Institutional Investor Diversification and the Pricing of Risk

by

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Abstract

Empirical asset pricing research has found limited support for the theoretical prediction that only market risk is priced. Using institutional investor data, we examine whether market frictions, which are absent in theoretical models, create differences in investor diversification and provide a partial explanation for the pricing of non-market risk. We find evidence more consistent with the CAPM when a firm's institutional investors hold portfolios that are highly correlated with the market index. We also find some evidence that an association between non-market risk (notably, book-to-market risk) and expected returns arises due to the under-diversification of a firm's institutional investors.

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1. Introduction

Traditional asset pricing theories suggest that only non-diversifiable risk is priced. In solving for an equilibrium where investors are able to diversify all risks except market risk, these models often rely on strong assumptions (e.g., homogenous beliefs, perfect markets). In the case of the capital asset pricing model (CAPM), such assumptions allow for a simple expression of expected returns as a function of systematic risk. While these models have strong intuitive appeal, empirical work has struggled to support the notion that only risk related to a systematic market factor is priced. In addition, several empirically-motivated risk factors (e.g., size, book-to-market) have been proposed based on consistent evidence that they significantly explain expected returns (Fama and French, 2004).

One possible explanation for these deviations from CAPM is that investors are constrained in some way from holding diversified portfolios (Levy, 1978; Merton, 1987). Fama and French (2007) conclude that distortions of expected returns away from the theoretical models can be large when investors with "asset tastes" account for substantial invested wealth and take positions much different from the market portfolio. If a firm's investors are unable or unwilling to diversify away a particular type of risk, then the firm's exposure to this risk should be related to its expected returns. In this paper, we use institutional investor data to examine whether market frictions create differences in investor diversification with regards to risk factors and, hence, provide a partial explanation for the pricing of these types of firm risk.

Prior research finds that many institutional investors deviate from holding the market portfolio (e.g., Brown and Goetzmann, 1997; Daniel, Grinblatt, Titman, and Wermers, 1997). Institutions have incentives to systematically tilt away from the market index when they face stringent fiduciary responsibilities (Del Guercio, 1996) or when they adopt investment styles (e.g., growth, small-cap) as a competitive strategy to attract a stable investor base (O'Barr and Conley, 1992). Prior work also finds that institutional investors fulfill an important role in price formation (e.g., Gompers and Metrick, 2001; Jiambalvo, et al. 2002). We build on this work to test whether the under-diversification and the price-setting influence of institutional investors are related to the evidence that traditional asset pricing theories have difficulty explaining the cross-section of stock returns. Our evidence suggests that measures of firm risk are related to expected return when the portfolios of a firm's institutional investors are under-diversified with respect to these types of risk.

First, we develop a diversification measure for a firm's institutional investors. We use quarterly SEC filings to construct the portfolios held by individual institutional investors. For each institution, we calculate the percent of variation in portfolio returns explained by the market factor and the association between portfolio returns and the returns of other non-market factors (e.g., the size and book-to-market factors). We find that the sensitivity of an institutional investor's portfolio return to market and non-market risk factors is associated with the degree to which it adopts a style based on growth, market cap, or active trading, as well as on the size of the institution's portfolio and the institution's fiduciary responsibility. This evidence suggests that the incentives faced by institutional investors create frictions that expose their portfolios to varying degrees of market and non-market risk factors, for which they may demand compensation in a firm's expected returns.

Next, we test whether the portfolio return sensitivities of a firm's institutional investors are associated with the types of risk that are priced for the firm. We average the institution-level portfolio sensitivities to the firm-level, weighting each sensitivity by the institution's percentage ownership of the firm. This approach assumes that the preferences of firm's average institutional investor are correlated with the preferences of the firm's marginal inventor (similar to Hand, 1990). We find that when a firm's average institutional investor holds a portfolio whose return is highly correlated with the market factor, the firm's market beta is more strongly associated with its average returns, consistent with the CAPM predictions. Moreover, the intercept in the model is significantly closer to zero. Thus, the degree to which a firms' investor base holds portfolios that are highly exposed to the market index is associated with the relation between beta and expected returns.[1]

Finally, we find evidence that the pricing of a firm's sensitivity to non-market risk factors depends on whether the portfolios of the firm's institutional investors are sensitive to these risks. We find that a firm's sensitivity to the HML factor (i.e., book-to-market factor) has a stronger association with average realized returns for the firms where the average institutional investor's portfolio is more sensitive to this factor. This result suggests that firms have higher expected returns when their exposure to the HML factor adds risk to their investors' portfolios. In addition, when examining the pricing of firm characteristics (instead of factor sensitivities), we find that the association between firm size and average realized returns is stronger when a firm's average institutional investor holds a portfolio that is more sensitive to the SMB factor.

Our paper contributes to the literature by showing that institutional investor diversification with respect to potential risk factors is associated with the market pricing of those factors. This evidence supports the predictions of asset pricing theories like the CAPM that a firm's risk should only be priced when investors cannot diversify it away. Rather than relying on

[1] As we discuss in Section 4.6, we estimate a number of alternative averaging schemes for the marginal investor diversification proxy, including weighted averages based on the recent change in ownership and purchase activity. We also attempt to alleviate concerns about a given firm disproportionately affecting its institutional investors' portfolios by calculating the properties of the average investor based on the subset of institutions whose ownership of a specific firm is less than 1% of their portfolio. In these cases, the average institutions holding a given stock may have a portfolios that deviates from the market portfolio, but it does not deviate due to an over-weighting of that particular stock,. We find similar results across these approaches.

a market index to measure the market portfolio, we incorporate data on whether the average institutional investor data is sensitive to types of risk. Our evidence on the pricing of non-market risk suggests that future researchers focus on the ways in which investor holdings deviate from theoretical models with rational investors (i.e., under-diversified portfolios) when exploring the pricing of other risk factors (e.g., bankruptcy risk, governance risk, etc.) rather than appealing to more general market frictions or investor irrationality.

We also contribute to the literature by providing a measure of the degree to which a firm's average institutional investor is under-diversified. Prior research on the relation between a firm's investor base and expected returns has primarily focused on the number of investors and the type of investors (individual vs. institutional). Recent work has examined the level of diversification by individual investors using measures based on the total number of securities held or the total volatility of their portfolio. We show that our measure of diversification is associated with the pricing of a firm's exposure to different types of risk.

The remainder of this paper is organized as follows. Section 2 describes the literature on the capital asset pricing model and our hypotheses. Section 3 outlines the sample selection, research design and variable measurement. Section 4 presents the descriptive statistics and empirical results and is followed by the conclusion in section 5.

2. Hypothesis development

2.1 Research on asset pricing

Portfolio theory suggests that a risk-averse investor considers the correlation between the assets in their portfolio when choosing portfolio weights to maximize their expected utility (e.g., Markowitz, 1952). As a result, when judging the risk of a single asset, risk-averse investors consider the correlation between the return from this asset and their overall portfolio returns.

Building on this work, the capital asset pricing model (CAPM) identifies conditions in which an asset's non-diversifiable risk affects the asset's expected return (Sharpe, 1964; Linter, 1965, Black, 1972). The CAPM's assumptions (e.g., homogenous beliefs, perfect capital market) result in an equilibrium in which all investors hold portfolios that are a linear combination of two assets: the market portfolio and a risk-free asset. As all investors hold some version of the market portfolio, an asset's exposure to non-diversifiable risk is characterized by its covariance with the market portfolio; i.e., its beta. In addition, the model predicts a linear relation between a firm's beta and the firm's expected returns.

Empirical research has produced limited results on the ability of firm betas to explain variation in expected returns across individual stocks (Fama and French, 2004).[2] The limited empirical support for the CAPM was greeted with skepticism due to the challenges in effectively measuring the constructs from the model (Roll, 1977; Ross, 1978). Several papers have attempted to remove measurement error by forming portfolios and testing the CAPM theory based on the pricing of portfolios of assets instead of individual assets. However, when using a portfolio approach, Fama and French (1992) are still unable to identify an association between beta and expected returns that is not confounded by firm size. Instead, a growing body of work documents risk premiums for other factors, such as firm size, book-to-market, and momentum (Fama and French, 2004). In addition, recent work has raised questions over whether idiosyncratic risk is priced (Malkiel and Xu, 2004). However, the pricing of these other risks raises additional questions over why these types of risks are not diversifiable (see, e.g., Lambert, Leuz, and Verrecchia, 2007).

2.2 Research on investor base effects

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[2] Empirical studies have also failed to support the notion of a world CAPM based on an international mix of assets (Karolyi and Stulz, 2002). One explanation is that investors exhibit "home bias" in their portfolios, consistent with frictions constraining international diversification (e.g., French and Poterba, 1991; Cooper and Kaplanis, 1994).

In the CAPM framework, all investors hold risky assets that are a transformation of the market portfolio and all firms have the same investor base. Subsequent research has explored whether the composition of a firm's investor base affects returns. Levy (1978) presents a model similar to the CAPM that includes a constraint on the number of securities that can be held in the portfolio of a firm's investors. When a firm's investors are constrained, they do not hold the market portfolio and both a firm's systematic and idiosyncratic risk are priced because the firm's investors are sensitive to both types of risk. Merton (1987) identifies a relation between a firm's investor base and expected returns through the firm's visibility. Each investor allocates portfolio weights across the risky assets that are known to that investor. When information is incomplete and some investors are unaware of certain assets, those investors hold less diversified portfolios. In equilibrium, the assets held by under-diversified investors command higher expected returns because the investors bear additional risk.

