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Abstract

Using a unique, hand-collected data set of hedge fund ownership, we examine the effects of hedge fund ownership on liquidity risk in the cross-section of stocks. After controlling for institutional preferences for stock characteristics, we find that stocks held by hedge funds as marginal investors are more sensitive to changes in aggregate liquidity than comparable stocks held by other types of institutions or by individuals. Stocks held by hedge funds also experience significantly negative abnormal returns during liquidity crises. These findings support the theory of Brunnermeier and Pedersen (2009) that ownership by levered traders leads to a greater liquidity risk.

KEYWORDS: Liquidity risk, institutional investors, hedge funds.

JEL classification: G14, G23, G12.

Introduction

"Hedge funds are selling billions of dollars of securities to meet demands for cash from their investors and their lenders, contributing to stock market's nearly 10% drop over the past two days."

-The Wall Street Journal, November 7, 2008

The financial markets turmoil in 2008 and 2009 has intensified the debate over the impact of institutional ownership on systematic liquidity risk. Hedge funds, in particular, have come under increased public scrutiny because of the possibility that their deleveraging may contribute to liquidity crises. The hedge fund sector makes extensive use of leverage, which is typically obtained through short-term funding (see, e.g., Lo, 2008; Ang, Gorovyy, and Inwegen, 2011). Policy makers, practitioners, and academic researchers have expressed concerns that liquidity shocks could force hedge funds to reduce leverage through asset sales into illiquid markets, amplifying the liquidity risk of these assets and increasing the risk exposure of the entire financial system.

Recent academic studies provide theoretical grounds for such concerns. These studies predict that institutional ownership can affect the sensitivity of asset returns to fluctuations in aggregate liquidity. For example, Brunnermeier and Pedersen (2009) propose a model that relates liquidity risk to ownership by levered speculators such as hedge funds. In their model, adverse funding shocks force hedge funds to liquidate their positions during liquidity crises at depressed prices, thus increasing the covariance between asset returns and market liquidity. An

implication of their model is that assets held by levered speculators such as hedge funds are more likely to be sold off following declines in market liquidity, and should therefore have high liquidity risk. An alternative view is that restrictions on fund withdrawal allow hedge funds to have long-term investment horizons, and act as suppliers of capital during liquidity crises[2]. According to this view, hedge fund ownership should have no adverse effect on liquidity risk, and it may even reduce the liquidity risk of stocks.

Ownership by other types of investors, such as mutual funds or commercial banks, could also affect liquidity risk. Grinblatt, Titman, and Wermers (1995), Wermers (1999), Nofsinger and Sias (1999), Griffin, Harris, and Topaloglu (2003), and Sias (2004) show that mutual funds tend to herd, i.e. buy into or out of the same stocks at the same time. Chordia, Roll, and Subrahmanyam (2000), and Koch, Ruenzi, and Starks (2010) hypothesize that correlated trading and herding among mutual funds can increase the liquidity risk of stocks. An implication of this argument is that stocks in mutual funds' portfolios should be more exposed to liquidity risk. Gatev and Strahan (2006) argue that, in contrast to other institutions, banks have a unique ability to trade against market-wide liquidity shocks because they experience funding flows and costs that covary negatively with market liquidity. This gives banks a unique ability to hedge against market-wide liquidity shocks. Therefore, ownership by banks could decrease the liquidity risk of stocks.

We test these hypotheses and empirically examine the effects of institutional ownership on the liquidity risk of stocks. Specifically, we measure liquidity risk as the covariance between individual stock returns and innovations in aggregate market liquidity, and investigate whether stocks with higher institutional ownership exhibit greater liquidity risk than comparable stocks

[2] See, e.g., Aragon (2007), and Sadka (2010) for a discussion of hedge fund lockups and other withdrawal restrictions.

held by individual investors. Furthermore, we use a unique, hand-collected data set of hedge fund holdings to examine whether stocks held by hedge funds as marginal investors have returns that covary more strongly with changes in aggregate liquidity than otherwise identical stocks held by other types of institutional investors. Such evidence would support the hypothesis that ownership by hedge funds affects liquidity risk more than ownership by other types of institutional investors, such as mutual funds, commercial banks, and insurance companies.

The empirical results support the hypothesis that institutional ownership has a significant effect on the liquidity risk of stocks and the hypothesis that ownership by different types of institutional investors has a differential effect on the liquidity risk of stocks. Specifically, the liquidity risk (liquidity beta) of stocks in quarter *q* is strongly associated institutional ownership in quarter *q-1*, and the finding persists even after controlling for stock characteristics and liquidity risk in quarter *q-1*.

In particular, the liquidity risk of stocks is positively and significantly related to hedge fund holdings in the cross-section. In other words, daily returns on stocks in which hedge funds are marginal investors are more sensitive to fluctuations in aggregate liquidity than returns on otherwise identical stocks held by individuals or other institutional investors. In contrast, the relationship between the liquidity risk of stocks and bank ownership is negative and significant, suggesting that stocks held by banks as marginal investors are less exposed to liquidity shocks than identical stocks held by individuals or other institutions. Finally, stocks owned by hedge funds as marginal investors experience significant negative abnormal returns on liquidity crisis days, whereas stocks held by banks as marginal investors experience significant positive abnormal returns.

These findings lend support to the model of Brunnermeier and Pedersen (2009) in which ownership by levered hedge funds magnifies liquidity risk. In particular, the model's prediction that forced selling by hedge funds exacerbates price declines during liquidity crises is borne out by the finding that stocks held by hedge funds experience negative abnormal returns on days with large adverse shocks to market liquidity. There is supporting evidence for the hypothesis that correlated trading and herding among mutual fund managers increases the liquidity risk of stocks in the early period of 1990-1999, but not in the recent period of 2000-2009. Liquidity betas in quarter *q* are not significantly related to mutual fund ownership in quarter *q-1* during the recent period. Nor are abnormal stock returns during liquidity crises significantly related to mutual fund holdings. Finally, both the tests on liquidity betas and abnormal stock returns on crisis days provide evidence to support the hypothesis of Gatev and Strahan (2006) that commercial banks' ownership of stocks is negatively related to liquidity risk.

Our paper contributes to several strands of literature. First, a growing literature investigates the relationship between institutional ownership and risk exposure. Dennis and Strickland (2002) show that stocks with higher institutional ownership experience more extreme returns during periods of market volatility. Coval and Stafford (2004) find that mutual fund transactions can create price pressure in equity markets. Koch, Ruenzi, and Starks (2010) document a positive relationship between liquidity co-movements across stocks and mutual fund ownership. We contribute to this literature by examining the relationship between liquidity risk and ownership by different types of institutional investors, such as mutual funds, hedge funds, or banks. We document a strong positive relation between liquidity risk and hedge fund ownership, and highlight the importance of hedge fund ownership for abnormal stock returns during liquidity crises.

Additionally, our findings provide supporting evidence from stock returns for the model of Brunnermeier and Pedersen (2009). Several recent papers also provide indirect tests of Brunnermeier and Pedersen's (2009) model. Boyson, Stahel, and Stulz (2010), Sadka (2010), and Teo (2010) find evidence supporting the model in hedge fund returns. Aragon and Strahan (2009) find that stocks held by hedge funds that used Lehman Brothers as their prime broker experienced abnormally large declines in liquidity and prices after Lehman's 2008 Bankruptcy. However, to our knowledge, our study is the first to test model of Brunnermeier and Pedersen (2009) in the cross-section of stocks using comprehensive data on hedge fund stock holdings. Finally, we contribute to research on systematic liquidity risk. Although studies have recognized the importance of systematic liquidity risk for asset prices (e.g., Amihud (2002), Pastor and Stambaugh (2003), Acharya and Pedersen (2005)), the sources of liquidity risk are not well understood. Our paper contributes to this literature by linking liquidity risk with institutional ownership and, in particular, hedge fund ownership.

The paper is organized as follows. Section 1 develops testable hypotheses about the impact of institutional ownership, especially hedge fund ownership, on the liquidity risk of stocks. Section 2 describes data collection procedure for hedge fund holdings and other data used in the paper. The empirical methods and summary statistics are presented in Section 3, Section 4 presents the empirical results, and Section 5 robustness tests. Section 6 provides concluding remarks.

1. Testable Hypotheses

This paper tests several hypotheses about the effects of institutional ownership on the liquidity risk of stocks. The first hypothesis (H1) states that institutional ownership affects the

liquidity risk of stocks in the cross-section. We test the hypothesis by examining whether institutional ownership in quarter *q-1* explains liquidity risk in quarter *q* in the cross-section. H1 is supported if ownership by any type of institution has explanatory power for liquidity risk after controlling for stock characteristics that could be associated with institutional preferences. The null hypothesis that institutional ownership has no effect on liquidity risk is retained if stocks that are largely owned by institutional investors have the same level of liquidity risk as stocks largely held by individual investors.

The literature on institutional investors has identified several trading patterns that could affect liquidity risk, each associated with a different type of institutional investors. Many hedge funds utilize leverage, which allows hedge funds to invest amounts larger than their capital base. Leverage is mainly provided by prime brokers of hedge funds through short-term funding (see, e.g., Lo, 1998; Ang, Gorovyy, and Inwegen, 2011). The use of leverage exposes hedge funds to the risk of a sudden withdrawal of funding by brokers, which can force hedge funds to close out their positions rapidly, even at unfavorable prices during market downturns and liquidity crisis. The model of Brunnermeier and Pedersen (2009) predicts that adverse shocks to market liquidity force hedge funds to sell and contribute to the poor performance of stocks in which hedge funds are marginal investors. Hence, we test the second hypothesis (H2) that greater hedge fund ownership leads to a higher liquidity risk of stocks in the cross-section. The hypothesis is supported if stocks held by hedge funds as marginal investors have a larger liquidity risk than stocks held by individuals after controlling for stock characteristics.

Mutual fund ownership could also increase liquidity risk if mutual funds tend to herd out of stocks at the same time, especially during liquidity crises. Our third hypothesis (H3) states that greater mutual fund ownership leads to a higher liquidity risk of stocks. The hypothesis is

supported if stocks held by mutual funds as marginal investors are subject to greater liquidity risk than stocks held by individuals given the stocks' characteristics.

In contrast to other institutional investors, commercial banks have funding flows that co-vary negatively with market liquidity. In addition, holdings reports consolidate banks' trading portfolios with shares held in trusts that are not subject to cash withdrawals. For both reasons, stocks held by commercial banks are less likely to be subject to liquidity-motivated sales during crises. The fourth hypothesis (H4) therefore states that greater ownership by commercial banks leads to a lower liquidity risk of stocks.

In addition to measuring the effects of institutional ownership against the benchmark of individual ownership, we compare the marginal effects of different types of institutional investors on liquidity risk. Specifically, the fifth hypothesis (H5) is that the effect of ownership by hedge funds on liquidity risk is larger than the effect of ownership by other types of institutional investors, such as mutual funds or independent advisers.

As a further test of the above hypotheses, we examine the relationship between institutional ownership and excess stock returns during liquidity crises. The finding that abnormal stock returns on crisis days are related to institutional ownership would provide additional support for hypothesis H1. Hypothesis H2 (H3) implies that stocks held by hedge funds (mutual funds) as marginal investors have negative abnormal returns on crisis days. According to hypothesis H4, abnormal returns during liquidity crises should be positively related to bank ownership. Hypothesis H5 implies that stocks held by hedge funds should experience greater losses on days with liquidity crises than stocks held by other institutional investors.

Institutional Ownership Data

1.1. Hedge Fund Holdings

We use a unique, hand-collected data set of hedge fund ownership from 1989 to 2009. Our data collection process starts with institutional holdings from 13F reports available through Thomson Financial, which identifies five groups of institutional investors (i.e., "banks", "insurance companies", "investment management companies", "investment advisers" and "others"). Unfortunately, the classification by Thomson Financial does not separate hedge funds from "investment advisers" and "others". We go through a labor intensive process to distinguish ownership by hedge funds from investment advisers and other types of institutional investors.

Hedge funds are private investment vehicles that are exempt from registration with the SEC as an investment company. However, like other institutional investors, hedge fund management companies must report their holdings with the SEC as long as they have more than $100 million of assets under discretionary management. All common stock positions greater than 10,000 shares or $200,000 in market value are subject to reporting. Holdings are reported quarterly, as of the end of each calendar quarter. Although the filings do not contain information on short positions in stocks, they provide the best available proxy for institutional stock holdings.

To identify hedge fund management companies among other institutional money managers, we extend the pioneering approach of Brunnermeier and Nagel (2004) and Griffin and Xu (2009). We obtain lists of hedge fund managers from multiple hedge fund databases, including TASS, HFR, CISDM, Morningstar, Barclay Hedge, and Bloomberg, and match hedge fund managers up with companies reporting their holdings on Form 13F. We look up the unmatched advisers and money managers, who report holdings in 13F but are not in our hedge

fund databases, to find out whether they are hedge fund managers. Overall, 1582 hedge fund management firms can be matched with institutional holdings from Thomson Financial during the sample period of 1989 to 2009.

