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Liquidity risk in stock returns: An event-study perspective

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ABSTRACT

We examine in an event-study context what factors affect the relative performance of stocks during liquidity crises. We find that market risk, measured by the market beta, is not a good measure of expected abnormal stock returns on days with liquidity crises. Instead, abnormal stock returns during liquidity crises are strongly negatively related to liquidity risk, measured by the co-movement of stock returns with market liquidity. The degree of informational asymmetry and the ownership structure of the firm also help to explain abnormal stock returns on crisis days. Our findings have important implications for managing the liquidity risk of equity portfolios.

0. Introduction

The financial crisis of 2007–2009 was associated with several liquidity shocks that stressed the importance of liquidity risk for stock returns. While some stocks performed relatively well during periods of market turbulence, other stocks proved to be highly exposed to market liquidity dry-ups and underperformed the market portfolio during the crisis. Understanding the variations in stock returns during liquidity crises is important for risk management and portfolio selection. However, previous research provides little insight into the factors that determine the relative performance of stocks during liquidity crises.

This paper examines the determinants of cross-sectional stock returns during liquidity crises in an event-study context. We use several alternative measures of market liquidity to identify liquidity crises, including the innovations in the proportional quoted bid–ask spread, the innovations in the proportional effective bid–ask spread, and the Amihud (2002) illiquidity measure. Liquidity crises are defined as days in the left tail of the distribution of each of these measures. Specifically, we focus on the 48 days (1% of sample days) or 24 days (0.5% of sample days) with the largest adverse shocks to market liquidity between 1993 and 2011. We then empirically investigate what risk measures and characteristics can explain stocks' relative performance during liquidity crises.

We test in the cross-section of stocks several hypotheses about the determinants of abnormal performance of stocks during liquidity crises. Pastor and Stambaugh (2003) propose that the liquidity risk of stocks be measured by the liquidity beta, i.e. the covariance between individual stock returns and innovations in aggregate market liquidity. They show that investors require positive risk premiums to hold stocks with high liquidity betas. Acharya and Pedersen (2005) and Korajczyk and Sadka (2008) demonstrate that the liquidity beta is a distinct category of risk from the characteristic liquidity of stocks. Recently, Cao et al. (2013a,b) explore a new dimension of hedge-fund and mutual-fund managers' timing ability by examining whether they can time market liquidity through adjusting their portfolios' market exposure as aggregate liquidity conditions change. They show that liquidity timing is an important source of fund managers' abnormal performance.

However, not much is known about the importance of the liquidity beta for risk management. We examine whether liquidity risk, measured by the estimated liquidity beta, can predict the differences in stocks' relative performance during liquidity crises. We further compare the importance of liquidity risk with that of market risk, measured by the market beta. In addition, we examine the role of asymmetric information in predicting crisis-day abnormal returns. We test the hypothesis that, during liquidity crises, stocks with a greater degree of information asymmetry underperform stocks with a smaller degree of information asymmetry.

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Finally, we examine whether the ownership structure of the firm's equity and the concentration of institutional ownership affect abnormal stock returns during liquidity crises. The ownership structure could matter if some types of institutional investors exhibit different trading pattern during liquidity crises than individual investors.

We find that crisis-day returns are strongly related to the liquidity beta that captures the co-movements of past stock returns with the liquidity factor. The liquidity beta alone explains up to 52% of the cross-sectional variation in stock portfolio returns during liquidity crises from 1993 to 2011, suggesting that the liquidity beta is a useful measure of risk for equity portfolios. In contrast, the market beta is not significantly associated with abnormal returns during liquidity crises between 1993 and 2011. In addition, abnormal returns during liquidity crises depend on informational asymmetry and the ownership structure of equity. Stocks with a greater degree of informational asymmetry, measured by the PIN model of Easley et al. (1996), experience significant negative abnormal stock returns on crisis days. The ownership structure of equity also matters for stock returns during liquidity crises. We find that firms with a greater fraction of shares held by investment companies experience significant negative abnormal stock returns on crisis days. This finding is consistent with the view that herding among fund managers increases the liquidity risk of stocks. In contrast, commercial bank stock ownership is associated with positive abnormal returns on crisis days, suggesting that banks are less likely to sell stocks in turbulent markets than other types of institutional investors or individual investors.

Overall, our results show that abnormal stock performance on crisis days is, in part, predictable. Based on past stock returns and several characteristics, investors can construct portfolios that significantly outperform the market during liquidity crises. Furthermore, such portfolios do not significantly differ in their degree of market risk, and thus should not have lower expected return according to the capital asset pricing model (CAPM). Nevertheless, these portfolios contain stocks with different sensitivities to market liquidity, degrees of information risk, and ownership structures. Previous research suggests that some of these risks and characteristics are priced (e.g., Pastor and Stambaugh, 2003; Easley et al., 2002). We therefore analyze the expected returns of portfolios sorted according to their predicted performance during liquidity crises during the period 1998–2011. Consistent with prior research, we find some evidence that portfolios with greater predicted returns during liquidity crises have lower average expected returns, in particular during the 1998–2007 period. These findings suggest that, although it is possible to effectively manage the liquidity risk of stocks, liquidity risk management is costly in terms of expected returns.

The rest of the article proceeds as follows. Section 1 presents testable hypotheses about the determinants of stocks' abnormal performance during liquidity crises. Section 2 describes methodology and data. Section 3 presents empirical results. Section 4 provides concluding remarks.