Many empirical studies have examined the general prediction that an increase in visibility coincides with a decrease in expected returns. Research on events that change the number of shareholders, such as changes in index membership or exchange listing, supports the hypothesis that increased visibility decreases expected returns (see, e.g., Shleifer 1986; Kadlec and McConnell, 1994; Foerster and Karolyi, 1999; Amihud, Mendelson, and Uno, 1999). Prior research has also used institutional investor data to measure a firm's visibility, finding positive associations between future returns and both the percentage of institutional ownership and the breadth (number) of institutional holders (Gompers and Metrick, 2001; Chen, Hong, and Stein. 2002). Lehavy and Sloan (2008) find evidence that the association between changes in breadth and returns is stronger for firms with higher levels of idiosyncratic risk, consistent with breadth of ownership reducing expected returns when idiosyncratic risk is high.[3]

Prior research provides many examples of cases where institutions do not hold a diversified, value-weighted market portfolio, which potentially creates positive or negative exposure to various types of risk (e.g., Brown and Goetzmann, 1997; Daniel, Grinblatt, Titman, and Wermers, 1997). One reason institutional investors choose portfolio weights that deviate from the market index is that they often adopt investment styles such as value or growth styles (Abarbanell et al., 2003), small-cap or large cap styles (Abarbanell et al., 2003), and high-turnover, index, or blockholder styles (Bushee, 2001). Institutional investors adopt investment styles to attract a stable investor base that seeks investment in firms targeted by the style and as optimal strategy to acquire information about a given subset of stocks (O'Barr and Conley, 1992, Van Nieuwerburgh and Veldkamp, 2005). Some institutional investors face stringent fiduciary responsibilities (e.g., bank trusts) that enforce a standard of prudence on each portfolio stock, which provides incentives for tilting away from low-rated and poorer performing stocks (Del Guercio, 1996). Similarly, institutions engaged in socially responsible investing will tilt away from the market portfolio by excluding firms in certain lines of business, such as tobacco (Geczy, Stambaugh, and Levin, 2005). Finally, institutions may choose to take an active role in governance, leading these investors to hold large blocks in certain firms to place pressure on the board of directors (e.g., Smith, 1996).[4]

[3] Prior work also finds associations between returns and other proxies for visibility, including individual investor diversification (Kumar, 2007), the fraction of investors holding a security (Bodnaruk and Ostberg, 2009), abnormally high trading volume (Gervais, Kaniel, and Mingelgrin, 2001), and advertising expenditures (Grullon, Kanatas, and Weston, 2004).

[4] Institutional investor under-diversification could also arise from a behavioral bias similar to those exhibited by individuals; however, recent work raises question on whether individuals actually exhibit these biases (e.g., Ivkovic and Weisbenner, 2005; Huberman and Jiang, 2006).

We assume that the average institutional investor plays the role of the marginal investor that sets a firm's expected return. Because of their larger size and sophistication, these investors are expected to have greater influence on the price formation process (Hand 1990). Prior work suggests that the presence of greater institutional ownership implies the presence of a more sophisticated marginal investor (Jiambalvo et al., 2002; Piotroski and Roulestone, 2004).[5] Similarly, Ali, Hwang, and Trombley (2003) and Collins, Gong and Hribar (2003) find lower hedge returns from trading strategies based on book-to-market and accruals, respectively, in firms with high institutional ownership, consistent with institutions increasing the efficiency of stock prices. Thus, measures based on an institutional investor's portfolio provides information on the pricing of risk from that investor's perspective and the average of these measures among institutions that own a firm provides a good proxy for the firm's marginal investor.

2.3 Empirical predictions

Empirical asset pricing research typically expresses an asset's excess return as the combination of a market factor and other risk factors:

$$R_{i,t} = \alpha_i + b_i MKT_t + s_i SMB_t + h_i HML_t + e_{1i,t} \quad (1)$$

Where
$R_{i,t}$ =Monthly return of asset i less the risk free rate
MKT_t =Monthly return on the market factor less the risk free rate
SMB_t =Monthly return on the Small minus Big (firm size) factor
HML_t =Monthly return on the High minus Low (book-to-market) factor
$e_{1i,t}$ =error term

The coefficients in the above model measure the extent to which each factor explains the variation in asset i's returns, which can be interpreted as an asset's exposure to a particular type of risk (Fama and French, 1993). Prior research has interpreted evidence of a non-zero intercept

[5] Institutional investors also indirectly affect market efficiency by facilitating short-selling. Consistent with institutional ownership measuring short-selling constraints, Nagel (2005) finds that firms with low levels of ownership have greater incidence of over-valuation indicated by under-performance related to various anomalies.

in equation (1) as evidence that the asset pricing model is empirically misspecified (Black, Jensen, and Scholes, 1972; Gibbons, Ross, and Shanken, 1989; Fama and French, 1993).

While the coefficients from equation (1) reveal when an asset's return is associated with different types of risk, theory predicts that the marginal investor only prices risk that is correlated with their portfolio (non-diversifiable risk), implying the following expected return model:

$$E[R_{i,t}] = Cov(R_{i,t}, R_{pi,t})E[R_{pi,t}]/Var(R_{pi,t}) \quad (2)$$

$R_{pi,t}$ =Monthly return of the portfolio of assets held by the marginal investor in asset i less the risk free rate

Equation (2) indicates that the expected return on a given security is a function of the variance contributed to the marginal investor's portfolio ($Cov(R_{i,t}, R_{pi,t})$) and the expected return-variance trade-off implied by that investor's portfolio ($E[R_{pi,t}]/Var(R_{pi,t})$). In the case of the CAPM, all investors hold some transformation of the market portfolio and equation (2) reduces to a linear function of the market risk premium ($E[R_{i,t}]=E[MKT_t]b_i$) for all firms.

To test whether an asset's exposure to a given type of risk is priced, researchers examine the association between factor sensitivities (the coefficients from equation (1)) and the cross-section of asset returns (see, e.g., Black, Jensen, and Scholes, 1972; Fama and MacBeth, 1973, Cochrane, 2005). The following equation allows for a test of whether assets with a greater exposure to a given factor have higher average returns.

$$R_{i,t} = \gamma_0 + \gamma_1 b_i + \gamma_2 s_i + \gamma_3 h_i + e_{3i,t} \quad (3)$$

The CAPM makes the following predictions for equation (3): $\gamma_1=E[MKT_t]$ and $\gamma_0=\gamma_2=\gamma_3=0$. However, Fama and French (2004) note that the coefficients obtained from models estimating the association between returns and market beta (b_i) often do not support these predictions (e.g., $\gamma_1<E[MKT_t]$ and $\gamma_0\neq0$).

We begin our examination of the marginal investor's portfolio by relaxing the assumption that the marginal investor always holds an exact transformation of the market portfolio. Instead, we assume that the marginal investor in firm i holds a portfolio whose return ($R_{pi,t}$) follows the market index with some tracking error:

$$R_{pi,t} = \lambda_{0,i} + \lambda_{MKT,i}MKT_t + e_{4i,t} \quad (4)$$

Substituting the definition from equation (4) into equation (2) yields the following expression for expected returns:

$$\begin{aligned} E[R_{i,t}] &= \{ \lambda_{MKT,i}Cov(R_{i,t}, MKT_t) + Cov(R_{i,t}, e_{4i,t}) \}E[R_{pi,t}]/Var(R_{pi,t}) \quad (4a) \\ &= \lambda_{MKT,i}b_iVar(MKT_t)E[R_{pi,t}]/Var(R_{pi,t}) + Cov(R_{i,t}, e_{4i,t})E[R_{pi,t}]/Var(R_{pi,t}) \\ &= \gamma_0 + \gamma_{1i}b_i \end{aligned}$$

Where

$$\gamma_0 = Cov(R_{i,t}, e_{4i,t})E[R_{pi,t}]/Var(R_{pi,t})$$

$$\gamma_{1i} = \lambda_{MKT,i}Var(MKT_t)E[R_{pi,t}]/Var(R_{pi,t})$$

The above expression indicates that the association between a firm's expected return and the firm's market beta (γ_{1i}) depends on the properties of the marginal investor's portfolio. This relation can also be written as a function of the percent of variation in the marginal investor's portfolio that is explained by the market factor (CAPM_RSQ):

$$\gamma_{1i} = CAPM\_RSQ_i\{E[MKT_t] + (\lambda_{0,i}/\lambda_{MKT,i})\}$$

$CAPM\_RSQ_i$ =R-square from equation (4)

The relation between the premium for market risk (γ_{1i}) and CAPM_RSQ can be viewed as testing the assumptions underlying the CAPM. In this context, the CAPM's prediction on the pricing of market risk should be empirically observable when a firm's investors hold portfolios that resemble those held by the investors in the CAPM. If an investor portfolio meets the CAPM criteria (i.e., $CAPM\_RSQ_i$=100% and $\lambda_{0,i}=0$), then $\gamma_1=E[MKT_t]$.[6] However, when these criteria are not met ($CAPM\_RSQ_i$<100% and/or $\lambda_{0,i}\neq 0$), there is an error-in-variables problems from using the market index as the measure of the average investor's portfolio that will bias the estimated γ_1 coefficient. The relation described by equation (4a) motivates our first hypothesis:

H_1: The association between market beta (b_i) and expected returns is greater when a larger percent of the variation in the average institutional investor's portfolio is explained by the market factor (i.e., CAPM_RSQ is larger).