After matching, we cross-check all companies that are registered as investment advisers to make sure that their primary business is managing hedge funds. All companies that manage portfolios of $25 million or more for non-hedge fund clients such as mutual funds, pension funds, and individual investors, must be registered with the SEC as investment advisers. More than a half of the sample companies are registered investment advisers. We manually cross-check the registration documents (form ADV) for all registered companies, and classify them as hedge fund managers if they meet both of the following conditions: more than 50% of their clients are hedge funds or high net worth individuals, and they charge performance-based fees. Many large management firms, such as Blackrock Advisers, LLC or First Quadrant, LP, are reclassified as independent investment advisers because they fail to satisfy these criteria. Based on these criteria, we also classify as investment advisers major U.S. and foreign investment banks and their asset management subsidiaries. These companies (e.g., Goldman Sachs) do not belong to the sample of hedge fund management companies because hedge fund assets constitute only a small part of their reported holdings.

The final hedge-fund management company sample consists of 1,225 management firms whose holdings represent hedge fund ownership. The number of corresponding hedge funds is more than 3,400 because hedge fund management firms frequently manage multiple funds. This sample is several times larger than those used in prior studies. The comprehensive sample allows us to examine the importance of hedge fund ownership for systematic liquidity risk.

1.2. Holdings of Other Types of Institutional Investors

Altogether, we distinguish among six types of institutional investors: (1) banks, (2) insurance companies, (3) investment companies (or mutual funds), (4) investment advisers, (5) hedge funds, and (6) others. The classifications are based on the type codes available on Spectrum before 1998, extended to cover later years, and refined to distinguish among hedge funds, mutual funds, investment advisers and other types of institutions. The "typecode" variable from Spectrum has classification errors in recent years, and most institutions are improperly classified in the "others" group in 1998 and beyond. Thus, we do not use classification code from Spectrum beyond 1998.

The six institutional types are defined by their legal structure. Banks are regulated and supervised by federal and state regulatory agencies, including the Federal Deposit Insurance Corporation and the Federal Reserve Board. Insurance companies are governed by state insurance regulations. Investment companies include mutual funds, closed-end funds, and unit trusts registered under the Investment Company Act of 1940. Since investment companies are dominated by mutual funds in terms of assets under management[3], we use the term "investment companies" and "mutual funds" interchangeably. The fourth category, investment advisers, includes institutions registered under the Investment Advisers act of 1940 that are not registered as an investment company and are not classified as hedge fund managers. Small independent advisers, broker-dealers, and major investment banks that were not registered as bank holding companies before 2008 are classified as investment advisers. Finally, the category "others"

[3] According to the 2010 Investment Company Factbook, U.S.-registered investment companies managed $12.2 trillion at year-end 2009. Among various types of investment companies, mutual funds managed $11.1 trillion; closed-end funds, ETFS, and Unit Investment Trusts managed $1.1 trillion.

includes university and private endowments, philanthropic foundations, and corporate pension funds.

1.3. Summary of Institutional Ownership

Institutional stock holdings data are obtained for each quarter from December 1989 through September 2009 for common stocks listed on NYSE, AMEX, or NASDAQ. Institutional ownership is measured as the fraction of shares held by each type of institutions. The ownership fractions are calculated by summing up the shares held by each type of institutions and dividing by the total number of shares outstanding on the report date.

Table 1 summarizes institutional ownership of common stocks and shows that total number of institutions holding sample stocks is 5271. As Panel A reports, most of the institutions are investment advisers (2357) or hedge funds (1225), and the number of hedge funds increases rapidly towards the end of the sample period. Panel B shows that the average fraction of shares held by institutions is 55.7%, with mutual funds (28.5%) and banks (9.9%) being the most important institutional investors. Hedge funds hold on average 4.8% of the outstanding shares, but their ownership fraction increases from 1.2% to 8.7% between 1989 and 2009.

The increasing importance of institutional investors is also apparent in Figures 1 and 2, which depict, respectively, the number of institutions holding shares and the average fraction of shares held by institutions quarter by quarter. The overall increase in the fraction of shares held by institutions has been well documented in the literature (e.g. Gompers and Metrick (2001), Bennett, Sias, and Starks (2002), and Sias, Starks, and Titman (2006)). This paper documents the rapid growth of hedge fund ownership between 1989 and 2009 using the hand-collected comprehensive sample of hedge fund ownership. As Figure 2 shows, hedge fund holdings have

increased dramatically in the last 20 years. In aggregate, hedge funds hold 10.5% of the sample firm's stocks in the first quarter of 2008, before their ownership decreases to 7.6% in the last quarter of 2008 as a result of the financial crisis. Bank holdings and mutual fund holdings are relatively stable over time, especially during the past ten years.

2. Empirical Methods

The empirical analysis utilizes quarterly holdings data and daily stock returns to assess the effects of institutional ownership on the liquidity risk of stocks. The analysis is carried out in several steps. First, we construct daily liquidity measures such as the effective bid-ask spread, the quoted bid-ask spread, and the Amihud (2002) measure for each stock using both intraday and daily data. The daily changes in firm-level liquidity are then aggregated across common stocks traded on NYSE, AMEX, or NASDAQ to obtain the innovations in the aggregate equity-market liquidity (Details about the computation of liquidity measures are provided in Appendix A). Figure 3 plots the innovations in the market-wide effective bid-ask spread, which is the main measure of market liquidity used throughout the paper.

Next, we measure liquidity risk by the liquidity beta, i.e. the sensitivity of daily stock returns to innovations in equity market liquidity. Liquidity betas are estimated for both portfolios and individual stocks, and tests for the effects of institutional trading on liquidity risk are conducted at the portfolio level as well as the individual stock level. The tests at the portfolio level examine the liquidity risk of portfolios sorted by institutional ownership. At the firm level, we estimate cross-sectional regressions of liquidity betas on institutional ownership and firm characteristics, and assess the relative effects of different types of institutional investors on

liquidity risk. Finally, we directly examine the relationship between institutional ownership and excess stock returns during days with extreme negative liquidity shocks.

2.1. Measurement of Liquidity Risk

Following Pastor and Stambaugh (2003) and Acharya and Pedersen (2005), we measure the liquidity risk of a stock (portfolio) as the sensitivity of its returns to innovations in aggregate market liquidity. Also known as the liquidity beta, this measure of systematic risk captures the notion that some stocks are more sensitive to market liquidity shocks than other stocks. In each quarter, the liquidity beta is estimated from a regression of daily stock returns on market returns and innovations in market liquidity:

$$R_{i,t} = \beta_i^0 + \beta_i^M R_{M,t} + \beta_i^L \Delta L_t + \varepsilon_{i,t}, \quad (1)$$

where $R_{i,t}$ denotes the return on the i-th stock (portfolio) on day t, $R_{M,t}$ is the return on the CRSP value-weighted portfolio on day t, ΔL_t is the innovation in market liquidity on day t, β_i^M is the market beta for stock i, and β_i^L is the liquidity beta for stock i.

2.2. Tests of the Effects of Institutional Ownership on Liquidity Risk

The analysis at the portfolio level is conducted as follows. First, stocks are sorted into deciles according to their total institutional ownership as well as the ownership fractions of banks, insurance companies, mutual funds, investment advisers, hedge funds, and others at the end of each quarter. Then, we compute daily equal-weighted returns on the ten ownership-sorted portfolios during the next calendar quarter. This procedure is repeated each quarter to create a time series of portfolio returns that is used to estimate liquidity betas as in equation (1). Finally, we regress portfolio liquidity betas on the average fraction of shares held by institutions in each portfolio to examine whether liquidity risk is associated with institutional ownership. In addition

to the univariate analysis of liquidity betas, we examine the liquidity betas of 25 portfolios independently sorted by institutional ownership and a control characteristic such as the average bid-ask spread or market capitalization.

There are two reasons why institutional ownership could be associated with liquidity betas: (1) institutional ownership affects the liquidity risk of stock returns, and (2) some institutions exhibit preferences for stock characteristics that are correlated with liquidity risk. For example, mutual funds prefer liquid stocks of large firms (Falkenstein (1996)), and hedge funds prefer smaller stocks, value stocks and stocks that have higher volatility (Griffin and Xu(2009)).

We conduct a firm-level analysis and control for stock characteristics that are associated *ex ante* with liquidity risk. Specifically, we estimate cross-sectional regressions of firm-level liquidity betas on past quarter institutional ownership, while controlling for a wide range of lagged stock characteristics and the lagged liquidity betas:

$$\beta_{i,q}^{L} = \gamma_0 + \gamma_1' OWNERSHIP_{i,q-1} + \gamma_2' CONTROLS_{i,q-1} + \beta_{i,q-1}^{L} + \varepsilon_{i,q,} \qquad (2)$$

where $\beta_{i,q}^{L}$ is the liquidity beta for the i-th stock in quarter q, $OWNERSHIP_{i,q-1}$ is a vector of the fractions of shares held by banks, insurance companies, mutual funds, investment advisers, hedge funds, and others at the end of the quarter *q-1* for stock i. The vector of control variables includes firm-specific measures of average liquidity, market risk, momentum, volatility, leverage, size, book-to-market ratio, and a measure of information asymmetry, all lagged one quarter. The specification also includes the lagged liquidity beta ($\beta_{i,q-1}^{L}$) to control for the fact that institutional investors may differ in their willingness to assume liquidity risk.

The inference is conducted using the Fama and MacBeth (1973) methodology. This method is designed for cross-sectional analysis and its standard errors are robust to fixed time

effects. All variables are standardized to have zero means and unit variances in each quarter. The cross-sectional slope coefficient estimates for each quarter are averaged over time to arrive at the final estimate. The corresponding standard errors are computed from the time series of coefficient estimates, and the reported t-statistics are based on Newey-West (1987) heteroskedasticity and autocorrelation consistent standard errors.

2.3. An Event Study of Liquidity Crises

Dennis and Strickland (2002) propose to analyze rare market events such as days with exceptional stock market volatility in an event study framework. We apply this approach to large and negative liquidity shocks, and examine the relationship between institutional ownership and abnormal stock returns on crisis days. Specifically, a negative liquidity event is defined as the 1% (or 3%) of days with the largest negative shocks to market liquidity. On each of the 50 (or 150) event days, we estimate the following cross-sectional regression:

$$AR_{i,t} = \gamma_0 + \gamma_1{}'OWNERSHIP_{i,q-1} + \gamma_2{}'CONTROLS_{i,q-1} + \beta^L_{i,q-1} + \varepsilon_{i,t,} \quad (3)$$

where $AR_{i,t}$ denotes the abnormal return on the i-th stock on event day *t*, and $\beta^L_{i,q-1}$ is the lagged liquidity risk of the i-th stock in the quarter preceding the event day *t*. The definitions of the ownership variables (OWNERSHIP) and control variables (CONTROLS) are the same as those in equation (2). Abnormal stock returns are measured as the difference between a stock's return and the contemporaneous market portfolio return and the inferences use the Fama-MacBeth methodology.

2.4. Sample Characteristics and Control Variables

We use a sample comprised of common stocks listed on NYSE, AMEX, or NASDAQ over the period January 1990 through December 2009. The data are from the intersection of

CRSP, COMPUSTAT, ISSM and TAQ databases. Several filters are imposed to obtain the final sample. First, only stocks with more than 50 trading days in both the current and previous quarters are included. This requirement ensures that a reliable estimate of liquidity beta and control variables can be obtained in two consecutive quarters. Second, stocks with share price less than $3 at the end of the previous month are excluded. Third, companies incorporated outside the U.S, closed-end funds, real estate investment trusts, and financial firms are excluded. The final sample consists of 197,390 firm/quarter observations over 80 quarters, and the average number of stocks per quarter is 2467.

All control variables are measured over the quarter prior to estimating liquidity betas. Specifically, stock liquidity is the time-series average of the proportional effective bid-ask spread; market risk is the beta coefficient from the market model using daily returns over the previous three months, where the CRSP value-weighted index of all NYSE, AMEX, and NASDAQ stocks is used as a proxy for the market portfolio; volatility is the standard deviation of daily returns over the preceding three months; and momentum is the average stock return over the same period[4]; leverage is the sum of current liabilities and long-term debt over total book assets; book-to-market ratio is the book value of total shareholders' equity divided by the market value of equity; and firm size is the market capitalization of equity in millions of dollars; NASDAQ dummy is an indicator variable for whether a stock is listed on NASDAQ.

In addition to firm characteristics, we also control for the concentration of institutional ownership, which is measured by the Hefindahl index (i.e. the sum of the squared ownership fractions of all institutional investors). Ownership concentration can be an important

[4] Jegadeesh and Titman (1993) document that strategies which buy stocks that performed well in the past generate positive abnormal returns. Grinblatt, Titman, and Wermers (1995) show that mutual funds are momentum investors who tend to purchase stocks based on their past returns.

determinant of liquidity risk if large block owners exhibit different trading behavior than small investors. The last control variable is a measure of asymmetric information, which is the probability of informed trading (PIN) from the model developed by Easley, Kiefer, O'Hara, and Paperman (1996). The PIN measure is estimated for each sample stock in each quarter. The inputs into the model, including the number of buys and sells on each day for each stock, are inferred from intraday transactions data of ISSM and TAQ. Further details about the estimation of the PIN measure are provided in Appendix B.

Table 2 reports summary statistics for the dependent and independent variables. All variables except institutional ownership and firm size are winsorized at the 2.5% and 97.5% tails to remove influential outliers. The dependent variables are three alternative measures of liquidity risk: the liquidity beta that relies on (1) the effective bid-ask spread as a liquidity measure, (2) the quoted bid-ask spread as a liquidity measure, and (3) the Amihud illiquidity measure. All three measures of liquidity risk have a positive mean, which is significantly different from zero.

