 4 tests the predictions of Merton (1987). Section 5 evaluates alternative explanations. Section 6 examines the impacts of institutional under-diversification on the implied cost of equity and real investment. Section 7 provides further robustness checks and Section 8 concludes.

2. Data, Construction of Variables and Summary Statistics

2.1 Data and Variables

Our data are from multiple sources. The data on quarterly stock holdings of institutional investors are from Thomson CDA/Spectrum (13F) from 1980 to 2013. In total, we have 223,808 institutional investor-quarter observations. The data on daily and monthly stock returns, trading volumes and annual accounting information are from CRSP and Compustat. We include all common stocks from NYSE/AMEX/NASDAQ with a share code of 10 or 11, which have available data on institutional holdings. The analyst coverage data are from I/B/E/S. At the stock level, we have 121,403 firm-year observations.

Next, we briefly describe the major variables used in the paper (see the Appendix for details). We first define the measure of institutional under-diversification. For the majority of our analyses, we will focus on the under-diversification measure constructed from the Carhart

(1997)'s 4-factor model. We proceed as follows. First, we estimate the degree of portfolio diversification at the investor level. In every quarter t and for each institutional investor j, we calculate its daily buy-and-hold portfolio returns based on its previous quarter-end stock holdings. Then, for each investor-quarter (j, t), we compute the goodness of fit, $R^2_{j,t}$, from the following Carhart 4-factor regression:

$$r_{j,s} - rf_s = \alpha_j + \beta_j(MKT_s - rf_s) + s_j SMB_s + h_j HML_s + u_j UMD_s + \varepsilon_{j,s}, \quad s \in Quarter\ t,$$

where $r_{j,s}$ is the daily portfolio return of investor j on date s.[4] Then, for investor-quarter (j, t), we define the portfolio under-diversification (UD, hereafter) at the investor level as:

$$UD_{j,t} = 1 - R^2_{j,t}.$$

One could argue that the goodness of fit is influenced by the missing factors. Therefore, for robustness checks, we also construct UD based on the Fama-French 5-factor model (Fama and French, 2015), Fama-French 3-factor model (Fama and French, 1992) as well as the CAPM model. The only difference is that we estimate the investor-level portfolio $R^2_{j,t}$ from the Fama-French 5-factor model, the Fama-French 3-factor model or from the CAPM model.

Next, we aggregate investor portfolio UD at the underlying stock level. For stock i at quarter t, we are interested in those institutional investors who are likely to be the marginal investor, i.e., investors who actually trade the stocks instead of staying on the sidelines. We thus focus on investors that have a change of holdings in stock i from quarter t-1 to quarter t. We also expect that buyers are more likely to be the marginal investor that determines the required rate of return than sellers because selling may be due to liquidation or even fire sale reasons (Shleifer and Vishny, 2011). Moreover, for investors who sell off their holdings from quarter t-1 to quarter t, the future required rate of return of the stock should matter less. Therefore, we

[4] The right-hand side variables include the excess market return over the risk-free rate (MKT_S-rf_s), the return difference between small and large capitalization stocks (SMB_s), the return difference between high and low book-to-market stocks (HML_s), and the return difference between stocks with high and low past returns (UMD_s). The data of the risk-free rate, market return, SMB, HML and UMD are obtained from Kenneth French's website.

focus on the investors who increase their holdings and calculate the buy-trading weighted investor under-diversifications. Specifically, for stock-quarter (i, t), for all institutional investors who increase their holdings of stock i from quarter t-1 to quarter t (investor set B={j: $\Delta Holding_{i,j,t} > 0$}), we calculate the institutional under-diversification for stock i as:

$$Institutional\ Under-diversification_{i,t} = \sum_{j \in B} w_{i,j,t} UD_{j,t}, \qquad w_{i,j,t} = \frac{\Delta Holding_{i,j,t}}{\sum_{k \in B} \Delta Holding_{i,k,t}}.$$

For robustness, we also consider two alternative weighting schemes, i.e., weighted by the net trades (including both buy- and sell-trades) or the institutional ownership. We defer the discussions to the robustness check section later.

We then evaluate the impacts of institutional investor UD on underlying stock's cost of equity. We calculate the returns of stock portfolios sorted by different levels of institutional under-diversification. Both equally-weighted and value-weighted portfolio returns are calculated. For each portfolio, we report the raw return, CAPM alpha, Fama-French 3-factor alpha, and Carhart 4-factor alpha. We will especially focus on the return (alpha) of the zero-cost long-short portfolios, calculated as the difference in returns (alphas) between the highest and lowest institutional under-diversification portfolios.

We also consider alternative measures of cost of equity. Following the recent accounting literature, we estimate the implied cost of equity from the current stock price and the future expected earnings. First, we use a cross-sectional model to estimate the one-year-ahead expected earnings as in either the Hou, Van Dijk, and Zhang (2012) model or the residual income model of Li and Mohanram (2014). Specifically, Hou, Van Dijk, and Zhang (2012) use the previous ten years of data to estimate the one-year ahead earnings from the following regressions:

$$E_{t+1} = \alpha_0 + \alpha_1 A_t + \alpha_2 D_t + \alpha_3 DD_t + \alpha_4 E_t + \alpha_5 NegE_t + \alpha_6 AC_t + \varepsilon_{t+1},$$

where E_t is the earnings in year t; A_t is the total assets in year t; D_t is the dividend payment in year t; DD_t is a dummy variable that equals 1 for dividend payers in year t; $NegE_t$ is a dummy

indicator that equals 1 for firms with negative earnings and 0 otherwise; and AC_t is the accruals.[5] Alternatively, Li and Mohanram (2014) use the previous five years of data to estimate the one-year-ahead earnings as follows:

$$E_{t+1} = \alpha_0 + \alpha_1 NegE_t + \alpha_2 E_t + \alpha_3 NegE_t * E_t + \alpha_4 B_t + \alpha_5 TACC_t + \varepsilon_{t+1},$$

where E_t is the earnings in year t, $NegE_t$ is a dummy indicator for negative earnings, B_t is the book value of equity, and $TACC_t$ is the total accruals.[6] Next, we use the Gordon and Gordon (1997) model to estimate the implied cost of equity as the predicted earnings divided by the stock price.[7] We set negative estimates to missing. For our purposes, we are interested in the implied cost of equity compensated for per unit of firm risk (i.e., the risk-adjusted implied cost of equity). We therefore define a measure of *implied cost of equity per unit of risk* as the ratio of the previously defined implied cost of equity divided by the annualized stock return volatility.

We control for a set of important firm-level characteristics such as return volatility, institutional ownership, Amihud illiquidity, recent stock returns, firm size, market-to-book, leverage, profitability, and cash holdings. *Return volatility is* the standard deviation of daily stock returns in a year/quarter. We also compute the *idiosyncratic volatility* of stocks using the standard deviation of the regression residuals estimated from the Carhart 4-factor model. *Amihud illiquidity* is the Amihud (2002) illiquidity measure, both at the quarterly level and at

[5] Earnings are computed as the earnings before special and extraordinary items (IB). Accruals are computed as the sum of change in non-cash current assets (ΔACT) and the change in debt included in current liabilities (ΔDLC) and the change in income taxes payable (ΔTXP) less the change in the cash and cash equivalents (ΔCHE) and the change in current liabilities (ΔLCT) and depreciation expense (ΔDP).

[6] Earnings are computed as the earnings before special and extraordinary items per share (IB – SPI). $NegE_t$ equals 1 for firms with negative earnings and 0 otherwise. Book value of equity is computed as the book value of common stocks (CEQ) divided by the number of shares outstanding (CSHO). Total accruals are computed as in Richardson et al. (2005), i.e., the sum of the change in non-cash working capital (ACT-CHE-LCT+DLC), the change in net non-current operating assets (AT-ACT-IVAO-LT+LCT+DLTT) and the change in net financial assets (IVST+IVAO-DLTT-DLC-PSTK), deflated by the number of shares outstanding (CSHO).

[7] We assume a 3-month reporting lag. That is, we match the stock price at the end of June of year t with the predicted earnings computed from firms with fiscal year ending between April of year t-1 and March of year t.

the annual level. It averages over each day in a year/quarter the square root of the ratio of the absolute price change divided by daily dollar volume. *Stock return* is the cumulative stock return in a year. *Market-to-book* ratio is defined as the market value of assets divided by the book value of assets. *Leverage* is the book leverage, defined as the total debt divided by the book assets. *Firm size* is the log value of the book assets. *Profitability* is the income before extraordinary items divided by the book assets. *Cash holding* is cash and short-term investments divided by the book assets. *Institutional ownership* is the ratio of total institutional holdings divided by the number of shares outstanding. We define *industry fixed effects* at the two-digit SIC level.

In our subsequent analyses, we will split our sample by the fraction of trading amount (relative to the total trading volume) of investors that we use to aggregate their portfolio under-diversification at the stock level, to verify that our results should be stronger among stocks where institutional investors are more likely to be the marginal investors. First, we consider all investors who increase their holdings of stock i from quarter t-1 to quarter t (investor set B={j: $\Delta Holding_{i,j,t} > 0$}). For each stock-quarter (i, t), we define the *institutional buy-trading fraction* as: $\sum_{j \in B} \Delta Holding_{i,j,t} / Volume_{i,t}$, where $\Delta Holding_{i,j,t}$ is the change in the number of shares held by investor j on stock i from quarter t-1 to quarter t, and $Volume_{i,t}$ is the total trading volume during quarter t. Second, we also focus on all investors who change their holdings from quarter t-1 to quarter t (investor set I={j: $Abs(\Delta Holding_{i,j,t}) > 0$}). For each stock-quarter (i, t), the *institutional total-trading fraction* is $\sum_{j \in I} Abs(\Delta Holding_{i,j,t}) / Volume_{i,t}$, where $Abs(\Delta Holding_{i,j,t})$ is the absolute change in the number of shares held by investor j on stock i from quarter t-1 to quarter t.

2.2 Summary Statistics

Table I provides summary statistics of our main variables. In Panel A, we report the mean and standard deviation of the investor-level portfolio under-diversification by investor types. Using the data on investor types obtained from Brian Bushee's website, we classify institutional investors into: bank trust, insurance company, investment company, independent investment advisor, private (corporate) pension fund, public pension fund, university and foundation endowments, and the rest. We report the portfolio under-diversifications based on the CAPM model, the Fama-French 3-factor model, and the Carhart 4-factor model.

First, as expected, the portfolio under-diversification drops when we include more factors in the benchmark asset pricing model to estimate the portfolio R-squared. For example, the Carhart 4-factor (Fama-French 3-factor, CAPM) portfolio under-diversification has a mean of 0.161 (0.170, 0.206) and a standard deviation of 0.193 (0.200, 0.221), respectively. Additionally, the investor portfolio under-diversification is quite persistent. For example, the average first-order autocorrelation coefficient is 0.83 for the Carhart 4-factor based measure.

Moreover, the portfolio under-diversification varies significantly across different investor types. Taking the Carhart 4-factor UD as an example, the most diversified investor type is public pension fund, with an average UD of 0.049 and a standard deviation of 0.104, while the most under-diversified investor type is university endowments and foundations fund, with a mean of 0.191 and a standard deviation of 0.219. The investor type with the largest number of institutional investors is independent investment advisor, among which the average UD is 0.159 with a standard deviation of 0.180.

The large variations in portfolio under-diversifications across different investor types suggest that there may be considerable cross-sectional differences across stocks in terms of the degree of under-diversifications of their marginal investors. Indeed, when we construct the weighted average investor-level UD at the stock level (i.e., the institutional under-diversification), using the buy-trading amount of institutional investors as the weight, the Carhart 4-factor (Fama-

French 3-factor, CAPM) institutional under-diversification has a mean of 0.085 (0.089, 0.140) and a standard deviation of 0.102 (0.105, 0.138) in Panel B. In the subsequent analyses, if not specifically mentioned, we focus on the institutional under-diversification measure constructed from the Carhart 4-factor model while using the ones based on the CAPM, the Fama-French 3-factor model, or the Fama-French 5-factor model as robustness checks.