1. Hypotheses

We test several hypotheses about stocks' abnormal performance during liquidity crises. First, we examine whether liquidity risk, measured by the liquidity beta, can explain the differences in the cross-section of stock returns on crisis days. Originally proposed by Pastor and Stambaugh (2003), the liquidity beta measures the sensitivity of stock returns to fluctuations in aggregate market liquidity. However, it is not obvious that the liquidity beta can be effectively used to manage liquidity risk. The liquidity beta is a linear measure of risk, whereas liquidity crises are extreme tail events. In addition, Wantabe and Wantabe (2007) argue that stock returns' sensitivities to aggregate liquidity fluctuations vary over time, suggesting that historical liquidity betas may not be useful for managing the liquidity risk of stocks. To assess whether the estimated liquidity beta is a valid measure of risk, we test the hypothesis that the estimated liquidity beta helps to explain the cross-sectional variation in stock returns during liquidity crises. We further compare the importance of the liquidity beta for managing liquidity risk with that of the market beta, estimated over the same time interval.

In addition, we test the hypothesis that, during liquidity crises, stocks with a greater degree of information asymmetry underperform stocks with a smaller degree of information asymmetry. The asymmetric information hypothesis is motivated by the finding of Jeffrey (2011) that higher quality of accounting information lowers the sensitivity of stock returns to market liquidity and reduces the cost of capital, and the finding of Petrasek (2012) that transparency has real effects on corporate financial policy. Intuitively, lower informational asymmetry could reduce the sensitivity of stock returns to market-wide liquidity shocks because investors have a strong preference for certainty during liquidity crises. This argument is also consistent with recent research that relates market-wide liquidity shocks to macroeconomic and financial uncertainty (e.g., Eisfeldt, 2004).

Next, we test the hypothesis that the ownership structure of equity affects abnormal stock returns during liquidity crises. We distinguish between equity ownership by individual and institutional investors, as well as ownership by different types of institutional investors, such as investment companies, banks, and other financial institutions. Institutional ownership could affect the sensitivity of stocks to liquidity shocks because institutional trades are more correlated with one another than trades by individual investors. For example, multiple studies document that managers of investment companies tend to herd, i.e. buy into or out of the same securities at the same time.[1] According to Chordia et al. (2000), and Koch et al. (2010), such herding by fund managers could induce correlated changes in liquidity across stocks and increase the liquidity risk of stocks. We therefore hypothesize that investment company ownership has a negative effect on stocks' abnormal performance during liquidity crises when fund managers herd out of stocks. On the other hand, Gatev and Strahan (2006) argue that commercial banks rarely herd with other institutional investors. Banks' funding flows are typically more stable than those of other institutional investors, and portfolios managed by banks also tend to have longer investment horizons than portfolios managed by other institutions or by individuals. We therefore test the hypothesis that commercial bank ownership is positively associated with abnormal stock returns during liquidity crises.

In addition to the level and composition of institutional ownership, ownership concentration could also matter for stock returns during liquidity crises. Edmans (2009), for example, suggests that ownership concentration could lower the liquidity risk of stocks because large shareholders are more likely to retain their shares in a liquidity crisis. We measure ownership concentration by the Herfindahl index, i.e. the sum of the squared ownership fractions of all institutional investors, and empirically examine the relation between ownership concentration and abnormal stock returns on crisis days.

Finally, we test the hypothesis that stock returns during liquidity crises depend on the level of short interest. Desai et al. (2002) and Boehmer et al. (2008) show that firms that are heavily shorted

[1] See, e.g., Sias and Starks (1997), Wermers (1999), Nofsinger and Sias (1999), Griffin et al. (2003), Sias (2004).

subsequently experience significant negative abnormal returns. The effect of shorting on stock returns could be particularly strong during liquidity crises when other investors are less willing to provide liquidity to short sellers. We therefore investigate whether the percentage of shares outstanding that were sold short predicts abnormal stock returns during liquidity crises.

2. Methodology and data

2.1. Identification of liquidity crises

Liquidity has multiple dimensions and researchers have proposed numerous measures of market liquidity. However, among the most widely used measures of stock market liquidity are the quoted bid–ask spread and the effective bid–ask spread (see, e.g., Chordia et al., 2000; Goyenko et al., 2009; Hameed et al., 2010). These measures can be estimated from stock transaction data and provide a good proxy for transaction costs and liquidity conditions in the stock market. We use the proportional quoted bid–ask spread and the proportional effective bid–ask spread to identify liquidity crises. As an alternative measure of stock market liquidity, we also use the Amihud (2002) liquidity measure.

The proportional quoted bid–ask spread is measured by the difference between the bid and ask quotes, divided by the quote midpoint. The proportional effective spread measures illiquidity as the difference between transaction price and the midpoint of the bid and ask quotes:

$$Effective\ Spread_{i,t} = \frac{2|P_{i,t} - M_{i,t}|}{M_{i,t}}, \tag{1}$$

where $P_{i,t}$ is the trade price for stock i at time t, and $M_{i,t}$ is the corresponding quote midpoint. Following Lee and Ready (1991), we match trades with the most recent quotes time-stamped at least five seconds before the quote. Assuming that the quote midpoint reflects the fundamental value of stock i at time t, the effective bid–ask spread can be interpreted as the difference between the transaction price and the fundamental value of the ith stock. The quoted spread tends to be larger than the effective spread because the quoted spread does not account for orders that are executed at prices better than the posted spread.

Another liquidity proxy is the Amihud (2002) illiquidity ratio, which measures the price impact associated with one million dollars of trading volume:

$$ILLIQ_{i,d} = \frac{|R_{i,d}|}{\$V_{i,d}}, \tag{2}$$

where $R_{i,d}$ is the returns on stock i for day d, and $\$V_{i,d}$ is the daily volume for stock i measured in millions of dollars. The Amihud measure is computed from data on daily closing prices and daily volume.