In the case where the error term in equation (4) ($e_{4i,t}$) is correlated with other factors (i.e., the SMB or HML factors), the properties of the marginal investor's portfolio are relevant to determine whether a firm's exposure to non-market risk is priced. We use the following model to formalize the association between the portfolio return earned by a firm's marginal investor:

$$R_{pi,t} = \lambda_{0i} + \lambda_{MKT,i}MKT_t + \lambda_{SMB,i}SMB_t + \lambda_{HML,i}HML_t + e_{5i,t} \quad (5)$$

Based on equation (5) and equation (2), expected returns are given by the following expression:

$$E[R_{i,t}] = \{ b_i\lambda_{MKT,i}Var(MKT_t) + s_i\lambda_{SMB,i}VAR(SMB_t) + h_i\lambda_{HML,i}Var(HML_t) + Cov(R_{i,t}, e_{5i,t}) \}\{ E[R_{pi,t}]/Var(R_{pi,t}) \} = \gamma_0 + \gamma_{1i}b_i + \gamma_{2i}s_i + \gamma_{3i}h_i \quad (5a)$$

Where

$$\gamma_0 = Cov(R_{i,t}, e_{4i,t})E[R_{pi,t}]/Var(R_{pi,t})$$
$$\gamma_{1i} = \lambda_{MKT,i}Var(MKT_t)E[R_{pi,t}]/Var(R_{pi,t})$$
$$\gamma_{2i} = \lambda_{SMB,i}Var(SMB_t)E[R_{pi,t}]/Var(R_{pi,t})$$
$$\gamma_{3i} = \lambda_{HML,i}Var(HML_t)E[R_{pi,t}]/Var(R_{pi,t})$$

The above analysis predicts that if investor i's portfolio is sensitive to a given factor, it will affect the investor's pricing of a firm's exposure to the risk factor. The pricing of non-market risks are

[6]In this case, the $\lambda_{MKT,i}$ for the average investor's portfolio is not relevant for expected returns. This is due to the fact that the variance contributed to an institution's portfolio from a stock with a positive market beta is positively related to the average investor's $\lambda_{MKT,i}$, but the price of risk for from the perspective of an investor is negatively related to the average investor's $\lambda_{MKT,i}$. In the case where CAPM_RSQ=100% and $\lambda_{0,i}=0$ these two effects perfectly offset, removing $\lambda_{MKT,i}$ from the calculation of expected returns.

related to the degree to which the marginal investor is exposed to these types of risk. The marginal investor's sensitivity to these types of risk ($\lambda_{SMB,i}$ or $\lambda_{HML,i}$) indicate whether the investor's portfolio is tilted away from the market portfolio in a particular way, as the theory behind the CAPM predicts that these weights are zero. For example, the association between a firm's exposure to the SMB factor (s_i) and expected returns (γ_{2i}) is positively related to the extent the firm's marginal investor's portfolio is sensitive to SMB risk ($\lambda_{SMB,i}$).[7] This leads to our second hypothesis:

H_2: The association between a firm's sensitivity to SMB (HML) risk and expected returns is more positive when the firm's average institutional investor's portfolio return is positively related to SMB (HML) risk.

If the pricing of non-market risks arises in cases where the marginal investor is sensitive to non-market risks, then the pricing of these risks can be viewed as rational in a model where diversification is constrained due to some friction. This hypothesis specifically links the pricing of risk to the ability of a firm's investor base's ability to diversify that risk. This argument is more specific and testable than alternative explanations in which non-market factors capture a more general risk factor or that the pricing of non-market factors reflects some type of general irrationality.

The framework used to motivate H2 assumes that a firm's investors are concerned about the trade-off between their portfolio's expected return and the portfolio's total variance; i.e., fund managers are compensated based on their portfolio's return and variance. However, this may not be the case. For example, if value fund managers are not penalized for taking on value risk, then these managers would not require additional compensation in the form of a risk premium for

[7] This is due to the fact that the term $Var(SMB_t)E[R_{pi,t}]/Var(R_{pi,t})$ is positive, assuming the marginal investor requires a positive trade-off between expected return and variance. As a result, the sign of γ_{2i} is equal to the sign of $\lambda_{SMB,i}$. As investors may pursue a small cap or large cap strategy, the sign of $\lambda_{SMB,i}$ could be positive or negative.

adding another value stock to their portfolio, which is already strongly exposed to a value factor. This would imply the null of H2: there would be no relation between λ_{HML} and γ_{3i}. However, for this to be the case, the supervisors of fund managers would need to be able to estimate λ_{HML} and adjust the fund managers' compensation accordingly.

3. Research Design

3.1 Sample

We begin our sample selection with all firm-years listed on the NYSE, AMEX, and NASDAQ exchanges. We also require that all firms have market value of equity (ME) on June 30th of year t, market value of equity on December 31st of year t-1, and accounting information from year t-1 used to calculate book-to-market ratio (BEME). BEME is the ratio of the book value of equity to the market value of equity defined as in Davis, Fama, and French (2000).[8] We use log(BEME) in our tests, which limits our analysis to firms with positive book values. We also require that we can calculate returns over the 12 months preceding July 1 of year t. In addition, we limit our analysis to firm-years where we can calculate the firm's historical beta based on the prior 60 months of data, with a minimum requirement of 24 months.

Next, we obtain institutional investor holdings data from the Thomson Reuters Spectrum database. We require that firms are listed on Spectrum on June 30th of the year to be included in the sample, which limits to the sample to 1980 – 2007. For each June 30th firm-year observation, we pull the firm's monthly returns from CRSP for the following twelve months. Finally, we estimate equation (1) for each firm to measure a firm's exposure to various types of risk for all

[8] BEME on June of year t is the ratio of the book value of equity (BE) reported during calendar year t-1 over the market value of equity reported on December of year t-1. BE is equal to stockholders' equity plus deferred taxes and investment tax credit (data35) less book value of preferred stock. Based on availability stockholders' equity is equal to data60, the book value of common stock (data85) plus the carrying value of preferred stock (data130), or the book value of assets (data6) less the book value of liabilities (data181), in that order. Based on availability the book value of preferred stock is equal to the redemption value (data56), the liquidation value (data10), or the par value (data130), in that order.

firms with at least 24 months of data. Our final sample consists of 102,729 firm-years (10,217 unique firms) covering the 324 months from July 1980 through June 2007.

3.2 Measurement of the marginal investor's sensitivities to factor returns

For each firm, we measure the properties of the marginal investor's portfolio using the properties of the average institutional investor's portfolio. First, we calculate the return for each individual institution's portfolio in each month ($R_{pj,t}$ for each investor j) based on the weights in place on the preceding calendar quarter filing reported on Spectrum (e.g., portfolio weights on March 31 are used to calculate portfolio returns for April, May, and June). We adjust for delisting by assuming that when a portfolio firm delists in the middle of a quarter, the institution re-invests the funds into the CRSP value weighted index for the remainder of the quarter.[9]

Next, we estimate equations (4) and (5) for each institution.[10] We use the R-square from equation (4) to measure $CAPM\_RSQ_j$ and we use the coefficients from equation (5) to calculate $\lambda_{SMB,j}$ and $\lambda_{HML,j}$. After calculating these measures for each institution, we average them to the firm-quarter level, weighting each institutional-level observation by the percentage of the firm it owns in that quarter. Thus, institutions that own more shares are assumed to have a greater effect on the pricing of the firm.[11]

We expect that the characteristics of a firm's investor base are most likely to affect expected returns when these characteristics are persistent (i.e., these institutions engage in transactions which set prices over time). For example, if a firm's institutional investors are

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[9] We adjust for delisting using the following algorithm. If the return for a portfolio firm is missing in a given month, we use the delisting return and delisting codes where available. If the delisting return is less that -55 and the delisting code is between 399 and 701 we set the delisting return to -100%. If the delisting return is less that -55 and the delisting code is less than 400 or more than 700 we set the delisting return to 0.0%. If the return for a given stock on the CRSP monthly stock file is missing but there is no delisting data, the return for that month is set equal to zero. If the portfolio firm is listed on CRSP with missing returns for all three months in a calendar quarter, the observation is dropped from the investor's portfolio.

[10] The monthly factors are available at: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

[11] This is distinct from Levy (1978), where the perception of investors that own a single stock are averaged together by weighting based on the total wealth of each investor. We examine this assumption further in Section 4.6.

under-diversified in a single quarter, then the pricing of non-market risks may attract other more diversified institutions. These new investors would be willing to purchase shares at prices that imply a lower cost of capital. However, we find that the levels of our average investor proxies are fairly stable over time.[12] To maximize the power of our tests, we seek to identify cases where a firm has a persistent level of under-diversified institutions over a long window.[13] Thus, we average these quarterly measures over the life of the firm. For example, $CAPM\_RSQ_{it}$ is the weighted average value of $CAPM\_RSQ_j$ for investors that own shares of firm i in quarter t and $CAPM\_RSQ_i$ is the average value of $CAPM\_RSQ_{it}$ calculated across all quarters for firm i. To calculate the firm-level average, we require that firms have 15 quarters of data.