Panel B also reports summary statistics of other firm characteristics. The average institutional ownership is 34%.[8] Importantly, the average fraction of institutional trading amount relative to total trading volume is 79%, suggesting that institutional investors trading the stocks are the reasonable proxies for the marginal investors of average stocks. It is worth mentioning that because we measure institutional trading by the absolute change in holdings in consecutive quarters, the volume of institutional trading may be largely under-estimated if some investors have both buys and sells during the quarter. As the sellers may be driven by the liquidity constraints or fire sale reasons, institutional buyers are more likely to be the marginal investor who determines the future required returns of the stock. If we focus on the institutional investors with increased holdings, the average fraction of institutional buy-trading relative to total trading volume during a quarter is 45%. This evidence validates our institutional under-diversification measure as a reasonable proxy for the marginal investor's under-diversification.

In Panel A, Table II, we present the pairwise correlation between institutional under-diversification and other firm characteristics. We consider firm characteristics such as institutional ownership, stock return, return volatility, Amihud illiquidity, firm size, book leverage, market-to-book, profitability, and cash holding. The first column indicates that institutional under-diversification has a low correlation with those major firm characteristics (less than 0.07 in all cases). In Panel B, we further split the entire sample year by year into high and low institutional under-diversification subsamples by the sample median. We compare firm

[8] The average institutional ownership has been increasing over the sample period, from 22.4% during the 1980s to 31.9% during the 1990s and 50.6% during the 2000s.

characteristics between the two subsamples and perform both the t-test and Wilcoxon test for the differences. We see that stocks with higher institutional under-diversification are slightly larger, with higher institutional ownership, more likely to be growth firms, more liquid, and have higher stock returns.[9]

3. Institutional Under-diversification Discounts

We now create portfolios of stocks sorted by institutional under-diversification. At the beginning of each month from January 1981 to December 2013, stocks are sorted into quintiles based on the previous quarter-end institutional UD. To avoid the microstructure noise, we exclude penny stocks (i.e., the previous month-end stock prices less than \$1) in the construction of portfolios. Portfolio 1 has the lowest institutional UD, while Portfolio 5 has the highest institutional UD. Both equally-weighted and value-weighted returns are calculated. "Long Portfolio 5 & Short Portfolio 1" is the zero-cost portfolio, which is long portfolio 5 and short portfolio 1.

In Figure I, we calculate the cumulative log returns of the zero-cost portfolio of stocks sorted by institutional UD from January 1981 to December 2013. We plot both the equally-weighted and the value-weighted portfolio returns. The cumulative log return is almost monotonically increasing over the entire sample period except the subprime crisis period of 2008. Converting into the absolute magnitudes, this implies a cumulative return of 863% (1109%) for the zero-cost portfolio if it is equally-weighted (value-weighted) during the last 33 years.

3.1 Main Results

[9] Even if the magnitudes of some of the differences are not large, the large number of observations in our sample makes the differences between subsamples always statistically significant.

We report the main results in Table III. For each portfolio, we report the raw return, CAPM alpha, Fama-French 3-factor alpha, and the Carhart 4-factor alpha. We present the results for the equally-weighted and value-weighted portfolios in Panels A and B, respectively.

For equally-weighted portfolios, the raw monthly returns increase monotonically from 0.75% of Portfolio 1 to 1.35% of Portfolio 5. We observe similar patterns for the excess returns, i.e., the CAPM alpha increases from -0.22% of Portfolio 1 to 0.30% of Portfolio 5; the Fama-French 3-factor alpha increases from -0.37% of Portfolio 1 to 0.14% of Portfolio 5; and the Carhart 4-factor alpha increases from -0.22% of Portfolio 1 to 0.31% of Portfolio 5. The results on the value-weighted portfolios display consistent patterns that both the raw and excess returns increase monotonically from Portfolio 1 to Portfolio 5.

The key results are on the returns of the long-short portfolio. The equally-weighted long-short portfolio produces a monthly raw return of 0.59% (t=6.54), a CAPM alpha of 0.53% (t=5.96), a Fama-French alpha of 0.51% (t=5.65), and a Carhart 4-factor alpha of 0.52% (t=4.83). The value-weighted long-short portfolio produces a monthly raw return of 0.69% (t=4.25), a CAPM alpha of 0.67% (t=4.03), a Fama-French 3-factor alpha of 0.67% (t=4.48), and a Carhart 4-factor alpha of 0.73% (t=4.63). Thus, we observe very strong under-diversification discounts.

These results convey two important messages. First, the fact that under-diversification discounts are larger among value-weighted portfolios than equally-weighted portfolios suggests that these results are different from usual return anomalies and are unlikely to be driven by mispricing or private information, which are often stronger among small cap stocks. It also suggests that our results are not driven by the illiquidity (risk) premium. Indeed, univariate results in Table II show that stocks with high institutional under-diversification tend to be more liquid.

Second, the raw return and the excess returns of the long-short portfolios, for both the equally-weighted portfolio and the value-weighted portfolio, are fairly stable across different factor models. This suggests that the returns of the long-short portfolios are not due to exposures to existing pricing factors like the Fama-French three factors and the momentum factor. It validates our institutional under-diversification measure because, by construction, the investor portfolio under-diversification captures the variations in investor returns unrelated to the existing pricing factors, possibly due to missing factors or idiosyncratic risks.

A close look at the one-way sorting in Panels A and B seems to suggest that stocks with the lowest institutional UD (Portfolio 1) contribute significantly to the long-short portfolio returns, especially for the Fama-French alphas when equally-weighted returns are computed in Panel A, which appears to be "a diversification premium" instead of "an under-diversification discount". In fact, this is a misconception, because the one-way sorting results in Panels A and B are contaminated by the idiosyncratic volatility effect.[10] Ang, Hodrick, Xing and Zhang (2006) document that stocks with higher idiosyncratic volatility have lower excess returns, i.e., the idiosyncratic volatility puzzle. So, the lower returns of Portfolio 1 in Panels A and B could be driven by the idiosyncratic volatility. We will address this issue further in the next section.

3.2 Double Sorting

One might still wonder whether the institutional diversification discounts are largely driven by other important firm characteristics, such as market capitalization and market-to-book ratio (Fama and French 1992), idiosyncratic risk (Ang, Hodrick, Xing and Zhang, 2006), liquidity (Amihud, 2002), or institutional ownership (Gompers and Metrick, 2001). To address this concern, we further perform double sorting to control for these firm characteristics. We double sort stocks in both dependent and independent manners.

[10] Unreported results indicate that stocks in Portfolio 1 and in Portfolio 5 have on average higher idiosyncratic volatilities than other stocks.

For example, in the case of market capitalization, we create 25 stock portfolios from dependent sorting, by first sorting stocks into quintiles based on the previous month-end market capitalization and then within each market capitalization quintile, further sorting stocks into quintiles based on the previous quarter-end institutional under-diversification. For independent sorting, we sort stocks based on the firm characteristic and institutional under-diversification independently. We compute the equally-weighted or value-weighted portfolio returns. Then, for each under-diversification quintile, we calculate the simple average portfolio return across all 5 market capitalization quintiles. Next, we calculate the return of the long-short portfolio as the difference in the average returns between the highest and lowest under-diversification quintiles. We use the same procedure for the other firm characteristics.

For brevity, we only report the dependent sorting results in Table IV and present the results from the independent sorting in Table A.I of the Online Appendix. Panels A and B of Table IV display the equally-weighted and value-weighted results, respectively. In all of these specifications, we find both quantitatively and qualitatively similar results as those reported in Table III. Thus, our results are not driven by spurious correlation between institutional under-diversification and other firm characteristics.

3.3 Subsample Analyses

Next, we provide subsample analyses on the portfolio returns sorted by institutional under-diversification in Table V. For brevity, we focus on the equally-weighted portfolios (which display relatively "smaller" under-diversification discounts in Table III) in this analysis as we are more interested in the average effects of institutional under-diversification in different subsamples. In Panel A, we split the sample period into three sub-periods: 1981-1991, 1992-2002, and 2003-2013. Our results are persistent during all three periods. The long-short portfolio produces a Carhart 4-factor alpha of 0.26% (t=1.92) per month during the period 1981-1991,

0.63% (t=2.85) per month during the period 1992-2002, and 0.48% (t=3.45) per month during the period 2003-2013.

In Panel B, we further exclude the month of January or December during portfolio formation to rule out the concerns of tax-loss induced trades. Compared with Table III, the magnitudes of under-diversification discounts are larger (smaller) when excluding January (December). Nevertheless, we still observe significant institutional under-diversification discounts during months other than January or December.

In Panel C, we exclude small-cap stocks in the formation of portfolios, further alleviating concerns that our results are driven by small stocks with potential anomalies related to mispricing or private information. We expect that such anomalies, if any, should concentrate among small cap stocks, which face more market frictions. We consider three different cut-offs: the previous month-end market capitalization above 100 million, above 200 million, or above 300 million. Empirically, this means excluding 37%, 52%, or 60% of the universe of the CRSP stocks when constructing the portfolios. We find consistent and slightly stronger results compared to the previous results in Table III. The long-short portfolio generates a Carhart 4-factor alpha of 0.82%, t=6.01 (0.83%, t=5.55; 0.75%, t=4.92) when we exclude stocks with lagged market capitalization below \$100 (\$200, \$300) million in the formation of portfolios.

Overall, these results produce robust evidence that the long-short portfolio sorted by institutional under-diversification generates significantly positive returns. The result is unlikely driven by existing valuation anomalies documented in the literature. Rather, it is more consistent with our argument that the under-diversified marginal investor demands higher required rate of returns for bearing firm-specific risks, which are not captured by the existing factors.

4. Interpreting the Under-Diversification Discounts: Merton (1987)

Merton (1987) suggests that under-diversified investors demand higher expected returns for bearing idiosyncratic risks. This implies that for a set of stocks with given level of idiosyncratic risks, poorly diversified investors would require higher returns, compared with well-diversified investors. If it is indeed the case, we should expect that the returns of the long-short portfolios to be higher among stocks with higher idiosyncratic risks.

We verify this conjecture in Panel A, Table VI. We sort stocks into portfolios by institutional under-diversification conditioning on idiosyncratic stock volatility. Specifically, at the beginning of each month, we first sort stocks into terciles based on the previous month idiosyncratic return volatility. Then, for each idiosyncratic volatility tercile (low/medium/high), we further sort stocks into quintiles based on the previous quarter-end institutional under-diversification, and we calculate the difference in returns between the highest and lowest institutional under-diversification portfolios. For brevity, we only report the value-weighted portfolio returns. The results are consistent with our expectations. For example, the Carhart alpha of the long-short portfolio increases from 0.53% per month (t=3.50) in the low volatility tercile to 1.13% per month (t=4.12) in the high volatility tercile.

On the other hand, for a set of poorly diversified investors, they would demand higher returns for stocks with larger idiosyncratic risks than stocks with lower idiosyncratic risks. We verify this conjecture by running Fama-MacBeth regressions over individual stocks in Panel B, Table VI. As before we focus on the institutional under-diversification measure constructed from the Carhart 4-factor model. We classify institutional under-diversification levels into two groups. That is, to distinguish different institutional under-diversification levels, we define a dummy variable, UD, which takes 1 when the institutional under-diversification measure is above the

cross-sectional median in each month and 0 otherwise. The factor betas are estimated from a rolling-window regression, using the previous 60 months of data. At least 24 months of monthly observations are required. We also control for other stock characteristics that might predict stock returns, including size, book-to-market, illiquidity, and momentum. The size is the log market capitalization of the firm at the end of the previous month; book-to-market ratio is computed as in Fama and French (1992); Amihud illiquidity is computed from the previous quarter, and momentum is the cumulative stock return over the previous six months after skipping one month.

Model (1) of Panel B restates our previous result that institutional under-diversification implies higher future stock returns, as we see the UD dummy has a significantly positive coefficient of 0.0026 (t=6.32). Model (2) replicates Ang, Hodrick, Xing and Zhang (2006) that stocks with higher idiosyncratic volatilities have lower returns. The UD dummy and idiosyncratic volatility effect continue to be significant when both are present in Model (3). This addresses the concern raised in the previous section. We formally test Merton (1987)'s prediction in Model (4) in which we add the interaction term of the UD dummy and idiosyncratic volatility. Consistent with Merton (1987), stocks with poorly diversified institutional investors (UD dummy=1) require higher returns when idiosyncratic volatilities are larger, e.g., the interaction term has a significantly positive coefficient of 0.002 (t=3.80).