The spread measures are constructed using the trades and quotes for ordinary common stocks listed on NYSE, AMEX, or NASDAQ during the period January 1993 to December 2011. Shares issued by foreign firms, closed-end funds, or real estate investment trusts and shares priced below $3 at the beginning of each month are excluded. In the quotes files, we retain only regular quotes with positive size, a positive bid–ask spread, and a proportional spread of less than 25%. In 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%. The spread for each stock is calculated daily as the volume-weighted average across all valid trades.

To obtain market-wide liquidity measures, we aggregate the daily percentage changes in liquidity across all stocks traded on consecutive days. Averaging the changes in liquidity rather than liquidity levels to helps to reduce potential econometric problems (see, Chordia et al. (2000)). Finally, we remove predictable liquidity reversals with an AR(2) filter, standardize each measure, and multiply by minus one so that adverse liquidity shocks have a negative sign.

Fig. 1 plots daily innovations in the proportional quoted bid–ask spread during 1993–2011. The horizontal line marks the days on which liquidity crises occurred, which are defined as the 48 days (1% of the sample days) with the most adverse changes in market-wide liquidity. Additionally, we also examine the 24 days (0.5% of the sample days) with the worst liquidity shocks. According to the quoted bid–ask spread measure, some of the worst liquidity crises between 1993 and 2011 occurred on October 27, 1997, during the economic crisis in Asia; September 31, 1998, due to LTCM crisis and the political uncertainty in Russia; September 17, 2001, after the terrorist attacks against the U.S.; March 10, 2008, preceding the collapse of Bear Sterns; and on September 29, 2008, when lawmakers rejected the bailout for U.S. financial industry.

As shown in Table 1, the proportional quoted bid–ask spread is strongly correlated with the proportional effective bid–ask spread over the sample period 1993–2011. The Pearson correlation between the effective and the quoted spread measure is 0.54. Even more importantly, the two measures largely overlap in their designation of liquidity crises. Out of the 48 days identified as liquidity crises according to the proportional quoted bid–ask spreads, 26 days are also identified as liquidity crises according to the proportional effective bid–ask spread. However, both spread measures have low correlations with the Amihud measure, suggesting that the Amihud measure captures a different dimension of liquidity. All the liquidity measures are positively correlated with the value-weighted CRSP market return. The Amihud measure appears to be most closely related to market declines since 14 out of the 48 liquidity crises identified by that measure fall on days with the steepest market declines as measured by the CRSP value-weighted index during 1993–2011.

2.2. Methodology

We apply the event-study approach proposed by Dennis and Strickland (2002) to examine what factors affect abnormal stock returns on days with large shocks to market liquidity. The analysis is conducted at the portfolio level and at the firm level. At the portfolio level, we sort stocks into quintiles based on their risk measures and characteristics in the pre-event period. The estimation period for all measures of risk is the calendar quarter preceding each liquidity event,[2] and the accounting variables and institutional ownership are measured at the end of the quarter. We then compute the abnormal market-adjusted return on each quintile portfolio during each of the 48 crisis days. In addition to reporting the average abnormal return on each portfolio, we estimate regressions of daily portfolio returns on the risk measures and characteristics to test the hypotheses about the determinants of crisis-day returns.

The analysis at the firm level is conducted as follows. Using all 48 crisis days, we estimate the following panel regression:

$$R_i = \delta_0 + \delta_1\beta_i^M + \delta_2\beta_i^L + \delta_3 PIN_i + \gamma_1' IO_i + \delta_4 HI_i + \delta_5 SI_i + \gamma_2' CHAR_i + \varepsilon_{i,} \tag{3}$$

where R_i is the market-adjusted return for stock i on the event day. The market beta (β^M) is estimated using daily stock returns and value-weighted market returns, and the liquidity beta (β^L) estimated using daily stock returns and innovations in market liquidity over

[2] The results are similar if the estimation period is from trading day $t-65$ to $t-5$ relative to each liquidity event.