We acknowledge that our proxies are noisy measures for perception of risk by the marginal investor. First, the Spectrum database aggregates holdings to the institution level, instead of the fund level. This aggregation may overstate institutional investor diversification if an institution offers value and growth funds that offset each other when we examine total institutional holdings. This measurement error will likely result in values of $CAPM\_RSQ_i$ that are closer to one and values of $\lambda_{SMB,i}$ and $\lambda_{HML,i}$ that are closer to zero. Second, our measure is based only on the institutions listed on the Spectrum database. We expect that the portfolios held by other investors (employees, executives, founders, retail investors, hedge funds) are likely to be less diversified. However, as trades from the investors on Spectrum are expected to account for a relatively large amount of trading volume, we expect that their perception of risk is most important in pricing the stock.

[12] The firm-quarter levels of our measures all have auto-correlations above 87%. However, the level of each measure has a negative and significant correlation with the subsequent change, implying some degree of mean reversion. We also examine the entrance of new institutions over time, finding that the presence of under-diversified investors tends to attract new investors are that are more diversified than the existing shareholders.

[13] As a sensitivity analysis, we repeat the analysis partitioning the sample based on rolling five-year calculations of institutions portfolios measured on June 30th. Using this approach, we find similar results.

3.3 Estimation of the pricing of factor sensitivities

To estimate the extent to which the properties of a firm's average institutional investor portfolios affect asset pricing, we examine whether the coefficients in the regression of firm returns on factor sensitivities (equation (3)) vary with the properties of the firm's investor base. Our first hypothesis predicts that when a firm's institutional investors hold portfolios that resemble those held by investors in the CAPM (e.g., CAPM_RSQ is high), then the firm's exposure to the market factor (b_i) will have a greater positive association with average returns. Our second hypotheses predicts that when a firm's institutional investors hold portfolios that are positively related to a non-market risk (e.g., $\lambda_{SMB,i}>0$), then the firm's exposure to that type of risk (e.g., s_i) will have a more positive association with returns. We test these hypotheses by examining if the coefficients in equation (3) vary across different samples. We divide the sample into three groups based on the type of portfolios held by the average institution on June 30th and then estimate equation (3) for each sample.[14,15] To control for cross-sectional dependence, equation (3) is estimated monthly and inferences are based on the average coefficients and their corresponding Fama-MacBeth t-statistics. Before estimating these equations (3), all independent variables are winsorized at the 1st and 99th percentile.

The structure of our analysis is similar to models employed by Ferson and Harvey (1999), who examine the time-series variation in the coefficients from a second stage model similar to equation (3). Their study provides evidence that the monthly coefficients obtained

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[14] Rather than partitioning the sample into three groups, we also use the entire sample to estimate a version of equation (3) where the coefficients are each interacted with the scaled decile rank of one of our variables of interest (CAPM_RSQ, of λ_{SMB} and λ_{HML}). Under this specification, the results are similar.

[15] For portfolio based tests, the rankings based on our institutional investor variables (e.g., residual CAPM_RSQ) are calculated within each portfolio group on a given date. As the rankings are based within each of the 25 ME-BEME portfolios, this ensures there are 25 ME-BEME portfolios in the low, medium, and high groups. For the tests based on firm-level variables (Tables 5 and 6), the rankings are calculated across all firms on a given date.

from estimating equation (3) vary over time with macroeconomic variables. In our study, we examine the cross-sectional variation in the coefficients from equation (3).

Sorting firms into different sub-samples raises the concern that we could be partitioning the sample based on a correlated omitted variable. Moreover, when dividing the sample into sub-samples, it is important that we preserve variation in the independent variables within each group to identify coefficient estimates for each group that can be compared across groups. To address these concerns, we remove variation in our proxies related to control variables and form deciles based on the residual levels of these proxies.[16] We use two groups of control variables. The first group contains variables that capture firm risk attributes as our intention is to form groups based on the firm's investor base and not based on the firms' risk properties. The second group of control variables contains proxies for visibility among institutional investors, which we include to distinguish our work from prior studies on visibility. We include both groups of controls in the following model, which is estimated each June 30th:

$$\begin{aligned} DEPVAR = {} & \theta_0 + \theta_1 R(b_i) + \theta_2 R(s_i) + \theta_3 R(h_i) + \theta_4 R(RMSE) \\ & + \theta_5 R(\ln(ME_{i,t})) + \theta_6 R(\ln(BEME_{i,t})) \\ & + \theta_7 R(NUM\_INST_{i,t}) + \theta_8 R(PIH_{i,t}) + error \end{aligned} \quad (6)$$

DEPVAR	= CAPM_RSQ, λ_{SMB}, or λ_{HML}
R(z)	= Scaled decile rank of variable z
b_i, s_i, and h_i	= Coefficients from firm-level estimates of equation (1)
RMSE	= Root mean squared error from firm-level estimates of equation (1)
ln(ME)	= Natural log of market value of equity on June 30th of year t based on prices and shares from the CRSP monthly stock file.
ln(BEME)	= Natural log of a firm's book-to-market ratio, defined as in Davis, Fama, and French (2000).
$NUM\_INST_{i,t}$	= Number of institutional investors listed on June 30th
$PIH_{i,t}$	= Total percent ownership by institutional investors on June 30th

4. Descriptive Statistics and Empirical Results

[16] We also estimated all of our results partitioning based on the raw values of the proxies, rather than the residual value from this model. All of our inferences are unchanged with this approach.

4.1 Descriptive statistics

We first provide descriptive statistics on the portfolios held by individual institutional investors. These descriptive statistics allow a comparison to prior research, which suggests that individual institutional investors frequently hold portfolios that deviate from a broad market index. We document this lack of complete diversification at the individual institution level by estimating the association between an institution's portfolio return and various factors. Next, we present descriptive statistics on the properties of a firm's average institutional investor to identify whether exposure to idiosyncratic factors averages to zero at the firm level.

Table 1 provides descriptive statistics on the portfolios held by individual institutional investors. The first row reports the R-square from equation (4) for each institution (CAPM_RSQ). For the mean (median) institution, the return on the market index explains 73.1% (79.5%) of that institution's portfolio return, indicating that individual institutions track the market with some error. Next, we estimate equation (5) for each institution to measure the extent to which institutions are exposed to non-market risks (SMB and HML). The table presents the distribution of these coefficients and their corresponding t-statistics for the null hypothesis that an individual coefficient is zero. The parameters from equation (5) provide further evidence that market risk is important for the average institution (λ_{MKT} is positive and highly significant for almost all institutions). In addition, the coefficients on the non-market factors in equation (5) indicate that individual institutions frequently hold portfolios that are either positively or negatively related to these non-market factors. For example, the first (third) quartile of $t(\lambda_{SMB})$ indicates a significantly negative (positive) λ_{SMB} coefficient, which shows that at least one quarter of institutions have a negative (positive) exposure to the SMB factor.

While the parameters in Table 1 provide descriptive evidence consistent with past research on institutional investor holdings, the idiosyncratic risks borne by individual institutions may cancel when all institutions that own a given firm are aggregated together. The descriptive statistics in Panel A of Table 2 suggest this is not the case. The mean (median) value of CAPM_RSQ for a firm's average institutional investor indicates that the market index explains 84.2% (85.6%) of the return earned by its average institutional investor. This R-square is higher than the median based on individual institutions, suggesting that weighting the average based on percentage holdings places a greater weight on institutions with higher values of CAPM_RSQ, which could result if larger institutions hold more diversified portfolios. While this value of CAPM_RSQ is higher than the value in Panel A, it does imply that there could be considerable measurement error in some cases if researchers use the CRSP value-weighted index to measure the portfolio held by the marginal investor.

The distribution of the firm-level average values of λ_{SMB} and λ_{HML} also indicate that the exposure of individual institutions to non-market risk does not disappear when these institutions are aggregated to the firm level. The positive mean and median values for these variables suggest that, for many firms, the marginal investor would bear additional risk if that firm had a positive sensitivity to SMB or HML risk.

Panel B reports a correlation matrix of the partitioning variables. The correlation matrix reveals that our proxy for the pricing of market risk (CAPM_RSQ) is negatively correlated with the both λ_{SMB} and λ_{HML}, while there is a positive correlation between λ_{SMB} and λ_{HML}. These correlations suggest that, when partitioning on a single variable, it is likely that the pricing of multiple risks can change. Our research design addresses this concern by allowing the coefficients on all independent variables in equation (3) to vary across sub-samples.

Table 3 presents models of the determinants of each of our partitioning variables. These models provide evidence on the extent to which our measures of the average institution's perception of risk are related to frictions on an institution's portfolio decisions such as investment styles (e.g., small/large cap, value/growth, transient/dedicated) or fiduciary obligations. We estimate the following model for each variable:

$$\begin{aligned} DEPVAR = {} & \mu_0 + \mu_1 AVG(SMALL\_CAP) + \mu_2 AVG(LARGE\_CAP) \\ & + \mu_3 AVG(VAL) + \mu_4 AVG(GRO) + \mu_5 AVG(DED) \\ & + \mu_6 AVG(TRA) + \mu_7 AVG(BANK) + \mu_8 AVG(P\&E) + \mu_9 AVG(NAV) \\ & + \mu_{10} AVG(NSTK) + error \end{aligned} \quad (7)$$

DEPVAR	= CAPM_RSQ, λ_{SMB}, or λ_{HML}
SMALL_CAP	= an indicator for institutions that follow a small cap strategy
LARGE_CAP	= an indicator for institutions that follow a large cap strategy
VAL	= an indicator for institutions that follow a value strategy
GRO	= an indicator for institutions that follow a growth strategy
DED	= an indicator for institutions that follow a dedicated strategy
TRA	= an indicator for institutions that follow a transient strategy
NAV	= an indicator that the value of equity held by the fund is in the top third of all funds on that calendar date.
NSTK	= an indicator that the number of stocks held by the fund is in the top third of all funds on that calendar date.
BANK	= an indicator for bank trusts.
P&E	= an indicator for pensions and endowments.