5. Testing Alternative Explanations of the Under-Diversification Discounts

Three sources could contribute to the strong under-diversification discounts we documented above. First, it is well known that markets could be incomplete due to frictions. Frictions such

as taxation, information acquisition costs, transaction costs, investment style constraints, and uninsurable labor income shocks, prevent market completeness and mandate investors to take less diversified positions. These under-diversified investors require higher expected returns for bearing firm-specific risks (Merton, 1987), as we show in the previous section. Second, institutional investors choose less diversified portfolios due to investment selectivity based on their skills or information advantage. Third, it is possible that behavioral bias lead to the institutional under-diversification. We further evaluate the last two explanations in Tables VII and VIII.

5.1 Investor Ability

One potential explanation is that institutional under-diversification captures institutional investor's selectivity due to their abilities. For example, Titman and Tiu (2011) find that low R^2 hedge funds have better future performances, while Amihud and Goyenko (2013) find similar results for mutual funds. However, among the overall institutional investors, Lewellen (2011) find little evidence of stock picking skills. Nonetheless, we directly test this hypothesis by excluding investors that may potentially have better stock selectivity. First, in Panel A of Table VII we exclude institutional investors with portfolio under-diversification above the 67^{th} percentile of the sample distribution. Again, we observe the strong under-diversification discount.

To further test the investor ability hypothesis, we exclude the outperformers in Panel B. We follow Daniel, Grinblatt, Titman and Wermers (1997) to calculate the DGTW adjusted portfolio returns for each institutional investor. In every quarter t, and for each institutional investor j, we calculate the adjusted portfolio return as $\mathrm{DGTW}_{j,t} = \sum_{i=1}^{N} \omega_{i,t-1} (\mathrm{Ret}_{i,t} - \mathrm{Benchhmark}_{i,t})$, where $\omega_{i,t-1}$ is the portfolio weight on stock i at the end of quarter t-1, $\mathrm{Ret}_{i,t}$ is the quarter t return of stock i, and $\mathrm{Benchhmark}_{i,t}$ is the quarter t return of the characteristic-based benchmark portfolio that is matched to stock i along the

dimensions of size (market value of equity), book-to-market ratio, and momentum. Then, we exclude investors with portfolio DGTW-adjusted returns above the 67th percentile of the sample distribution. Still, Panel B exhibits a strong under-diversification discount.

5.2 Information Advantage

One may also wonder whether the under-diversification discounts mirror the information advantage that the less diversified institutional investors might have. From Tables II and III, we find that higher institutional UD stocks are more liquid. Thus, it is unlikely that the higher returns of high institutional UD stocks are driven by more intense informed trading because informed trading should be associated with lower stock liquidity. Nevertheless, we formally test this information driven explanation in two dimensions. We first re-examine our results by excluding the likely informed investors in our analysis. Next, we test whether our results are driven by stocks with higher information asymmetry.

Panel C of Table VII tests a subset of institutional investors who are less likely to be informed investors. Yan and Zhang (2009) find that trades by short-term investors are more informative than those by long-term investors because short-term investors have more incentive to collect and trade on information. We thus exclude the likely informed investors (short-term, transient investors) in our analysis to minimize the impact of information advantage. We use the institutional investor style classification obtained from Brian Bushee's website, whereby, in each year, institutional investors are classified into three styles: Permanent Transient /Quasi-indexer/Dedicated (Bushee and Noe, 2000; Bushee, 2001). We exclude transient investors when we calculate the buy-trading weighted institutional under-diversification. We sort stocks into quintiles by the non-transient institutional under-diversification and calculate the returns for the long-short portfolios following the same methodology as in Table III. The results remain the same as (slightly stronger) the findings reported in Table III. The equally-weighted (value-

weighted) long-short portfolio produces a Carhart 4-factor alpha of 0.58%, t=5.87 (0.76%, t=5.37) per month. This result is contrary to the alternative explanation that the under-diversification discounts are driven by the information advantage of the less diversified investors.

Next, we test whether our results are driven by stocks that have higher information asymmetry. We provide evidence in the previous section that our results remain robust and actually become stronger when we exclude small-cap stocks from our sample that are expected to have high information asymmetry. Further, as lower analyst coverage implies higher information asymmetry (Derrien and Kecskes, 2013), we use the number of analysts following the stocks to measure the information environment of the stocks. We perform a dependent double-sorting to control for the heterogeneity of information asymmetry among stocks in Table IV. Again, we see that the results are robust to the differences in information asymmetry of stocks.

5.3 Behavioral Bias

Another concern is that institutional under-diversification is correlated with behavioral biases. For example, Kumar (2007, 2009) uses proprietary data on individual investors from a brokerage house and find that individual investors are under-diversified because of behavioral biases and that the return predictability of investor under-diversification is related to mispricing due to noise trading. Given the trading size and sophistication of institutional investors, it is unlikely that our results are mainly driven by behavioral biases. Nonetheless, we perform two sets of tests to rule out this concern in Table VIII.

First, the behavioral explanation suggests that institutional under-diversification discounts are likely to be stronger if we construct the under-diversification measure among small institutional investors. In Panel A, we first classify institutional investors into small and large investors, based on their stock holdings at the end of the previous quarter, using the sample

median as the breakpoint. Then, we compute large/small institutional UD among large and small investor under-diversification separately. Finally, we sort stocks into quintiles by the large or small institutional UD and calculate the long-short portfolio returns. In contrast with the behavioral explanation, Panel A shows that the under-diversification discounts are much stronger among large institutional investors, who are more likely to be the marginal investor, instead of small institutional investors. In fact, the under-diversification discounts are insignificant for the measure based on small investors when value-weighted returns are computed.

Behavioral explanation also suggests higher under-diversification discounts when investor behavioral bias is likely large. We test this prediction using the investor sentiment data in Baker and Wurgler (2006). We obtain the data on investor sentiment during the period 1981-2010 from Jeffrey Wurgler's website. It is constructed as the first principal component of six (standardized) sentiment proxies (i.e., the dividend premium, IPO volume, first day returns on IPOs, close-end fund discount, new equity issuance and NYSE turnover). In Panel B, we sort stocks into portfolios by institutional under-diversification conditioning on investor sentiment. We split the entire sample period into terciles (high sentiment/medium sentiment/low sentiment) and calculate the raw returns and the excess returns for the long-short portfolios sorted by the previous quarter-end institutional UD. We report both the equally-weighted and the value-weighted portfolio returns.

The results are clearly against the behavioral bias explanation. The long-short portfolio returns are actually much smaller and only marginally significant during the high sentiment period. For example, the equally-weighted long-short portfolio generates a Carhart 4-factor alpha of 0.31%, t=1.75 (0.30%, t=1.97; 0.75%, t=4.83) per month in the high (medium, low) sentiment period. The value-weighted long-short portfolio generates a Carhart 4-factor alpha of

0.41%, t=1.30 (0.93%, t=2.74; 0.63%, t=2.78) per month in the high (medium, low) sentiment period.

Overall, the results in Table VII and Table VIII do not support the alternative explanations based on investment ability or information advantage of asset managers, or mispricing due to behavioral biases. They are more consistent with the argument that the under-diversified marginal investors demand higher required rate of returns for bearing firm-specific risks.

6. Implied Cost of Equity and Real Investment

We established the effects of institutional under-diversification on underlying stock returns, i.e., the under-diversification discounts. Still, one might worry that realized returns are noisy proxies for the cost of equity, which could be influenced by investor bias and market trading frictions. Thus, in this section, we strengthen our results in two ways. First, instead of using realized returns, we take a different approach and follow the accounting literature to estimate the implied cost of equity and investigate the impact of institutional under-diversification on the implied cost of equity.[11] Second, we examine the real effects on the firm operating activities, e.g., real investment. We run panel regressions for the estimation while controlling for other firm characteristics. To further confirm our measure as a valid proxy for the diversification of the marginal investor, we also separately examine the effects of institutional under-diversifications on firms with high or low institutional buy-trading fractions. We expect to observe stronger effects among firms with higher institutional buy-trading fractions, for which the investors we use to aggregate investor-level under-diversification are more likely to be the marginal investor.

6.1 Implied Cost of Equity

[11] Hann, Ogneva, and Ozbas (2013) apply the implied cost of equity to study corporate operating diversifications.

As previously described, we use two alternative ways to estimate the implied cost of equity. We follow the Li and Mohanram (2014) model in Panel A, and the Hou, Van Dijk, and Zhang (2012) model in Panel B of Table IX. Because the implied cost of equity is not adjusted by firm risks, while we argue that the under-diversified marginal investor needs to be compensated for bearing firm-specific risks, we expect that institutional under-diversification should be more related to the implied cost of equity per unit of risk (i.e., the risk-adjusted implied cost of capital, similar to the Sharp ratio defined at the individual stock level). We therefore standardize the implied cost of equity by the annual stock return volatility in the previous year and use it as the dependent variable. We run panel regressions while controlling for firm characteristics such as institutional ownership, return volatility, Amihud illiquidity, firm size, book leverage, profitability and cash holding. All independent variables are taken at the end of the previous year. To further control for unobserved firm characteristics, in Columns (4)-(6), we include firm fixed effects. Columns (1) and (4) are based on the full sample. In Columns (2)-(3) and (5)-(6), we split the sample into high and low subsamples by the measure of institutional buy-trading fraction (above/below the sample median). We include year and industry fixed effects and cluster the errors at the firm level in all specifications.

Panel A displays a significantly positive relationship between institutional under-diversification and the implied cost of equity per unit of risk. An increase of 0.1 in institutional under-diversification increases the implied cost of equity per unit of risk by 7.1% (t=7.67) relative to the sample mean. Consistently, this result is stronger for high institutional buy-trading stocks, where a 0.1 increase in institutional under-diversification increases the implied cost of equity per unit of risk by 10.1% (t=6.96) relative to the sample mean, compared to that of 5.1% (t=4.48) among low institutional buy-trading stocks. These results are robust to the inclusion of firm fixed effects. The alternative cost of equity measure in Panel B shows similar results.

6.2 Real Investment

Given the impacts of institutional UD on the cost of equity, we next examine whether it has real effects on the corporate side, e.g., investment, in Table X. Investment is the ratio of capital expenditures divided by book assets. As predicted by the Q-theory, the results indicate that institutional under-diversification is negatively related to future investment. An increase of 0.1 in institutional under-diversification reduces the real investment by 0.13% of total book assets. The effect is stronger among stocks with higher institutional buy-trading fraction, among which an increase of 0.1 in institutional under-diversification reduces investment by 0.24% of book assets. These results are robust to the inclusion of firm fixed effects. The control variables also make intuitive sense. Institutional ownership, profitability, cash holding, market-to-book are positively correlated with investment, while return volatility, illiquidity, and leverage negatively relate to investment.

Overall, these results provide supporting and consistent evidence that if the marginal investors are under-diversified, there is a higher cost of equity for the underlying firm, which generate real impacts on corporate investment.

7. Robustness Checks

Finally, we provide further robustness checks to all of our previous results in Table XI by using alternative measures of institutional under-diversification. For brevity, we only report the variables of interest. The specifications are the same as those in the previous tables. First, we consider three alternative benchmark asset pricing models when computing investor under-diversification. In Panel A, we use the institutional under-diversification measure based on the Fama-French 5-factor model. In Panel B, we use the institutional under-diversification measure based on the Fama-French 3-factor model. In Panel C, we use the one constructed from the

CAPM model. Second, we consider two alternative weighting schemes when computing the institutional under-diversification at the stock level. In Panel D, we include both the investors that increase their holdings and the ones that decrease their holdings. We calculate the institutional under-diversification as the buy- and sell-trading weighted investor under-diversification and use the absolute amount of change in holdings as the weight. In Panel E, we use the institutional ownership as the weight to compute the institutional under-diversification at the stock level, whereby we include all institutional investors who have net buy or sell trades in the previous quarter.

The results based on these alternative measures of institutional under-diversification are consistent with the previous ones. For example, the equally-weighted (value-weighted) long-short portfolio sorted by the Fama-French 5-factor institutional UD generates a Fama-French 5-factor alpha of 0.48% (0.72%) per month. The equally-weighted (value-weighted) long-short portfolio sorted by the Fama-French 3-factor institutional UD generates a Carhart 4-factor alpha of 0.57% (0.74%) per month. The equally-weighted (value-weighted) long-short portfolio sorted by the CAPM institutional UD generates a Carhart 4-factor alpha of 0.47% (0.38%) per month. The equally-weighted (value-weighted) long-short portfolio sorted by the buy- and sell-trading weighted institutional UD generates a Carhart 4-factor alpha of 0.39% (0.39%) per month. The equally-weighted (value-weighted) long-short portfolio sorted by the ownership weighted institutional UD generates a Carhart 4-factor alpha of 0.34% (0.33%) per month. The results on the implied cost of equity (per unit of risk) and investment are all consistent with the previous ones, and the effects are more evident among the subsamples when the investors are more likely to be the marginal investors, i.e., stocks with high institutional trading fraction as well as stocks with high institutional ownership.