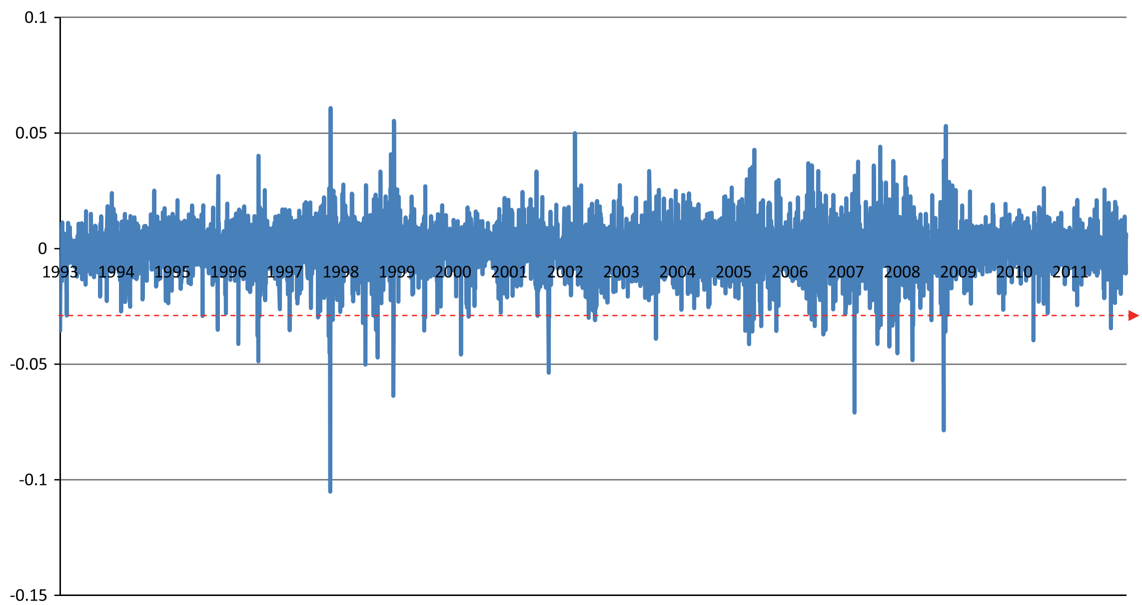

Fig. 1. Liquidity shocks measured by the quoted bid–ask spread. The figure plots daily innovations in market-wide proportional quoted bid–ask spread from January 1993 to December 2011. Negative observations indicate an increase in bid–ask spread. The measure was obtained by aggregating the daily changes in firm-specific bid–ask spread across publicly traded stocks. The dashed horizontal line marks the 48 days with the most adverse shocks to market liquidity.

Table 1
Correlations among liquidity measures.

	Quoted Spread	Effective Spread	Amihud Measure
Effective Spread	0.54	1	0.12
	(26 days)	(48 days)	(9 days)
Amihud Measure	0.09	0.12	1
	(7 days)	(9 days)	(48 days)
Market Return	0.37	0.29	0.16
	(7 days)	(7 days)	(14 days)

The table reports the correlations between the innovations in three different measures of market liquidity and the CRSP value-weighted market return for the period 1993–2011. The liquidity measures are: The proportional quoted bid–ask spread, the proportional effective bid–ask spread, and the Amihud (2002) measure. Liquidity crises are defined as 1% of sample days with the worst adverse shocks to these measures. The total number of liquidity crises is 48. The number of liquidity crises on which the liquidity measures agree is shown in parentheses below the correlation coefficients.

the pre-event calendar quarter. *PIN* is the probability of informed trading, a measure of information asymmetry, and *IO* is institutional ownership segregated into three categories: investment companies, banks, and others. Ownership concentration, which is another dimension of institutional ownership, is measured by the Hefindahl index (*HI*). Short interest (*SI*) is measured by the ration of the number of shares sold short to total shares outstanding. We control for a number of firm and stock characteristics (*CHAR*), such as the bid–ask spread and the average Amihud illiquidity, past stock returns, standard deviation, leverage, book-to-market, and size. We run the regression on pooled data with event-day fixed effects and standard errors clustered by liquidity event. As an alternative test, we estimate one cross-sectional regression for each liquidity event and use the approach of Fama and MacBeth (1973) to compute the parameter estimates and standard errors.

2.3. Explanatory variables and sample characteristics

The probability of informed trading (PIN) is based on the model developed by Easley et al. (1996), which measures the likelihood that there is informed trading in a stock. 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 their model, the market maker estimates the probability that any trade occurring at time t is information-based as:

$$PIN(t) = \frac{P(t)\mu}{P(t)\mu + 2\varepsilon}, \tag{4}$$

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 Eq. (4) 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 $\theta = (\alpha, \delta, \mu, \varepsilon)$ 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.[3] The daily likelihood of observing any sequence of B buys and S sells is given by:

$$L(\theta|B,S) = (1-\alpha)e^{-\varepsilon}\frac{\varepsilon^B}{B!}e^{-\varepsilon}\frac{\varepsilon^S}{S!} + \alpha\delta e^{-\varepsilon}\frac{\varepsilon^B}{B!}e^{-(\mu+\varepsilon)}\frac{(\mu+\varepsilon)^S}{S!} + \alpha(1 - \delta)e^{-(\mu+\varepsilon)}\frac{(\mu+\varepsilon)^B}{B!}e^{-\varepsilon T}\frac{\varepsilon^S}{S!}, \tag{5}$$

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:

[3] 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.

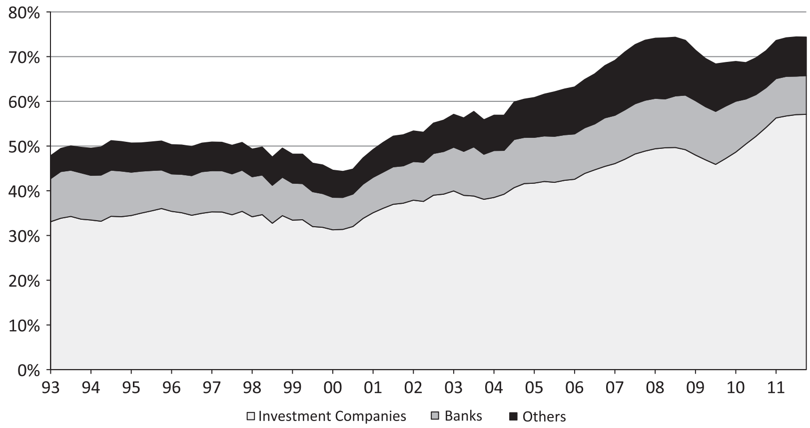

Fig. 2. Institutional holdings of sample shares. The figure plots the percentage of the outstanding shares in the sample stocks held by institutional investors from 1993 to 2011. Institutional holdings are divided into three categories based on the type of institutional investors: (1) investment companies, (2) banks, and (3) others. The category "investment companies" includes mutual funds, closed end funds, unit trusts, pension funds, and investment advisors. The category "others" includes endowments, foundations, insurance companies, and private pension funds.

$$L(\theta|(B_1,S_1)\ldots(B_D,S_D)) = \prod_{i=1}^{D} L(\theta|(B_i,S_i)). \quad (6)$$

Using intraday data from TAQ, we estimate the model for each stock with more than 50 trading days during the estimation period from $t-65$ *to* $t-5$ days preceding each liquidity event. 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 (6). The likelihood function is maximized using a dual quasi-Newton algorithm. Convergence of the optimization problem yields parameter estimates along with their standard errors.

