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Liquidity risk and institutional ownership ☆

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ABSTRACT

Institutional ownership affects the sensitivity of stock returns to changes in market liquidity (liquidity risk). Overall, institutional ownership lowers the liquidity risk of stocks. However, different types of institutions affect liquidity risk in opposite ways. Stocks held by hedge funds, especially levered hedge funds, as marginal investors are more sensitive to changes in market liquidity than comparable stocks held by other types of institutions or by individuals. In contrast, stocks held by banks are less sensitive to changes in aggregate liquidity. These findings are robust to alternative specifications that control for institutional preferences for different stock characteristics and risk.

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1. Introduction

Although institutional ownership has long been regarded as a stabilizing factor in financial markets, questions have been raised about the impact of institutional investors on stock market stability during liquidity crises. Among institutional managers, hedge funds, in particular, have come under increased public scrutiny in the aftermath of the recent financial crisis because of their use of leverage and reliance on short-term funding. Policy makers, practitioners, and academic researchers have expressed concerns that hedge fund ownership may increase the exposure of stocks to fluctuations in market liquidity (liquidity risk).

Researchers have proposed potential channels through which institutional ownership can affect the liquidity risk of stocks. Baker and Stein (2004) argue that institutional ownership decreases the sensitivity of stock returns to fluctuations in market liquidity because institutional trades are less likely to be motivated by sentiment than individual trades. In their model, high liquidity is a symptom of the fact that the market is dominated by irrational investors, who underreact to information contained in order flow, thereby boosting liquidity. To the degree that investor sentiment affects the trading of individual investors more than the trading of institutional investors (e.g., Lee, Shleifer, and Thaler, 1991), Baker and Stein (2004) predict that institutional ownership should reduce the liquidity risk of stocks.

Others argue that different types of institutional investors affect liquidity risk in opposite ways. For example, Brunnermeier and Pedersen (2009) propose a model that relates liquidity risk to ownership by levered speculators such as hedge funds. The hedge fund sector makes extensive use of leverage, which is typically obtained through short-term funding (e.g., Lo, 2008; Ang, Gorovyy, and Inwegen, 2011). In the model of Brunnermeier and Pedersen (2009), low market liquidity increases margins and decreases the amount of leverage available to speculators. Faced with higher margin requirements and increased funding costs, speculators are forced to sell their assets, leading to declines in the prices of assets held by speculators. An important implication of their model is that assets held by levered speculators such as hedge funds are likely to be sold off when market liquidity dries up 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. According to this view, hedge fund ownership should have no adverse effect on liquidity risk and 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. Although mutual funds do not typically use leverage, their trading behavior could amplify liquidity risk. In particular, Grinblatt, Titman, and Wermers (1995), Nofsinger and Sias (1999), Wermers (1999), and Sias (2004) show that mutual funds tend to herd, that is, buy into or out of the same stocks at the same time. Chordia, Roll, and Subrahmanyam (2000) and Koch, Ruenzi, and Starks (2012) hypothesize that correlated trading and herding among mutual funds can lead to commonality in the performance of assets held by mutual funds. An implication of this argument is that stocks in mutual fund portfolios should have high 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 the unique ability to hedge against market-wide liquidity shocks. Therefore, ownership by banks could decrease the liquidity risk of stocks.

To test these hypotheses, we examine the effects of institutional ownership on liquidity risk in the cross-section of stocks. Specifically, we investigate whether stocks with higher institutional ownership exhibit greater or lower liquidity risk than comparable stocks held by individual investors. Furthermore, we distinguish between the holdings by different types of institutional investors, such as hedge funds, mutual funds, and banks.

In particular, 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, and whether the effect of hedge fund ownership on liquidity risk is related to hedge funds' use of leverage. Such evidence would support the hypothesis that ownership by levered traders of the type discussed by Brunnermeier and Pedersen (2009) 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. Overall, higher institutional ownership at the end of quarter q lowers the liquidity risk of stocks in quarter $q+1$ and the effect persists even after controlling for stock characteristics and liquidity risk in quarter q. However, different types of institutional investors affect liquidity risk in opposite ways. In particular, hedge fund holdings are positively and significantly related to liquidity risk of stocks 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. Positive changes in hedge fund ownership are also followed by significant increases in liquidity risk. Moreover, using data on hedge fund leverage, we find that the effect of hedge fund ownership on liquidity risk is related to hedge funds' use of leverage. The holdings of hedge fund companies that use leverage are more strongly associated with liquidity risk than the holdings of hedge fund companies that do not use leverage and the holdings of other financial institutions.

Mutual fund holdings are less strongly associated with liquidity risk than hedge fund holdings. As opposed to hedge funds, mutual funds typically do not use leverage or rely on short-term funding. Thus, the stronger effect of hedge fund ownership on liquidity risk compared to mutual fund ownership supports the view that liquidity risk is related to hedge funds' use of leverage. Finally, in striking contrast to mutual funds or hedge funds, the relation between the liquidity risk of stocks and bank ownership is negative and significant, which indicates that stocks held by banks as marginal investors are less exposed to liquidity shocks than identical stocks held by individuals or other institutions.

The results about the relation between liquidity risk and hedge fund and bank ownership are robust to alternative specifications that control for the tendency of hedge funds to choose riskier investments than banks or mutual funds. We find that the relation between hedge fund and bank ownership and liquidity risk is not explained by the preferences of institutional investors for stocks with different characteristics, but rather appears to be explained by the different trading patterns among various types of institutional investors.

Our paper contributes to the literature that examines the effects of institutional investors on financial markets. Dennis and Strickland (2002) show that abnormal stock returns during periods of high market volatility are related to the percentage of institutional ownership. Cao and Petrasek (2013) find that institutional ownership can be used to predict abnormal stock returns during liquidity crises, and Beber, Brandt, Cosemans, and Verardo (2012) find that institutional ownership affects stock liquidity. Others, including Boyson, Stahel, and Stulz (2010), Teo (2011), Aragon and Strahan (2012), and Cao, Chen, Liang, and Lo (2013), study hedge fund returns and trading during periods of market stress. We contribute to this literature by examining the relation between liquidity risk and ownership by different types of institutional investors, such as mutual funds, hedge funds, and banks. Finally, we contribute to research on systematic liquidity risk by linking liquidity risk to institutional ownership, and in particular, ownership by levered hedge funds.

The paper is organized as follows. In Section 2, we develop testable hypotheses about the impact of institutional ownership on the liquidity risk of stocks. In Section 3, we describe the data. In Section 4, we present the empirical results and in Section 5 the robustness tests. We provide concluding remarks in Section 6.

2. Testable hypotheses

We test several hypotheses about the effects of institutional ownership on the liquidity risk of stocks. In the first hypothesis (H1), we posit that institutional ownership affects the liquidity risk of stocks in the cross-section differently than individual ownership because institutional investors exhibit different trading patterns than individual investors. Baker and Stein (2004), for example, suggest that stocks that are held by institutional investors are not susceptible to investor sentiment as much as stocks that are held by individuals, and should therefore have lower liquidity risk. We test the

hypothesis by examining whether the aggregate institutional ownership in quarter $q-1$ explains liquidity risk in quarter q in the cross-section. Hypothesis H1 is supported if the aggregate institutional ownership has a different effect on liquidity risk than individual ownership, after taking into account stock characteristics and risk measures that could be associated with institutional preferences. The null hypothesis is that institutional ownership has no differential effect on liquidity risk from individual ownership.