8. Conclusions

This paper directly examines the impacts of investor diversification on the cost of equity of underlying stocks from the marginal investor perspective, using the institutional investor holdings data. Compared with individual investors, institutional investors are more likely to be the marginal investor and suffer less from behavioral biases, given their trading size and sophistication. We find strong evidence of under-diversification discounts that firms with less diversified institutional investors have higher cost of equity. As a result, these firms experience lower real investment.

These results are robust to firm characteristics such as market capitalization, book-to-market ratio, idiosyncratic volatility, liquidity, and institutional ownership. We also show that institutional selectivity or behavioral bias cannot explain such under-diversification discounts. The significant excess returns of the long-short portfolio relative to the commonly used benchmark models indicate that there are some firm-specific attributes that are not captured by the existing factors. Our results lean to the market incompleteness explanation (Merton, 1987) indicating that the under-diversification of marginal investors contributes to the pricing of such firm-specific attributes.

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Appendix: Variable Definitions

Institutional under-diversification (Carhart 4-factor model): First, we estimate the degree of portfolio diversification at the institutional investor level. In every quarter t, and for each institutional investor j, we calculate its daily buy-and-hold portfolio returns based on its previous quarter-end stock holdings. Then, for each investor-quarter (j, t), we compute the $R^2_{j,t}$ from the following Carhart four-factor regression:

$$r_{j,s} - rf_s = \alpha_j + \beta_j(MKT_s - rf_s) + s_j SMB_s + h_j HML_s + u_j UMD_s + \varepsilon_{j,s}, \quad s \in Quarter\ t,$$

where $r_{j,s}$ is the daily portfolio return of investor j on date s, and the right-hand side variables include the excess market return over the risk-free rate (MKT_s-rf_s), the return difference between small and large capitalization stocks (SMB_s), the return difference between high and low book-to-market stocks (HML_s), and the return difference between stocks with high and low past returns (UMD_s). The data of the risk-free rate, market return, SMB, HML and UMD are obtained from Kenneth French's website. Then, for investor-quarter (j, t), we define the portfolio under-diversification at the investor level as:

$$UD_{j,t} = 1 - R^2_{j,t}.$$

Next, we aggregate investors' portfolio under-diversifications at the stock level. For stock i at quarter t, we are interested in those institutional investors who are likely to be the marginal investor, i.e., investors who actually trade the stocks instead of staying on the sidelines. We thus focus on investors that have a change of holdings in stock i from quarter t-1 to quarter t. We also expect that buyers are more likely to be the marginal investor that determines the required rate of return than sellers because selling may be due to liquidation or even fire sale reasons. Moreover, for investors who sell off their holdings from quarter t-1 to quarter t, the future required rate of return of the stock should matter less. Therefore, we focus on the investors who increase their holdings and calculate the buy-trading weighted investors' under-diversifications. Specifically, for stock-quarter (i, t), for all institutional investors who increase their holdings of stock i from quarter t-1 to quarter t (investor set B={j: $\Delta Holding_{i,j,t} > 0$ }), we calculate the institutional under-diversification as:

$$Institutional\ Underdiversification_{i,t} = \sum_{j \in B} w_{i,j,t} UD_{j,t}, \quad w_{i,j,t} = \frac{\Delta Holding_{i,j,t}}{\sum_{k \in B} \Delta Holding_{i,k,t}}.$$

Institutional under-diversification (Fama-French 5-factor model): We follow the same methodology to define the Fama-French 5-factor based institutional under-diversification. The only difference is that we estimate the investor-level portfolio $R^2_{j,t}$ from the Fama-French 5-factor model (Fama and French, 2014):

$$r_{j,s} - rf_s = \alpha_j + \beta_j(MKT_s - rf_s) + s_j SMB_s + h_j HML_s + r_j RMW_s + c_j CMA_s + \varepsilon_{j,s}, \quad s \in Quarter\ t.$$

Institutional under-diversification (Fama-French 3-factor model): We follow the same methodology to define the Fama-French 3-factor based institutional under-diversification. The only difference is that we estimate the investor-level portfolio $R^2_{j,t}$ from the Fama-French 3-factor model:

$$r_{j,s} - rf_s = \alpha_j + \beta_j(MKT_s - rf_s) + s_j SMB_s + h_j HML_s + \varepsilon_{j,s}, \quad s \in Quarter\ t.$$

Institutional under-diversification (CAPM): We follow the same methodology to define the CAPM 1-factor based institutional under-diversification. The difference is that we estimate the investor-level $R^2_{j,t}$ from the CAPM:

$$r_{j,s} - rf_s = \alpha_j + \beta_j(MKT_s - rf_s) + \varepsilon_{j,s}, \quad s \in Quarter\ t.$$

Institutional ownership: For stock i at quarter t, it is the ratio of total institutional holdings divided by the number of shares outstanding.

Institutional buy-trading fraction: We focus on all the investors that increase their holdings of stock i from quarter t-1 to quarter t (investor set B={j: $\Delta Holding_{i,j,t} > 0$}). For each stock-quarter (i, t), the institutional buy-trading fraction is defined as $\sum_{j\in B} \Delta Holding_{i,j,t} / Volume_{i,t}$, where $\Delta Holding_{i,j,t}$ is the change in the number of shares held by investor j on stock i from quarter t-1 to quarter t, and $Volume_{i,t}$ is the total trading volume during quarter t.

Institutional total-trading fraction: We focus on all the investors that change their holdings from quarter t-1 to quarter t (investor set I={j: $Abs(\Delta Holding_{i,j,t}) > 0$}). For each stock-quarter (i, t), institutional total-trading fraction is defined as $\sum_{j\in I} Abs(\Delta Holding_{i,j,t})/Volume_{i,t}$, where $Abs(\Delta Holding_{i,j,t})$ is the absolute change in the number of shares held by investor j on stock i from quarter t-1 to quarter t.

Stock return: the cumulative stock return in a year.

Return volatility: the standard deviation of daily stock returns in a year/quarter. To relate to the idiosyncratic volatility literature, we also compute the idiosyncratic volatility of stocks using the standard deviation of the regression residuals estimated from the Carhart 4-factor model.

Amihud illiquidity: the Amihud (2000) illiquidity measure, at quarterly or annual frequency. It averages the square root of the ratio of the absolute price change divided by daily dollar volume over each day in year/quarter t. It is calculated as:

$$Illiquidity_{i,t} = \frac{1}{D_t}\sum_{days\in t}(1000 * \sqrt{\frac{|daily\ return|}{daily\ dollar\ volume}}),$$

where D_t is the number of days in year/quarter t.

Firm size: the log value of book assets (Compustat item, AT).

Market-to-book: market value of assets/book assets, where the market value of assets is calculated as: stock price (PRCC_F) * shares outstanding (CSHO) + short term debt(DLC) + long term debt(DLTT) + preferred stock liquidation value (PSTKL) – deferred taxes and investment tax credits (TXDITC).

Book leverage: total debt/book assets, where the total debt is long term debt (DLTT) + short term debt (DLC).

Profitability: operating income before depreciation (OIBDP)/book assets (AT).

Cash holding: cash and short-term investments (CHE)/book assets (AT).

*Implied cost of equity per unit of risk (*Li and Mohanram, 2014*):* We follow the Li and Mohanram (2014) residual income model to estimate the implied cost of equity. It is the discount rate used to compute the present stock price from the expected future cash flows. To avoid the data availability issue with analysts' earnings forecasts, we follow the cross-sectional regression method to estimate the expected earnings, based on the residual income valuation. Specifically, following Li and Mohanram (2014), we estimate the one-year ahead earnings as follows:

$$E_{t+1} = \alpha_0 + \alpha_1 NegE_t + \alpha_2 E_t + \alpha_3 NegE_t * E_t + \alpha_4 B_t + \alpha_5 TACC_t + \varepsilon_{t+1},$$

where E_t is the earnings in year t, $NegE_t$ is a dummy indicator for negative earnings, B_t is the book value of equity, and $TACC_t$ is the total accruals. Earnings are computed as the earnings

before special and extraordinary items per share ((IB-SPI)/CSHO). $NegE_t$ equals 1 for firms with negative earnings and 0 otherwise. Book value of equity is computed as the book value of common stocks divided by the number of shares outstanding (CEQ/CSHO). Total accruals are computed as in Richardson et al. (2005), i.e., the sum of the change in non-cash working capital (WC=(ACT-CHE)-(LCT-DLC), divided by CSHO), the change in net non-current operating assets (NCO= (AT-ACT-IVAO)-(LT-LCT-DLTT), divided by CSHO) and the change in net financial assets (FIN=(IVST+IVAO)-(DLTT+DLC+PSTK), divided by CSHO). To minimize the survivorship bias, we use the previous 5 years data to run pool regressions to estimate the coefficients and then compute the predicted earnings one-year ahead. Next, we use the Gordon and Gordon (1997) model to estimate the implied cost of equity as the predicted earnings divided by the stock price. We assume a 3-month reporting lag. That is, we match the stock price at the end of June of year t with the predicted earnings computed from firms with fiscal year ending between April of year t-1 and March of year t. We set negative estimates to missing. Then, we calculate the *implied cost of equity per unit of risk as* the ratio of the implied cost of equity divided by the annualized stock return volatility.

Implied cost of equity per unit of risk (Hou, Van Dijk, and Zhang, 2012): Alternatively, we follow the Hou, Van Dijk, and Zhang (2012) model to estimate the implied cost of equity. Specifically, we estimate the one-year ahead earnings as follows, using the previous ten years of data:

$$E_{t+1} = \alpha_0 + \alpha_1 A_t + \alpha_2 D_t + \alpha_3 DD_t + \alpha_4 E_t + \alpha_5 NegE_t + \alpha_6 AC_t + \varepsilon_{t+1},$$

where E_t is the earnings in year t, A_t is the total assets in year t, D_t is the dividend payment in year t, DD_t is a dummy variable that equals 1 for dividend payers in year t, $NegE_t$ is a dummy indicator that equals 1 for firms with negative earnings and 0 otherwise, and AC_t is the accruals. Earnings are computed as the earnings before special and extraordinary items (IB). Accruals are computed as the sum of change in non-cash current assets (ACT) and the change in debt included in current liabilities (DLC) and the change in income taxes payable (TXP) less the change in the cash and cash equivalents (CHE) and the change in current liabilities (LCT) and depreciation expense (DP). Next, we use the Gordon and Gordon (1997) model to estimate the implied cost of equity as the predicted earnings divided by the stock price. We match the stock price at the end of June of year t with the predicted earnings computed from firms with fiscal year ending between April of year t-1 and March of year t. We set estimates to missing. Then, we calculate the *implied cost of equity per unit of risk as* the ratio of the implied cost of equity divided by the annualized stock return volatility.

Investment: the ratio of capital expenditures (CAPX) divided by the lagged book assets (AT).

Industry fixed effects: industry dummy variables defined at the two-digit SIC level.

Figure I: Long-Short Portfolio Returns Sorted by Institutional Under-Diversification

This figure presents the *cumulative log returns* of a long-short portfolio of stocks sorted by institutional under-diversification. We focus on the institutional under-diversification constructed from the Carhart 4-factor model. The definition is detailed in the appendix. In each month from January 1981 to December 2013, stocks are sorted into quintiles based on the previous quarter-end institutional under-diversification, and the average monthly return of each portfolio is calculated. The return of the long-short portfolio is calculated as the difference between the highest institutional under-diversification portfolio (P5) and the lowest institutional under-diversification portfolio (P1). We plot the *cumulative log returns* for both the equally-weighted portfolios and the value-weighted portfolios.