Data on institutional ownership of common shares from 1993 to 2011 are obtained from Thomson Financial. The original source of the data is 13F reports filed quarterly by institutional investors with more than $100 million of assets under management. Based on Thomson's classifications, we distinguish among three types of financial institutions: (1) investment companies, including mutual funds, closed end funds, unit trusts, pension funds, and investment advisors, (2) commercial banks, and (3) all other financial institutions, such as insurance companies, endowments, foundations, and private pension funds. Fig. 2 shows the percentage of outstanding shares held by the three types of institutional investors in each quarter. Institutional investors hold on average 59% of the outstanding sample shares during the sample period. Investment companies are the most important type of financial institutions, holdings 41% of sample shares on average, whereas banks hold about 10% and other institutions about 8%. Ownership concentration is measured by the Herfindahl index, i.e. the sum of the squared ownership fractions of all institutional investors.

For the sub-period 2000–2011, we obtain data on short interest for each sample stock from Bloomberg. The short interest is measured as the total number of uncovered shares held short as of the 15th day of each month. To make meaningful comparisons, we divide short interest by total shares outstanding from CRSP. Similar to institutional holdings, we associate each liquidity crisis with the short interest data from the previous calendar quarter.

Data on control variables, including momentum, leverage, book-to-market equity, and market capitalization, are from CRSP and Compustat databases. Momentum is the average daily stock return during the estimation period. 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.

The sample is comprised common stocks issued by U.S. firms and listed on NYSE, AMEX, or NASDAQ between 1993 and 2011.[4] Sample stocks must have data on CRSP, TAQ, and Compustat during the event period and the estimation period spanning the previous calendar quarter. Closed-end funds, real estate investment trust, financial firms, and stocks priced less than $3 at the end of the estimation period are excluded. In addition, we include only stocks with more than 50 trading days during the estimation period to obtain reliable estimates of the explanatory variables.

Table 2 presents summary statistics for the sample of 207,790 quarterly observations on risk measures and firm characteristics during 1993–2011. The average market beta is 1.06. The average liquidity beta is 0.04 (0.05) when market liquidity is measured by the proportional quoted (effective) bid–ask spread, and 0.05 when market liquidity is measured by the Amihud measure. The average probability of informed trading (PIN) is 0.18. The average annualized return of sample stocks is 11.01%. The average short interest is 5.23% of the outstanding shares during the 2000–2011 sub-period.

3. Empirical results

3.1. Portfolio-level analysis

We sort stocks into quintile portfolios based on different risk measures and characteristics to investigate what factors affect abnormal stock returns during liquidity crises. Table 3 presents the average market-adjusted returns during liquidity crises for sets of portfolios sorted by the different risk measures and characteristics. Liquidity crises are defined as the 48 days with the worse adverse shocks to market liquidity between 1993 and 2011, and market liquidity is measured by the proportional quoted bid–ask spread. The table reveals that there is a large variation in abnormal returns on crisis days across the quintile portfolios sorted by several risk measures.

Most prominently, crisis-day abnormal returns on the five portfolios are monotonically decreasing in the historical liquidity beta. For example, the average market-adjusted return is 1.25% for stocks in the lowest liquidity beta portfolio, but −1.56% for stocks in the highest liquidity beta portfolio. We estimate a panel regres-

[4] The sample period starts at the inception of the TAQ dataset in 1993 because microstructure data are needed to compute measures of market liquidity and the PIN measure.

Table 2
Summary statistics.

Variable	Mean	Standard Deviation	Lower Quartile	Median	Upper Quartile
Market Beta	1.06	1.59	−0.02	1.05	2.12
Liquidity Beta (Quoted Spread)	0.04	0.44	−0.17	0.02	0.23
Liquidity Beta (Effective Spread)	0.05	0.51	−0.18	0.02	0.25
Liquidity Beta (Amihud)	0.05	0.54	−0.19	0.02	0.26
PIN	0.18	0.10	0.11	0.17	0.25
Investment Company Ownership	0.41	0.22	0.24	0.41	0.57
Bank Ownership	0.10	0.07	0.04	0.09	0.14
Other Ownership	0.08	0.08	0.03	0.06	0.11
Ownership Concentration	0.03	0.04	0.01	0.02	0.03
Short Interest	5.23%	6.05%	1.42%	3.37%	6.97%
Bid–Ask Spread	2.31%	7.76%	0.23%	0.55%	1.34%
Amihud Illiquidity	0.11	0.12	0.04	0.08	0.15
Momentum	0.05%	0.51%	−0.21%	0.03%	0.25%
Standard Deviation	3.59%	1.72%	2.49%	3.255%	4.23%
Leverage	0.20	0.20	0.02	0.17	0.33
Book-to-Market Equity	0.51	0.40	0.25	0.44	0.68
Market Capitalization	3399	15,238	139	467	1646
Return ($t+1$)	11.01%	60.72%	−49.60%	6.14%	60.49%

The table reports summary statics for the sample of 207,790 quarterly observations on risk measures and firm characteristics from 1993 to 2011. Market beta is the slope coefficient from regressions of daily stock returns on the value-weighted market index. Liquidity beta is the slope coefficient from regressions of daily stock returns on innovations in market liquidity measured by the proportional quoted bid–ask spread, the proportional effective bid–ask spread, or the Amihud illiquidity measure. PIN is the probability of informed trading from the model of Easley et al. (1996). Institutional ownership is measured as a fraction of the outstanding shares held by investment companies, banks, and other institutions at the end of each quarter. Ownership concentration is measured by the Herfindahl index, i.e. the sum of the squared fractions of shares held by each institutional investor. Short interest is the total number of shares sold short measured as a percentage of the outstanding shares. The short interest data start in 2000. Momentum is the average daily stock return and standard deviation is calculated from daily 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. Market capitalization is measured in millions of dollars. Return ($t+1$) is the annualized return measured over the subsequent calendar quarter.