There are several trading patterns discussed in the literature on institutional investors that could affect liquidity risk, each associated with a different type of institutional investor. Many hedge funds utilize leverage, which allows them to invest amounts larger than their capital base. Leverage is mainly provided by prime brokers of hedge funds through short-term funding (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. Brunnermeier and Pedersen (2009) predict 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, in the second hypothesis (H2) we posit that greater hedge fund ownership leads to higher liquidity risk of stocks in the cross-section than individual ownership. The hypothesis is supported if stocks held by hedge funds as marginal investors have a larger liquidity risk than stocks held by individuals, in particular if the hedge funds use leverage.

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. In our third hypothesis (H3) we posit that greater mutual fund ownership leads to higher stock liquidity risk. 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 same stock characteristics.

Commercial banks have funding flows that covary negatively with market liquidity because they are viewed as a safe haven by investors during periods of market stress. Stocks held by commercial banks are therefore less likely to be subject to liquidity-motivated sales during crises than stocks held by individuals. Therefore, in the fourth hypothesis (H4) we posit that greater ownership by commercial banks leads to lower stock liquidity risk than individual ownership.

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. We focus on the role of leverage, which plays a pivotal role in Brunnermeier and Pedersen's (2009) model of liquidity risk. Hedge funds typically make more use of leverage than other types of institutional investors, and they typically obtain leverage through short-term funding from prime brokers. Therefore, in the fifth hypothesis (H5) we posit that ownership by hedge funds increases liquidity risk more than ownership by other types of institutional investors, such as mutual funds or banks.

3. Data

3.1. Hedge fund holdings

We use a unique, hand-collected hedge fund ownership dataset from 1989 to 2012. 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 or others. We therefore conduct a labor-intensive process to distinguish ownership by hedge funds from investment advisers and other types of institutional investors.

Hedge funds are often structured as private investment vehicles, allowing them to be exempt from registration with the U.S. Securities and Exchange Commission (SEC) as an investment company. However, hedge fund management companies must—like other institutional investors—report their holdings to the SEC as long as they have more than $100 million of assets under discretionary

management. All long positions in common stocks 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, unless investors request confidential treatment for certain holdings (Agarwal, Jiang, Tang, and Yang, 2013). Although the filings do not contain certain confidential holdings and cover only long positions, they provide the best available proxy for institutional stock holdings.

To identify hedge fund management companies among other institutional money managers, we obtain lists of hedge fund managers from multiple hedge fund databases, including TASS, HFR, CISDM, Morningstar, BarclayHedge, and Bloomberg, and match hedge fund managers with companies reporting their holdings on Form 13F. We look up any 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, 1,933 hedge fund management firms can be matched with institutional holdings from Thomson Financial during the 1989–2012 sample period. However, many matched firms also manage mutual funds, pension funds, and other non-hedge fund investments. We eliminate from the hedge fund sample firms that are primarily non-hedge fund managers by cross-checking the registration documents for all registered companies (form ADV). Institutions are classified as hedge fund managers only 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 and First Quadrant, LP, are reclassified as independent investment advisers because they fail to satisfy these criteria. The final hedge fund management company sample consists of 1,517 management firms (with more than 4,000 hedge funds) whose holdings represent hedge fund ownership.

Altogether, we distinguish between 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 last category, others, includes university and private endowments, philanthropic foundations, and corporate pension funds. The classifications are based on the type codes available on Spectrum before 1998,[1] extended to cover later years and refined to distinguish between hedge funds, mutual funds, investment advisers, and other types of institutions.

3.2. Summary of institutional ownership

Institutional stock holdings data are obtained for each quarter from December 1989 through September 2012 for common stocks listed on the New York Stock Exchange (NYSE), American Stock Exchange (AMEX), or NASDAQ. Institutional ownership is measured as the fraction of shares held by each type of institution. The ownership fractions are calculated by summing the shares held by each type of institutions and dividing by the total number of shares outstanding on the report date.

Table 1 summarizes the institutional ownership of common stocks and shows 6,193 institutions holding sample stocks. As Panel A reports, most of the institutions are investment advisers (2,868) and hedge funds (1,517) and the number of hedge funds increases rapidly toward the end of the sample period. Panel B shows that the average fraction of shares held by institutions is 57.5%, with mutual funds (29.0%) and banks (9.6%) being the most important institutional investors. Hedge funds hold on average 5.4% of the outstanding shares, but their ownership fraction increases from 1.2% to 8.9% between 1989 and 2012. The increasing importance of hedge funds is also apparent in Fig. 1, which depicts the average fraction of shares held by different types of institutions quarter by quarter. As Fig. 1 shows, hedge fund holdings have increased dramatically in the last 20 years. In aggregate, hedge funds hold 10.5% of the sample firms' 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 have been relatively stable over time, especially during the past 10 years.

[1] The type code variable from Spectrum has had 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.

Table 1
Summary statistics of institutional ownership.

Year	Total	Banks	Insurance companies	Mutual funds	Investment advisers	Hedge funds	Others
Panel A: Number of institutions holding common stocks							
1989–1994	1,621	326	103	419	546	123	104
1995–1999	2,304	302	109	503	942	300	148
2000–2004	2,970	249	93	435	1,240	642	311
2005–2009	3,744	235	88	364	1,705	1,062	290
2010–2012	3,781	225	76	319	1,826	1,050	285
1989–2012	6,193	550	166	597	2,868	1,517	495
Panel B: Fraction of stocks held by institutions							
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
2010–2012	0.644	0.081	0.024	0.319	0.087	0.089	0.043
1989–2012	0.575	0.096	0.033	0.290	0.062	0.054	0.039

This table provides summary statistics for institutional ownership of sample stocks over the 92 quarters from 1989:Q4 through 2012:Q3. The sample stocks are listed on the 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 they hold. The holdings are broken down by type of institutional investor 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 final category, others, includes endowments, foundations, and private pension funds.

3.3. Sample characteristics and control variables

We use a sample comprised of common stocks listed on the NYSE, AMEX, or NASDAQ over the period January 1990 through December 2012. The data are from the Center for Research in Security Prices (CRSP), Compustat, Institute for the Study of Security Markets (ISSM) and Trade and Quote (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 a share price less than $3 at the end of the previous month are excluded. Third, companies incorporated outside the United States, closed-end funds, real estate investment trusts, and financial firms are excluded. The final sample consists of 236,493 firm-quarter observations over 92 quarters, with an average of 2,571 stocks per quarter.

The dependent variables are three alternative measures of liquidity risk: the liquidity beta that relies on the effective bid–ask spread as a liquidity measure, the quoted bid–ask spread as a liquidity measure, or the Amihud illiquidity measure. Following Acharya and Pedersen (2005), we measure stock (portfolio) liquidity risk 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:

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

where $R_{i,t}$ denotes the return on the ith 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.

The innovations in market liquidity (ΔL_t) are obtained by aggregating the daily changes in firm-level liquidity across common stocks traded on the NYSE, AMEX, or NASDAQ. The main liquidity