As the dependent variable is measured at the firm level, all independent variables are averaged each June 30th across a firm's institutions and then averaged to the firm level. SMALL_CAP, LARGE_CAP, VAL and GRO are defined following a process similar to those used in Abarbanell et al. (2003). DED and TRA are defined following a process similar to Bushee (2001).

Table 3 presents estimates of equation (7). Several of the associations documented in this table are expected given the definitions of the institutional investor variables. For example, small cap and large cap (value and growth) strategies are expected to be related to the $\lambda_{SMB,i}$

($\lambda_{HML,i,}$) coefficient from equation (5). We also expect that, as the average institution's portfolio increases in total value and in number of stocks, it will more closely resemble the market portfolio (i.e., a higher value of CAPM_RSQ). The signs of the coefficients are consistent with these expectations.

The coefficients on the BANK variable suggest that on the fiduciary responsibilities of bank trusts lead them to focus on market risk, as these variables are positively related to CAPM_RSQ, but negatively related to λ_{HML} and λ_{SMB}. Similarly, the negative coefficient on PNE in the model predicting λ_{SMB} suggests that pension funds are less likely to be exposed to small firm related risk. Overall, these associations suggest that fiduciary concerns affect investor portfolios, although these constraints tend to encourage fund managers to focus their portfolios toward market risks and away from risks related to small firms or value firms.

The trading style of the investor base is also correlated with the tilt of an investor's portfolio toward various risk factors. We measure trading styles with the Bushee (2001) classification of institutions into transient (high turnover, low average holdings), dedicated (low turnover, large average holdings), and quasi-indexer groups (low turnover, low average holdings). As transient (TRA) and dedicated (DED) indicators are included in the regression, the omitted group is the quasi-indexers, who are likely to resemble the CAPM investors to the extent that they follow a market index. Ownership by both transient and dedicated investors is negatively related to CAPM_RSQ, indicating that institutions that follow a high-turnover (transient) or large-stake (dedicated) strategy are likely to tilt away from the market portfolio. In addition, both transient and dedicated investor ownership are negatively related to λ_{HML} and positively related to λ_{SMB}, suggesting that institutions that implement either a high or low turnover strategy are less exposed to HML risk and more exposed to SMB risk.

4.2 Empirical tests based on portfolio level data

Prior research suggests that estimating equation (1) using firm-level data may result in estimated coefficients that contain measurement error, which can cause an errors-in-variables problem when the estimated coefficients are used as independent variables in equation (3) (e.g., Fama and MacBeth, 1973). To address this problem, researchers typically perform asset pricing tests based on the portfolios rather than the individual firms.

Table 4 presents estimates of equation (3) across sub-samples using the portfolio approach. We form 25 ME-BEME portfolios as in Fama and French (1996). Panel A presents a model for the full sample (i.e., tests based on 25 ME-BEME portfolios). Panels B-D present models in which the sample is split into thirds using the residual levels of one of the partitioning variables ($CAPM\_RSQ_i$, $\lambda_{SMB,i}$, or $\lambda_{HML,i}$) obtained from equation (6).

The signs of the intercept and coefficients presented in Panel A are similar to prior work. For example, as in Petkova (2006), the coefficient on the intercept (γ_0) is positive and significant, the coefficient on the portfolio's market beta (γ_1) is negative, the coefficient on the portfolio's sensitivity to the SMB factor (γ_2) is positive and insignificant, and the coefficient on the portfolio's sensitivity to the HML factor (γ_3) is positive and significant.[17] As noted by prior studies, the coefficients from Panel A are difficult to reconcile with the predictions of the CAPM. The negative coefficient is substantially less than the value of $E[MKT_t]$, which is equal to 0.64 during the sample period used in this study. In addition, the significant intercept and the

[17] While all of the signs reported in Panel A of Table 4 are consistent with those reported in Petkova (2006), the coefficient estimate for γ_1 is more negative in our study. In addition, the t-statistic is significantly negative, while its significance was only marginal in the Petkova study. This difference appears to be due in part to the difference in time periods in the two studies (Petkova studies July 1963 through December 2001). To investigate whether this time period difference causes the discrepancy in significance we repeat the analysis Panel A of Table 4 using the 25 ME-BEME portfolios from Ken French's website during our sample period (324 months from July 1980 through June 2007). We find that using these portfolios γ_1 is significant during this window.

significant coefficient on the portfolio's sensitivity to the HML factor raise questions about what type of risk is priced by investors.

Panel B presents results where the sample is partitioned based on the extent to which institutions are expected to be sensitive to market risk (CAPM_RSQ). Consistent with hypothesis 1, the coefficient on a portfolio's market beta (γ_1) is significantly higher when the firm's investors have higher levels of CAPM_RSQ (t=4.24). The γ_1 coefficient is still negative for the high CAPM_RSQ group (γ_1=-0.45), although it is not significant (t=-1.09). Thus, the large negative coefficient on market betas that is observed in Panel A is driven by firms for which the market factor accounts for a relatively low amount of the variation in institutional investor portfolios. A comparison across groups also indicates that the intercept in equation (3) is significantly closer to zero when investors hold portfolios that are more similar to those held by investors in the CAPM model (t=-3.52).

Panel C presents the model in which the sample is partitioned based on the extent to which institutions are expected to be sensitive to SMB risk ($\lambda_{SMB,i}$). A comparison of the high and low groups indicates that the firms with high values of λ_{SMB} have more negative γ_2 coefficients (t=-2.08), contrary to hypothesis 2. However, because this pattern across these three groups is not monotonic, we view this as only limited evidence related to our hypothesis.

Panels D presents the results where the sample is partitioned based on the extent to which institutions are expected to be sensitive to HML risk ($\lambda_{HML,i}$). Consistent with hypothesis 2, the coefficient on a portfolio's HML beta (γ_3) is significantly higher when the firm's investors have higher levels of $\lambda_{HML,i}$ (t=5.97). These results indicate that a stronger association between HML and expected returns exists when institutional investors are highly exposed to the HML factor.

Overall, the portfolio tests indicate that, when a firm's average institutional investor portfolio is highly sensitive to the market factor, the firm's market beta has a less negative association with its average returns, and the intercept is closer to zero, both of which are more consistent with CAPM predictions. We also find that a firm's sensitivity to the HML factor (i.e., book-to-market factor) has a stronger association with expected returns for the firms where the average institutional investor's portfolio exhibits more sensitivity to this factor, suggesting that these investors demand compensation for bearing this type of risk due to their portfolio's exposure to this factor.

4.3 Empirical tests based on firm-level factor sensitivities

A critique of portfolio based tests is that the portfolios are formed on an *ad hoc* basis that could bias results (Lo and MacKinlay, 1990). To avoid these concerns, we estimate equation (3) across different sub-samples using firm-level estimates of each firm's factor sensitivities (equation (1)). Table 5 presents estimates of the models presented in Table 4 using dependent and independent variables that are measured at the firm level. The baseline model in Panel A presents coefficients whose sign and limited significance are consistent with prior research (e.g., Core, Guay, and Verdi, 2008).

As in Table 4, Panel B presents the regression where the sample is partitioned based on the residual level of CAPM_RSQ. The results show that the association between firm-level market betas and returns is stronger when CAPM_RSQ is higher (t=4.41), again supporting hypothesis 1. A comparison across the groups reveals not only an increasing pattern in γ_1, but that γ_1 is equal to 0.57 (t=2.09) in the high group. This value is noticeably closer to the value of $E[MKT_t]$, which is predicted by the CAPM. The intercept (γ_0) in the high group is lower than in the low group, but the difference is not significant.

Panel C presents models partitioned based on the residual value of λ_{SMB}. Similar to Table 4, there is no evidence that the pricing of SMB risk varies based on the portfolios held by a firm's institutional investors. Finally, Panel D provides further evidence that the pricing of a firm's sensitivity to HML risk is stronger when a firm's average institutional investor's portfolios are sensitive to that type of risk. In Panel D, γ_3 is significantly less negative when a firm's institutional investors are sensitive to this type of risk (t=-4.05), consistent with hypothesis 2. However, this result must be viewed with caution as, when viewed individually, the γ_3 estimate for the high group is not significantly different from zero. Overall, the results of the firm-level approach are consistent with the portfolio-level tests.

4.4 Empirical tests based on the characteristics of individual firms

As an alternative to the factor-based approach, we use a firm's characteristics to measure a firm's exposure to risk. Some researchers have argued that firm characteristics may be measures of a firm's risk (e.g., Fama and French, 1993); although, the use of characteristics is debatable because factor loadings are more consistent with asset pricing theories such as the CAPM (Cochrane, 2005). Alternatively, characteristics may capture information about an asset's mispricing if investor optimism results in over-valuation for large stocks or stocks with low book-to-market levels (e.g., Lakonishok, Shleifer and Vishny, 1994). To perform our tests based on characteristics, we follow Fama and French (1992) and re-write equation (3) in the following way.

$$R_{i,t} = \gamma_0 + \gamma_1 b_{PORTi} + \gamma_2 \ln(ME_i) + \gamma_3 \ln(BEME_i) + e_{3i,t} \quad (3b)$$

b_{PORTi} = the market beta from the size-market beta portfolio that a firm is assigned to on June 30th [18]

[18] As in Fama and French (1992), rather than estimate a firm's beta based on its own time series, we estimate betas for 100 portfolios based on ME and past beta and assign each firm the beta of the portfolio. These portfolios are not restricted to include only Spectrum firms.