Table 3
Portfolio abnormal returns during liquidity crises.

Sorted by	Quintile portfolio						R^2
	1 (low)	2	3	4	5 (high)	Slope coeff.	
Market Beta	−0.19%	0.05%	0.23%	0.01%	−0.10%	0.01	0.01
Liquidity Beta	1.25%	0.54%	0.13%	−0.35%	−1.56%	−2.89***	0.52
PIN	0.46%	0.03%	0.01%	−0.18%	−0.31%	−3.00***	0.17
Inv. Company Ownership	0.13%	0.16%	−0.05%	−0.07%	−0.17%	−0.57***	0.17
Bank Ownership	−0.44%	−0.17%	0.02%	0.23%	0.36%	4.14***	0.21
Other Ownership	0.03%	0.11%	0.04%	−0.02%	−0.16%	−1.26***	0.11
Ownership Concentration	−0.02%	0.02%	0.00%	0.02%	−0.02%	−0.52	0.00
Short Interest	−0.15%	0.07%	0.14%	0.03%	−0.03%	−0.11	0.00
Bid–Ask Spread	0.14%	0.13%	0.08%	−0.04%	−0.31%	−0.29**	0.06
Amihud Illiquidity	0.13%	0.04%	0.02%	−0.09%	−0.10%	−1.07**	0.10
Momentum	−0.06%	0.13%	0.18%	0.05%	−0.29%	−0.11	0.00
Standard Deviation	0.09%	0.10%	0.04%	−0.05%	−0.18%	−0.04***	0.10
Leverage	−0.12%	0.04%	0.05%	0.05%	−0.05%	0.03	0.00
Book-to-Market Equity	−0.26%	−0.09%	0.06%	0.19%	0.09%	0.30*	0.04
Market Capitalization	−0.15%	0.07%	0.15%	−0.03%	−0.03%	−0.11	0.00

The table reports the abnormal returns during liquidity crises on quintile portfolios sorted by different risk measures and characteristics. Liquidity crises are defined as the 48 days (1% of sample days) with the most adverse shocks to market liquidity from 1993 to 2011, and market liquidity is measured by the proportional quoted bid–ask spread. Abnormal returns are measured in excess of the market. The sorts on short interest begin in 2000. The last two columns show the slope coefficients and the R-squares from regressions of portfolio returns against the average of the sorting variable for each portfolio. Slope coefficients significant at the 10%, 5%, or 1% level are marked with one, two, or three asterisks, respectively.

sion of portfolio returns on liquidity betas and find a statistically significant relation between the two variables. The slope of the regression line is −2.89, statistically significant at the 1% level. Moreover, the liquidity beta alone explains 52% of the cross-sectional variation in portfolio returns on crisis days. However, there is not a monotonic relation between market risk and crisis-day performance. When stocks are sorted into quintile portfolios based on the market beta, crisis-day returns are not well explained by the portfolio ranking. Also, the slope of the regression line of crisis-day returns on the market beta is not statistically different from zero.

Several other risk measures are significantly related to crisis-day abnormal returns. Sorting on the PIN measure of asymmetric information shows a negative effect of informational asymmetry on crisis-day performance. The slope of the regression line of portfolio abnormal returns on the PIN measure is −3.00, significant at the 1% level. In addition, sorting stocks into portfolios based on the percentage of the outstanding shares held by different types of financial institutions shows that institutional ownership is related to stock returns during liquidity crises. In particular, stock ownership by investment companies is negatively associated with crisis-day performance. The estimated slope coefficient for investment company ownership is −0.57, significant at the 1% level. Besides, the explanatory power of the regression model is relatively large, as indicated by the R-squared of 0.17. In contrast, there is a positive association between bank ownership and portfolio crisis-day abnormal returns if stocks are sorted based on the fraction of shares held by banks. The slope coefficient for bank ownership is 4.14, significant at the 1% level. These contrasting results for investment companies and bank holding companies show that the type of institutional ownership matters for crisis-day performance. Ownership by other types of institutional investors such as pension funds and insurance companies is also negatively associated with stock returns during liquidity crises.

Among the remaining portfolio sorts, three variables are significantly negatively related to crisis-day performance: The bid–ask spread, Amihud illiquidity, and standard deviation. Book-to-market equity is positively associated with crisis-day performance at the 10% level, suggesting that value stocks outperform growth stocks on crisis days. Short interest (from 2000), ownership concentration, and several other explanatory variables are not significantly related to crisis-day abnormal returns at the portfolio level.

3.2. Firm-level analysis

Next, we estimate firm-level regressions of crisis-day market-adjusted returns on multiple risk measures and characteristic to examine whether the proposed risk measures provide incremental explanatory power for stock returns during liquidity crises after controlling for stock characteristics. Table 4 reports the regression estimates for 48 liquidity events defined according to three different liquidity measures: the proportional quoted bid–ask spread, the proportional effective bid–ask spread, and the Amihud measure.

Table 4
Regressions of crisis-day abnormal returns on risk measures and stock characteristics (48 liquidity events).