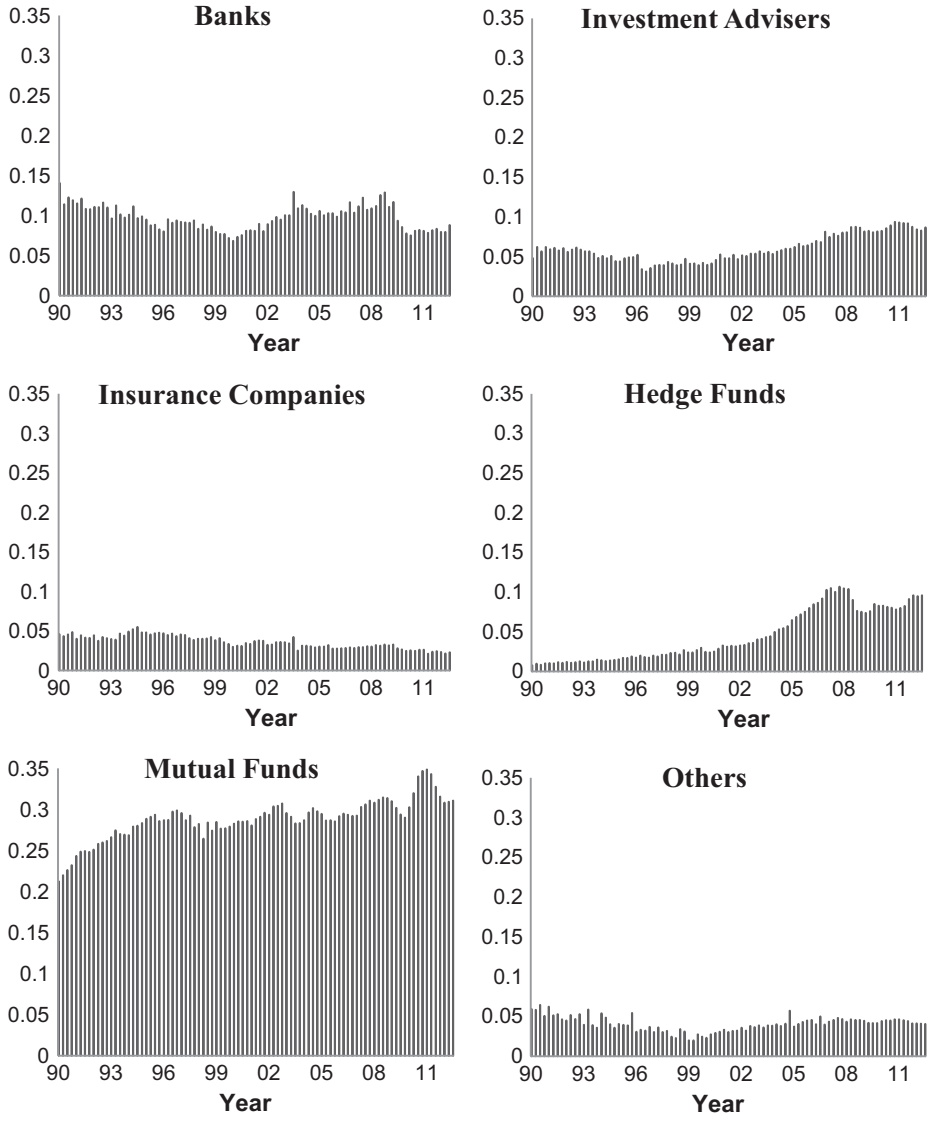

Fig. 1. Fraction of outstanding shares held by different types of institutional investors. The figure shows the average percentage of shares held by six types of institutional investors for the sample stocks over the 92 quarters from 1989:Q4 through 2012:Q3. Sample stocks are listed on the NYSE, AMEX, 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 final category, others, includes endowments, foundations, and private pension funds.

measure is the proportional effective bid–ask spread. In addition, we use the quoted bid–ask spread and the Amihud (2002) measure as alternative liquidity measures.[2]

We control for a number of firm characteristics that may be correlated with liquidity risk. Among the characteristics, liquidity has been suggested as a determinant of stocks' sensitivity to systematic liquidity shocks (i.e., their liquidity risk). For example, Acharya and Pedersen (2005) find that liquidity

[2] For an excellent review of alternative liquidity measures, see Goyenko, Holden, and Trzcinka (2009).

Table 2
Summary statistics of liquidity betas and stock characteristics.

Variable	Mean	Standard deviation	Lower quartile	Median	Upper quartile
Liquidity beta (effective spread)	0.04	0.44	−0.18	0.02	0.24
Liquidity beta (quoted spread)	0.05	0.54	−0.21	0.02	0.28
Liquidity beta (Amihud)	0.04	0.46	−0.19	0.02	0.24
Effective spread	0.71%	0.76%	0.20%	0.44%	1.00%
Quoted spread	1.13%	1.11%	0.35%	0.76%	1.49%
Market beta	1.06	1.62	−0.08	1.05	2.19
Standard deviation	3.90%	2.81%	1.64%	3.39%	5.64%
Average daily return	0.09%	0.44%	−0.15%	0.07%	0.30%
Leverage	0.20	0.19	0.02	0.17	0.33
Book-to-market	0.52	0.39	0.26	0.44	0.69
Market capitalization ($ millions)	3,817	15,992	212	604	2,009
Total institutional ownership	0.57	0.27	0.36	0.60	0.79
Bank ownership	0.10	0.07	0.04	0.09	0.13
Insurance company ownership	0.03	0.04	0.01	0.02	0.04
Mutual fund ownership	0.29	0.17	0.15	0.28	0.42
Investment advisor ownership	0.06	0.06	0.02	0.05	0.09
Hedge fund ownership	0.05	0.08	0.01	0.03	0.07
Other ownership	0.04	0.04	0.01	0.03	0.05
Ownership concentration	0.03	0.05	0.01	0.03	0.05
PIN	0.19	0.09	0.12	0.17	0.25
Short interest	0.05	0.06	0.01	0.02	0.06
Stocks per quarter	2,571	1,107	1,254	3,094	3,492

This table reports summary statics for the sample of 236,493 stock-quarter observations. The sample period covers the 92 quarters from January 1990 through December 2012. 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. The *Book-to-market* ratio is defined as the book value of total shareholder equity divided by the market value of equity. *Ownership concentration* is measured by the Herfindahl index and the *PIN* is a measure of asymmetric information. The *Short interest* ratio is the number of shares held short divided by the number of outstanding shares. The data on short interest ratio start in 2000.

risk is correlated with stocks' characteristic liquidity, although the correlation is far from perfect. We measure liquidity by the proportional effective bid–ask spread,[3] and examine whether institutional ownership explains the liquidity risk of stocks after accounting for their characteristic liquidity. Even though stock liquidity is likely to depend on institutional ownership, which could lead us to underestimate the overall effect of institutional ownership on liquidity risk, we are primarily interested in understanding the cross-sectional variation in liquidity risk that is not explained by liquidity itself. We therefore include the lagged effective bid–ask spread as a control variable.

The other control variables are measured as follows: 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; 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; the book-to-market ratio is the book value of total shareholder equity divided by the market value of equity; firm size is the market capitalization of equity in millions of dollars; and *NASDAQ* dummy is an indicator variable for whether a stock is listed on NASDAQ. All control variables are measured over the quarter prior to estimating liquidity betas.

[3] Alternatively, we also measure liquidity by the average of the proportional quoted bid–ask spread and the Amihud measure.

[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 that tend to purchase stocks based on their past returns.

In addition to firm characteristics, we also control for the concentration of institutional ownership, which is measured by the Herfindahl index (i.e., the sum of the squared ownership fractions of all institutional investors). Ownership concentration can be an important determinant of liquidity risk if block owners exhibit different trading behavior than small investors. Another 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). We estimate the *PIN* for each sample stock each quarter. The inputs into the model, including the number of buys and sells each day for each stock, are inferred from the intraday transactions data of ISSM and TAQ. Finally, we include the *Short interest* ratio as a control variable. Short interest is the number of shares of each stock that have been sold short by investors but have not yet been repurchased. Institutional investors, and particularly hedge funds, often establish short positions in stocks that they consider overvalued, and short interest is therefore important for understanding the overall effect of institutional ownership on liquidity risk. Because short positions are not covered by institutional holdings data from 13F reports, we obtain data on short positions as of the 15th in the last month of each quarter from Bloomberg. We divide the short positions by the outstanding shares in each quarter to calculate the short interest ratio. Since our short interest data start in 2000, we use the short interest ratio only in sub-period tests.

Table 2 reports summary statistics for the dependent and independent variables. All variables except institutional ownership, short interest ratios, 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. All three measures of liquidity risk have a positive mean, which is significantly different from zero.