The predicted signs for independent variables in equation (3b) are the same as the corresponding factor based variables in equation (3), except a *negative* coefficient on $\ln(ME_i)$ is indicative of the pricing of a small firm effect.

Table 6 provides estimates of equation (3b) for the entire sample and across sub-samples. Panel A presents results similar to those presented in Fama and French (1992): the association between the market beta and returns is not significantly different from zero, while $\ln(ME_i)$ is negatively related to expected returns and $\ln(BEME_i)$ is positively related to returns.

The estimates of equation (3b) in Panel B provides further evidence that market risk is more likely to be priced when the firm's average institutional investor resembles the investors in the CAPM model. The firms with high residual values of CAPM_RSQ have significantly greater γ_1 coefficients (t=3.25), indicating that the pricing of market risk is significantly greater when investors hold portfolios that are highly sensitive to the market portfolio A comparison of the high and low groups also reveals that the effect of the size characteristic ($\ln(ME_i)$) on returns is significantly closer to zero when $CAPM\_RSQ_i$ is high. Finally, these panels provide evidence that the effect of the book-to-market characteristic ($\ln(BEME_i)$) on returns is higher when $CAPM\_RSQ_i$ is high.

In contrast to the prior tables, the model in Panel C of Table 5 *supports* our hypothesis on the pricing of the size characteristic, while the model in Panel D does not provide any evidence supporting our hypothesis on the pricing of the book-to-market characteristic. In Panel C, a comparison of the groups partitioned based on λ_{SMB} indicates that the coefficient on $\ln(ME_i)$ is significantly more negative when λ_{SMB} is high (t=-7.49). However, in Panel D, a comparison of the groups partitioned based on λ_{HML} does not find a significant difference between the coefficients on $\ln(BEME_i)$ in the high and low groups (t=0.67).

Overall, when examining the pricing of firm characteristics (instead of factors), we find similar results for the market factor, but not for the book-to-market factor. We also now find significant results for the size factor using firm characteristics: the association between firm size and expected returns is stronger when a firm's average institutional investor holds a portfolio that is more sensitive to the SMB factor.

4.5 Estimates of equation (3) across sub-samples partitioned using visibility measures

To distinguish our measures from existing work on visibility, we estimate the pricing models partitioning the sample based on total institutional ownership percentage. This analysis assumes that as more institutions own a stock, fewer idiosyncratic risks are priced (i.e., all institutions are assumed to be well diversified). Table 7 presents these models. Across the models in Table 7, there are few results that are consistent across these panels. For example, while Panel A presents evidence consistent with institutions increasing the pricing of market risk, the opposite is suggested by the results in Panels B and C. These results combined with the evidence in Tables 4-6 suggest that incorporating details on the types of institutional ownership provides incremental information on the extent to which institutions affect the pricing of risk.

4.6 Alternative ways to calculate the properties of a firm's average institutional investor

One contribution of this paper is to provide improved measures of the preferences of the marginal investor. Thus, we test the robustness of our measure by exploring alternative methods for capturing the preferences of the average investor.

First, institutional investor trading activity may be a better measure of the extent to which institutions influence prices. For example, a company's founder could be an under-diversified investor with a large block holding, but the risk preferences of that individual would not affect prices if he does not trade often. To address this issue, we weight our calculation of the average investor based on the absolute change in percentage of firms' shares traded by each institution during a given quarter. This produces a measure of the average institutional investor that places a greater weight on those institutions that traded during that quarter and are more likely to affect prices. The properties of the average investor using these weights are very highly correlated with the measures reported in the paper. We also weight our calculation using only net purchases during the quarter under the assumption that institutions entering a stock are more likely to demand compensation for risk than institutions exiting a stock, which may be selling for liquidity or other reasons. Using these alternative measures of the average investor sensitivities, we find results that are similar to those presented in the tables.

Second, in calculating the preferences of the average investor, there may be a concern that an institution's ownership of a particular stock is very large and hence the properties of the institution's portfolio mechanically reflect the properties of a firm's return distribution. While we address this concern by using control variables related to firm characteristics in equation (6), we also address this issue through our calculation of the average investor properties. When calculating the properties of a firm's average investor in a given quarter, we remove all institutions whose ownership of that specific firm exceeds 1%. Dropping these institutions requires that if a firm's investors' portfolios are tilted away from the market portfolio, it is not due to their investment in that stock in question, but rather through their holdings in other stocks. Using this alternative calculation of the average investor's properties, we obtain similar results to those reported in the tables.

Third, we augment our tests to control for differences in risk aversion across institutions. Specifically, if institutions that have large values of λ_{SMB} and λ_{HML} require a smaller amount of return in compensation for the higher variance, this may obscure our hypothesized effects. To address this issue, instead of beginning our analysis with institution-level measures of λ_{SMB} and λ_{HML}, we adjust these variables for differences in the risk-reward trade-off and repeat our analysis. The new variables are defined as $\lambda_{SMB}Var(SMB_t)E[R_{pi,t}]/Var(R_{pi,t})$ and $\lambda_{HML}Var(HML_t)E[R_{pi,t}]/Var(R_{pi,t})$. Using these alternative measures, our results related to the pricing of SMB and HML risk are similar.

4.7 Inclusion of a momentum factor

As prior work indicates that institutional investor holdings may be a function of prior stock price performance (Grinblatt, Titman, and Wermers, 1995) and past returns may predict future returns (Jegadeesh and Titman, 1993), we add a momentum factor to Equation (1) and Equation (5) and replicate the tests in Tables 4, 5, and 6. We do not find evidence that firm sensitivities to a momentum factor are more positively related to returns when institutions are sensitive to the momentum factor using the factor models in Tables 4 and 5. However, similar to the results related to the pricing of the size characteristics, we find that that if a firm's institutions are sensitive to the momentum factor, then size-adjusted returns over the prior 12 months are more positively related to subsequent returns using the characteristic model in Table 6.

5. Conclusion

Empirical research on asset pricing has encountered challenges in finding support for the theoretical prediction that only market risk is priced. We provide insight into whether these challenges result from the abstraction of frictions in theoretical models that may exist and constrain the portfolios held by a firm's investors. We use institutional investor data to infer the extent to which the theoretical notion that all investors hold the market portfolio is valid for a given firm's investor base. In addition, we provide evidence on the degree to which non-market risks are diversified and the implications of this lack of diversification for asset pricing. We find stronger evidence supporting the pricing of market risk when investors hold portfolios that are highly correlated with the market index. We also find some evidence supporting the hypothesis that an association between non-market risk and expected returns may arise due to a lack of diversification, especially with regards to the book-to-market factor. Our findings suggest that future research should analyze the extent to which a firm's institutional investors are sensitive to a risk factor as an intermediate step in testing whether a risk factor is diversifiable or whether it should be priced.

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Table 1
Descriptive statistics on institution-level portfolio return sensitivities to factor returns

	Mean	Standard Deviation	Min	Q1	Median	Q3	Max
CAPM_RSQ	0.731	0.211	0.004	0.625	0.795	0.891	0.992
λ_0	0.093	0.596	-8.459	-0.077	0.074	0.248	10.094
λ_{MKT}	1.052	0.277	-0.441	0.935	1.016	1.112	4.386
λ_{SMB}	0.114	0.395	-2.482	-0.152	0.004	0.296	3.885
λ_{HML}	0.055	0.414	-3.397	-0.114	0.054	0.245	2.990
$t(\lambda_0)$	0.413	1.231	-3.552	-0.391	0.431	1.249	5.383
$t(\lambda_{MKT})$	22.170	17.631	-1.399	9.479	18.076	29.379	175.889
$t(\lambda_{SMB})$	-0.284	4.557	-22.510	-3.001	0.057	2.501	27.295
$t(\lambda_{HML})$	0.966	3.777	-14.060	-1.336	0.720	2.932	17.431

Table 1 presents descriptive statistics on the portfolios held by individual institutions (N=3,535 institutions). Based on a firm's quarterly holdings, we calculate its portfolio return ($R_{pj,t}$). The variables in the above table are based on the parameters estimated from equations (4) and (5). Equation (4) is defined as: $R_{pj,t} = \lambda_{0,j} + \lambda_{MKT,j}MKT_t + e_{4j,t}$. Equation (5) is: $R_{pi,t}=\lambda_{0i} + \lambda_{MKT,i}MKT_t + \lambda_{SMB,i}SMB_t + \lambda_{HML,i}HML_t + e_{5i,t}$. CAPM_RSQ$_j$ is the Model R-square from equation (4) for an institution, while the coefficients and corresponding t-statistics presented in Table 1 are from equation (5).