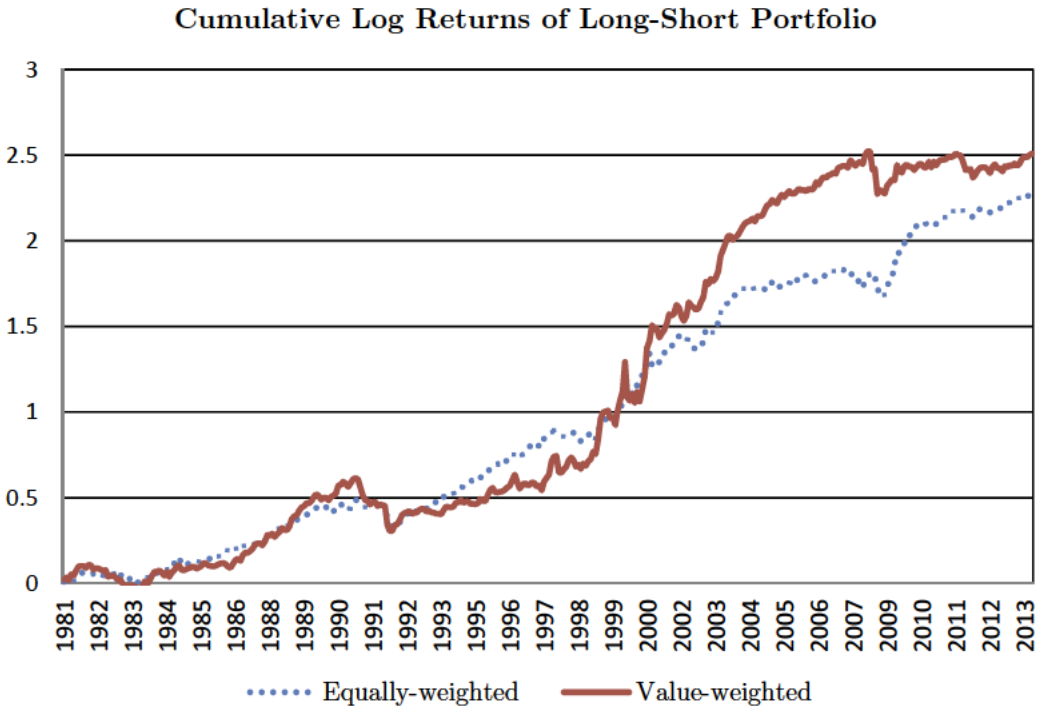

Table I
Summary Statistics

This table presents summary statistics of the main variables used. The data on quarterly stock holdings of institutional investors come from Thomson CDA/Spectrum (13F) from 1980 to 2013. The data on daily and monthly stock returns, trading volumes and annual accounting information are from CRSP and Compustat.

Panel A: Investor-level Portfolio Under-diversification by Investor Type

In Panel A, we report the mean and standard deviation of the investor-level portfolio under-diversification (UD) by investor type. We follow the investor type classifications from 13F and classify institutional investors into: bank trust, insurance company, investment company, independent investment advisor, private (corporate) pension fund, public pension fund, university and foundation endowments, and the rest. We use the investor type classification obtained from Brian Bushee's website. We report the investor-level UD based on the CAPM model, the Fama-French 3-factor model, and the Carhart 4-factor model. N represents the number of investor-quarter observations.

	Investor-level UD (CAPM)		Investor-level UD (Fama-French 3-factor)		Investor-level UD (Carhart 4-factor)		
Investor Type	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	N
Bank trust	0.137	0.170	0.117	0.158	0.112	0.153	26263
Insurance company	0.177	0.240	0.153	0.221	0.147	0.216	8946
Investment company	0.172	0.214	0.136	0.189	0.127	0.181	6949
Indepen. investment advisor	0.208	0.210	0.170	0.186	0.159	0.180	155118
Private pension fund	0.193	0.262	0.168	0.242	0.160	0.235	4735
Public pension fund	0.068	0.129	0.054	0.113	0.049	0.104	2276
University endowments	0.234	0.251	0.199	0.225	0.191	0.219	1860
Miscellaneous	0.222	0.219	0.186	0.199	0.175	0.193	12776
Overall	0.206	0.221	0.170	0.200	0.161	0.193	223808

Panel B: Summary Statistics of Firm Characteristics

In Panel B, we report the summary statistics of firm characteristics. For each variable, we report the mean, the median, and the standard deviation. N denotes the number of firm-year observations.

	Mean	Median	Std. Dev.	N
Institutional UD (Carhart 4-factor)	0.085	0.054	0.102	121403
Institutional UD (Fama-French 3-factor)	0.089	0.058	0.105	121403
Institutional UD (CAPM)	0.140	0.097	0.138	121403
Institutional ownership	0.343	0.285	0.276	121403
Institutional buy-trading fraction	0.453	0.292	0.610	121403
Institutional total-trading fraction	0.790	0.562	0.991	121040
Stock return	0.162	0.031	0.863	121403
Return volatility	0.039	0.032	0.026	121403
Amihud illiquidity	0.559	0.282	0.685	121403
Firm size (log(total assets))	5.067	4.896	2.127	121403
Book leverage	0.230	0.196	0.209	121403
Market-to-book	1.767	1.088	2.644	121403
Profitability	0.043	0.107	0.529	121403
Cash holding	0.177	0.082	0.218	121403
Implied cost of equity per unit of risk	0.242	0.180	0.216	66333
Investment	0.063	0.041	0.089	120029

Table II
Institutional Under-diversification and Firm Characteristics

This table presents the correlation between institutional under-diversification and other firm characteristics. We focus on the institutional under-diversification measure constructed from the Carhart 4-factor model. We consider firm characteristics such as institutional ownership, stock return, return volatility, Amihud illiquidity, firm size, book leverage, market-to-book, profitability, and cash holding. The variable definitions can be found in the appendix. We report the pairwise correlation in Panel A. In Panel B, we split the full sample into high and low institutional under-diversification subsamples by the sample median (year by year). We compare firm characteristics between the two subsamples and perform both t-test and Wilcoxon test for the differences. *** represents significance level at 1%.

Panel A: Correlation Matrix

	Institut. UD	Institut. own.	Stock return	Return vol.	Amihud illiquid.	Firm size	Book lev.	Market-to-book	Profit.
Institutional UD	1								
Institutional ownership	-0.025	1							
Stock return	0.018	0.090	1						
Return volatility	0.033	-0.347	-0.067	1					
Amihud illiquidity	0.008	-0.531	-0.078	0.531	1				
Firm size	-0.067	0.638	0.050	-0.462	-0.573	1			
Book leverage	-0.012	-0.048	-0.061	-0.003	0.072	0.196	1		
Market-to-book	0.035	-0.026	0.214	0.105	-0.111	-0.202	-0.162	1	
Profitability	-0.021	0.135	0.082	-0.235	-0.104	0.208	0.027	-0.204	1
Cash holding	0.056	-0.034	0.044	0.189	-0.045	-0.272	-0.427	0.326	-0.175

Panel B: Firm Characteristics by Low and High Institutional Under-diversification

	Low Inst. UD	High Inst. UD	Diff.	T-test	Wilcoxon
Institutional ownership	0.313	0.369	0.055	35.72***	46.39***
Firm Size	4.989	5.179	0.190	15.77***	21.23***
Book leverage	0.234	0.226	-0.008	-6.97***	-9.35***
Market-to-book	1.709	1.797	0.088	5.90***	12.34***
Profitability	0.039	0.050	0.011	3.66***	3.10***
Cash holding	0.161	0.189	0.028	22.50***	18.74***
Return volatility	0.039	0.037	-0.002	-14.71***	-6.44***
Amihud illiquidity	0.649	0.467	0.172	-47.42***	-31.42***
Stock return	0.136	0.193	0.057	11.64***	8.27***

Table III
Portfolio Returns by Institutional Under-diversification: Main Results

This table reports the returns of stock portfolios sorted by institutional under-diversification. We focus on the Carhart 4-factor based institutional under-diversification. At each month-beginning from January 1981 to December 2013, stocks are sorted into quintiles based on the previous quarter-end institutional under-diversification. Portfolio 1 has the lowest institutional under-diversification while Portfolio 5 has the highest institutional under-diversification. Both equally-weighted and value-weighted portfolio returns are calculated. For each portfolio, we report the raw return, the CAPM alpha, the Fama-French 3-factor alpha, and the Carhart 4-factor alpha. "Long Portfolio 5 & Short Portfolio 1" is the difference in returns between the highest and lowest institutional under-diversification portfolios. Panels A and B present the results for the equally-weighted portfolios and the value-weighted portfolios, respectively. ***, ** and * represent significance levels at 1%, 5%, and 10%, respectively, using robust standard errors with t-statistics given in parentheses. N denotes the number of total months.

Panel A: Equally-Weighted Portfolios

Portfolios Sorted by Institutional Under-diversification	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Portfolio 1	0.0075	-0.0022	-0.0037***	-0.0022*	396
		(-1.36)	(-3.30)	(-1.76)	
Portfolio 2	0.0097	-0.0009	-0.0022***	-0.0010	396
		(-0.83)	(-3.25)	(-1.56)	
Portfolio 3	0.0114	0.0006	-0.0005	0.0005	396
		(0.54)	(-0.92)	(1.04)	
Portfolio 4	0.0134	0.0024*	0.0010	0.0025***	396
		(1.87)	(1.47)	(4.00)	
Portfolio 5	0.0135	0.0030*	0.0014	0.0031***	396
		(1.94)	(1.37)	(2.95)	
Long Portfolio 5 & Short Portfolio 1	0.0059***	0.0053***	0.0051***	0.0052***	396
	(6.54)	(5.96)	(5.65)	(4.83)	

Panel B: Value-Weighted Portfolios

Portfolios Sorted by Institutional Under-diversification	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Portfolio 1	0.0059	-0.0038***	-0.0045***	-0.0044***	396
		(-3.31)	(-4.41)	(-4.16)	
Portfolio 2	0.0101	0.0001	0.0004	0.0006	396
		(0.28)	(0.85)	(1.26)	
Portfolio 3	0.0110	0.0012**	0.0012**	0.0010**	396
		(2.39)	(2.26)	(2.12)	
Portfolio 4	0.0120	0.0021**	0.0018**	0.0018**	396
		(2.54)	(2.46)	(2.38)	
Portfolio 5	0.0128	0.0028***	0.0022**	0.0030***	396
		(2.62)	(2.41)	(3.05)	
Long Portfolio 5 & Short Portfolio 1	0.0069***	0.0067***	0.0067***	0.0073***	396
	(4.25)	(4.03)	(4.48)	(4.63)	

Table IV
Portfolio Returns by Institutional Under-diversification: Double Sorting

In this table, we perform double-sorting of stocks by institutional under-diversification and other firm characteristics, dependently. We consider variables such as market capitalization, market-to-book, idiosyncratic volatility, Amihud illiquidity, analyst coverage, institutional ownership and institutional buy-trading fraction. Specifically, for example, in the case of market capitalization, we create 25 stock portfolios, by first sorting stocks into quintiles based on the previous month-end market capitalization, then within each market capitalization quintile, further sorting stocks into quintiles based on the previous quarter-end institutional under-diversification. We compute the equally-weighted or value-weighted portfolio returns. Then, for each under-diversification quintile, we calculate the simple average portfolio return across all 5 market capitalization quintiles. Next, we calculate the return of the long-short portfolio, as the difference in the average returns between the highest and lowest under-diversification quintiles. We follow the same procedure for the other variables. In Panel A we report the results for the equally-weighted portfolios, and in Panel B we present the results for the value-weighted portfolios. ***, **, and * represent significance levels at 1%, 5%, and 10%, respectively, using robust standard errors with t-statistics given in parentheses. N denotes the number of total months.