In Table 2, the summary statistics for the control variables indicate that the sample is made up of relatively liquid stocks. The average *Effective spread* is 0.71% and the average *Quoted spread* is 1.13%. The *Standard deviation* of daily returns is 3.90% and the *Average daily return* is 0.09%. The average (median) *Market capitalization* of sample firms is $3.82 billion ($604 million). *Leverage* is on average 0.20, the book-to-market ratio is 0.52, the *PIN* is 0.19, and the average *Short interest* ratio is 5% of shares outstanding.

4. Results

Two types of tests are performed to examine the effects of institutional ownership on liquidity risk. Liquidity betas are estimated for both portfolios and individual stocks. Tests for the effects of institutional trading on liquidity risk are conducted at both the portfolio level and 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.

4.1. Portfolio-level analysis

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 equally-weighted returns on the 10 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 Eq. (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.

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

Table 3
Institutional ownership for 10 ownership-sorted portfolios.

Sorted by ownership of:	Ownership decile portfolio									
	P-1 (low)	2	3	4	5	6	7	8	9	P-10 (high)
All institutions	0.097	0.256	0.373	0.473	0.559	0.634	0.702	0.768	0.835	0.933
Banks	0.010	0.029	0.049	0.069	0.088	0.107	0.125	0.146	0.174	0.450
Insurance companies	0.003	0.009	0.015	0.021	0.027	0.033	0.041	0.051	0.068	0.404
Mutual funds	0.034	0.097	0.153	0.204	0.253	0.300	0.348	0.401	0.465	0.706
Investment advisers	0.007	0.018	0.027	0.036	0.044	0.053	0.065	0.080	0.105	0.359
Hedge funds	0.003	0.008	0.013	0.018	0.025	0.034	0.047	0.064	0.094	0.345
Others	0.003	0.009	0.015	0.023	0.032	0.040	0.048	0.057	0.073	0.486

At the end of each quarter, stocks are sorted into decile portfolios on the basis of total institutional ownership and sorted 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. This table reports the time-series averages of the fractions of shares held by institutional investors for the ownership-sorted portfolios. The sample period covers the 92 quarters from January 1990 through December 2012. The average number of stocks in each portfolio is 257.

Table 4
Liquidity betas for 10 ownership-sorted portfolios.

Sorted by ownership of:	P-1 (low)	2	3	4	5	6	7	8	9	P-10 (high)	Slope
All institutions	0.13	0.08	0.05	0.03	0.02	0.02	0.01	0.02	0.02	0.04	−0.12**
	(8.73)	(6.05)	(4.31)	(3.19)	(2.17)	(2.46)	(1.74)	(2.03)	(1.87)	(3.36)	(−4.13)
Banks	0.21	0.13	0.07	0.04	0.03	0.01	0.00	−0.01	−0.02	−0.02	−0.38*
	(11.90)	(8.17)	(4.74)	(3.08)	(2.98)	(0.92)	(0.50)	(−0.86)	(−2.67)	(−2.73)	(−2.34)
Insurance	0.14	0.04	0.03	0.01	0.01	0.02	0.02	0.02	0.01	0.03	−0.05
	(9.20)	(2.70)	(1.96)	(0.96)	(0.96)	(2.08)	(2.98)	(2.89)	(1.76)	(3.09)	(−0.46)
Mutual funds	0.11	0.05	0.04	0.03	0.02	0.02	0.02	0.03	0.04	0.05	−0.05
	(7.89)	(3.98)	(3.88)	(3.11)	(2.76)	(2.44)	(2.21)	(3.15)	(3.92)	(4.30)	(−1.10)
Investment advisers	0.09	0.05	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	−0.02
	(6.10)	(4.69)	(3.29)	(3.12)	(3.50)	(3.35)	(3.32)	(3.73)	(3.38)	(3.70)	(−0.30)
Hedge funds	0.00	0.01	0.01	0.01	0.02	0.04	0.04	0.07	0.08	0.10	0.28**
	(0.32)	(0.75)	(1.72)	(1.76)	(1.89)	(4.30)	(4.05)	(5.53)	(6.77)	(7.63)	(4.01)
Others	0.13	0.08	0.05	0.03	0.02	0.00	0.00	0.01	0.01	0.02	−0.08
	(9.62)	(6.41)	(3.89)	(2.19)	(1.44)	(0.53)	(0.47)	(1.12)	(1.11)	(1.66)	(−0.79)

This 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 equally weighted portfolio returns against innovations in market liquidity (measured by the proportional effective bid–ask spread) while controlling for market returns. The sample period covers the 92 quarters from January 1990 through December 2012. The *t*-statistics in parentheses are computed using Newey-West standard errors with eight 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.

* Statistical significance at the 5% level.

** Statistical significance at the 1% level.

are the time series averages of the fractions of shares held by institutions. The average number of stocks in each portfolio is 257. Total institutional holdings comprise 9.7% of portfolio 1 and 93.3% of portfolio 10 during 1989–2012. 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 70.6% for portfolio 10. Hedge fund ownership is close to zero for decile portfolio 1, 2.5% for portfolio 5, and 34.5% for portfolio 10 if the sample stocks are sorted by hedge fund ownership. These results indicate 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 market-wide liquidity measured by the effective bid–ask spread (see Eq. (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 0.13 for portfolio 1 but only 0.02 for portfolio 9 and 0.04 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 also, to a lesser degree, to ownership by insurance companies and institutions classified as others. In sharp contrast, stock liquidity risk is positively related to hedge fund ownership: the greater 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

Table 5
Liquidity betas for 25 portfolios sorted by hedge fund (bank) ownership and liquidity.

	Own-1 (low)	Own-2	Own-3	Own-4	Own-5 (high)
Panel A: Sorted by hedge fund ownership and liquidity					
Liq-1 (Liquid)	−0.03	0.01	0.01	0.06	0.08
	(−2.79)	(0.95)	(0.65)	(4.62)	(5.76)
Liq-2	−0.01	0.01	0.02	0.04	0.08
	(−1.06)	(0.07)	(2.28)	(3.56)	(5.96)
Liq-3	0.01	−0.01	0.03	0.04	0.07
	(0.49)	(−0.65)	(3.07)	(3.09)	(5.69)
Liq-4	−0.02	0.01	0.02	0.04	0.09
	(−1.56)	(1.72)	(2.14)	(3.73)	(6.74)
Liq-5 (Illiquid)	0.05	0.06	0.08	0.10	0.14
	(4.68)	(5.71)	(6.85)	(8.13)	(9.84)
Panel B: Sorted by bank ownership and liquidity					
Liq-1 (Liquid)	0.13	0.05	0.02	−0.01	−0.02
	(7.86)	(3.33)	(2.16)	(−1.13)	(−2.55)
Liq-2	0.14	0.05	0.03	0.01	−0.02
	(8.92)	(3.26)	(2.39)	(0.45)	(−2.46)
Liq-3	0.13	0.05	0.01	−0.01	−0.02
	(8.81)	(3.83)	(1.30)	(−0.67)	(−2.94)
Liq-4	0.15	0.04	0.01	−0.01	−0.02
	(8.83)	(3.06)	(1.22)	(−0.92)	(−2.43)
Liq-5 (Illiquid)	0.19	0.08	0.03	0.01	−0.03
	(10.61)	(5.56)	(3.00)	(0.50)	(−2.62)

Panel C: Regressions of portfolio liquidity betas on hedge fund (bank) ownership and liquidity

	(1)	(2)
Hedge fund ownership	0.41**	–
	(8.31)	–
Bank ownership	–	−0.53**
	–	(−3.95)
Liquidity	0.04**	0.01
	(6.44)	(0.76)
Intercept	−0.01	0.06**
	(−1.89)	(3.55)

This 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 equally weighted portfolio returns against innovations in market liquidity (measured by the proportional effective bid–ask spread) while controlling for market returns. The sample period covers the 92 quarters from January 1990 through December 2012. The *t*-statistics in parentheses below liquidity betas are computed using Newey-West standard errors with eight 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.