Table 2
Descriptive statistics on firm-level average institutional investor factor sensitivities

Panel A: Distribution of variables measuring the average institutional investor's portfolio

	Mean	Standard Deviation	Min	Q1	Median	Q3	Max
CAPM_RSQ	0.842	0.068	0.576	0.813	0.856	0.887	0.957
λ_{SMB}	0.129	0.150	-0.142	0.019	0.114	0.219	0.576
λ_{HML}	0.075	0.112	-0.249	0.012	0.076	0.142	0.371

Panel B: Pearson correlation between variables measuring the average institutional investor's portfolio

	CAPM_RSQ	λ_{SMB}	λ_{HML}
CAPM_RSQ	1.000		
λ_{SMB}	-0.686	1.000	
λ_{HML}	-0.218	0.053	1.000

All correlations presented in Panel B are significant at the 5% level

Table 2 presents the firm-level measures of the portfolio held by the firm's average institutional investor (N=10,217 firms). First, the institution-level variables are based on parameters estimated from equations (4) and (5). Equation (4) is: $R_{pj,t} = \lambda_{0,j} + \lambda_{MKT,j}MKT_t + e_{4j,t}$. Equation (5) is: $R_{pi,t}=\lambda_{0i} + \lambda_{MKT,i}MKT_t + \lambda_{SMB,i}SMB_t + \lambda_{HML,i}HML_t + e_{5i,t}$. $CAPM\_RSQ_j$ is the R-square from equation (4) for an institution, while the $\lambda_{SMB,i}$ and $\lambda_{HML,i}$ coefficients and corresponding are from equation (5). Next, we average these variables to the firm-quarter level, weighting each institutional-level observation by the percentage of the firm that it holds in that quarter. Thus, institutions that own more shares are assumed to have a greater effect on the pricing of the firm. Finally, we average these quarterly measures over the life of the firm to create a firm-level variable. For example, $CAPM\_RSQ_{it}$ is the weighted average value of $CAPM\_RSQ_j$ for the investors that own shares of firm i in quarter t and $CAPM\_RSQ_i$ is the average value of $CAPM\_RSQ_{it}$ calculated across all quarters for firm i. To calculate the firm-level average, we require that all firms have 15 quarters of data.

Table 3

Regression of institutional investor factor sensitivities on institutional investor characteristics

$$DEPVAR = \mu_0 + \mu_1 AVG(SMALL\_CAP) + \mu_2 AVG(LARGE\_CAP) + \mu_3 AVG(VAL) + \mu_4 AVG(GRO) + \mu_5 AVG(DED) + \mu_6 AVG(TRA) + \mu_7 AVG(BANK) + \mu_8 AVG(P\&E) + \mu_9 AVG(NAV) + \mu_{10} AVG(NSTK) + error \quad (7)$$

DEPVAR = $CAPM\_RSQ_i$, $\lambda_{SMB,i}$, or $\lambda_{HML,i}$

	DEPVAR= CAPM_RSQ	DEPVAR= $\lambda_{SMB,i}$	DEPVAR= $\lambda_{HML,i}$
Intercept	0.768**	-0.054**	0.129**
Avg(SMALL_CAP)	-0.134**	0.476**	0.073**
Avg(LARGE_CAP)	-0.025**	-0.069**	0.027**
Avg(VAL)	-0.032**	0.000	0.194**
Avg(GRO)	0.013**	0.041**	-0.286**
Avg(DED)	-0.034**	0.112**	-0.037**
Avg(TRA)	-0.020**	0.018*	-0.136**
Avg(BANK)	0.028**	-0.094**	-0.054**
Avg(P&E)	0.008	-0.056**	-0.025
Avg(NAV)	0.056**	-0.088**	0.049**
Avg(NSTK)	0.115**	0.117**	-0.094**

*, ** Significantly different from zero at the 0.05, and 0.01 level respectively, using a two tailed test.

The dependent variables in this regression are institutional investor-level factor sensitivities. $CAPM\_RSQ_j$ is the R-square from equation (4): $R_{pj,t} = \lambda_{0,j} + \lambda_{MKT,j}MKT_t + e_{4j,t}$, where $R_{pj,t}$ is the monthly return on the portfolio held by the institutional investor j and MKT_t is the monthly return on the market factor less the risk free rate. $\lambda_{SMB,i}$ and $\lambda_{HML,i}$ are the coefficients from equation (5): $R_{pi,t}=\lambda_{0i} + \lambda_{MKT,i}MKT_t + \lambda_{SMB,i}SMB_t + \lambda_{HML,i}HML_t + e_{5i,t}$, where SMB_t is the monthly return on the Small minus Big (firm size) factor and HML_t is the monthly return on the High minus Low (book-to-market) factor. Avg(x) is the firm-level average of the investor based variables. First, we calculate the weighted average of each variable for each firm on June 30th, weighting based on percentage ownership. Next, we average the annual variables (June 30th averages) to a firm-level average. SMALL_CAP (LARGE_CAP) is an indicator for institutions where institution type = Small Cap (Large Cap). VAL (GRO) is an indicator for institutions where institution type = Value (growth). DED (TRA) is an indicator for institutions where institution type = Dedicated (Transient). SMALL_CAP, LARGE_CAP, VAL and GRO are defined following a process similar to those used in Abarbanell et al. (2003). DED and TRA are defined following a process similar to Bushee (2001). BANK is an indicator for bank trusts. P&E is an indicator for corporate pensions, public pensions, and endowments. NAV is an indicator that the value of equity held by the fund is in the top third of all funds on that calendar date. NSTK is an indicator that the number of stocks held by the fund is in the top third of all funds on that calendar date.

Table 4
Expected return tests across sub-samples using portfolios

Panel A: Model with no interactions (25 ME-BEME portfolios)

	Average	t-statistic
γ_0	2.18	5.67
γ_1	-1.36	-3.06
γ_2	0.09	0.47
γ_3	0.37	1.97

Panel B: Partitions based on residual values of CAPM_RSQ

	LOW		MED		HIGH		HIGH - LOW	
	Average	t-statistic	Average	t-statistic	Average	t-statistic	Average	t-statistic
γ_0	2.67	6.56	2.44	4.99	1.27	3.78	-1.40	-3.52
γ_1	-2.01	-4.45	-1.48	-2.90	-0.45	-1.09	1.56	4.24
γ_2	0.08	0.37	0.19	0.90	0.11	0.54	0.04	0.38
γ_3	0.34	1.73	0.17	0.86	0.50	2.55	0.15	1.45

Panel C: Partitions based on residual values of $\lambda_{SMB,i}$

	LOW		MED		HIGH		HIGH - LOW	
	Average	t-statistic	Average	t-statistic	Average	t-statistic	Average	t-statistic
γ_0	1.56	4.86	2.34	4.67	2.33	5.70	0.77	1.88
γ_1	-0.70	-1.77	-1.42	-2.71	-1.71	-3.73	-1.01	-2.77
γ_2	0.14	0.65	0.29	1.45	-0.06	-0.29	-0.20	-2.08
γ_3	0.47	2.41	0.22	1.12	0.34	1.68	-0.13	-1.16

Panel D: Partitions based on residual values of $\lambda_{HML,i}$

	LOW		MED		HIGH		HIGH - LOW	
	Average	t-statistic	Average	t-statistic	Average	t-statistic	Average	t-statistic
γ_0	1.38	3.54	2.10	5.37	2.34	5.62	0.95	2.34
γ_1	-0.35	-0.78	-1.32	-2.95	-1.80	-3.97	-1.45	-3.95
γ_2	0.30	1.43	0.19	0.91	-0.14	-0.68	-0.43	-4.67
γ_3	0.14	0.72	0.37	1.90	0.77	3.75	0.63	5.97

Table 4 presents estimates of equation (3) across sub-samples using a portfolio approach. Equation (3) is: $R_{i,t} = \gamma_0 + \gamma_1 b_i + \gamma_2 s_i + \gamma_3 h_i + e_{3i,t}$, where $R_{i,t}$ is the monthly return of asset i less the risk free rate and b_i, s_i, and h_i are the coefficients from equation (1): $R_{i,t} = \alpha_i + b_i MKT_t + s_i SMB_t + h_i HML_t + e_{1i,t}$, where MKT_t is the monthly return on the market factor less the risk free rate, SMB_t is the monthly return on the Small minus Big (firm size) factor, and HML_t is the monthly return on the High minus Low (book-to-market) factor. $CAPM\_RSQ_j$, $\lambda_{SMB,i}$, and $\lambda_{HML,i}$ are defined in Table 2. The table presents the average coefficient and Fama-MacBeth t-statistic from 324 monthly regressions. All independent variables are winsorized at the 1st and 99th percentile. Residual values obtained by regressing the variable on a set of controls (equation (6)): $DEPVAR = \theta_0 + \theta_1 R(b_i) + \theta_2 R(s_i) + \theta_3 R(h_i) + \theta_4 R(RMSE) + \theta_5 R(\ln(ME_{i,t})) + \theta_6 R(\ln(BEME_{i,t})) + \theta_7 R(NUM\_INST_{i,t}) + \theta_8 R(PIH_{i,t}) + error$, where: DEPVAR = $CAPM\_RSQ_i$, $\lambda_{SMB,i}$, or $\lambda_{HML,i}$ and R(z)= Scaled decile rank of variable z, RMSE is the root mean squared error from firm-level estimates of equation (1), $\ln(ME_{i,t})$ is the log of market value of equity on June 30th of year t , $\ln(BEME_{i,t})$ is the log the ratio of the book value of equity (BE) reported during calendar year t-1 over the market value of equity reported on December of year t-1, $NUM\_INST_{i,t}$ is number of institutional investors listed on June 30th of year t, $PIH_{i,t}$ is percent ownership by institutional investors on June 30th of year t.