The summary statistics for the control variables reflect that the sample is made up of stocks that are relatively liquid. The average effective bid-ask spread is 0.74%, and the average quoted bid-ask spread is 1.16%. The standard deviation of daily returns is 3.89%, and the average daily return 0.09%. The average (median) market capitalization of sample firms is $3.8 billion ($600 million). The leverage ratio is on average 0.21, the book-to-market ratio is 0.51, and the average probability of informed trading is 0.2.

3. Empirical Results

3.1. Portfolio-level Analysis

Table 3 presents the percentage of stocks held by institutional investors for each decile portfolio, where portfolio 1 (10) has the lowest (highest) total institutional ownership. The reported numbers are the time-series averages of the fractions of shares held by institutions. The average number of stocks in each portfolio is 247. Total institutional holdings are 9.4% for portfolio 1, and 92.4% for portfolio 10 during the 1989-2009 time period. When stocks are sorted by ownership of mutual funds in each quarter, the fraction of shares held by mutual funds is 3.4% for portfolio 1, and 69.9% for portfolio 10. Hedge fund ownership is close to zero for decile portfolio 1, 2.1% for portfolio 5, and 32.4% for portfolio 10 if sample stocks are sorted by hedge fund ownership. These results suggest a large variation in total institutional ownership and in each type of institutional ownership across the decile portfolios.

Table 4 reports estimates of liquidity betas with respect to the market-wide liquidity measured by the effective bid-ask spread (see equation (1)), and the associated t-statistics for each decile portfolio. Overall, the relationship between liquidity risk in quarter q and total institutional ownership in quarter q-1 exhibits a monotonically decreasing pattern: the smaller the institutional ownership of a decile portfolio, the larger the liquidity risk (portfolio 10 is the only exception). The estimated liquidity beta is 0.15 for portfolio 1, but only 0.03 for portfolio 9 and 0.05 for portfolio 10.

When portfolios are formed based on the ownership of each type of institution, the results reported in Table 4 reveal a richer pattern. Liquidity risk is negatively related to bank ownership and to a lesser degree also to ownership by insurance companies and institutions classified as "others". In sharp contrast, liquidity risk of stocks is positively related to hedge fund ownership:

the larger the hedge fund ownership, the larger the liquidity risk. Mutual fund ownership, on the other hand, is not significantly related to liquidity risk.

We estimate the slope of the regression line of portfolio liquidity betas against the percentage of shares held by institutional investors in each portfolio. The slope for total institutional ownership is negative and significant with a t-statistic of -4.5, confirming a negative relation between liquidity risk and total institutional holdings. Among the six types of institutional investors, the most significant slope coefficient is for hedge fund ownership, followed by bank ownership. The slope coefficient of hedge fund ownership is positive and significant at 1% level (with a t-statistic of 4.7), while the coefficient of bank ownership is negative and significant at 5% level (with a t-statistic of -2.4). Portfolios sorted by ownership of other types of institutional investors do not reveal a significant relationship between ownership and liquidity risk.

Finally, we examine the liquidity betas, in quarter *q*, of 25 portfolios independently sorted into quintiles based on institutional ownership and liquidity (the average proportional effective bid-ask spread) in quarter *q-1*. Panel A of Table 5 and Panel A of Figure 4 show the liquidity betas for 25 portfolios double-sorted by hedge fund ownership and liquidity. Stocks that are illiquid (i.e. stocks with wide bid-ask spreads), on average, tend to have higher liquidity risk than liquid stocks in the subsequent quarter. However, liquidity risk is positively associated with hedge fund ownership even after controlling for the bid-ask spread. Regardless of their liquidity, stocks with higher hedge fund ownership have greater liquidity risk in the subsequent quarter than stocks with lower hedge fund ownership. Panel B of Table 5 and Panel B of Figure 4 report the liquidity betas if stocks are double-sorted by bank ownership and liquidity. The figure clearly reveals the negative relationship between bank ownership and liquidity risk. Stocks with

high bank ownership have less liquidity risk than stocks with low bank ownership, regardless of how liquid they are on average.

In Panel C of Table 5, portfolio liquidity betas are regressed against the institutional ownership of each portfolio and its average effective bid-ask spread. The coefficient on hedge fund ownership is positive and significant at the 1% level (with a t-statistic of 9.77), while the coefficient on bank ownership is negative and significant at the 1% level (with a t-statistic of -4.04). Thus, liquidity risk remains strongly related to hedge fund and bank ownership even after accounting for the differences in liquidity of stocks held by hedge funds and banks. These results remain unchanged if the control portfolios are formed based on the proportional quoted bid-ask spread, Amihud illiquidity, or market capitalization.

3.2. Firm-level Analysis

This sub-section provides additional insights into the effects of institutional ownership on liquidity risk. Specifically, we examine the relationship between liquidity risk and institutional ownership at the firm-level, controlling for past liquidity risk and institutional investors' preferences for stock characteristics that are correlated with liquidity risk. We also investigate the marginal effect of one institutional type on liquidity risk by holding constant the ownership fractions of the other institutional types.

Table 6 reports the time-series averages of the quarterly slope coefficients from Fama-MacBeth cross-sectional regressions of liquidity betas on institutional ownership, various stock characteristics and other control variables. Based on specifications (1) and (2), we note that the main results about the relationship between liquidity risk and institutional ownership do not change when control variables are included in the analysis. Because institutional ownership and control variables are standardized in each quarter, we can interpret the estimated coefficients as

marginal effects on liquidity risk when the corresponding explanatory variable changes by one standard deviation.

According to the second specification in Table 6, the fraction of shares held by hedge funds in quarter *q-1* is positively associated with liquidity risk in quarter *q* in the cross-section, with a coefficient of 0.191, and significant at the 1% level (the Newey-West t-statistic is 5.28). In contrast, fractional ownership by banks is negatively associated with liquidity risk. The coefficient on bank ownership is -0.139 with a t-statistic of -7.67, significant at the 1% level. Additionally, the ownership fractions of investment advisers and institutions classified as "others" are related to liquidity risk at the 5% level. Investment advisers enter the regression with a positive sign, and "others" with a negative sign. However, both marginal effects are small compared with the effects of hedge fund or bank ownership. The effect of mutual fund ownership on liquidity risk is not significant.

Among the control variables, the average bid-ask spread is positively related to liquidity risk, indicating that illiquid stocks on average tend to have a higher degree of liquidity risk. Return momentum, as measured by average stock returns over the preceding quarter, is also positively associated with liquidity risk. Further, liquidity betas are smaller for stocks with higher book-to-market ratios, larger market capitalization, and larger market betas. The effect of informational asymmetry on liquidity risk is positive and significant at the 5% level. Nevertheless, none of the control variables subsumes the effect of institutional ownership on liquidity risk. Institutional ownership alone accounts for 2.4% of the cross-sectional variation in liquidity betas, whereas the average R^2 is 5.5% after controlling for stock characteristics and the lagged liquidity beta.

In summary, the results presented in Table 6 support the hypothesis (H1) that institutional ownership affects liquidity risk in stocks' cross-section. Liquidity risk in quarter *q* is positively related to hedge fund ownership and negatively related to bank ownership in quarter *q-1*. These results are robust even after controlling for stock characteristics and after taking into account ownership concentration, informational asymmetry, and liquidity risk in quarter *q-1*. The evidence at both the portfolio and the individual stock level supports the hypothesis (H2) that hedge fund ownership has an increasing effect on the liquidity risk of stocks. In contrast, there is little support for the hypothesis (H3) that greater mutual fund ownership leads to a higher liquidity risk because of mutual fund herding and correlated trading. Liquidity betas are not significantly related to mutual fund ownership in the cross-section. The hypothesis (H4) that greater ownership by banks leads to a lower liquidity risk of stocks is also supported by test results at the portfolio and at the firm level.

Finally, we test hypothesis H5 by examining whether the marginal effect of hedge fund ownership is greater than the marginal effects of other types of institutional investors, and report the results in Panel B of Table 6. Based on the estimates of quarterly coefficients, the null hypothesis that the marginal effects are equal is rejected at any conventional level of significance. For instance, the F-statistic for testing the difference between the coefficients on hedge fund and mutual fund ownership (0.191 versus 0.018) is 20.9, significant at the 1% level. The difference between the coefficients on hedge funds and investment advisers, 0.191 versus 0.043, is also significant using the F-test. In pairwise comparisons, the null hypothesis that the marginal effect of hedge fund ownership equals the marginal effect of mutual fund (or, banks, etc.) ownership is strongly rejected against the alternative hypothesis that the marginal effect of hedge funds is greater than that of mutual funds (or, banks, etc.). Thus, the evidence supports the

hypothesis (H5) that hedge fund ownership has a larger effect on liquidity risk than ownership by other types of institutions.

3.3. An Event Study of Liquidity Crises

Next, we turn to an examination of abnormal stock performance during liquidity crises. The negative event days are defined as the 1% of the sample days (50 days in total) with the largest negative changes in market liquidity. Figure 3 plots the time series of innovations in the aggregate proportional effective bid-ask spread from January 1990 through December 2009. The major spikes correspond to recognizable liquidity events, such as the panic on October 27, 1997, which was caused by the Asian financial crisis, the events surrounding the Russian financial crisis in August 1998, the aftermath of September 11 attacks in 2001, and the turmoil in the financial markets on September 29, 2008, when U.S. lawmakers rejected the bailout plan for the financial industry.

Using the Fama-MacBeth method, the cross-section model of equation (3) is estimated for each event day and the estimated coefficients are averaged across the 50 event days. The variables in this regression are not standardized to facilitate the interpretation of the coefficient estimates, and returns are expressed in percent. The average abnormal return on event days is -0.17%.

Table 7 provides the regression results relating negative event-day abnormal returns to institutional ownership. The estimates in Table 7 show that abnormal stock returns during liquidity crises are strongly related to institutional ownership of the previous quarter, even after controlling for stock characteristics and the lagged liquidity beta. Stocks held by hedge funds as marginal investors experience significantly negative abnormal returns on days with extremely large declines in market liquidity. The coefficient for hedge fund ownership is -2.041 (t-statistic

-2.92), while the coefficient for bank ownership is 1.471 (t-statistic 2.79). Both coefficients are significant at the 1% level (see specification (2) in Table 7).

To put these numbers in perspective, the estimates indicate that a one standard deviation increase in hedge fund ownership in a quarter preceding crisis days is associated with an average abnormal return of -0.14% (-2.04% x 0.07) on crisis days. In contrast, a one standard deviation increase in bank ownership leads to a positive abnormal return of 0.10% (1.47% x 0.07) on crisis days. The effect of mutual fund ownership on abnormal stock performance during liquidity crises is insignificant. The coefficients on stock holdings of other institutions such as insurance companies or investment advisers are also insignificant.

Abnormal performance during liquidity crises also depends on past stock return volatility, momentum, book-to-market ratio, information asymmetry, and past liquidity risk. Highly volatile stocks, stocks with positive return momentum, and stocks with low book-to-market ratios in the quarter preceding a liquidity-shock day experience negative abnormal returns on crisis days. Crisis-day returns are also more negative for stocks with greater informational asymmetry as measured by the probability of informed trading (PIN), and for stocks with greater liquidity risk in the past quarter.

Panel B of Table 7 provides an F-test for the null hypothesis that hedge fund ownership has the same effect on abnormal stock performance during liquidity crises as ownership by other types of institutional investors. Based on the estimates in the second specification in Panel A of Table 7, the null hypothesis that the effects are equal is rejected at the 5% level for banks, insurance companies, mutual funds, and institutions classified as “others”. The null hypothesis is rejected at the 10% level for ownership by independent investment advisers.

Collectively, these results provide support for the hypothesis (H2) that greater hedge fund ownership increases the liquidity risk of stocks and for the hypothesis (H4) that greater bank ownership decreases the liquidity risk of stocks. These findings do not change if negative event days are defined as the 3% of sample days (150 days in total) with the largest negative changes in market liquidity.

4. Robustness Analysis

4.1. Alternative Liquidity Betas

The liquidity beta from equation (1) measures only exposure to the liquidity shocks that are distinct from stock market movements. An alternative approach to estimating liquidity betas is to regress stock returns on market liquidity innovations (see, Achayra and Pedersen, 2005, Eq. (15)). The resulting measure of liquidity risk (henceforth the univariate liquidity beta) can be interpreted as the covariance between stock returns and market liquidity innovations. The univariate liquidity beta for stock *i* is estimated using the following equation:

$$R_{i,t} = \beta_i^0 + \beta_i^{LU} \Delta L_t + \varepsilon_{i,t}, \tag{4}$$

where $R_{i,t}$ denotes the return on the i-th stock (portfolio) on day *t*, ΔL_t denotes the innovation in market liquidity, and β_i^{LU} is the univariate liquidity beta. We estimate equation (4) and obtain a univariate liquidity beta for each stock in each quarter. The multivariate and univariate liquidity betas are strongly correlated in the cross-section: the time-series average of correlations between them is 0.8 during the sample period.