Liquidity measure	Proportional Quoted Spread	Proportional Effective Spread	Amihud Illiquidity
Market Beta	0.01	−0.01	−0.13***
	(0.02)	(0.03)	(0.04)
Liquidity Beta	−3.23***	−3.88***	−1.29***
	(0.52)	(0.41)	(0.36)
PIN	−2.34**	−2.15**	−2.01*
	(0.96)	(1.05)	(1.00)
Investment Company Ownership	−1.01***	−0.82***	−0.82***
	(0.14)	(0.15)	(0.25)
Bank Ownership	2.91***	2.14**	2.78**
	(0.56)	(0.87)	(1.27)
Other Ownership	−0.41*	−0.36	−0.28
	(0.22)	(0.27)	(0.33)
Ownership Concentration	1.16***	1.47***	1.14**
	(0.38)	(0.39)	(0.56)
Bid–Ask Spread	−0.03	−0.02	0.05
	(0.12)	(0.01)	(0.03)
Amihud Illiquidity	−0.35	−0.18	0.35
	(0.40)	(0.66)	(0.80)
Momentum	0.18	0.07	−0.16
	(0.27)	(0.27)	(0.30)
Standard Deviation	−0.03**	−0.01	−0.01
	(0.01)	(0.01)	(0.01)
Leverage	−0.12	−0.07	−0.57*
	(0.13)	(0.15)	(0.30)
Book-to-Market Equity	0.06	0.09	0.60*
	(0.19)	(0.19)	(0.30)
Market Capitalization (log)	−0.10	−0.09	−0.01
	(0.06)	(0.08)	(0.07)
R^2	0.09	0.14	0.03
No. of observations	149,656	134,952	140,537

The table shows the estimates from panel regressions of crisis-day market-adjusted returns on risk measures and lagged stock characteristics. Crisis days are defined as the 48 days (1% of sample days) with the most adverse shocks to market liquidity from 1993 to 2011. Market liquidity is measured using three alternative measures: the proportional quoted bid–ask spread, the proportional effective bid–ask spread, and Amihud illiquidity. Standard errors adjusted for clustering by event day are in parentheses. Coefficients significant at the 10%, 5%, or 1% level are marked with one, two, or three asterisks, respectively.

Results for crisis days based on the proportional quoted bid–ask spread are shown in the first column of Table 4. Abnormal stock returns on crisis days are strongly negatively related to liquidity risk, measured by the liquidity beta. The coefficient on the liquidity beta is −3.23 and significant at the 1% level, suggesting that a one standard deviation increase in the liquidity beta reduces crisis-day performance by −1.42% (−3.23 ∗ 0.44). In contrast, market risk, measured by the market beta, is not significantly related to abnormal stock returns on crisis days. In addition, stock performance during liquidity crises is significantly negatively related to informational asymmetry, as measured by the probability of informed trading (PIN). A one standard deviation increase in the PIN measure is associated with a negative abnormal performance on crisis days of −0.23% (−2.34 ∗ 0.10). Also, abnormal performance during liquidity crises is related to the ownership structure of the firm. Compared to ownership by individual investors, which is the omitted ownership category, stock ownership by investment companies leads to a significant underperformance on crisis days. A 10% increase in investment company ownership is associated with an average abnormal return of −0.22% (−1.01 ∗ 0.22). In contrast, higher bank ownership leads to a significantly positive abnormal performance on crisis days. The estimates show that a 10% increase in bank ownership is associated an average abnormal return of 0.20% (2.91 ∗ 0.07) during liquidity crises. Ownership concentration, measured by the Herfindahl index, is positively rated to abnormal returns during liquidity crises, showing that firms with concentrated ownership structures tend to outperform the market during liquidity crises. Finally, more volatile stocks have significant negative abnormal returns on crisis days. Short interest and other stock characteristics are not significantly related to crisis-day performance.

The second column in Table 4 shows the regression results based on the proportional effective bid–ask spread as a measure of market liquidity. The estimates based on the effective spread are quantitatively and qualitatively similar to those based on the quoted spread.[5] Stock returns on the 48 event days are still significantly negatively related to the liquidity beta, the PIN measure, and investment company ownership. Bank ownership and ownership concentration have a positive effect on crisis-day returns. The effect of market risk on event-day abnormal returns remains insignificant.

Turning to the results based on the Amihud measure of market liquidity reported in the third column of Table 4, we find that both the liquidity beta and the market beta are significantly negatively related to abnormal performance on crisis days. However, the marginal effect of one standard deviation change in the liquidity beta is −0.70 (−1.29 ∗ 0.54), several times larger than the marginal effect of one standard deviation change in market risk −0.20% (−0.13 ∗ 1.59). The significance of the market beta in explaining abnormal stock returns during liquidity crises defined according to the Amihud measure is perhaps not surprising given that 14 days with the largest declines in the Amihud measures are also among the 48 days with the most negative market returns between 1993 and 2011. Similar to the other measures, the results based on the Amihud measure show that abnormal stock returns during liquidity crises are significantly related to the PIN measure, investment company ownership, bank ownership, and the concentration of institutional ownership.

[5] The number of cross-sectional observations differs slightly across the liquidity measures because each definition of liquidity crises corresponds to different days.

Table 5
Regressions of crisis-day abnormal returns on risk measures including short interest (2000–2011).