Table 5
Expected return tests across sub-samples using firm-level sensitivities

Panel A: Model with no interactions

	Average	t-statistic
γ_0	0.61	5.31
γ_1	0.35	1.38
γ_2	0.15	0.72
γ_3	-0.18	-0.93

Panel B: Partitions based on residual values of CAPM_RSQ

	LOW		MED		HIGH		HIGH - LOW	
	Average	t-statistic	Average	t-statistic	Average	t-statistic	Average	t-statistic
γ_0	0.66	5.28	0.68	5.32	0.50	3.73	-0.16	-1.49
γ_1	0.15	0.58	0.34	1.33	0.57	2.09	0.42	4.41
γ_2	0.13	0.63	0.13	0.61	0.21	0.96	0.08	1.08
γ_3	-0.14	-0.75	-0.23	-1.21	-0.20	-0.95	-0.06	-0.84

Panel C: Partitions based on residual values of $\lambda_{SMB,i}$

	LOW		MED		HIGH		HIGH - LOW	
	Average	t-statistic	Average	t-statistic	Average	t-statistic	Average	t-statistic
γ_0	0.47	3.38	0.83	7.01	0.65	5.11	0.18	1.68
γ_1	0.59	2.17	0.27	1.04	0.07	0.29	-0.52	-5.26
γ_2	0.22	1.02	0.10	0.51	0.14	0.67	-0.09	-1.23
γ_3	-0.20	-0.99	-0.22	-1.14	-0.15	-0.80	0.06	0.79

Panel D: Partitions based on residual values of $\lambda_{HML,i}$

	LOW		MED		HIGH		HIGH - LOW	
	Average	t-statistic	Average	t-statistic	Average	t-statistic	Average	t-statistic
γ_0	0.67	4.73	0.72	6.20	0.53	3.93	-0.14	-1.24
γ_1	0.61	2.35	0.31	1.18	-0.01	-0.02	-0.62	-6.17
γ_2	0.19	0.86	0.14	0.66	0.16	0.77	-0.03	-0.43
γ_3	-0.27	-1.39	-0.20	-1.00	0.00	-0.01	0.27	4.05

Table 5 presents estimates of equation (3) across sub-samples using firm-level sensitivities, rather than portfolios. Equation (3) is: $R_{i,t} = \gamma_0 + \gamma_1 b_i + \gamma_2 s_i + \gamma_3 h_i + e_{3i,t}$. All variables are defined in Table 4. The table presents the average coefficient and Fama-MacBeth t-statistic from 324 monthly regressions. All independent variables are winsorized at the 1st and 99th percentile. Residual values obtained by regressing the variable on a set of controls (the residual from equation (6)): $DEPVAR = \theta_0 + \theta_1 R(b_i) + \theta_2 R(s_i) + \theta_3 R(h_i) + \theta_4 R(RMSE) + \theta_5 R(\ln(ME_{i,t})) + \theta_6 R(\ln(BEME_{i,t})) + \theta_7 R(NUM\_INST_{i,t}) + \theta_8 R(PIH_{i,t}) + error$, where: DEPVAR = $CAPM\_RSQ_i$, $\lambda_{SMB,i}$, or $\lambda_{HML,i}$.

Table 6
Expected return tests across sub-samples using characteristics

Panel A: Model with no interactions

	Average	t-statistic
γ_0	1.87	5.50
γ_1	-0.05	-0.14
γ_2	-0.14	-2.15
γ_3	0.30	3.55

Panel B: Partitions based on residual values of CAPM_RSQ

	LOW		MED		HIGH		HIGH - LOW	
	Average	t-statistic	Average	t-statistic	Average	t-statistic	Average	t-statistic
γ_0	2.53	6.93	1.90	5.17	1.50	4.44	-1.03	-5.17
γ_1	-0.29	-0.83	0.02	0.05	0.19	0.59	0.48	3.25
γ_2	-0.27	-4.00	-0.15	-2.35	-0.08	-1.18	0.20	6.58
γ_3	0.22	2.45	0.17	1.77	0.44	4.76	0.22	2.94

Panel C: Partitions based on residual values of $\lambda_{SMB,i}$

	LOW		MED		HIGH		HIGH - LOW	
	Average	t-statistic	Average	t-statistic	Average	t-statistic	Average	t-statistic
γ_0	1.55	4.30	2.15	5.78	2.58	7.35	1.03	5.32
γ_1	0.27	0.75	0.00	0.00	-0.26	-0.77	-0.53	-3.35
γ_2	-0.09	-1.40	-0.17	-2.78	-0.33	-4.47	-0.24	-7.49
γ_3	0.43	4.42	0.15	1.56	0.21	2.42	-0.22	-2.99

Panel D: Partitions based on residual values of $\lambda_{HML,i}$

	LOW		MED		HIGH		HIGH - LOW	
	Average	t-statistic	Average	t-statistic	Average	t-statistic	Average	t-statistic
γ_0	1.69	4.55	2.07	6.13	2.27	6.22	0.58	2.64
γ_1	0.31	0.87	-0.10	-0.30	-0.48	-1.50	-0.80	-5.11
γ_2	-0.11	-1.56	-0.15	-2.47	-0.21	-2.99	-0.11	-2.92
γ_3	0.28	2.92	0.28	2.97	0.33	3.77	0.05	0.67

Table 6 presents estimates of equation (3b) across sub-samples using firm-level characteristics. Equation (3b) is: $R_{i,t} = \gamma_0 + \gamma_1 b_{PORTi} + \gamma_2 \ln(ME_i) + \gamma_3 \ln(BEME_i) + e_{3i,t.}$, where b_{port} is the market beta from the portfolio that a firm is assigned to on June 30th (firms are divided into 100 portfolios based on size decile and the past beta decile within each size decile), $\ln(ME_{i,t})$ is the log of market value of equity on June 30th of year t, and $\ln(BEME_{i,t})$ is the log the ratio of the book value of equity (BE) reported during calendar year t-1 over the market value of equity reported on December of year t-1. All other variables are defined in Table 4. The table presents the average coefficient and Fama-MacBeth t-statistic from 324 monthly regressions. All independent variables are winsorized at the 1st and 99th percentile. Residual values obtained by regressing the variable on a set of controls (the residual from equation (6)): $DEPVAR= \theta_0 + \theta_1 R(b_i) + \theta_2 R(s_i) + \theta_3 R(h_i) + \theta_4 R(RMSE) + \theta_5 R(\ln(ME_{i,t}))+ \theta_6 R(\ln(BEME_{i,t})) + \theta_7 R(NUM\_INST_{i,t}) + \theta_8 R(PIH_{i,t})$ + error, where: DEPVAR = $CAPM\_RSQ_i$, $\lambda_{SMB,i}$, or $\lambda_{HML,i}$.

Table 7
Expected return tests with partitions based on measures of visibility

Panel A: Models estimated using portfolios and partitions based on $PIH_{i,t}$

	LOW		MED		HIGH		HIGH - LOW	
	Average	t-statistic	Average	t-statistic	Average	t-statistic	Average	t-statistic
γ_0	1.88	6.37	2.08	5.06	0.76	1.81	-1.12	-2.69
γ_1	-1.35	-3.50	-1.18	-2.60	0.00	-0.01	1.34	3.62
γ_2	0.23	1.07	0.04	0.18	0.14	0.66	-0.09	-0.77
γ_3	0.38	1.74	0.40	2.06	0.24	1.23	-0.14	-0.85

Panel B: Models estimated using firm-level data and partitions based on $PIH_{i,t}$

	LOW		MED		HIGH		HIGH - LOW	
	Average	t-statistic	Average	t-statistic	Average	t-statistic	Average	t-statistic
γ_0	0.45	3.02	0.66	5.77	0.86	6.31	0.40	2.43
γ_1	0.54	1.99	0.35	1.37	0.20	0.75	-0.34	-2.36
γ_2	0.30	1.37	0.05	0.23	-0.21	-1.20	-0.51	-5.22
γ_3	-0.19	-0.94	-0.18	-0.95	-0.16	-0.87	0.04	0.33

Panel C: Models estimated using firm-level characteristics and partitions based on $PIH_{i,t}$

	LOW		MED		HIGH		HIGH - LOW	
	Average	t-statistic	Average	t-statistic	Average	t-statistic	Average	t-statistic
γ_0	2.78	8.38	1.49	4.53	1.27	3.38	-1.51	-4.18
γ_1	0.23	0.53	0.10	0.28	-0.22	-0.72	-0.45	-1.67
γ_2	-0.50	-6.25	-0.11	-1.87	-0.02	-0.44	0.47	6.73
γ_3	0.39	4.31	0.28	2.93	0.08	0.86	-0.32	-3.29

Table 7 presents estimates of equation (3) across sub-samples using multiple approaches. Equation (3) is equal to the following model: $R_{i,t} = \gamma_0 + \gamma_1 b_i + \gamma_2 s_i + \gamma_3 h_i + e_{3i,t}$. Panel A presents a portfolio approach. Panel B presents firm-level sensitivities. Panel C present an approach using firm-level characteristics (equation 3b). The table presents the average coefficient and Fama-MacBeth t-statistic from 324 monthly regressions. All independent variables are winsorized at the 1st and 99th percentile. All variables are defined in the Tables 4 - 6.