Portfolio-level results using the univariate liquidity betas are reported in Table 8. The relationship between the univariate liquidity beta and total institutional ownership remains

negative. The negative relation between liquidity risk and bank holdings, and the positive relation between liquidity risk and hedge fund holdings, are even more pronounced than if the multivariate liquidity beta is used to measure liquidity risk (compare Table 8 with Table 4). These results further demonstrate that it is important to distinguish the effect of hedge funds on liquidity risk from the effects of banks and other institutional investors.

Table 9 reports the results of firm-level analysis when the univariate liquidity beta is used to measure liquidity risk. It shows that liquidity risk is significantly related to hedge fund ownership, and the coefficient on hedge fund ownership is significant at the 1% level (t-statistic 8.42). Bank ownership continues to have a significant negative effect on liquidity risk. One difference between Table 9 and Table 6 is that the univariate liquidity betas are positively related to mutual fund ownership. However, the marginal effect of hedge fund ownership (coefficient of 0.277) is about four times larger than that of mutual fund ownership (coefficient of 0.070). The difference between the coefficients for hedge fund and mutual fund ownership is significant at the 1% level using an F-test. Another difference between Table 9 and Table 6 is that the average R^2 is higher when using the univariate liquidity beta. The average R^2 is 5.2% when ownership variables are used to explain the cross-sectional variation in liquidity risk, while the average R^2 increases to 15.1% if all control variables are included in the analysis.

4.2. Alternative Measures of Market Liquidity

The analysis of the relationship between liquidity risk and institutional holdings so far has relied on the effective bid-ask spread as a measure of aggregate market liquidity. However, there are other liquidity measures that have been proposed to capture the different dimensions of liquidity. To address the concern that the empirical results may be sensitive to the choice of a liquidity measure, we use the quoted bid-ask spread and the Amihud illiquidity measure as

alternative liquidity measures to estimate liquidity betas, and then re-examine the cross-sectional relation between liquidity betas and institutional ownership using equation (2).

Table 10 reports results of firm-level analysis when liquidity is measured by the proportional quoted spread, instead of the proportional effective spread. The results are consistent with those reported in Table 6. For example, in the second specification of Table 10, the coefficient of hedge fund ownership is positive and significant at the 1% level (t-statistic is 3.04), while the coefficient of bank ownership is negative and significant (t-statistic is -4.90). The test results for pair-wise comparisons reveal that hedge fund ownership has a greater positive effect on liquidity risk than ownership by any other type of institutional investors, including mutual funds and independent investment advisers.

The empirical results relying on the Amihud liquidity measure are presented in Table 11. The signs of the coefficients on institutional ownership are the same as those reported in Table 6. According to the second specification of Table 11, hedge fund ownership continues to have the greatest positive effect on liquidity betas with a coefficient of 0.184 (t-statistic 4.61), and bank ownership the greatest negative impact with a coefficient of -0.078 (t-statistic -3.07). One difference between Table 11 and Table 6 is that the effect of mutual fund ownership is significant at the 5% level when liquidity betas are estimated with respect to the Amihud illiquidity measure. In pairwise tests, we find that the marginal effect of hedge fund ownership (0.184) is more than ten times larger than the marginal effect of mutual fund ownership (0.016), and the difference is significant at the 1% level.

4.3. Liquidity Betas Using Dimson's Model

The estimates of liquidity betas are obtained from daily data and could therefore be affected by non-synchronous price movements. Following Dimson (1979), we address this

problem by estimating liquidity betas as the sum of the slope coefficients on current and lagged innovations in market liquidity. Specifically, we obtain the quarterly estimate of the liquidity beta of the i-th stock from the following regression:

$$R_{i,t} = \beta_i^0 + \beta_i^{M1} R_{M,t} + \beta_i^{M2} R_{M,t-1} + \beta_i^{L1} \Delta L_t + \beta_i^{L2} \Delta L_{t-1} + \varepsilon_{i,t}, \quad (5)$$

where $R_{i,t}$ denotes the return on the i-th stock on day *t*, $R_{M,t}$ is the return on the CRSP value-weighted portfolio on day *t*, and ΔL_t is the innovation in market liquidity on day *t*. The liquidity beta for stock *i* is then calculated as the sum of the two liquidity betas: $\beta_i^L = \beta_i^{L1} + \beta_i^{L2}$.

Table 12 provides the results of cross-sectional regressions of the Dimson liquidity betas against institutional ownership and control variables. The liquidity betas are estimated using innovations in the proportional effective bid-ask spread as a measure of market liquidity. The economic and statistical significance of institutional ownership does not change when the Dimson liquidity betas are used as the dependent variable (compare with Table 6). Ownership concentration has a significant positive effect on liquidity risk in Table 12, but the effect of other variables on liquidity risk remains unchanged.

4.4. Subsample Analysis

To check whether the findings are robust over time, we examine the effects of institutional ownership on liquidity risk over two sub-sample periods: 1990-1999 and 2000-2009. It is noted that the first sub-period is characterized by low hedge fund ownership (1 to 2%) and a gradually increasing ownership by mutual funds. During the second sub-period, we witness an explosive growth in hedge fund holdings. Hedge funds exercise discretionary control of 8.7% of publically traded stocks during 2005-2009, while mutual fund and bank ownerships remain unchanged.

Table 13 provides estimation results of firm-level tests for the two sub-periods. The results show that hedge fund and bank ownership are significantly related to liquidity risk during both sub-periods. We note that the effect of hedge fund ownership on liquidity risk almost doubles during 2000:2009 (0.255 versus 0.127) as hedge fund ownership becomes widespread. The test for the difference between the two periods suggests that the marginal effect of hedge funds on liquidity risk is significantly larger in recent years (2000-2009) than in early years (1990-1999). In contrast, the coefficient on mutual funds is significant during 1990-1999 and it becomes insignificant in the recent period of 2000-2009, indicating that the effect of mutual fund holdings on liquidity risk is diminishing over time. Finally, the effect of bank ownership is not significantly different across the two sub-periods.

An additional subsample test is performed to check the robustness of results reported in earlier sections. To ensure that the firm-level liquidity betas can be reliably estimated, we repeat the analysis on a subset of the most liquid stocks. Specifically, we estimate the regression model in equation (2) for the subsample of stocks that trade on every day during the three-month estimation period for liquidity betas. The results are stronger than those based on the entire sample in Table 6. The magnitude of the coefficient estimates and their significance are not affected, but the average R^2 when control variables are included increases from 5.5% to 8.5%, and institutional ownership alone accounts for 4% of the total cross-sectional variation in liquidity betas. These results are not reported to conserve space but are available upon request.

5. Conclusion

Although researchers have recognized the importance of liquidity risk for asset prices, an important and yet unanswered question is why some stocks are more exposed to fluctuations in

market liquidity than others. This paper examines whether institutional ownership affects the liquidity risk of stocks. In particular, we use a unique, hand-collected data set of hedge fund ownership to answer the following questions: (1) What is the effect of institutional ownership on the liquidity risk of stocks in the cross-section?; (2) Does the effect of hedge fund ownership on stocks' liquidity risk differ from the effects of ownership by other types of institutional investors such as mutual funds or banks? (3) What is the relationship between hedge fund (or bank) ownership and abnormal stock performance during liquidity crises? These questions are important for academics, policy makers, and institutional investors as well as individual investors.

The empirical results support the hypothesis that institutional ownership affects the liquidity risk of stocks. Stocks in which hedge funds are marginal investors have returns that are more sensitive to changes in aggregate liquidity than stocks held by individuals. In contrast, stocks in which commercial banks are marginal investors tend to be less exposed to market liquidity fluctuations. These results hold even after controlling for stock characteristics such as size, average liquidity, market risk, momentum, volatility and book-to-market ratio, suggesting that the results cannot be explained by institutional investors' preference for stocks with certain characteristics.

In particular, we find a significant and positive relationship between hedge fund ownership in quarter *q-1* and liquidity risk of stocks in quarter *q*. Hedge fund ownership has a significantly larger effect on liquidity risk than mutual fund ownership or ownership by other types of institutional investors. Furthermore, the effect of hedge fund ownership on liquidity risk is the most pronounced during liquidity crises. On days with large adverse shocks to market liquidity, there is a negative relationship between abnormal stock returns and the fraction of

shares held by hedge funds in the preceding quarter. These findings support the model of Brunnermeier and Pedersen (2009) in which adverse liquidity shocks force levered institutions such as hedge funds to reduce their leverage by selling off assets, leading to declining asset prices and liquidity spirals.

Mutual fund ownership is significantly related to liquidity risk during the first sub-period of 1990-1999, but not so in recent years of 2000-2009. Thus, there is some evidence to support the hypothesis that herding and correlated trading by mutual fund managers lead to an increase in the liquidity risk of stocks. In contrast, stocks held by commercial banks as marginal investors have a significantly lower liquidity risk than comparable stocks held by other types of institutional investors or by individual investors. Also, bank ownership in the quarter preceding liquidity crises is positively associated with abnormal stock returns during liquidity crises. This result provides supporting evidence for the hypothesis of Gatev and Strahan (2006) that banks have a unique ability to hedge against market-wide liquidity shocks.

This study contributes to our understanding of the relationship between liquidity risk and institutional ownership in general, and during liquidity crises in particular. Furthermore, it contributes to the growing body of evidence that hedge fund ownership can increase the risk exposure of the financial system (e.g., Brunnermeier and Nagel (2004), Mitchell, Pedersen, and Pulvino (2007), Aragon and Strahan (2009), Boyson, Stahel, and Stulz (2010)). Future research should examine the importance of hedge fund ownership for liquidity risk in other financial markets such as the debt market.

Appendix A: Measurement of Market Liquidity

Liquidity has multiple dimensions, and alternative measures of liquidity have been proposed in the literature (see, e.g., Goyenko, Holden, and Trzcinka, 2009). In this paper, market liquidity innovations are measured as the cross-sectional average of daily changes in the proportional effective bid-ask spread. In addition, we use the quoted bid-ask spread and the Amihud (2002) measure as alternative liquidity measures. These widely-used measures are designed to capture the different dimensions of liquidity.

The proportional effective spread is defined as two times the absolute value of the difference between the actual transaction price and the midpoint of the bid and ask quote, divided by the quote midpoint:

$$Effective\ Spread_{i,t} = \frac{2\left|P_{i,t} - M_{i,t}\right|}{M_{i,t}}, \tag{6}$$

where $P_{i,t}$ is the trade price for stock i at time t, and $M_{i,t}$ is the corresponding quote midpoint. The effective spread is designed to capture illiquidity as the difference between the fundamental value of a security, as proxied by the quote midpoint, and the market-clearing transaction price.

To compute the spread measures, we use intraday trades and quotes from ISSM (prior to 1993) and TAQ. We obtain trades and quotes for ordinary common stocks listed on NYSE, AMEX, or NASDAQ during the sample period January 1990 to December 2009. We exclude shares priced less than $3 at the end of the previous month, shares of companies incorporated outside the U.S, closed-end funds, and real estate investment trusts. In addition, we apply the following filters to remove errors and outliers from the intraday data: For the trades file, we retain only regular trades, trades with regular condition of sale, trades with a positive price and size, and trades with an absolute price change of less than 10%. For the quotes file, we retain

only regular quotes with a positive bid-ask spread, positive size, and a proportional quoted spread of less than 25%. Trades are matched with quotes that precede each trade by at least 5 seconds, and classified into buys and sells using the method developed by Lee and Ready (1991). Finally, the effective spread is calculated for each transaction, and the daily spread is calculated for each stock as the volume-weighted average across all valid transactions.

The second liquidity measure is the proportional quoted bid-ask spread, which is defined as the difference between the bid and ask prices divided by the quote mid-point. The third liquidity measure is the Amihud (2002) measure of illiquidity. This measure captures the daily price response associated with one million dollars of trading volume. It is computed from daily closing stock prices and volume. Specifically, the Amihud illiquidity ratio is defined as:

$$AMIHUD_{i,t} = \frac{|R_{i,t}|}{\$V_{i,t}}, \tag{7}$$

where $R_{i,t}$ is the returns on stock i for day t, and $\$V_{i,t}$ is the daily volume for stock i measured in millions of dollars.

The daily changes in firm-specific liquidity are aggregated across common stocks traded on NYSE, AMEX, or NASDAQ. Specifically, the daily percentage change in firm-specific liquidity for each liquidity measure L is computed as follows:

$$\Delta L_{i,t} = log \frac{L_{i,t}}{L_{i,t-1}}, \tag{8}$$

where $L_{i,t}$ is a measure of the liquidity level of stock i on day t. The ratio is defined only if both $L_{i,t}$ and $L_{i,t}$ are non-missing. Then, the equal-weighted average is taken over all common stocks that have a price of at least $3 at the end of the previous month, were not delisted from an exchange in a given calendar month, and have more than 100 valid observations of liquidity

changes in a given calendar year. To reduce the effect of outliers, we cap the $\Delta L_{i,t}$ ratio at plus (minus) one. Finally, predictable liquidity reversals are removed with an AR(2) filter, the measures are standardized by the standard deviation over the past 750 days, and multiplied by minus one to represent innovations in liquidity rather than illiquidity. Four days with predictable bid-ask spread changes due to reductions in minimum tick sizes, including 06/02/1997, 06/24/1997, 01/29/2001, and 04/09/2001, are excluded from the analysis.

The effective spread is significantly correlated with the quoted spread and the Amihud measure. The correlation is 0.53 with the effective spread, and 0.16 with the quoted spread over the sample period. All liquidity measures are positively correlated with returns on the CRSP value-weighted portfolio.