Panel A: Equally-Weighted Portfolios

Long Portfolio 5 & Short Portfolio 1 by Institutional Under-diversification	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Control for market capitalization	0.0064***	0.0060***	0.0056***	0.0059***	396
	(5.43)	(4.90)	(5.11)	(4.55)	
Control for market-to-book	0.0051***	0.0045***	0.0041***	0.0042***	396
	(4.65)	(4.12)	(4.35)	(3.64)	
Control for idiosyncratic volatility	0.0047***	0.0040***	0.0042***	0.0044***	396
	(4.84)	(4.36)	(4.55)	(4.11)	
Control for Amihud illiquidity	0.0063***	0.0060***	0.0055***	0.0056***	396
	(5.34)	(4.88)	(5.08)	(4.29)	
Control for analyst coverage	0.0053***	0.0049***	0.0045***	0.0046***	396
	(4.66)	(4.22)	(4.39)	(3.46)	
Control for institutional ownership	0.0052***	0.0048***	0.0048***	0.0049***	396
	(4.43)	(4.16)	(3.96)	(4.28)	
Control for institutional buy-trading	0.0053***	0.0045***	0.0046***	0.0052***	396
	(5.41)	(4.84)	(4.80)	(5.16)	

Panel B: Value-Weighted Portfolios

Long Portfolio 5 & Short Portfolio 1 by Institutional Under-diversification	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Control for market capitalization	0.0064***	0.0059***	0.0054***	0.0057***	396
	(5.11)	(4.54)	(4.78)	(4.38)	
Control for market-to-book	0.0056***	0.0052***	0.0049***	0.0055***	396
	(3.99)	(3.39)	(3.71)	(4.03)	
Control for idiosyncratic volatility	0.0077***	0.0074***	0.0072***	0.0075***	396
	(4.95)	(4.46)	(4.94)	(4.83)	
Control for Amihud illiquidity	0.0055***	0.0052***	0.0048***	0.0049***	396
	(4.41)	(3.96)	(4.24)	(3.82)	
Control for analyst coverage	0.0068***	0.0065***	0.0063***	0.0062***	396
	(5.08)	(4.32)	(5.19)	(4.80)	
Control for institutional buy-trading	0.0057***	0.0053***	0.0056***	0.0059***	396
	(4.01)	(3.67)	(4.23)	(4.09)	
Control for institutional ownership	0.0059***	0.0056***	0.0057***	0.0061***	396
	(4.22)	(3.99)	(4.39)	(4.14)	

Table V
Portfolio Returns by Institutional Under-diversification: Subsamples

In this table, we provide subsample analyses of the portfolio returns sorted by institutional under-diversification as previously constructed in Table III. For brevity, we only report the equally-weighted portfolios as we are more interested in the average effects of institutional under-diversification in different subsamples. In Panel A, we split the overall sample period into three sub-periods: 1981-1991, 1992-2002, and 2003-2013. Panel B presents results excluding January or December in the portfolio formation. In Panel C, we exclude small-cap stocks in the formation of portfolios. We consider different cut-offs: previous month-end market capitalization above 100 million, above 200 million, or above 300 million. ***, **, and * represent significance levels at 1%, 5%, and 10%, respectively, using robust standard errors with t-statistics given in parentheses.

Panel A: Subsamples by Different Time Periods

Long Portfolio 5 & Short Portfolio 1 by Institutional Under-diversification	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Period: 1981-1991	0.0035***	0.0034***	0.0031**	0.0026*	132
	(3.20)	(3.12)	(2.51)	(1.92)	
Period: 1992-2002	0.0079***	0.0074***	0.0070***	0.0063***	132
	(4.33)	(4.14)	(4.30)	(2.85)	
Period: 2003-2013	0.0063***	0.0046***	0.0046***	0.0048***	132
	(3.79)	(2.96)	(3.18)	(3.45)	

Panel B: Subsamples Excluding January or December

Long Portfolio 5 & Short Portfolio 1 by Institutional Under-diversification	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Excluding January	0.0071***	0.0064***	0.0061***	0.0068***	363
	(8.08)	(7.57)	(7.37)	(7.59)	
Excluding December	0.0051***	0.0045***	0.0044***	0.0046***	363
	(5.39)	(4.98)	(4.66)	(4.17)	

Panel C: Subsamples Excluding Small-cap Stocks

Long Portfolio 5 & Short Portfolio 1 by Institutional Under-diversification	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Mkt Cap>100 Million	0.0086***	0.0079***	0.0076***	0.0082***	396
	(6.95)	(6.34)	(5.97)	(6.01)	
Mkt Cap>200 Million	0.0086***	0.0078***	0.0076***	0.0083***	396
	(6.12)	(5.55)	(5.37)	(5.55)	
Mkt Cap>300 Million	0.0076***	0.0069***	0.0068***	0.0075***	396
	(5.16)	(4.66)	(4.58)	(4.92)	

Table VI
Institutional Under-diversification, Idiosyncratic Volatility, and Stock Returns: Merton (1987)

Panel A: Portfolio Sorting Conditioning on Idiosyncratic Return Volatility

In this panel, we sort stocks into portfolios by idiosyncratic return volatility as well as institutional under-diversification. We estimate monthly idiosyncratic volatility of stocks using the standard deviation of the regression residuals estimated from the Carhart 4-factor model. Specifically, at each month-end, we first sort stocks into terciles based on the previous month idiosyncratic return volatility. Then, for each idiosyncratic volatility tercile (high/medium/low), we further sort stocks into quintiles based on the previous quarter-end institutional under-diversification. We calculate the value-weighted portfolio returns, and the difference in returns between the highest and lowest institutional under-diversification portfolios. We report the raw return, the CAPM alpha, the Fama-French 3-factor alpha, and the Carhart 4-factor alpha, for the lowest institutional under-diversification portfolio (Portfolio 1), the highest institutional under-diversification portfolio (Portfolio 5), and the long-short portfolio ("Long Portfolio 5 & Short Portfolio 1"). ***, ** and * represent significance levels at 1%, 5%, and 10%, respectively, using robust standard errors with t-statistics given in parentheses. N denotes the number of total months.

Portfolios Sorted by Institutional UD Conditioning on Idiosyncratic Volatility	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Low idiosyncratic volatility					
Portfolio 1	0.0046	-0.0006	-0.0014	-0.0019**	396
		(-0.59)	(-1.54)	(-2.08)	
Portfolio 5	0.0092	0.0044***	0.0032***	0.0033***	396
		(4.20)	(2.94)	(3.04)	
Long Portfolio 5 & Short Portfolio 1	0.0046***	0.0049***	0.0046***	0.0053***	396
	(3.42)	(3.49)	(3.22)	(3.50)	
Medium idiosyncratic volatility					
Portfolio 1	0.0032	-0.0037**	-0.0045***	-0.0033**	396
		(-2.39)	(-3.15)	(-2.44)	
Portfolio 5	0.0116	0.0045***	0.0035**	0.0047***	396
		(2.88)	(2.47)	(3.28)	
Long Portfolio 5 & Short Portfolio 1	0.0084***	0.0082***	0.0079***	0.0080***	396
	(4.00)	(3.69)	(3.77)	(3.64)	
High idiosyncratic volatility					
Portfolio 1	-0.0051	-0.0134***	-0.0139***	-0.0114***	396
		(-5.49)	(-7.91)	(-5.95)	
Portfolio 5	0.0056	-0.0036	-0.0033	-0.0001	396
		(-1.34)	(-1.59)	(-0.06)	
Long Portfolio 5 & Short Portfolio 1	0.0117***	0.0101***	0.0107***	0.0113***	396
	(4.83)	(4.40)	(4.68)	(4.12)	

Table VI (Cont'd)

Panel B: Fama-MacBeth regressions

This panel presents Fama-MacBeth regressions using the monthly excess returns of individual stocks, as follows:

$$R_{i,t} - R_{f,t} = \gamma_0 + \gamma_{MKT}\beta_{MKT,i,t} + \gamma_{HML}\beta_{HML,i,t} + \gamma_{SMB}\beta_{SMB,i,t} + \gamma_{UMD}\beta_{UMD,i,t} + C_{UD}UD_{i,t} + C_{IVOL}IVOL_{i,t} + C_{UDIVOL}(UD_{i,t} * IVOL_{i,t}) + control\ variables + \varepsilon_{i,t}.$$

Stock betas are estimated from the rolling window regressions, using previous 60-month of data, with at least 24-month observations required. As before we focus on the institutional under-diversification measure constructed from the Carhart 4-factor model. To distinguish different institutional under-diversification levels, we define a dummy variable, UD, which takes 1 when the institutional under-diversification measure is above the cross-sectional median in each month and 0 otherwise. *IVOL* is measured as the standard deviation of the residuals from the Carhart 4-factor model estimated with daily data within a month, and it is lagged one month relative to excess returns. Other control variables include: *size* is the log market capitalization of the firm at the end of the previous month; *BE/ME* is the book-to-market ratio of the stock as in Fama and French (1992); *Amihud illiquidity* is the Amihud (2000) illiquidity measure, computed from the previous quarter; *Ret61* is the stock return over the previous six months after skipping a month. All non-return variables are winsorized at the 0.5% and 99.5% level. All coefficients are multiplied by 100 for reporting purposes. ***, **, and * represent significance levels at 1%, 5%, and 10%, respectively, with t-statistics given in parentheses.

Dep. Var.: Excess Stock Returns	(1)	(2)	(3)	(4)
Institutional under-diversification (UD)	0.26***		0.27***	1.00***
	(6.32)		(6.64)	(4.59)
Idiosyncratic volatility (IVOL)		-0.50***	-0.53***	-0.63***
		(-5.10)	(-5.42)	(-6.30)
UD*IVOL				0.20***
				(3.80)
Control variables				
γ_{MKT}	0.02	0.14	0.12	0.12
	(0.14)	(1.37)	(1.20)	(1.21)
γ_{HML}	0.09	0.05	0.05	0.05
	(1.19)	(0.70)	(0.74)	(0.75)
γ_{SMB}	-0.06	0.01	-0.01	-0.01
	(-0.95)	(0.10)	(-0.26)	(-0.25)
γ_{UMD}	-0.21***	-0.21***	-0.20***	-0.20***
	(-2.96)	(-3.09)	(-2.89)	(-2.88)
Size	-0.04	-0.09**	-0.09***	-0.09***
	(-0.93)	(-2.52)	(-2.65)	(-2.70)
BE/ME	0.25***	0.22***	0.21***	0.21***
	(4.91)	(4.89)	(4.39)	(4.35)
Amihud illiquidity	0.05	0.15	0.18	0.19
	(0.43)	(1.29)	(1.43)	(1.50)
Ret61	0.94***	0.90***	0.92***	0.92***
	(4.73)	(4.82)	(4.78)	(4.77)
R-squared	0.05	0.05	0.06	0.06

Table VII
Tests for Alternative Explanations I: Investor Selectivity

In this table, we provide additional tests on the portfolio returns sorted by institutional under-diversification, by explicitly excluding investors that may possess better stock selectivity or information advantages. We focus on the Carhart 4-factor based institutional under-diversification. For brevity, we focus on the returns of the long-short portfolio. We report both the equally-weighted and the value-weighted portfolio returns.

In Panel A, in each quarter, we exclude investors with portfolio under-diversification above the 67th percentile of the sample distribution. In Panel B, we follow the methodology of Daniel, Grinblatt, Titman and Wermers (1997) to calculate the DGTW adjusted portfolio returns. In every quarter t, and for each institutional investor j, we calculate the adjusted portfolio return as $\mathrm{DGTW}_{j,t} = \sum_{i=1}^{N} \omega_{i,t-1} (\mathrm{Ret}_{i,t} - \mathrm{Benchhmark}_{i,t})$, where $\omega_{i,t-1}$ is the portfolio weight on stock i at the end of quarter t-1, $\mathrm{Ret}_{i,t}$ is the quarter t return of stock i, and $\mathrm{Benchhmark}_{i,t}$ is the quarter t return of the characteristic-based benchmark portfolio that is matched to stock i along the dimensions of size (market value of equity), book-to-market ratio, and momentum. Then, we exclude investors with portfolio DGTW-adjusted returns above the 67th percentile of the sample distribution. In Panel C, we exclude transient investors. We use information on institutional investor style classification obtained from Brian Bushee's website, where in each year, institutional investors are classified into three styles: Permanent Transient /Quasi-indexer/Dedicated (Bushee, 2000, Bushee and Noe, 2001).

Panel A: Excluding High UD Investors

Long Portfolio 5 & Short Portfolio 1 by Institutional Under-diversification	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Equally-Weighted	0.0050***	0.0042***	0.0046***	0.0045***	396
	(5.58)	(4.88)	(5.57)	(4.66)	
Value-Weighted	0.0054***	0.0048***	0.0058***	0.0058***	396
	(3.48)	(2.88)	(3.78)	(3.79)	

Panel B: Excluding Outperformed Investors

Long Portfolio 5 & Short Portfolio 1 by Institutional Under-diversification	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Equally-Weighted	0.0052***	0.0044***	0.0040***	0.0050***	396
	(5.07)	(4.41)	(4.09)	(4.82)	
Value-Weighted	0.0055***	0.0053***	0.0050***	0.0065***	396
	(3.49)	(3.32)	(3.46)	(4.66)	

Panel C: Excluding Transient Investors

Long Portfolio 5 & Short Portfolio 1 by Institutional UD	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Equally-Weighted	0.0061***	0.0063***	0.0057***	0.0058***	396
	(7.02)	(6.99)	(6.80)	(5.87)	
Value-Weighted	0.0065***	0.0074***	0.0069***	0.0076***	396
	(4.50)	(4.76)	(5.04)	(5.37)	

Table VIII
Tests for Alternative Explanations II: Behavioral Bias

In this table, we provide additional tests on the portfolio returns sorted by institutional under-diversification. We focus on the Carhart 4-factor based institutional under-diversification. For brevity, we focus on the returns of the long-short portfolio. We report both the equally-weighted and the value-weighted portfolio returns.