** Statistical significance at the 1%. level.

negative and significant, with a t-statistic of -4.13, confirming a negative relation between liquidity risk and total institutional holdings. Among the six types of institutional investors, there is a significant slope coefficient for hedge fund and bank ownership. The slope coefficient of hedge fund ownership is positive and significant at the 1% level (with a t-statistic of 4.01), while the coefficient of bank ownership is negative and significant at the 5% level (with a t-statistic of -2.3). Portfolios sorted by ownership of other types of institutional investors do not reveal a significant relationship between ownership and liquidity risk.

Acharya and Pedersen (2005) show that liquidity risk is correlated with stock liquidity, although the correlation is far from perfect. They find that liquidity risk is priced in addition to the characteristic liquidity of stocks. We therefore examine whether institutional ownership explains the cross-sectional variation in liquidity risk of stocks after accounting for liquidity. Specifically, we estimate 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 Fig. 2 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 Fig. 2 report the liquidity betas if stocks are double-sorted by bank ownership and liquidity. Fig. 2 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.

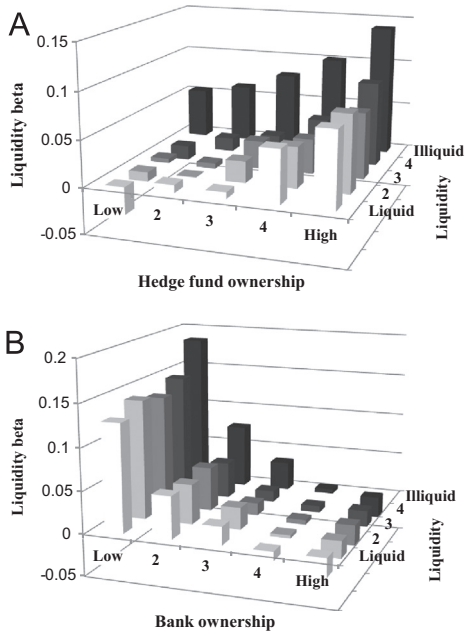

Fig. 2. Liquidity betas for 25 portfolios sorted by hedge fund (bank) ownership and liquidity. Panel A: Sorted by hedge fund ownership and liquidity. Panel B: Sorted by bank ownership and liquidity. This figure shows the liquidity betas for 25 portfolios independently sorted into quintiles based on hedge 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 each quarter and liquidity betas are estimated over the subsequent quarter by regressing daily equally weighted portfolio returns against innovations in market liquidity, while controlling for market returns. The sample period covers the 92 quarters from January 1990 through December 2012. 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.

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 of hedge fund ownership is positive and significant at the 1% level (t-statistic=8.31), while the coefficient of bank ownership is negative and significant at the 1% level (t-statistic=-3.95). Thus, liquidity risk remains strongly related to hedge fund and bank ownership, even after accounting for the differences in the 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, market capitalization, or past liquidity betas.

4.2. Firm-level analysis

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) institutions prefer stock characteristics that are correlated with liquidity risk. For example, mutual funds prefer the liquid stocks of large firms, while 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:

$$\beta^{L}_{i,q} = \gamma_0 + \gamma_1' \, OWNERSHIP_{i,q-1} + \gamma_2' \, CONTROLS_{i,q-1} + \beta^{L}_{i,q-1} + \varepsilon_{i,q,} \tag{2}$$

where $\beta^{L}_{i,q}$ is the liquidity beta for the ith stock in quarter q and $OWNERSHIP_{i,q-1}$ 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 stock-specific measures of average liquidity, market risk, momentum, volatility, leverage, size, book-to-market ratio, and a measure of information asymmetry, all lagged by one quarter. To control for the fact that institutional investors may differ in their willingness to assume liquidity risk, specification (2) also includes the lagged liquidity beta ($\beta^{L}_{i,q-1}$).

The inference is conducted using the Fama-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 mean and unit variance 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) heteroscedasticity and autocorrelation consistent standard errors.

Table 6 reports the time series averages of the quarterly slope coefficients from Fama-MacBeth cross-sectional regressions of liquidity betas on the aggregate institutional holdings (as a fraction of the outstanding shares), various stock characteristics, and other control variables. Based on specifications (1) and (2), we note that the relation between liquidity risk and the total institutional ownership does not change when control variables are included in the analysis. The total institutional ownership continues to have a significant negative effect on liquidity risk in the cross-section, showing that shocks that are held by institutional investors on average have a lower liquidity risk than stocks held by individual investors.

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. The effect of the total institutional ownership on liquidity risk is negative but small when compared to individual ownership. According to the second specification in Table 6, the coefficient estimate on institutional ownership is -0.014, significant at the 1% level (t-statistic$=-2.82$). Thus, a one standard deviation increase in institutional holdings (an increase by 27% of shares outstanding) has the effect of decreasing the liquidity beta by about 0.01 standard deviation after controlling for stock characteristics and liquidity.

Table 6
Cross-sectional regressions of liquidity betas on total institutional ownership.

	(1)		(2)	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Total institutional own.	−0.062**	−6.90	−0.014**	−2.82
Own. concentration			0.004*	2.48
Avg. effective spread			0.064**	5.10
Market beta			−0.011**	−2.70
Standard deviation			0.003	0.91
Average return			0.023**	2.80
Leverage			0.002	0.58
Book-to-market			−0.021*	−2.74
Market cap.			−0.032*	−2.75
NASDAQ dummy			0.035	1.64
PIN			0.015**	3.06
Lagged liquidity beta			0.041**	5.25
Avg. R^2	0.009		0.049	

This table reports the estimates from cross-sectional regressions of liquidity betas on the fraction of shares held by institutional investors and on control variables. The analysis covers the 92 quarters from 1990:Q1 through 2012:Q4, with 236,493 stock-quarter observations. All variables are standardized to have zero mean and unit variance in each quarter. This table reports the time-series averages of the quarterly cross-sectional slope coefficients and the Fama-MacBeth *t*-statistics corrected for serial correlation using Newey-West standard errors with four lags.

* Statistical significance at the 5% level.

** Statistical significance at the 1% level.

Table 7 reports the coefficient estimates when the ownership fractions of different types of institutional investors enter the regressions as separate variables, and paints a more complete picture about the importance of institutional ownership for liquidity risk. The marginal effects of different categories of institutional ownership are benchmarked against the effect of individual ownership, which is the omitted ownership category. According to the second specification in Table 7, the fraction of shares held by hedge funds in quarter q - 1 is strongly positively associated with liquidity risk in quarter q in the cross-section, with a coefficient of 0.209, and significant at the 1% level (t-statistic = 5.98). Thus, a one standard deviation increase in hedge fund holdings (an increase by 8% of shares outstanding) increases the liquidity beta by about 0.2 standard deviations.

In contrast, fractional ownership by banks is strongly negatively associated with liquidity risk. The coefficient of bank ownership is −0.145, with a t-statistic of −8.26, showing that a one standard deviation increase in bank ownership (an increase by 7% of shares outstanding) has an effect of reducing the liquidity beta by 0.15 standard deviations. Additionally, the ownership fractions of mutual funds and investment advisers are positively related to liquidity risk at the 5% level. However, the marginal effects of mutual fund and investment adviser ownership are small compared to the effects of hedge fund or bank ownership.