Appendix B: The Estimation of the Probability of Informed Trading (PIN)

This appendix provides information about the estimation of the probability of informed trading (PIN). The PIN model, developed by Easley et al. (1996), uses trade data to estimate how likely it is the market maker believes that there is informed trading in a security. The probability depends on the arrival rates of informed and uninformed traders, as well as on the market maker's beliefs regarding the occurrence of information events.

In the model, the market maker estimates the probability that any trade that occurs at time t is information-based as:

$$PIN(t) = \frac{P(t)\mu}{P(t)\mu + 2\varepsilon}, \tag{9}$$

where P(t) is the probability of an information event, μ is the rate of informed trade arrivals, and ε is the rate of unformed trade arrivals. The numerator in equation (9) is the expected number of orders from informed investors, and the denominator is the total number of orders. The market maker knows the arrival rates (μ and ε), and has prior beliefs about the probability of informational events (α), and the probability of bad news (δ). She uses the arrival rates of buy and sell orders to update her beliefs about the probability of good and bad events.

Parameters θ = (α, δ, μ, ε) are known to the market maker who also observes the order arrival process. The researcher observes only the arrival of B buy orders and S sell orders. However, Easley et al. (1996) show that under certain assumptions, the parameters can be recovered by maximizing the likelihood of observing a sequence of orders that contains B buys and S sells.[5] The daily likelihood of observing any sequence of B buys and S sells is given by:

[5] Buy and sells follow an independent Poisson process on each day. More buys are expected on days with good events, and more sells on days with bad events. Each day is either a no-event day, a good-event day, or a bad-event day, and trades observed on different days are independent.

$$L(\theta|B,S) = (1-\alpha)e^{-\varepsilon}\frac{\varepsilon^B}{B!}e^{-\varepsilon}\frac{\varepsilon^S}{S!} + \alpha\delta e^{-\varepsilon}\frac{\varepsilon^B}{B!}e^{-(\mu+\varepsilon)}\frac{(\mu+\varepsilon)^S}{S!} + \alpha(1-\delta)e^{-(\mu+\varepsilon)}\frac{(\mu+\varepsilon)^B}{B!}e^{-\varepsilon T}\frac{\varepsilon^S}{S!}, \tag{10}$$

where the first, second, and third terms show, respectively, the likelihood of observing B buys and S sells on a non-event day, a bad-event day, and a good-event day. Over a period of D days, the parameters can be estimated from the daily numbers of buys and sells by maximizing the product of daily likelihoods:

$$L(\theta|(B_1,S_1)\ldots(B_D,S_D)) = \prod_{i=1}^{D} L(\theta|(B_i,S_i). \tag{11}$$

Using intraday data from ISSM (before 1993) and TAQ (after 1993), we estimate the model for each stock with more than 50 trading days in a quarter. Trades are classified as buys or sells using the Lee and Ready (1991) algorithm, which involves a quote test and a tick test. The daily number of buyer-initiated trades and seller-initiated trades is an input into the joint likelihood function (11). The likelihood function is maximized using a dual quasi-Newton algorithm. Convergence of the optimization problem yields parameter estimates along with their standard errors.

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Figure 1
Number of Institutions Holding Shares

The figure plots the number of institutional investors holding sample stocks over the 80 quarters from Q4:1989 through Q3:2009. Sample stocks are listed on NYSE, AMEX, or NASDAQ. Institutions are classified as banks, insurance companies, mutual funds, investment advisers, hedge funds, or others. Tick marks correspond to the last quarter of a given year.

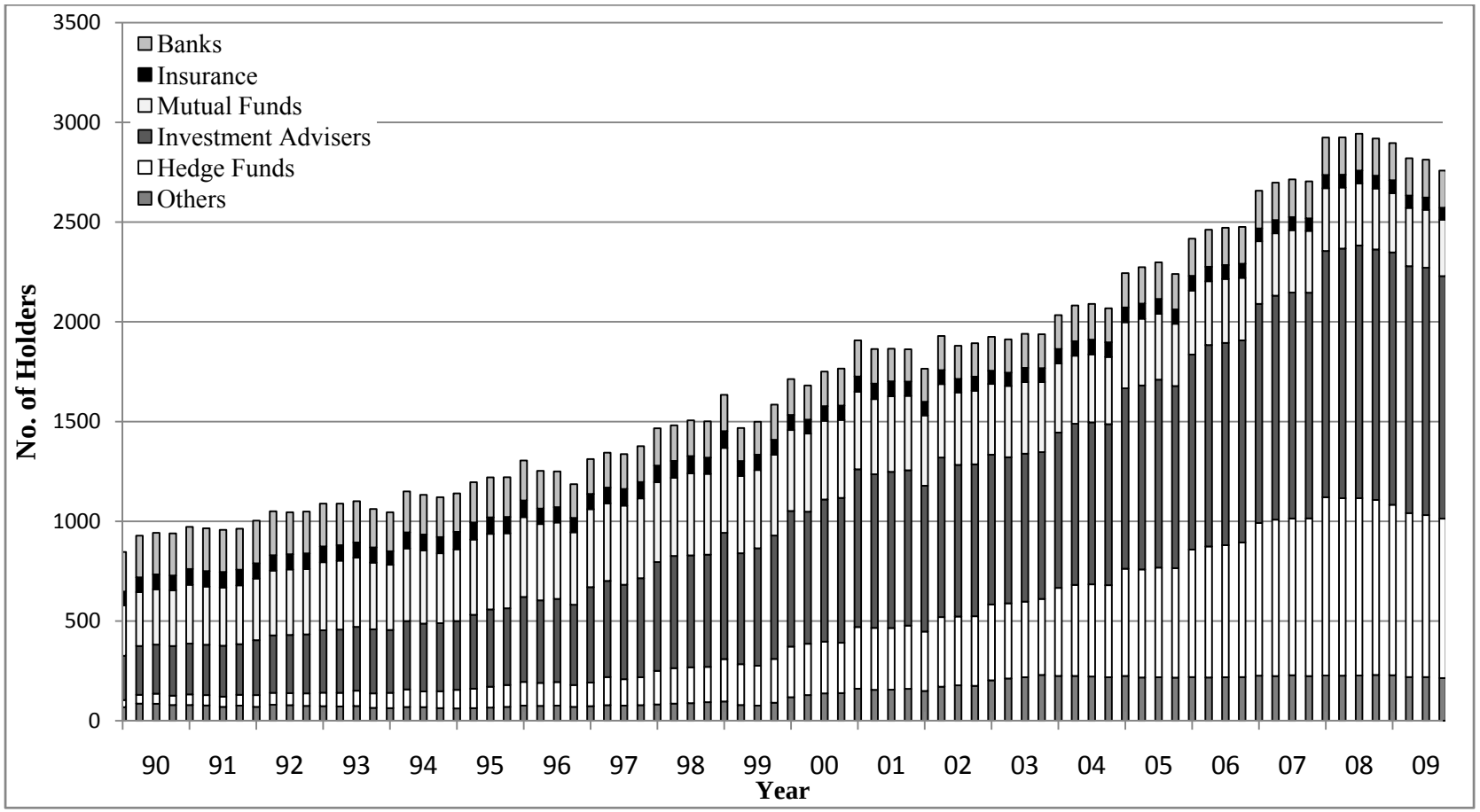


Figure 2

Fraction of Shares Held by Different Types of Institutional Investors

The figure plots the average percentage of shares held by six types of institutional investors for the sample stocks over the 80 quarters from Q4:1989 through Q3:2009. Sample stocks are listed on NYSE, AMEX, or NASDAQ. The institutional investor types are (1) banks, (2) insurance companies, (3) mutual funds, (4) investment advisers, (5) hedge funds, and (6) others. The category "others" includes endowments, foundations, and private pension funds.

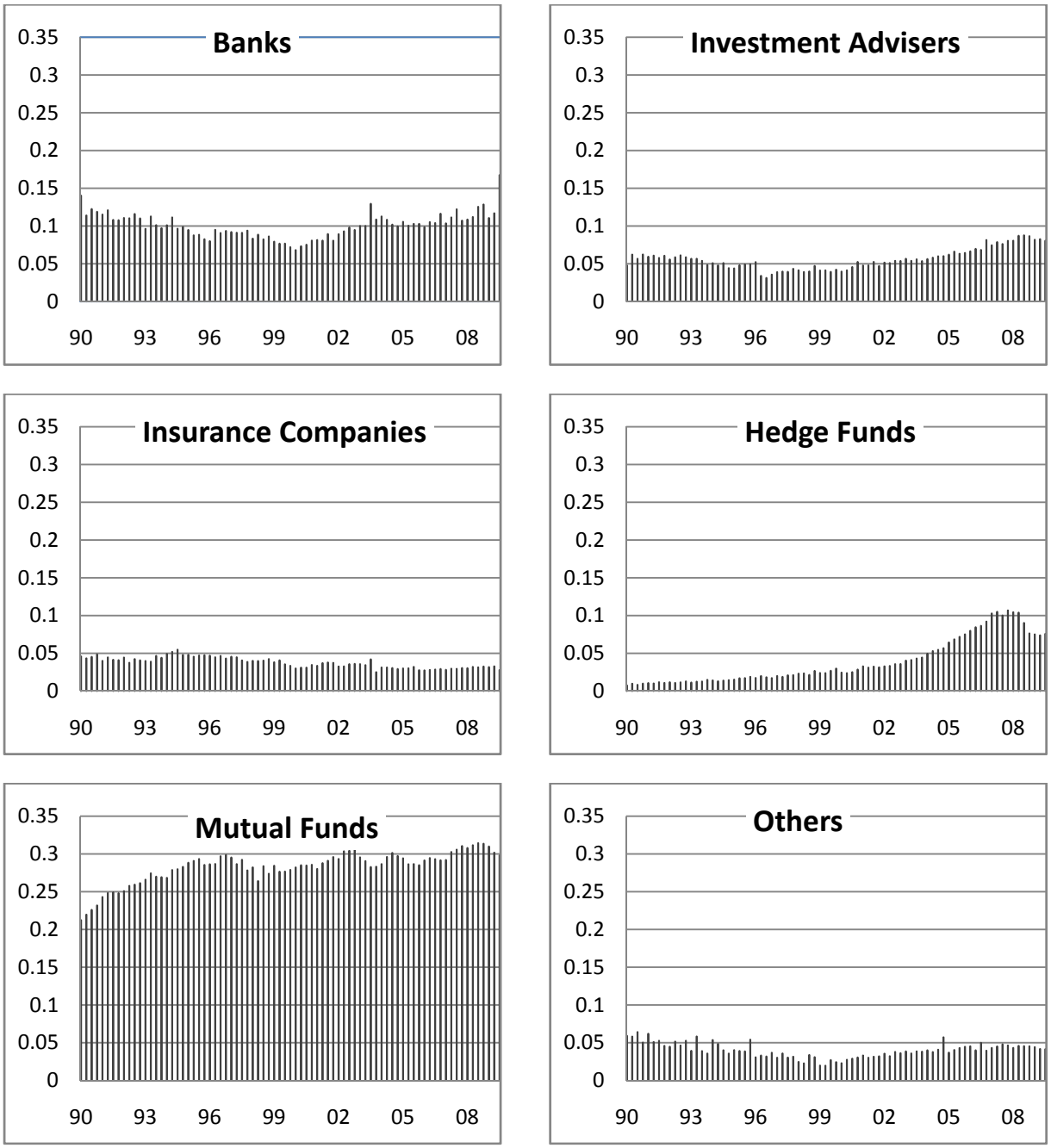


Figure 3
Innovations in Aggregate Liquidity

The figure shows the daily changes in the market-wide proportional effective bid-ask spread, multiplied by minus one to measure changes in liquidity. The firm-specific proportional effective spread is derived from intraday data, and daily changes are calculated for each stock. Market-wide liquidity innovations are obtained by aggregating the daily changes in firm-specific bid-ask spread across common stocks listed on NYSE, AMEX, or NASDAQ.