In Panel A, we first identify institutional investors as large vs. small investors based on their total stock holdings (above/below the sample median, defined quarter by quarter). Then, at the firm level, we separately calculate the buy-trading weighted institutional under-diversification among large investors as well as among small investors. Next, we sort stocks into quintiles by the large/small institutional under-diversification and calculate the returns for the long-short portfolios accordingly. In Panel B, we sort stocks into portfolios by institutional under-diversification conditioning on Baker and Wurgler (2006)'s measure of investor sentiment. We obtain the data on investor sentiment during the period of 1981 to 2010 directly from Jeffrey Wurgler's website. We split the entire sample period into terciles (high sentiment/medium sentiment/low sentiment) and calculate the raw returns and the excess returns for the long-short portfolios sorted by the previous quarter-end institutional under-diversification.

Panel A: Long-Short Portfolios by Institutional UD (Large vs. Small Investors)

Long Portfolio 5 & Short Portfolio 1 by Institutional UD (Large Investors)	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Equally-Weighted	0.0059***	0.0052***	0.0051***	0.0048***	396
	(6.11)	(5.54)	(5.47)	(4.16)	
Value-Weighted	0.0075***	0.0074***	0.0078***	0.0076***	396
	(4.67)	(4.36)	(5.00)	(4.71)	
Long Portfolio 5 & Short Portfolio 1 by Institutional UD (Small Investors)	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Equally-Weighted	0.0025**	0.0024**	0.0019*	0.0023**	396
	(2.48)	(2.43)	(1.94)	(2.15)	
Value-Weighted	0.0013	0.0019	0.0009	0.0007	396
	(0.86)	(1.19)	(0.59)	(0.45)	

Panel B: Long-Short Portfolios Conditioning on Investor Sentiment

Long Portfolio 5 & Short Portfolio 1 by Institutional UD	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Equally-Weighted					
Low sentiment period	0.0088***	0.0067***	0.0068***	0.0075***	120
	(4.71)	(3.83)	(4.35)	(4.83)	
Medium sentiment period	0.0039**	0.0029**	0.0031**	0.0030**	120
	(2.48)	(2.06)	(2.19)	(1.97)	
High sentiment period	0.0056***	0.0057***	0.0034**	0.0031*	120
	(3.47)	(3.56)	(2.02)	(1.75)	
Value-Weighted					
Low sentiment period	0.0063**	0.0052**	0.0056**	0.0063***	120
	(2.57)	(2.23)	(2.53)	(2.78)	
Medium sentiment period	0.0087***	0.0077***	0.0085***	0.0093***	120
	(3.07)	(2.70)	(3.07)	(2.74)	
High sentiment period	0.0073**	0.0076**	0.0036	0.0041	120
	(1.99)	(2.11)	(1.14)	(1.30)	

Table IX
Institutional Under-diversification and Risk-adjusted Implied Cost of Equity

In this table, we examine the link between institutional under-diversification and the expected return/risk characteristics of individual stocks. First, for each firm-year, we estimate the proxy for the expected return as the implied cost of equity, defined as the internal rate of return that equates the current stock price to discounted expected future earnings. Then, we standardize the implied cost of equity by the annualized stock return volatility, and define it as a measure of the risk-adjusted implied cost of equity and use it as the main dependent variable. We focus on the institutional under-diversification measure constructed from the Carhart 4-factor model. All independent variables are taken at the end of the previous year.

In Panel A, we follow the residual income model of Li and Mohanram (2014) to estimate the implied cost of equity. In Panel B, we follow the Hou, Van Dijk, and Zhang (2012) model to estimate the implied cost of equity. Column (1) is based on the full sample. In columns (2)- (3) and (5)-(6), we split the sample into high and low subsamples by the measure of institutional buy-trading fraction (above/below the sample median). In columns (4)-(6), we include firm fixed effects. We cluster the errors at the firm level in all specifications See the appendix for details. ***, **, and * represent significance levels at 1%, 5%, and 10%, respectively, using robust standard errors with t-statistics given in parentheses.

Panel A: ICC Measure I (Li and Mohanram, 2014)

Dep. Var.:		Split by Inst. Buy-trading			Split by Inst. Buy-trading	
ICC per Unit of Risk	Full Sample	High	Low	Full Sample	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Institutional UD	0.179***	0.255***	0.129***	0.108***	0.160***	0.062**
	(7.67)	(6.96)	(4.48)	(4.61)	(4.48)	(2.07)
Controls						
Institutional ownership	-0.113***	-0.052***	-0.157***	-0.038***	0.011	-0.075***
	(-16.68)	(-5.91)	(-15.67)	(-4.10)	(0.86)	(-5.71)
Return volatility	-2.269***	-3.096***	-1.893***	-1.829***	-1.763***	-1.798***
	(-15.42)	(-14.49)	(-10.21)	(-12.89)	(-7.62)	(-10.21)
Stock return	-0.008***	-0.007***	-0.009***	-0.010***	-0.009***	-0.011***
	(-5.40)	(-2.96)	(-5.09)	(-6.52)	(-3.58)	(-5.77)
Amihud illiquidity	0.038***	0.021***	0.045***	0.033***	0.008	0.042***
	(10.69)	(4.12)	(10.40)	(7.13)	(1.07)	(7.42)
Firm size	0.011***	0.007***	0.013***	0.018***	0.017***	0.019***
	(9.76)	(4.93)	(8.03)	(6.72)	(4.75)	(4.86)
Book leverage	-0.035***	-0.036***	-0.026**	-0.058***	-0.060***	-0.044***
	(-4.51)	(-3.54)	(-2.33)	(-5.73)	(-4.76)	(-2.89)
Market-to-book	-0.035***	-0.051***	-0.028***	-0.031***	-0.048***	-0.023***
	(-15.32)	(-19.73)	(-11.46)	(-12.45)	(-16.92)	(-8.96)
Profitability	0.077***	0.122***	0.074***	0.181***	0.252***	0.157***
	(3.71)	(4.88)	(3.01)	(8.00)	(8.19)	(5.69)
Cash holding	0.034***	0.077***	0.015	0.035***	0.042***	0.031*
	(3.49)	(5.58)	(1.25)	(2.87)	(2.69)	(1.81)
Year FE	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	-	-	-
Firm FE	-	-	-	Y	Y	Y
Clustering	Firm	Firm	Firm	Firm	Firm	Firm
Number of Obs.	60,247	30,552	29,695	60,247	30,552	29,695
R-squared	0.288	0.311	0.305	0.459	0.463	0.471

Table IX (Cont'd)

Panel B: ICC Measure II (Hou, Van Dijk, and Zhang, 2012)

Dep. Var.:	Split by Inst. Buy-trading				Split by Inst. Buy-trading	
ICC per Unit of Risk	Full Sample	High	Low	Full Sample	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Institutional UD	0.102***	0.160***	0.075**	0.073***	0.110***	0.052*
	(3.82)	(3.95)	(2.21)	(3.27)	(3.17)	(1.78)
Controls						
Institutional ownership	-0.055***	-0.061***	-0.043***	-0.012	-0.023**	-0.012
	(-8.01)	(-6.93)	(-4.45)	(-1.45)	(-2.16)	(-0.99)
Return volatility	-4.476***	-5.111***	-4.208***	-1.903***	-2.481***	-1.692***
	(-23.91)	(-17.74)	(-17.16)	(-16.09)	(-12.08)	(-11.39)
Yearly return	-0.006***	-0.007***	-0.005***	-0.008***	-0.008***	-0.007***
	(-5.29)	(-4.42)	(-3.69)	(-8.57)	(-6.06)	(-6.37)
Amihud illiquidity	0.084***	0.071***	0.091***	0.032***	0.019***	0.036***
	(17.97)	(10.06)	(15.10)	(7.79)	(3.12)	(6.61)
Firm size	0.005***	0.005***	0.005***	0.019***	0.022***	0.019***
	(4.15)	(3.10)	(2.58)	(8.13)	(7.25)	(5.50)
Book leverage	-0.009	0.001	-0.018	-0.025***	-0.015	-0.035**
	(-1.04)	(0.05)	(-1.36)	(-2.73)	(-1.27)	(-2.57)
Market-to-book	-0.017***	-0.039***	-0.012***	-0.014***	-0.035***	-0.010***
	(-8.62)	(-17.20)	(-6.90)	(-10.13)	(-16.00)	(-7.69)
Profitability	0.055***	0.205***	0.064***	0.196***	0.411***	0.150***
	(3.15)	(7.11)	(3.68)	(11.18)	(14.78)	(8.09)
Cash holding	0.040***	0.072***	0.042***	0.048***	0.060***	0.056***
	(3.74)	(5.03)	(3.11)	(5.04)	(4.48)	(4.47)
Year FE	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	-	-	-
Firm FE	-	-	-	Y	Y	Y
Clustering	Firm	Firm	Firm	Firm	Firm	Firm
Number of Obs.	67,623	34,577	33,046	67,623	34,577	33,046
R-squared	0.385	0.402	0.394	0.635	0.630	0.644

Table X
Institutional Under-diversification and Investment

In this table, we examine the link between institutional under-diversification and corporate investment. The dependent variable (corporate investment) is the ratio of capital expenditures divided by book assets. We focus on the institutional under-diversification measure constructed from the Carhart 4-factor model. All independent variables are taken at the end of the previous year. Column (1) is based on the full sample. In columns (2)-(3) and (5)-(6), we split the sample into high and low subsamples by the measure of institutional buy-trading fraction (above/below the sample median). In columns (4)-(6), we include firm fixed effects. We cluster the errors at the firm level in all specifications. ***, **, and * represent significance levels at 1%, 5%, and 10%, respectively, using robust standard errors with t-statistics given in parentheses.

Dep. Var.: Investment		Split by Inst. Buy-trading			Split by Inst. Buy-trading	
	Full Sample	High	Low	Full Sample	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Institutional UD	-0.013***	-0.024***	-0.002	-0.011***	-0.022***	-0.004
	(-3.02)	(-3.47)	(-0.43)	(-3.02)	(-3.71)	(-0.73)
Controls						
Institutional ownership	0.009***	-0.002	0.017***	0.011***	0.004	0.016***
	(5.05)	(-0.90)	(6.12)	(5.32)	(1.62)	(5.04)
Return volatility	-0.105***	0.088***	-0.135***	-0.125***	-0.057**	-0.148***
	(-5.58)	(2.91)	(-6.70)	(-7.78)	(-2.07)	(-7.35)
Yearly return	0.005***	0.003***	0.004***	0.004***	0.003***	0.004***
	(11.98)	(6.53)	(10.84)	(13.29)	(7.38)	(10.12)
Amihud illiquidity	-0.009***	-0.011***	-0.007***	-0.007***	-0.009***	-0.006***
	(-15.44)	(-10.49)	(-10.43)	(-12.47)	(-8.54)	(-7.89)
Firm size	-0.002***	-0.003***	-0.002***	-0.003***	-0.005***	-0.003***
	(-7.44)	(-7.75)	(-4.03)	(-6.77)	(-6.43)	(-4.15)
Book leverage	-0.009***	-0.003	-0.006**	-0.027***	-0.030***	-0.022***
	(-4.41)	(-1.13)	(-2.37)	(-14.48)	(-10.92)	(-8.79)
Market-to-book	0.001***	0.003***	0.001***	0.001***	0.002***	0.000***
	(5.66)	(6.71)	(3.71)	(4.78)	(5.50)	(2.71)
Profitability	0.006	0.062***	0.003	0.003	0.043***	0.002
	(1.40)	(14.01)	(1.41)	(1.39)	(11.02)	(1.46)
Cash holding	-0.017***	-0.017***	-0.013***	0.007***	-0.003	0.012***
	(-9.39)	(-5.71)	(-5.83)	(3.55)	(-0.90)	(4.80)
Year FE	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	-	-	-
Firm FE	-	-	-	Y	Y	Y
Clustering	Firm	Firm	Firm	Firm	Firm	Firm
Number of Obs.	101,042	52,347	48,695	101,042	52,347	48,695
R-squared	0.231	0.299	0.201	0.557	0.612	0.512

Table XI
Robustness Checks

In this table, we provide robustness checks to the previous results, by considering alternative measures of institutional under-diversification. The specifications are the same as those in the previous tables. For brevity, we only report the variables of interests.