Among the control variables in Table 7, 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 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 1% level. Nevertheless, none of the control variables subsume the effect of institutional ownership on liquidity risk. Institutional ownership alone accounts for 2.2% 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 in Tables 6 and 7 support the hypothesis (H1) that institutional ownership affects liquidity risk in stocks' cross-section. The effect of the total institutional ownership on liquidity risk is negative but economically small compared to the effect of individual ownership. More importantly, liquidity risk in quarter q is strongly positively related to hedge fund ownership and negatively related to bank ownership in quarter $q-1$. These results are robust even after controlling

Table 7
Regressions of liquidity betas on ownership of different types of institutional investors.

	Panel A: Parameter estimates (1)		(2)	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Banks	−0.275**	−10.53	−0.145**	−8.26
Insurance companies	−0.025	−1.10	0.013	0.68
Mutual funds	0.008	0.74	0.021*	2.14
Investment advisers	0.044	1.82	0.046*	2.45
Hedge funds	0.235**	8.26	0.209**	5.98
Others	−0.096*	−2.40	−0.039	−1.05
Own. concentration			0.006	1.13
Avg. effective spread			0.061**	5.13
Market beta			−0.012**	−3.22
Standard deviation			0.002	0.62
Average return			0.020**	2.65
Leverage			−0.001	−0.27
Book-to-market			−0.018*	−2.48
Market cap.			−0.022*	−2.24
NASDAQ dummy			0.016	0.93
PIN			0.015**	3.12
Lagged liquidity beta			0.035**	5.55
Avg. R^2	0.022		0.055	

Panel B: Tests for differences between hedge funds and other institutional investors

	Difference	*F*-statistic	*p*-value
Hedge funds—Banks	0.354	81.85	< 0.01
Hedge funds—Insurance companies	0.196	24.33	< 0.01
Hedge funds—Mutual funds	0.188	26.88	< 0.01
Hedge funds—Investment advisers	0.163	16.86	< 0.01
Hedge funds—Others	0.248	23.69	< 0.01

This table reports the results from cross-sectional regressions of liquidity betas on the fraction of shares held by different types of institutional investors and on control variables. The analysis covers the 92 quarters from 1990:Q1 through 2012:Q4, with 236,493 stock-quarter observations. All variables are standardized to have zero mean and unit variance in each quarter. This table reports the time-series averages of the quarterly cross-sectional slope coefficients and the Fama-MacBeth *t*-statistics corrected for serial correlation using Newey-West standard errors with four lags. * and ** indicate statistical significance at the 5% and 1% levels, respectively. 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.

for stock characteristics and taking into account ownership concentration, informational asymmetry, and liquidity risk in quarter $q-1$.

Thus, the evidence at both the portfolio and individual stock levels supports the hypothesis (H1) that institutional ownership has a differential effect on liquidity risk. Furthermore, there is evidence to support hypothesis (H2) that hedge fund ownership has an increasing effect on the liquidity risk of stocks. There is also some support for the hypothesis (H3) that greater mutual fund ownership leads to higher liquidity risk because of mutual fund herding and correlated trading. Liquidity betas significantly related to mutual fund ownership at the 5% level according to specification (2) in Table 7. The hypothesis (H4) that greater ownership by banks leads to lower liquidity risk of stocks is also supported by test results at the portfolio and firm levels.

The tests so far have benchmarked the effects of institutional ownership on liquidity risk against the effect of individual ownership (the omitted ownership category). Next, we compare the marginal effects of different types of institutions on liquidity risk against each other. Specifically, we test hypothesis H5 by examining whether the marginal effect of hedge fund ownership is greater than that for other types of institutional investors and report the results in Panel B of Table 7.

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 (0.209 vs. 0.021) is 26.88, significant at the 1% level. The difference between the coefficients of hedge funds and investment advisers (0.209 vs. 0.046) 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 hypothesis (H5) that hedge fund ownership increases liquidity risk more than ownership by other types of institutions.

As an alternative to Fama-MacBeth (1973) regressions, we estimate pooled regressions with time fixed effects and standard errors clustered two-way by time and firm. The estimates and inferences are very similar to those from cross-sectional regressions. For brevity, these results are not reported but are available upon request.

4.3. Hedge fund leverage

Leverage plays a pivotal role as the transmitting mechanism for liquidity shocks in the model of Brunnermeier and Pedersen (2009). However, not all hedge funds use leverage. We therefore proceed to separate levered from unlevered hedge funds and perform another test of the Brunnermeier-Pedersen model by examining the relation between liquidity risk and ownership by levered hedge funds.[5]

Several issues arise in separating the holdings of levered and unlevered hedge funds. First, holdings are reported at the hedge fund management company level, whereas leverage is a characteristic of individual hedge funds. We therefore collect information on the use of leverage at the fund level from the hedge fund databases that track such information, including TASS, HFR, BarclayHedge, CISDM, and Morningstar (in this order of preference), and aggregate the information to the management company level.[6] Specifically, in each year, we identify unique names of hedge funds from the five databases that pursue an equity-oriented strategy.[7] Hedge funds that pursue other strategies including fixed-income, macro, commodity, currency, emerging market or convertible arbitrage strategies are not considered because these funds do not typically hold U.S. equities. Funds-of-funds are also excluded because they do not directly hold stocks. Overall, from the five hedge fund databases, we identify 3,598 unique funds that are likely to invest in 13F stocks.

For each of the qualifying hedge funds, we obtain information on the use of leverage. In addition to leverage, we gather information on the funds' assets under management (AUM), initial lockup periods, and redemption notice periods (if available). For each management company in a given year, we then compute the percentage of AUM of funds that use leverage, and classify a management company as levered if the assets of funds that use leverage are greater than the assets of funds that do not use leverage.[8, 9] Otherwise, the management company is classified as unlevered in a given year.

Another issue is that leverage is reported to the databases at a single date, whereas hedge funds' decisions to use or not use leverage may change over time. We address this concern by using old vintages of the hedge fund databases that were downloaded at the time of the holdings report (if available) or after the holdings report. For example, our first download of the TASS database is from March 2007, and we use this download to classify the funds in TASS up to the end of 2007. From 2007 onward, we use more recent versions of the TASS database to classify hedge funds into one of the two leverage groups. We proceed in a similar way with funds identified from the other databases. Since we

[5] We are grateful to an anonymous referee who suggested these tests.

[6] Joenväärä, Kosowski, and Tolonen (2013) show that there are qualitative and quantitative differences in conclusions about hedge fund performance and characteristics among hedge fund databases. We therefore combine information on hedge fund characteristics from several hedge fund databases.

[7] The equity-based strategies are: long/short equity, equity hedge, event-driven, multi-strategy, equity market neutral, equity long bias, equity short bias, merger arbitrage, U.S. equity, sector equity, special situations, activist, and "other."

[8] When the AUM is missing, we assign equal weights to all funds.

[9] As a robustness check, we also assign equal weights to all funds when calculating leverage at the management company level. The results are similar.

Table 8
Characteristics of levered and unlevered hedge fund management companies.