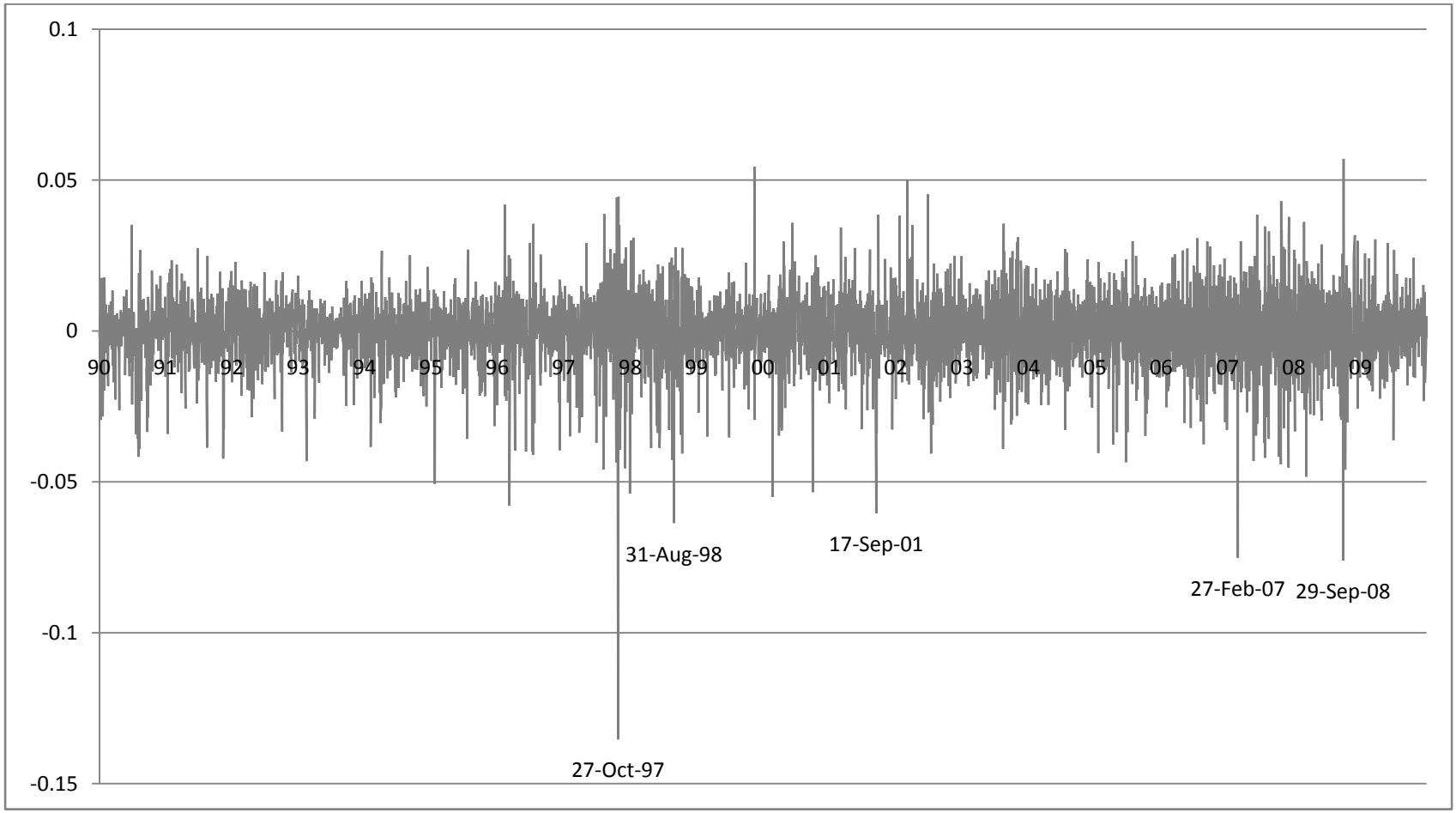
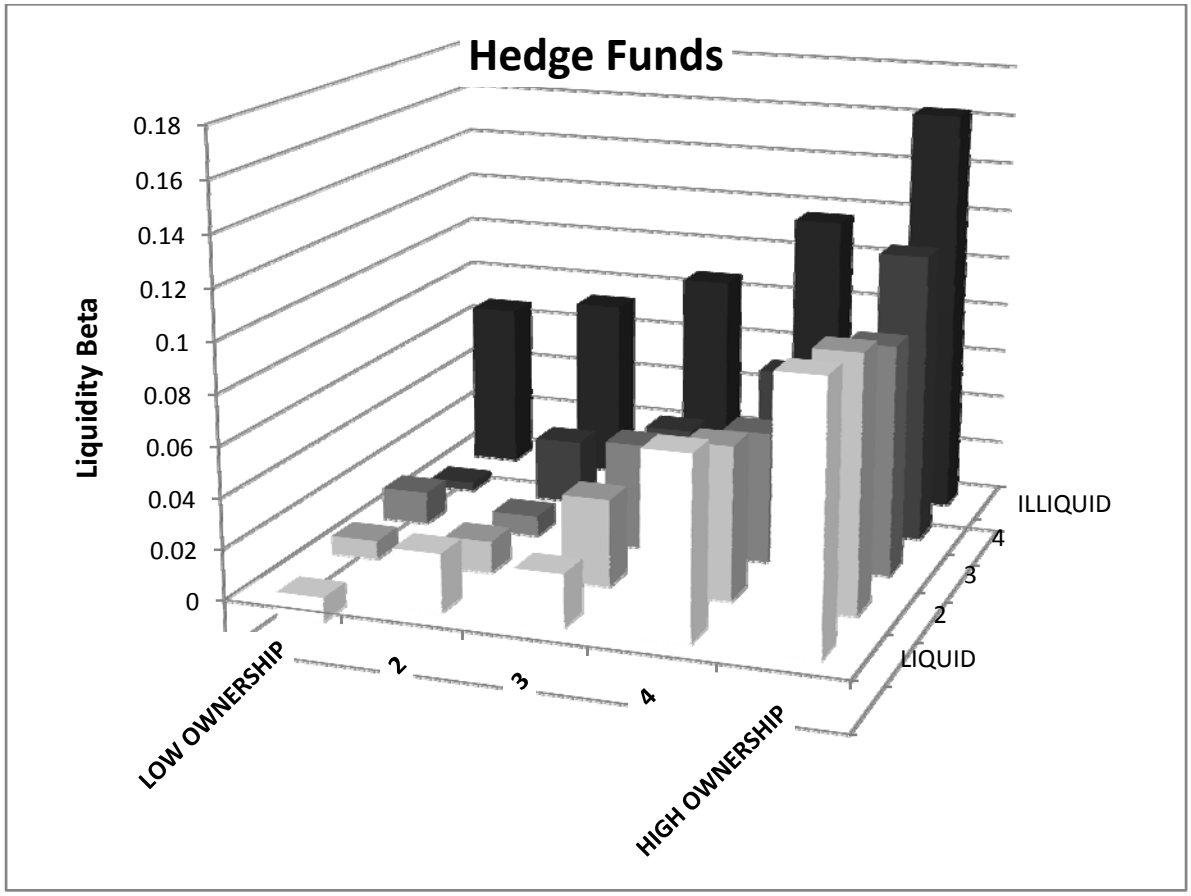


Figure 4

Liquidity Betas for 25 Portfolios Sorted by Hedge Fund (Bank) Ownership and Liquidity

The figure plots liquidity betas for 25 portfolios independently sorted into quintiles based on hedge fund (Panel A) or bank (Panel B) ownership and liquidity. The liquidity of each stock is measured by its proportional effective bid-ask spread. Stocks are sorted into portfolios in each quarter, and liquidity betas are estimated over the subsequent quarter by regressing daily equal-weighted portfolio returns against innovations in market liquidity while controlling for market returns. Ownership portfolio 1 (5) contains stocks in the lowest (highest) hedge fund or bank ownership quintile. Liquidity portfolio 1 (5) contains stocks in the lowest (highest) effective bid-ask spread quintile.

Panel A: Sorted by Hedge Fund Ownership and Liquidity



Panel B: Sorted by Bank Ownership and Liquidity

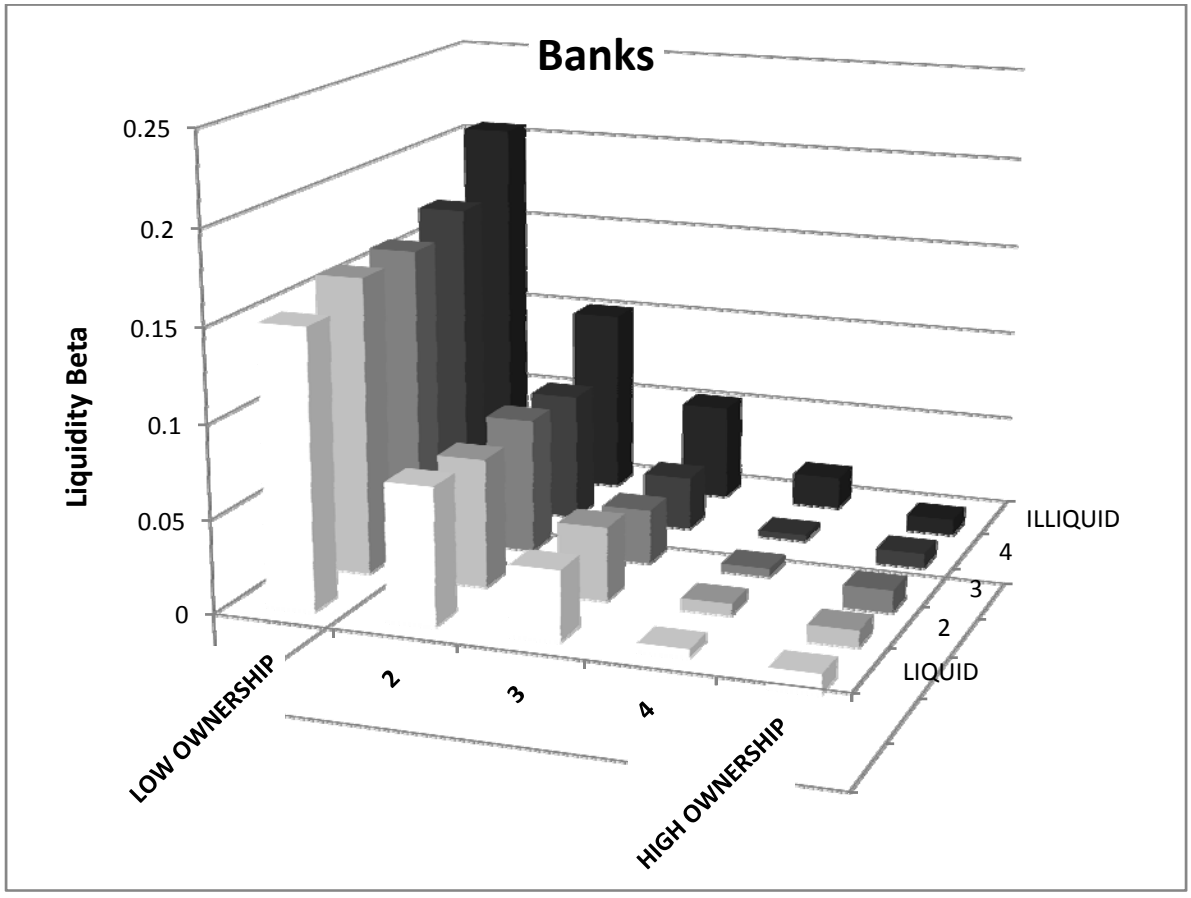


Table 1

Summary Statistics of Institutional Ownership

The table provides summary statistics for institutional ownership of sample stocks over the 80 quarters from Q4:1989 through Q3:2009. Sample stocks are listed on NYSE, AMEX, or NASDAQ. Panel A shows the total number of institutions holding common stocks, and Panel B shows the average fraction of outstanding shares held by these institutions. The holdings are broken down by type of institutional investors and sub-period. The six types of institutional investors are (1) banks, (2) insurance companies, (3) mutual funds, (4) investment advisers, (5) hedge funds, and (6) others. The category "others" includes endowments, foundations, and private pension funds.

Panel A: Number of Institutions Holding Common Stocks

Year	Total	Banks	Insurance companies	Mutual funds	Investment advisers	Hedge funds	Others
1989-2009	5271	524	153	576	2357	1225	436
1989-1994	1621	326	103	419	546	123	104
1995-1999	2304	302	109	503	942	300	148
2000-2004	2970	249	93	435	1240	642	311
2005-2009	3744	235	88	364	1705	1062	290

Panel B: Fraction of Stocks Held by Institutions

Year	All Institutions	Banks	Insurance companies	Mutual funds	Investment advisers	Hedge funds	Others
1989-2009	0.557	0.099	0.035	0.285	0.057	0.048	0.038
1989-1994	0.526	0.110	0.045	0.257	0.055	0.012	0.049
1995-1999	0.493	0.085	0.041	0.275	0.042	0.022	0.030
2000-2004	0.534	0.092	0.033	0.286	0.052	0.038	0.035
2005-2009	0.636	0.112	0.030	0.299	0.075	0.087	0.044

Table 2

Summary Statistics of Liquidity Betas and Stock Characteristics

The table reports summary statics for the sample of 197,390 stock/quarter observations. The sample period covers the 80 quarters from January 1990 through December 2009. Liquidity betas are measured quarterly by regressing daily stock returns on daily changes in aggregate liquidity while controlling for market returns. Aggregate liquidity is measured by the effective bid-ask spread, the quoted bid-ask spread, or Amihud illiquidity. Market betas are estimated using daily market model regressions. The standard deviation and average return are based on daily stock returns. Leverage is the sum of current liabilities and long-term debt over total book assets, measured at the end of the previous quarter. Book-to-market ratio is defined as the book value of total shareholders' equity divided by the market value of equity. Ownership concentration is measured by the Herfindahl index, and PIN is a measure of asymmetric information.