In Panel A, we use the institutional under-diversification measure based on the Fama-French 5-factor model (Fama and French, 2014). In Panel B, we contruct the measure by the Fama-French 3-factor model, and in Panel C, we use the one constructed from CAPM. In Panel D, we include both the investors that increase their holdings and the ones that decrease their holdings in the construction of institutional under-diversification. The investor-level portfolio under-diversification is still computed using the Carhart 4-factor model. We now calculate the institutional under-diversification as the buy- and sell-trading weighted investor under-diversification and use the absolute amount of change in holdings as the weight. For consistency, we split the full sample into high and low subsamples by the measure of institutional total-trading fraction (i.e., institutional trading divided by total trading volume, above/below the sample median). In Panel E, we calculate institutional under-diversification as the ownership-weighted investor under-diversification, and use the institutional holding of the stock as the weight. The investor-level portfolio under-diversification is computed from the Carhart 4-factor model. To capture the effect of marginal investors, we use investors who change their ownership (*either buying or selling*) during the previous quarter. For consistency, we split the full sample into high and low subsamples by the level of institutional ownership (above/below the sample median). ***, **, and * represent significance levels at 1%, 5%, and 10%, respectively, using robust standard errors with t-statistics given in parentheses.

Panel A: Institutional Under-diversification (Fama-French 5-factor)

Table III: Long-Short Portfolio Returns

Long Portfolio 5 & Short Portfolio 1 by Institutional UD	Raw Return	CAPM Alpha	Fama-French 3-factor Alpha	Fama-French 5-factor Alpha	N
Equally-Weighted	0.0060***	0.0054***	0.0051***	0.0048***	396
	(6.74)	(6.20)	(5.73)	(4.95)	
Value-Weighted	0.0073***	0.0072***	0.0072***	0.0072***	396
	(4.55)	(4.39)	(4.65)	(4.32)	

Table VIII: Implied Cost of Equity per Unit of Risk

Panel A	Split by Inst. Buy-trading			Split by Inst. Buy-trading		
	Full Sample	High	Low	Full Sample	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Institutional UD	0.181***	0.265***	0.126***	0.110***	0.169***	0.060**
	(7.58)	(7.09)	(4.25)	(4.58)	(4.57)	(1.96)
Panel B						
Institutional UD	0.095***	0.158***	0.063*	0.073***	0.108***	0.052*
	(3.47)	(3.79)	(1.81)	(3.18)	(3.07)	(1.74)

Table IX: Investment

	Split by Inst. Buy-trading			Split by Inst. Buy-trading		
	Full Sample	High	Low	Full Sample	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Institutional UD	-0.013***	-0.027***	-0.002	-0.013***	-0.023***	-0.004
	(-3.05)	(-3.78)	(-0.34)	(-3.19)	(-3.85)	(-0.81)

Table XI (Cont'd)

Panel B: Institutional Under-diversification (Fama-French 3-factor)

Table III: Long-Short Portfolio Returns

Long Portfolio 5 & Short Portfolio 1 by Institutional UD	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Equally-Weighted	0.0063***	0.0056***	0.0054***	0.0057***	396
	(6.68)	(6.12)	(5.79)	(5.00)	
Value-Weighted	0.0069***	0.0066***	0.0069***	0.0074***	396
	(4.14)	(3.86)	(4.37)	(4.49)	

Table VIII: Implied Cost of Equity per Unit of Risk

Panel A		Split by Inst. Buy-trading			Split by Inst. Buy-trading	
	Full Sample	High	Low	Full Sample	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Institutional UD	0.179***	0.255***	0.129***	0.108***	0.160***	0.062**
	(7.67)	(6.96)	(4.48)	(4.61)	(4.48)	(2.07)
Panel B						
Institutional UD	0.083***	0.137***	0.061*	0.059***	0.095***	0.039
	(3.27)	(3.53)	(1.87)	(2.76)	(2.91)	(1.40)

Table IX: Investment

		Split by Inst. Buy-trading			Split by Inst. Buy-trading	
	Full Sample	High	Low	Full Sample	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Institutional UD	-0.013***	-0.024***	-0.002	-0.011***	-0.022***	-0.004
	(-3.02)	(-3.47)	(-0.43)	(-3.02)	(-3.71)	(-0.73)

Table XI (Cont'd)

Panel C: Institutional Under-diversification (CAPM)

Table III: Long-Short Portfolio Returns

Long Portfolio 5 & Short Portfolio 1 by Institutional UD	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Equally-Weighted	0.0053***	0.0046***	0.0045***	0.0047***	396
	(5.57)	(5.07)	(5.29)	(4.64)	
Value-Weighted	0.0047***	0.0044**	0.0036**	0.0038**	396
	(2.65)	(2.38)	(2.34)	(2.30)	

Table VIII: Implied Cost of Equity per Unit of Risk

Panel A	Split by Inst. Buy-trading			Split by Inst. Buy-trading		
	Full Sample	High	Low	Full Sample	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Institutional UD	0.094***	0.190***	0.049***	0.063***	0.128***	0.021
	(6.34)	(7.98)	(2.75)	(4.23)	(5.53)	(1.11)
Panel B						
Institutional UD	0.026	0.079***	0.007	0.048***	0.088***	0.028
	(1.52)	(2.93)	(0.33)	(3.40)	(4.07)	(1.52)

Table IX: Investment

	Split by Inst. Buy-trading			Split by Inst. Buy-trading		
	Full Sample	High	Low	Full Sample	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Institutional UD	-0.012***	-0.017***	-0.008**	-0.009***	-0.013***	-0.006*
	(-4.43)	(-3.50)	(-2.38)	(-3.76)	(-3.21)	(-1.84)

Table XI (Cont'd)

Panel D: Institutional Under-diversification (Absolute-trading Weighted)

Table III: Long-Short Portfolio Returns

Long Portfolio 5 & Short Portfolio 1 by Institutional UD	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Equally-Weighted	0.0048***	0.0042***	0.0041***	0.0039***	396
	(5.07)	(4.43)	(4.14)	(3.33)	
Value-Weighted	0.0045**	0.0043**	0.0045***	0.0039**	396
	(2.48)	(2.37)	(2.67)	(2.29)	

Table VIII: Implied Cost of Equity per Unit of Risk

Panel A		Split by Inst. Trading			Split by Inst. Trading	
	Full Sample	High	Low	Full Sample	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Institutional UD	0.127***	0.258***	0.074***	0.062***	0.123***	0.028
	(5.77)	(6.55)	(3.08)	(2.72)	(3.20)	(1.04)
Panel B						
Institutional UD	0.080***	0.117***	0.083***	0.047**	0.061*	0.045
	(3.27)	(3.25)	(2.66)	(2.06)	(1.95)	(1.52)

Table IX: Investment

		Split by Inst. Trading			Split by Inst. Trading	
	Full Sample	High	Low	Full Sample	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Institutional UD	-0.011***	-0.024***	-0.005	-0.010***	-0.024***	-0.003
	(-3.24)	(-3.59)	(-1.22)	(-3.00)	(-4.06)	(-0.77)

Table XI (Cont'd)

Panel E: Institutional Under-diversification (Ownership-Weighted)

Table III: Long-Short Portfolio Returns

Long Portfolio 5 & Short Portfolio 1 by Institutional UD	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Equally-Weighted	0.0041***	0.0038***	0.0036***	0.0034***	396
	(4.21)	(3.84)	(3.51)	(2.70)	
Value-Weighted	0.0051***	0.0053***	0.0046***	0.0033**	396
	(2.96)	(2.99)	(2.83)	(1.97)	

Table VIII: Implied Cost of Equity per Unit of Risk

Panel A		Split by Inst. Ownership			Split by Inst. Ownership	
	Full Sample	High	Low	Full Sample	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Institutional UD	0.114***	0.203***	0.100***	0.066***	0.127***	0.060**
	(5.73)	(5.62)	(4.44)	(3.14)	(3.61)	(2.45)
Panel B						
Institutional UD	0.079***	0.132***	0.092***	0.054***	0.077***	0.059**
	(3.60)	(3.94)	(3.40)	(2.58)	(2.84)	(2.18)

Table IX: Investment

		Split by Inst. Ownership			Split by Inst. Ownership	
	Full Sample	High	Low	Full Sample	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
Institutional UD	-0.012***	-0.027***	-0.004	-0.010***	-0.023***	-0.004
	(-3.49)	(-3.82)	(-1.13)	(-3.26)	(-4.04)	(-1.14)

Online Appendix

Table A1: Portfolio Returns by Independent Double Sorting

In this table, we perform double-sorting of stocks by institutional under-diversification and other firm characteristics independently. We consider variables such as market capitalization, market-to-book, idiosyncratic volatility, Amihud illiquidity, and institutional ownership. Specifically, for example, in the case of market capitalization, we create 25 stock portfolios, by first sorting stocks into quintiles based on the previous month-end market capitalization and then *independently* sorting stocks into quintiles based on the previous quarter-end institutional under-diversification. We compute the equally-weighted or value-weighted portfolio returns. Then, for each under-diversification quintile, we calculate the simple average portfolio return across all 5 market capitalization quintiles. Next, we calculate the return of the long-short portfolio, as the difference in the average returns between the highest and lowest under-diversification quintiles. We follow the same procedure for the other variables. Panel A reports the results for the equally-weighted portfolios, and Panel B presents the results for the value-weighted portfolios. ***, **, and * represent significance levels at 1%, 5%, and 10%, respectively, using robust standard errors with t-statistics given in parentheses. N denotes the number of total months.

Panel A: Equally-Weighted Portfolios

Long Portfolio 5 & Short Portfolio 1 by Institutional Under-diversification	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Control for market capitalization	0.0066***	0.0060***	0.0058***	0.0062***	396
	(5.50)	(4.93)	(5.25)	(4.86)	
Control for market-to-book	0.0052***	0.0046***	0.0043***	0.0044***	396
	(4.81)	(4.27)	(4.63)	(3.89)	
Control for idiosyncratic volatility	0.0046***	0.0039***	0.0040***	0.0043***	396
	(4.79)	(4.25)	(4.47)	(3.84)	
Control for Amihud illiquidity	0.0075***	0.0070***	0.0067***	0.0070***	396
	(6.09)	(5.55)	(5.97)	(5.31)	
Control for analyst coverage	0.0060***	0.0055***	0.0053***	0.0054***	396
	(4.83)	(4.47)	(4.67)	(3.78)	
Control for institutional ownership	0.0056***	0.0052***	0.0053***	0.0054***	396
	(4.75)	(4.40)	(4.56)	(4.11)	
Control for institutional buy-trading	0.0056***	0.0047***	0.0047***	0.0053***	396
	(5.66)	(5.07)	(4.98)	(5.06)	

Panel B: Value-Weighted Portfolios

Long Portfolio 5 & Short Portfolio 1 by Institutional Under-diversification	Raw Return	CAPM Alpha	Fama-French Alpha	Carhart Alpha	N
Control for market capitalization	0.0068***	0.0062***	0.0059***	0.0064***	396
	(5.38)	(4.78)	(5.22)	(5.06)	
Control for market-to-book	0.0060***	0.0057***	0.0055***	0.0061***	396
	(4.13)	(3.69)	(3.94)	(4.17)	
Control for idiosyncratic volatility	0.0068***	0.0064***	0.0065***	0.0068***	396
	(4.75)	(4.21)	(4.75)	(4.57)	
Control for Amihud illiquidity	0.0064***	0.0059***	0.0057***	0.0060***	396
	(4.87)	(4.35)	(4.85)	(4.61)	
Control for analyst coverage	0.0073***	0.0068***	0.0069***	0.0070***	396
	(4.98)	(4.36)	(5.02)	(4.71)	
Control for institutional ownership	0.0070***	0.0066***	0.0071***	0.0074***	396
	(4.17)	(4.03)	(4.31)	(4.26)	
Control for institutional buy-trading	0.0069***	0.0066***	0.0068***	0.0068***	396
	(4.74)	(4.47)	(4.91)	(4.73)	