Variable	Levered company	Unlevered company	Difference	*t*-statistic
Ownership	0.03	0.02	0.01**	8.90
Number of funds	3.05	2.56	0.49*	2.16
Number of levered funds	2.62	0.47	2.15**	13.65
Number of unlevered funds	0.43	2.09	−1.66**	−9.01
AUM ($ millions)	716.32	487.73	228.59	1.73
Levered AUM ($ millions)	672.08	65.55	606.54**	5.79
Unlevered AUM ($ millions)	44.24	422.18	−377.94**	−5.38
Initial lockup period (months)	4.39	3.40	0.99	1.50
Redemption notice period (days)	40.36	41.33	−0.97	−0.65
Avg. number of HF companies	484	675		

This table reports the characteristics of levered and unlevered hedge fund management companies. A hedge fund company is classified as levered in a given year if the assets under management (AUM) of its equity-oriented funds that use leverage are greater than the AUM of its equity-oriented funds that do not use leverage. Otherwise, the company is classified as unlevered in a given year. The sample includes all management company-years for which information on leverage is reported in TASS, HFR, CISDM, BarclayHedge, or Morningstar database between 2001 and 2012. *Ownership* is the fraction of the outstanding shares that are held by all the hedge fund companies in the sample for the average sample stock. The remaining variables show the *Number of hedge funds*, the *Number of levered (unlevered) hedge funds*, total *AUM*, the *AUM of Levered (Unlevered)* hedge funds, the *Initial lockup period*, and the *Redemption notice period* for the average levered (unlevered) hedge fund company in the sample. The *t*-statistics are corrected for serial correlation using Newey-West standard errors with four lags. * and ** indicate that the difference between levered and unlevered hedge fund companies is statistically significant at the 5% and 1% levels, respectively.

do not have any downloads of the hedge fund databases from the 1990s, we are not able to reliably distinguish between levered and unlevered hedge funds during the period from 1990 to 2000. We therefore limit the tests of hedge fund leverage to the more recent period from 2001 to 2012.

Table 8 reports the characteristics of levered and unlevered hedge fund management companies between 2001 and 2012. There are, on average, 484 levered hedge fund companies and 675 unlevered hedge fund companies in the typical sample year. The levered hedge fund companies hold on average about 3% of the outstanding shares for sample stocks between 2001 and 2012, whereas the unlevered hedge fund companies hold about 2% of the outstanding shares.[10] Thus, although the number of levered hedge fund companies in the sample is smaller than the number of unlevered hedge fund companies, the equity holdings of levered hedge fund companies for the average sample stock are significantly larger (*t*-statistic=8.90) due to the effect of leverage and the larger size of levered hedge fund companies. We also note that the percentage of levered hedge fund companies and their share of total hedge fund holdings vary over the sample period. The share of levered hedge funds of total hedge fund holdings peaked at about 64% in mid-2007, and averaged about 56% between 2010 and 2012.

As Table 8 also shows, levered hedge fund companies on average manage 2.62 funds using leverage and 0.43 funds not using leverage, while unlevered companies manage 0.47 funds using leverage and 2.09 funds not using leverage. The hedge fund companies in the sample are typically large, with mean AUM of $716 million ($488 million) among levered (unlevered) companies. More than 90% of the assets of levered hedge fund hedge fund companies are managed by funds using leverage, while more than 85% of the assets of unlevered hedge fund firms are managed by funds not using leverage. Thus, even though hedge fund ownership is measured at the company level, it accurately reflects the variation in leverage among individual hedge funds. Finally, the initial lockup period and the redemption notice period are not significantly different among levered and unlevered hedge fund firms.

[10] Hedge fund companies that cannot be accurately classified—either because the companies cannot be matched to any of the five hedge fund databases, or because their funds do not report leverage—hold an additional 2% of the outstanding shares between 2001 and 2012.

Table 9
Regressions of liquidity betas on levered and unlevered hedge fund ownership.

	Panel A: Parameter estimates (1)		(2)	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Banks	−0.239**	−6.28	−0.162**	−5.92
Insurance companies	0.039	1.63	0.059*	2.50
Mutual funds	0.008	0.96	0.023*	2.77
Investment advisers	0.002	0.06	0.039	1.36
Levered hedge funds	0.590**	8.84	0.586**	7.50
Unlevered hedge funds	0.026	0.81	0.112	1.38
Others	0.023	0.64	0.063	1.61
Control variables	NO		YES	
Avg. R^2	0.017		0.042	

Panel B: Tests for differences between levered hedge funds and other institutional investors

	Difference	*F*-statistic	*p*-value
Levered HF—Banks	0.648	81.57	< 0.01
Levered HF—Insurance companies	0.527	41.65	< 0.01
Levered HF—Mutual funds	0.563	51.36	< 0.01
Levered HF—Investment advisers	0.547	43.26	< 0.01
Levered HF—Unlevered HF	0.474	17.68	< 0.01
Levered HF—Others	0.523	35.77	< 0.01

This table reports the results from cross-sectional regressions of liquidity betas on the fraction of shares held by different types of institutional investors, including levered and unlevered hedge funds, and on other control variables. The analysis covers the 48 quarters from 2001:Q1 through:2012:Q4, with 160,028 stock-quarter observations. All variables are standardized to have zero mean and unit variance in each quarter. Control variables are the same as in Table 6. Reported are the time-series averages of the quarterly cross-sectional slope coefficients and the Fama-MacBeth *t*-statistics corrected for serial correlation using Newey-West standard errors with four lags. * and ** indicate statistical significance at the 5% and 1% levels, respectively. 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 unlevered ownership and ownership by other types of institutional investors.

Using the data on equity ownership of levered and unlevered hedge fund firms, we examine the importance of hedge fund leverage for liquidity risk in the cross-section of stocks. Table 9 provides the results of cross-sectional regressions of liquidity betas on ownership variables, where hedge fund ownership is divided between levered and unlevered managers. The unclassified hedge fund holdings, which account for about 2% of the outstanding shares on average, are added to the unlevered hedge fund holdings for this test.[11] As shown in column (2) of Table 9, levered hedge fund ownership is positively and significantly related to liquidity risk in the cross-section, whereas unlevered hedge fund ownership is not significantly related to liquidity risk after controlling for levered hedge fund ownership. The coefficient on levered hedge fund ownership is 0.59, with a *t*-statistic of 7.50, but the coefficient on unlevered hedge fund ownership is insignificant. Thus, unlevered hedge fund ownership provides no additional information about the cross-section of liquidity risk over that provided by levered hedge fund ownership. In Panel B of Table 9, we show that the coefficient of levered hedge fund ownership is significantly larger than that of unlevered hedge fund ownership or ownership by other types of institutions.

Although unlevered hedge fund ownership is insignificant in Table 9, further tests indicate that its lack of significance is partly explained by the collinearity between levered and unlevered hedge fund ownership. If levered hedge fund ownership is excluded from the regression, the coefficient on unlevered hedge fund ownership remains positive and statistically significant. Furthermore, the variance inflation factor (VIF) for unlevered hedge fund ownership increases from 1.8 to 36.6 if levered

[11] The results are not sensitive to this choice.

hedge fund analysis is also included among the explanatory variables, indicating a high degree of collinearity between the two variables.

To examine the robustness of the estimates reported in Table 9, we orthogonalize levered hedge fund ownership by regressing it first against unlevered hedge fund ownership and use the residuals from this regression as an explanatory variable. We find that both levered and unlevered ownership is significantly positively related to liquidity risk in this test. On the other hand, if we orthogonalize unlevered hedge fund ownership first by regressing it against levered hedge fund ownership, we find that the orthogonalized unlevered hedge fund ownership is not significantly related to liquidity risk. These regressions (not reported for brevity) confirm the robustness of the coefficients reported in Table 9 with respect to levered hedge fund ownership, and show that unlevered hedge fund ownership provides no information about liquidity risk beyond that conveyed by levered hedge fund ownership. Taken together, these findings provide further evidence that hedge fund leverage increases the liquidity risk of stocks that hedge funds own.

5. Robustness analysis

5.1. The endogeneity of institutional ownership

The tests reported above show that liquidity risk is strongly related to hedge fund and bank ownership, and the ownership effect remains economically and statistically significant even after controlling for the tendency of hedge funds to choose riskier investments than banks or mutual funds. We interpret the evidence as supporting the hypothesis (H1) that institutional ownership affects the liquidity risk of stocks. In this section, we test whether the results can be also explained by the endogeneity of institutional ownership.