Variable	Mean	Standard Deviation	Lower Quartile	Median	Upper Quartile
Liquidity Beta (Eff. Spread)	0.05	0.46	-0.18	0.02	0.26
Liquidity Beta (Quoted Spread)	0.06	0.55	-0.21	0.03	0.29
Liquidity Beta (Amihud)	0.05	0.48	-0.19	0.02	0.26
Effective Spread	0.74%	0.74%	0.22%	0.48%	1.00%
Quoted Spread	1.16%	1.08%	0.41%	0.83%	1.54%
Market Beta	1.07	1.63	-0.08	1.05	2.19
Standard Dev. of Return	3.89%	2.80%	1.63%	3.38%	5.63%
Average Daily Return	0.09%	0.45%	-0.14%	0.08%	0.31%
Leverage	0.21	0.19	0.02	0.17	0.33
Book-to-Market	0.51	0.37	0.25	0.43	0.67
Market Capitalization ($ M)	3753	15713	214	610	2004
Total Institutional Ownership	0.56	0.27	0.35	0.58	0.77
Bank Ownership	0.10	0.07	0.04	0.09	0.14
Insurance Company Ownership	0.04	0.04	0.01	0.03	0.05
Mutual Fund Ownership	0.28	0.17	0.15	0.28	0.41
Investment Advisor Ownership	0.06	0.06	0.02	0.04	0.08
Hedge Fund Ownership	0.05	0.07	0.01	0.02	0.06
Other Ownership	0.04	0.04	0.01	0.03	0.05
Ownership Concentration	0.03	0.04	0.01	0.02	0.03
PIN	0.20	0.10	0.13	0.19	0.26
Stocks per Quarter	2467	1144	1142	3046	3420

Table 3

Institutional Ownership for 10 Ownership-Sorted Portfolios

At the end of each quarter, stocks are sorted into decile portfolios on the basis of total institutional ownership, and independently on the basis of ownership by banks, insurance companies, mutual funds, investment advisers, hedge funds, and others. Portfolio 1 (10) contains stocks in the lowest (highest) institutional ownership decile. The table reports the time-series averages of the fractions of shares held by institutional investors for the ownership-sorted portfolios. The average number of stocks in each portfolio is 247.

	Ownership Decile Portfolio									
Sorted by Ownership of:	P-1 (Low)	2	3	4	5	6	7	8	9	P-10 (High)
All Institutions	0.094	0.250	0.362	0.458	0.541	0.615	0.682	0.747	0.815	0.924
Banks	0.010	0.029	0.048	0.067	0.085	0.103	0.121	0.143	0.170	0.444
Insurance Companies	0.003	0.009	0.015	0.021	0.027	0.034	0.042	0.052	0.069	0.399
Mutual Funds	0.034	0.097	0.151	0.201	0.249	0.295	0.342	0.395	0.460	0.699
Investment Advisers	0.006	0.017	0.026	0.034	0.041	0.050	0.061	0.076	0.099	0.340
Hedge Funds	0.002	0.006	0.010	0.015	0.021	0.028	0.039	0.054	0.081	0.324
Others	0.003	0.008	0.015	0.023	0.032	0.040	0.047	0.056	0.072	0.483

Table 4

Liquidity Betas for 10 Ownership-Sorted Portfolios

The table reports liquidity beta estimates for the 10 ownership-sorted portfolios. Portfolio 1 (10) contains stocks in the lowest (highest) institutional ownership decile. Stocks are sorted into portfolios in each quarter, and liquidity betas are estimated over the subsequent quarter by regressing daily equal-weighted portfolio returns against innovations in market liquidity (measured by the proportional effective bid-ask spread) while controlling for market returns. The t-statistics in parentheses are computed using the Newey-West standard errors with 8 lags. The last column shows the slope coefficient and the associated t-statistic from regressions of portfolio liquidity betas against the average institutional ownership in each portfolio. Slope coefficients significant at the 5% (1%) level are marked with one (two) asterisks.

Sorted by Ownership of:	P-1 (Low)	2	3	4	5	6	7	8	9	P-10 (High)	Slope
All Institutions	0.15	0.10	0.08	0.06	0.04	0.04	0.03	0.03	0.03	0.05	-0.13**
	(9.2)	(7.2)	(5.8)	(4.8)	(3.9)	(4.1)	(3.2)	(3.3)	(3.2)	(4.7)	(-4.5)
Banks	0.22	0.15	0.09	0.06	0.05	0.02	0.01	0.00	-0.01	-0.01	-0.40*
	(11.8)	(9.3)	(6.3)	(4.6)	(4.3)	(2.4)	(1.0)	(0.5)	(-1.2)	(-1.2)	(-2.4)
Insurance Companies	0.16	0.07	0.05	0.03	0.03	0.03	0.03	0.03	0.02	0.04	-0.07
	(9.9)	(4.6)	(3.5)	(2.5)	(2.5)	(3.7)	(4.4)	(4.3)	(3.0)	(4.4)	(-0.6)
Mutual Funds	0.13	0.07	0.06	0.05	0.04	0.04	0.03	0.05	0.05	0.07	-0.05
	(8.3)	(5.3)	(5.4)	(4.7)	(4.3)	(4.1)	(3.7)	(4.7)	(5.3)	(5.6)	(-1.1)
Investment Advisers	0.11	0.07	0.05	0.04	0.04	0.04	0.04	0.05	0.05	0.06	-0.01
	(7.4)	(6.1)	(4.8)	(4.6)	(4.9)	(4.7)	(4.7)	(5.1)	(4.8)	(5.2)	(-0.2)
Hedge Funds	0.02	0.02	0.03	0.03	0.03	0.05	0.06	0.08	0.10	0.13	0.33**
	(1.4)	(2.5)	(3.1)	(3.2)	(3.1)	(5.4)	(5.2)	(6.8)	(8.0)	(9.0)	(4.7)
Others	0.15	0.11	0.07	0.04	0.03	0.02	0.01	0.01	0.02	0.03	-0.09
	(10.4)	(7.9)	(5.3)	(3.7)	(2.9)	(1.9)	(1.8)	(2.3)	(2.5)	(3.0)	(-0.8)

Table 5

Liquidity Betas for 25 Portfolios Sorted by Hedge Fund (Bank) Ownership and Liquidity

The table shows liquidity betas for 25 portfolios independently sorted into quintiles based on hedge fund (Panel A) or bank (Panel B) ownership and liquidity. The liquidity of each stock is measured by its proportional effective bid-ask spread. Stocks are sorted into portfolios in each quarter, and liquidity betas are estimated over the subsequent quarter by regressing daily equal-weighted portfolio returns against innovations in market liquidity (measured by the proportional effective bid-ask spread) while controlling for market returns. The t-statistics in parentheses below liquidity betas are computed using Newey-West standard errors with 8 lags. Ownership portfolio 1 (5) contains stocks in the lowest (highest) hedge fund or bank ownership quintile. Liquidity portfolio 1 (5) contains stocks in the lowest (highest) effective bid-ask spread quintile. Panel C reports the slope coefficients and the associated t-statistics from regressions of portfolio liquidity betas against hedge fund or bank ownership and liquidity. Slope coefficients significant at the 5% (1%) level are marked with one (two) asterisks.

	Own-1 (Low)	Own-2	Own-3	Own-4	Own-5 (High)
Panel A: Sorted by Hedge Fund Ownership and Liquidity					
Liq-1 (Liquid)	-0.01	0.02	0.02	0.07	0.10
	(-0.86)	(2.48)	(1.95)	(5.67)	(7.06)
Liq-2	0.01	0.01	0.03	0.06	0.10
	(0.72)	(1.40)	(3.29)	(4.75)	(6.95)
Liq-3	0.01	0.01	0.04	0.05	0.09
	(1.23)	(0.91)	(4.27)	(4.26)	(7.02)
Liq-4	0.01	0.03	0.04	0.06	0.12
	(0.31)	(2.93)	(3.37)	(5.10)	(8.09)
Liq-5 (Illiquid)	0.07	0.07	0.09	0.12	0.16
	(5.71)	(6.39)	(7.12)	(8.68)	(10.75)
Panel B: Sorted by Bank Ownership and Liquidity					
Liq-1 (Liquid)	0.15	0.07	0.04	0.01	-0.01
	(8.48)	(4.70)	(3.52)	(0.47)	(-1.17)
Liq-2	0.16	0.07	0.04	0.01	-0.01
	(9.23)	(4.64)	(3.48)	(0.76)	(-1.07)
Liq-3	0.16	0.07	0.03	0.01	-0.01
	(9.88)	(5.10)	(2.61)	(0.55)	(-1.44)
Liq-4	0.17	0.07	0.03	0.01	-0.01
	(9.70)	(4.73)	(2.65)	(0.40)	(-0.98)
Liq-5 (Illiquid)	0.21	0.10	0.05	0.02	-0.01
	(10.98)	(7.04)	(4.39)	(1.71)	(-0.92)

Table 5
Liquidity Betas for 25 Portfolios Sorted by Hedge Fund (Bank) Ownership and Liquidity

Panel C: Regressions of Portfolio Liquidity Betas on Hedge Fund (Bank) Ownership and Liquidity

	(1)	(2)
Hedge Fund Ownership	0.45**	-
	(9.77)	-
Bank Ownership	-	-0.57**
	-	(-4.04)
Liquidity	0.04**	0.01
	(6.62)	(0.79)
Intercept	0.01	0.08
	(0.47)	(4.39)

Table 6

Cross-Sectional Regressions of Liquidity Betas on Institutional Ownership

The table reports the results from Fama-MacBeth regressions of liquidity betas on the fraction of shares held by different types of institutional investors and on control variables. The analysis covers the 80 quarters from Q1:1990 through Q4:2009 with 197,390 stock/quarter observations. All variables are standardized to have zero means and unit variances in each quarter. Reported are the time-series averages of the quarterly cross-sectional slope coefficients and the Fama-MacBeth t-statistics corrected for serial correlation using the Newey-West standard errors with 4 lags. Coefficients significant at the 5% (1%) level are marked with one (two) asterisks. Based on specification (2) in Panel A, Panel B provides an F-test for the hypothesis that hedge fund ownership has the same marginal effect on liquidity risk as ownership by other types of institutional investors.

Panel A: Parameter Estimates

	(1)		(2)	
	Coefficient	T-statistic	Coefficient	T-statistic
Banks	-0.272**	-9.93	-0.139**	-7.67
Insurance Companies	-0.043	-1.90	-0.004	-0.21
Mutual Funds	0.008	0.61	0.018	1.70
Investment Advisers	0.052*	2.15	0.043*	2.26
Hedge Funds	0.239**	7.63	0.191**	5.28
Others	-0.128**	-3.22	-0.072*	-2.01
Own. Concentration			0.010	1.91
Avg. Effective Spread			0.063**	4.82
Market Beta			-0.009**	-2.69
Standard Deviation			0.004	1.27
Average Return			0.021**	2.76
Leverage			-0.001	-0.16
Book-to-Market			-0.017*	-2.12
Market Cap.			-0.029**	-2.95
NASDAQ Dummy			0.024	1.29
PIN			0.012*	2.53
Lagged Liquidity Beta			0.038**	5.41
Avg. R^2	0.024		0.055	

Table 6
Cross-Sectional Regressions of Liquidity Betas on Institutional Ownership

Panel B: Tests for Differences between Hedge Funds and Other Institutional Investors

	Difference	F-statistic	P-value
Hedge Funds - Banks	0.330	66.57	[<0.01]
Hedge Funds - Insurance Companies	0.195	23.08	[<0.01]
Hedge Funds - Mutual Funds	0.172	20.9	[<0.01]
Hedge Funds - Investment Advisers	0.148	13.17	[<0.01]
Hedge Funds - Others	0.263	26.63	[<0.01]

Table 7

Regressions of Crisis-Day Abnormal Returns on Institutional Ownership

The table presents the results from Fama-MacBeth regressions of crisis-day market-adjusted abnormal returns on the fraction of shares held by different types of institutional investors and on control variables. Liquidity crisis days are defined as the 50 days with the largest declines in market liquidity from 1990 to 2009. The sample is based on 125,236 firm-quarter observations over 50 crisis days. Market liquidity is measured by the proportional effective bid-ask spread. Returns are expressed in percent per day. Reported are the time-series averages of the quarterly cross-sectional slope coefficients and the Fama-MacBeth t-statistic corrected for serial correlation using the Newey-West standard errors with 4 lags. Coefficients significant at the 5% (1%) level are marked with one (two) asterisks. Based on specification (2) in Panel A, Panel B provides an F-test for the hypothesis that hedge fund ownership has the same marginal effect on crisis-day returns as ownership by other types of institutional investors.

Panel A: Parameter Estimates

	(1)		(2)	
	Coefficient	T-statistic	Coefficient	T-statistic
Banks	2.866**	3.15	1.471**	2.79
Insurance Companies	0.825	1.62	0.090	0.20
Mutual Funds	-0.266	-1.50	-0.220	-1.37
Investment Advisers	-0.309	-0.82	-0.749	-1.89
Hedge Funds	-3.204**	-3.46	-2.041**	-2.92
Others	0.888	1.71	-0.001	0.01
Own. Concentration			0.087	0.19
Avg. Effective Spread			-0.103	-1.64
Market Beta			-0.020	-1.63
Standard Deviation			-0.038**	-4.17
Average Return			-0.402*	-2.18
Leverage			-0.096	-0.89
Book-to-Market			0.250*	2.10
Market Cap.			0.001	-0.38
NASDAQ Dummy			-0.133	-1.25
PIN			-0.944**	-2.88
Lagged Liquidity Beta			-0.207*	-2.10
Avg. R^2	0.023		0.063	

Table 7
Regressions of Crisis-Day Abnormal Returns on Institutional Ownership

Panel B: Tests for Differences between Hedge Funds and Other Institutional Investors

	Difference	F-statistic	P-value
Hedge Funds - Banks	-3.512**	12.45	[<0.01]
Hedge Funds - Insurance Companies	-2.130**	8.96	[<0.01]
Hedge Funds - Mutual Funds	-1.820**	8.25	[<0.01]
Hedge Funds - Investment Advisers	-1.291	3.47	[0.07]
Hedge Funds - Others	-2.040*	6.39	[0.01]

Table 8

Univariate Liquidity Betas for 10 Ownership-Sorted Portfolios

The table reports the univariate liquidity beta estimates for the 10 ownership-sorted portfolios. Portfolio 1 (10) contains stocks in the lowest (highest) institutional ownership decile. The univariate liquidity betas are estimated by regressing daily equal-weighted portfolio returns against innovations in market liquidity (measured by the proportional effective bid-ask spread). The t-statistics in parentheses are computed using the Newey-West standard errors with 8 lags. The last column presents the slope coefficient and the associated t-statistic from regressions of portfolio liquidity betas against the average institutional ownership in each portfolio. Slope coefficients significant at the 5% (1%) level are marked with one (two) asterisks.

Sorted by Ownership of:	P-1 (Low)	2	3	4	5	6	7	8	9	P-10 (High)	Slope
All Institutions	0.41	0.40	0.39	0.38	0.37	0.37	0.37	0.38	0.38	0.38	-0.04
	(14.7)	(15.8)	(16.2)	(16.6)	(16.9)	(17.1)	(17.5)	(17.4)	(17.2)	(17.9)	(-3.4)**
Banks	0.45	0.44	0.44	0.42	0.40	0.37	0.36	0.34	0.32	0.31	-0.34**
	(15.6)	(16.3)	(16.3)	(16.4)	(16.8)	(16.8)	(16.7)	(16.8)	(16.2)	(16.1)	(-3.9)
Insurance Companies	0.44	0.42	0.40	0.38	0.37	0.37	0.36	0.36	0.36	0.37	-0.07
	(15.7)	(15.8)	(15.9)	(16.1)	(16.6)	(17.1)	(17.7)	(17.6)	(17.2)	(17.4)	(-0.9)
Mutual Funds	0.39	0.37	0.37	0.38	0.37	0.37	0.37	0.39	0.40	0.44	0.09**
	(14.7)	(15.3)	(16.3)	(16.6)	(16.8)	(17.2)	(17.4)	(17.6)	(18.0)	(17.8)	(3.3)
Investment Advisers	0.40	0.39	0.38	0.38	0.38	0.39	0.38	0.38	0.38	0.38	-0.03
	(15.8)	(16.7)	(16.9)	(17.5)	(17.0)	(17.4)	(17.3)	(17.4)	(17.2)	(17.1)	(-1.1)
Hedge Funds	0.31	0.33	0.34	0.35	0.37	0.40	0.41	0.44	0.45	0.47	0.41*
	(15.8)	(16.7)	(16.8)	(17.0)	(16.9)	(17.4)	(16.9)	(17.3)	(17.7)	(17.5)	(2.9)
Others	0.43	0.42	0.43	0.40	0.37	0.36	0.34	0.34	0.35	0.37	-0.06
	(17.0)	(17.0)	(17.0)	(17.0)	(17.0)	(17.0)	(17.0)	(17.0)	(17.0)	(17.0)	(-0.7)

Table 9

Cross-Sectional Regressions Using Univariate Liquidity Betas

The table reports the results from Fama-MacBeth regressions of the univariate liquidity betas on the fraction of shares held by different types of institutional investors and on control variables. The liquidity betas are estimated with respect to changes in the market-wide effective bid-ask spread, without controlling for market returns. The analysis covers the 80 quarters from Q1:1990 through Q4:2009 with 197,390 stock/quarter observations. All variables are standardized to have zero means and unit variances in each quarter. Reported are the time-series averages of the quarterly cross-sectional slope coefficients and the Fama-MacBeth t-statistics corrected for serial correlation using the Newey-West standard errors with 4 lags. Coefficients significant at the 5% (1%) level are marked with one (two) asterisks.

	(1)		(2)	
	Coefficient	T-statistic	Coefficient	T-statistic
Banks	-0.326**	-4.81	-0.120**	-4.11
Insurance Companies	-0.094*	-2.48	0.036	1.84
Mutual Funds	0.090**	4.85	0.070**	5.17
Investment Advisers	-0.046	-1.52	-0.009	-0.46
Hedge Funds	0.453**	9.23	0.277**	8.42
Others	-0.123**	-2.51	0.011	0.41
Own. Concentration			-0.005	-1.12
Avg. Effective Spread			-0.001	-0.04
Market Beta			0.033**	6.69
Standard Deviation			0.042**	7.61
Average Return			0.034*	2.55
Leverage			-0.011	-1.80
Book-to-Market			-0.035**	-3.52
Market Cap.			0.002	0.45
NASDAQ Dummy			0.178**	3.88
PIN			0.052**	3.15
Lagged Liquidity Beta			0.118**	5.23
Avg. R^2	0.052		0.151	

Table 10

Cross-Sectional Regressions of Liquidity Betas on Institutional Ownership Using the Quoted Bid-Ask Spread to Measure Market Liquidity

The table contains results from cross-sectional regressions of liquidity betas on institutional ownership and on control variables. Liquidity betas are measured with respect to changes in the proportional quoted bid-ask spread. The analysis covers the 80 quarters from Q1:1990 through Q4:2009 with 197,390 stock/quarter observations. All variables are standardized to have zero means and unit variances in each quarter. Reported are the time-series averages of the quarterly cross-sectional slope coefficients and the Fama-MacBeth t-statistics corrected for serial correlation using the Newey-West standard errors with 4 lags. Coefficients significant at the 5% (1%) level are marked with one (two) asterisks.

	(1)		(2)	
	Coefficient	T-statistic	Coefficient	T-statistic
Banks	-0.202**	-6.38	-0.110**	-4.90
Insurance Companies	-0.064**	-2.81	-0.032	-1.59
Mutual Funds	-0.010	-1.12	-0.005	-0.58
Investment Advisers	0.003	0.10	0.002	0.08
Hedge Funds	0.156**	4.67	0.120**	3.04
Others	-0.056*	-2.50	-0.022	-0.91
Own. Concentration			0.004	0.74
Avg. Effective Spread			0.031*	2.55
Market Beta			-0.006	-1.50
Standard Deviation			0.011**	2.66
Average Return			0.033**	4.10
Leverage			-0.005	-1.31
Book-to-Market			-0.009	-1.44
Market Cap.			-0.017**	-3.21
NASDAQ Dummy			0.014	0.69
PIN			-0.002	-0.33
Lagged Liquidity Beta			0.023**	2.77
Avg. R^2	0.016		0.042	

Table 11

Cross-Sectional Regressions of Liquidity Betas on Institutional Ownership Using the Amihud Measure of Market Liquidity

The table contains results from cross-sectional regressions of liquidity betas on institutional ownership and on control variables. Liquidity betas are measured with respect to changes in Amihud illiquidity. The analysis covers the 80 quarters from Q1:1990 through Q4:2009 with 197,390 stock/quarter observations. All variables are standardized to have zero means and unit variances in each quarter. Reported are the time-series averages of the quarterly cross-sectional slope coefficients and the Fama-MacBeth t-statistics corrected for serial correlation using the Newey-West standard errors with 4 lags. Coefficients significant at the 5% (1%) level are marked with one (two) asterisks.

	(1)		(2)	
	Coefficient	T-statistic	Coefficient	T-statistic
Banks	-0.166**	-3.78	-0.078**	-3.07
Insurance Companies	-0.081**	-4.25	-0.046**	-2.96
Mutual Funds	0.011	1.33	0.016*	2.18
Investment Advisers	0.059*	2.58	0.058**	2.81
Hedge Funds	0.219**	5.01	0.184**	4.61
Others	-0.091**	-5.28	-0.057**	-3.26
Own. Concentration			0.005	1.42
Avg. Effective Spread			0.027**	4.24
Market Beta			0.002	0.40
Standard Deviation			0.008	1.91
Average Return			0.014	1.57
Leverage			-0.005	-1.80
Book-to-Market			-0.013**	-2.71
Market Cap.			-0.016**	-4.29
NASDAQ Dummy			0.052*	2.19
PIN			-0.010	-1.90
Lagged Liquidity Beta			0.032**	4.83
Avg. R^2	0.012		0.032	

Table 12

Cross-Sectional Regressions of Dimson Liquidity Betas on Institutional Ownership

The table reports the results from Fama-MacBeth regressions of Dimson liquidity betas on the fraction of shares held by different types of institutional investors and on control variables. Dimson betas are obtained as the sum of the slope coefficients on current and lagged innovations in market liquidity. The effective bid-ask spread is used to measure market liquidity. The analysis covers the 80 quarters from Q1:1990 through Q4:2009 with 197,390 stock/quarter observations. All variables are standardized to have zero means and unit variances in each quarter. Reported are the time-series averages of the quarterly cross-sectional slope coefficients and the Fama-MacBeth t-statistics corrected for serial correlation using the Newey-West standard errors with 4 lags. Coefficients significant at the 5% (1%) level are marked with one (two) asterisks.

	(1)		(2)	
	Coefficient	T-statistic	Coefficient	T-statistic
Banks	-0.289**	-12.17	-0.153**	-8.41
Insurance Companies	-0.054	-2.48	-0.026	-1.42
Mutual Funds	0.012	0.92	0.026*	2.19
Investment Advisers	0.074*	2.57	0.051*	2.49
Hedge Funds	0.249**	7.33	0.202**	4.83
Others	-0.150**	-4.12	-0.101**	-2.92
Own. Concentration			0.014**	2.78
Avg. Effective Spread			0.069**	6.16
Market Beta			-0.010*	-2.56
Standard Deviation			0.007	1.99
Average Return			0.009	1.47
Leverage			0.001	0.02
Book-to-Market			-0.019*	-2.32
Market Cap.			-0.032**	-2.99
NASDAQ Dummy			-0.010	-0.67
PIN			0.013**	2.71
Lagged Liquidity Beta			0.045**	5.82
Avg. R^2	0.024		0.057	

Table 13
Sub-Period Analysis: 1990-1999 versus 2000-2009

The table contains sub-period results from cross-sectional regressions of liquidity betas on institutional ownership and on control variables. The liquidity betas are estimated with respect to changes in the market-wide effective bid-ask spread. The first and second subsamples contain 62,247 and 135,143 firm-quarter observations, respectively, and ach subsample covers 40 quarters. All variables are standardized to have zero means and unit variances in each quarter. Reported are the time-series averages of the quarterly cross-sectional slope coefficients and the Fama-MacBeth t-statistics corrected for serial correlation using the Newey-West standard errors with 4 lags. Coefficients significant at the 5% (1%) level are marked with one (two) asterisks. The last column reports p-values for t-tests of differences between the coefficients in the two sub-periods. Panel B provides an F-test for the hypothesis that hedge fund ownership has the same marginal effect on liquidity risk as ownership by other types of institutional investors in each sub-period.

Panel A: Parameter Estimates

	1990-1999		2000-2009		Difference
	Coefficient	T-statistic	Coefficient	T-statistic	p-value
Banks	-0.123**	-6.33	-0.155**	-5.07	[0.39]
Insurance Companies	-0.032	-1.52	0.025	0.91	[0.12]
Mutual Funds	0.031*	2.40	0.006	0.37	[0.06]
Investment Advisers	0.061*	2.53	0.025	0.90	[0.39]
Hedge Funds	0.127**	3.37	0.255**	5.48	[0.04]
Others	-0.161**	-3.76	0.016	0.42	[<0.01]
Own. Concentration	0.025**	3.68	-0.004	-1.03	[<0.01]
Avg. Effective Spread	0.093**	5.26	0.032**	2.86	[<0.01]
Market Beta	-0.002	-0.57	-0.016**	-3.50	[0.08]
Standard Deviation	0.005	1.39	0.003	0.62	[0.79]
Average Return	0.030**	3.34	0.012	1.02	[0.26]
Leverage	-0.005	-0.74	0.003	0.73	[0.38]
Book-to-Market	-0.023	-1.96	-0.010	-1.00	[0.30]
Market Cap.	-0.064**	-7.57	0.005	0.87	[<0.01]
NASDAQ Dummy	0.067*	2.29	-0.018	-1.57	[<0.01]
PIN	0.011	1.61	0.014	1.94	[0.73]
Lagged Liquidity Beta	0.046**	4.31	0.030**	3.41	[0.20]
Avg. R^2	0.074		0.033		

Table 13
Sub-Period Analysis: 1990-1999 versus 2000-2009

Panel B: Tests for Differences between Hedge Funds and Other Institutional Investors

	Period 1990-1999			Period 2000-2009		
	Difference	F-statistic	P-value	Difference	F-statistic	P-value
Hedge Funds - Banks	0.249	34.82	[<0.01]	0.410	54.28	[<0.01]
Hedge Funds - Insurance Companies	0.159	13.57	[<0.01]	0.230	18.39	[<0.01]
Hedge Funds - Mutual Funds	0.095	5.77	[0.02]	0.249	26.12	[<0.01]
Hedge Funds - Investment Advisers	0.066	2.17	[0.15]	0.230	18.21	[<0.01]
Hedge Funds - Others	0.287	25.49	[<0.01]	0.238	15.27	[<0.01]