Hedge funds could, for example, invest in stocks with high liquidity risk to earn the liquidity risk premium documented by Pastor and Stambaugh (2003). To understand whether this mechanism can explain the findings, we examine the liquidity betas in quarter q of 25 portfolios independently sorted into quintiles based on liquidity risk in quarter $q-1$ (the lagged liquidity beta) and their hedge fund or bank ownership. The estimated liquidity betas for the 25 portfolios sorted by hedge fund (bank) ownership and past liquidity risk are reported in Panel A (Panel B) of Table 10. Past liquidity risk is positively related to the current liquidity betas, showing that there is some persistence in liquidity risk. However, the effect of institutional ownership is not subsumed by past liquidity risk. As Panel C of Table 10 reports, the effect of hedge fund and bank ownership remains highly significant when portfolio liquidity betas are regressed against the institutional ownership of each portfolio and its past liquidity risk. These results show that hedge fund and bank holdings provide information about liquidity risk in quarter q beyond that conveyed by liquidity risk in quarter $q-1$, suggesting that institutional preferences for stocks with different sensitivities to aggregate liquidity cannot be used to explain our findings.

5.2. Alternative measures of market liquidity

Our 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, other liquidity measures have been proposed to capture the different dimensions of liquidity. To address the concern that the 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 re-examine the cross-sectional relation between liquidity betas and institutional ownership using Eq. (2).

The results relying on the alternative measures (not shown for brevity) are consistent with those based on the other liquidity measures. Hedge fund ownership continues to have the greatest positive effect on liquidity betas, and bank ownership the greatest negative impact. Although the effect of mutual fund ownership is also positive and significant at the 5% level when liquidity betas are

Table 10
Liquidity betas for 25 portfolios sorted by hedge fund (bank) ownership and past liquidity risk.

	Own-1 (low)	Own-2	Own-3	Own-4	Own-5 (high)
Panel A: Sorted by hedge fund ownership and past liquidity risk					
Risk-1 (Low)	−0.01	0.01	0.02	0.04	0.08
	(−1.02)	(1.01)	(2.54)	(3.61)	(5.04)
Risk-2	−0.01	0.01	0.04	0.05	0.08
	(−0.67)	(1.63)	(3.02)	(3.73)	(6.98)
Risk-3	−0.01	0.03	0.03	0.05	0.08
	(−0.61)	(2.21)	(2.90)	(3.94)	(5.67)
Risk-4	0.01	0.02	0.02	0.06	0.09
	(0.79)	(2.03)	(2.62)	(4.53)	(7.11)
Risk-5 (High)	0.05	0.03	0.04	0.07	0.11
	(2.99)	(2.36)	(3.70)	(5.34)	(7.63)
Panel B: Sorted by bank ownership and past liquidity risk					
Risk-1 (Low)	0.06	0.01	0.01	0.01	−0.02
	(6.72)	(2.98)	(1.26)	(0.25)	(−2.33)
Risk-2	0.10	0.04	0.02	0.01	−0.02
	(8.77)	(3.15)	(1.58)	(0.18)	(−1.36)
Risk-3	0.15	0.05	0.03	0.01	−0.02
	(9.38)	(3.41)	(2.00)	(0.10)	(−1.88)
Risk-4	0.17	0.05	0.02	0.01	−0.01
	(9.82)	(3.55)	(1.72)	(0.02)	(−1.34)
Risk-5 (High)	0.17	0.09	0.07	0.05	−0.01
	(9.88)	(3.86)	(2.31)	(1.14)	(−0.98)

Panel C: Regressions of portfolio liquidity betas on hedge fund (bank) ownership and past liquidity risk

	(1)	(2)
Hedge fund ownership	0.35**	–
	(9.45)	–
Bank ownership	–	−0.46**
	–	(−4.08)
Past liquidity risk	0.12**	0.23*
	(3.81)	(2.34)
Intercept	−0.02	−0.02
	(−1.99)	(−0.42)

This table shows liquidity betas for 25 portfolios independently sorted into quintiles based on hedge fund (Panel A) or bank (Panel B) ownership and past liquidity risk. Past liquidity risk of each stock is measured by the lagged liquidity beta. Stocks are sorted into portfolios in each quarter and liquidity betas are estimated over the subsequent quarter by regressing daily equally weighted portfolio returns against innovations in market liquidity (measured by the proportional effective bid–ask spread) while controlling for market returns. The sample period covers the 92 quarters from January 1990 through December 2012. The *t*-statistics in parentheses below liquidity betas are computed using Newey-West standard errors with eight lags. Ownership portfolio 1 (5) contains stocks in the lowest (highest) hedge fund or bank ownership quintile. Risk portfolio 1 (5) contains stocks in the lowest (highest) past liquidity risk 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 past liquidity risk.

* Statistical significance at the 5% level.

** Statistical significance at the 1% level.

estimated with respect to the Amihud illiquidity measure, the marginal effect of hedge fund ownership is significantly larger than the marginal effect of mutual fund ownership.

5.3. Sub-sample 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: 1990–2000 and 2001–2012. The first sub-period is characterized by low hedge fund ownership (1–2%) and 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 8.9% of publically traded stocks during 2010–2012, whereas bank ownership remains nearly unchanged.

The results (not tabulated) reveal that hedge fund and bank ownership is significantly related to liquidity risk during both sub-periods. The effect of hedge fund ownership on liquidity risk doubles during 2001–2012 (0.255 vs. 0.109) as hedge fund ownership becomes widespread. The test for the difference between the two sub-periods shows that the marginal effect of hedge funds on liquidity risk is significantly larger in recent years (2001–2012) than in early years (1990–2000), which indicates that increased use of leverage or capacity constraints may have amplified the effect of hedge funds in recent years. In contrast, the effect of mutual fund or bank ownership does not significantly differ between the two sub-periods.

We also use the short interest data, which are available for the second sub-period, to examine whether the association between liquidity risk and institutional ownership might be explained by higher short interest ratios for stocks held by institutional investors. We find that the coefficient estimates on hedge fund and bank ownership are almost unchanged after controlling for the short interest ratio. The coefficient on the short interest ratio is negative but insignificant in a multivariate regression that includes the entire set of control variables. Thus, differences in short interest cannot be used to explain the relation between liquidity risk and hedge fund or bank ownership.

6. Conclusion

Although researchers recognize 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. In this paper, we examine whether institutional ownership affects the liquidity risk of stocks. In particular, we use a detailed ownership dataset 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 stock liquidity risk differ from the effects of ownership by other types of institutional investors, such as mutual funds and banks? (3) Is the effect of hedge fund ownership on liquidity risk related to hedge funds' use of leverage? 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 differently than individual ownership. Stocks that are held by institutions on average have lower liquidity risk than stocks that are held by individual investors during the period from 1990 to 2012. This finding supports the theory of Baker and Stein (2004) that market liquidity is in part driven by individual investor sentiment. However, we also find that different types of institutional investors affect liquidity risk in opposite directions. In particular, there is a significant and positive relationship between hedge fund ownership in quarter q - 1 and the liquidity risk of stocks in quarter q. 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 particular if the hedge funds use leverage. Furthermore, hedge fund ownership has a significantly larger effect on liquidity risk than mutual fund ownership or ownership by other types of institutional investors. 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.

In contrast, stocks in which commercial banks are marginal investors tend to be less exposed to market liquidity fluctuations. We find a significant and negative relationship between bank ownership in quarter q - 1 and the liquidity risk of stocks in quarter q. 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. Finally, mutual fund ownership is significantly related to liquidity in several specifications. 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.

This study contributes to our understanding of the relationship between liquidity risk and institutional ownership in general and between liquidity risk and ownership by hedge funds in

particular. Future research should examine the importance of hedge fund ownership for liquidity risk in other financial markets such as the debt market.

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