Liquidity Measure	Proportional Quoted Spread	Proportional Effective Spread	Amihud Illiquidity
Market Beta	0.01	−0.03	−0.15***
	(0.03)	(0.05)	(0.05)
Liquidity Beta	−4.05***	−4.81***	−1.35***
	(0.73)	(0.61)	(0.40)
PIN	−5.50**	−5.48**	−3.47**
	(2.03)	(2.48)	(1.61)
Investment Company Ownership	−0.85***	−0.95***	−0.89***
	(0.19)	(0.26)	(0.24)
Bank Ownership	2.37***	1.48	2.13*
	(0.53)	(1.01)	(1.29)
Other Ownership	−0.22	−0.17	−0.34
	(0.26)	(0.36)	(0.37)
Ownership Concentration	1.09**	1.68**	1.64***
	(0.52)	(0.62)	(0.57)
Short Interest	−1.26	−0.34	0.29
	(1.22)	(1.71)	(1.09)
Bid–Ask Spread	0.01	−0.02	0.05
	(0.11)	(0.01)	(0.03)
Amihud Illiquidity	−0.69**	−0.11	−0.01
	(0.29)	(0.39)	(0.50)
Momentum	0.47	0.44	−0.04
	(0.43)	(0.47)	(0.33)
Standard Deviation	−0.02	−0.01	−0.01
	(0.02)	(0.01)	(0.01)
Leverage	−0.35**	−0.19	0.43
	(0.12)	(0.20)	(0.32)
Book-to-Market Equity	−0.10	0.03	0.45
	(0.29)	(0.33)	(0.35)
Market Capitalization (log)	−0.14*	−0.10	−0.03
	(0.08)	(0.13)	(0.10)
R^2	0.16	0.11	0.03
No. of observations	89,382	66,610	99,734
No. of events	30	23	36

The table shows the estimates from panel regressions of crisis-day market-adjusted returns on risk measures including short during the 2000–2011 sub-period. Crisis days are defined as the 48 days (1% of sample days) with the most adverse shocks to market liquidity from 1993 to 2011. The number of crisis days between 2000 and 2011 depends on the liquidity measure. Market liquidity is measured using three alternative measures: the proportional quoted bid–ask spread, the proportional effective bid–ask spread, and Amihud illiquidity. Standard errors adjusted for clustering by event day are in parentheses. Coefficients significant at the 10%, 5%, or 1% level are marked with one, two, or three asterisks, respectively.

Table 5 examines whether short interest—measured by the number of shares held short at the end of the quarter preceding each liquidity event divided by the number of outstanding shares—affects stocks' abnormal performance during liquidity crises. This test is limited to the 2000–2011 sub-period because our short interest data start in 2000. We find that the short interest ratio is not significantly related to crisis-day returns between 2000 and 2011.[6] The coefficient estimates on the short interest ratio are insignificant in regressions reported in Table 5. Also, including short interest has little effect on the other variables in the regression, and the liquidity beta, PIN, and institutional ownership continue to be the most important determinants of crisis-day returns. The magnitude of several coefficient estimates increases during the 2000–2011 sub-period which includes the 2008–2009 financial crisis, but the signs and significance of most coefficients remain the same as those shown in Table 4.

[6] In unreported results, we find that the coefficient on the short interest ratio is negative and marginally significant if short interest is measured immediately before each liquidity event.

Table 6
Regressions of crisis-day abnormal returns on risk measures and stock characteristics (24 liquidity events).

Liquidity Measure	Proportional Quoted Spread	Proportional Effective Spread	Amihud Illiquidity
Market Beta	−0.01	−0.01	−0.24***
	(0.04)	(0.05)	(0.06)
Liquidity Beta	−4.10***	−4.43***	−1.68***
	(0.83)	(0.63)	(0.51)
PIN	−3.48*	−4.53**	−2.86*
	(1.73)	(1.63)	(1.63)
Investment Company Ownership	−1.06***	−0.88***	−1.02**
	(0.26)	(0.29)	(0.40)
Bank Ownership	2.46***	2.93***	3.52*
	(0.86)	(1.02)	(2.05)
Other Ownership	−0.56*	−0.65*	−1.21**
	(0.31)	(0.36)	(0.53)
Ownership Concentration	1.76***	1.70***	2.15**
	(0.55)	(0.57)	(0.91)
Bid–Ask Spread	−0.05	0.11	0.05
	(0.25)	(0.25)	(0.06)
Amihud Illiquidity	0.13	−0.13	1.45
	(0.81)	(0.81)	(1.26)
Momentum	0.24	0.50	−0.41
	(0.45)	(0.41)	(0.42)
Standard Deviation	−0.04	−0.06**	−0.02
	(0.03)	(0.03)	(0.01)
Leverage	0.05	0.12	−0.89*
	(0.21)	(0.23)	(0.50)
Book-to-Market Equity	0.13	0.19	0.79*
	(0.35)	(0.35)	(0.45)
Market Capitalization (log)	−0.18	−0.21	−0.04
	(0.13)	(0.12)	(0.12)
R^2	0.11	0.14	0.05
No. of observations	71,818	71,150	71,297

The table shows the estimates from panel regressions of crisis-day market-adjusted returns on risk measures and lagged stock characteristics. Crisis days are defined as the 24 days (0.5% of sample days) with the most adverse shocks to market liquidity from 1993 to 2011. Market liquidity is measured using three alternative measures: the proportional quoted bid–ask spread, the proportional effective bid–ask spread, and Amihud illiquidity. Standard errors adjusted for clustering by event day are in parentheses. Coefficients significant at the 10%, 5%, or 1% level are marked with one, two, or three asterisks, respectively.

We further analyze the 24 largest adverse shocks to market liquidity during the sample period (0.5% of sample days), as measured by magnitude of negative liquidity shocks to the proportional quoted bid–ask spread, proportional effective bid–ask spread, and Amihud illiquidity. The results are reported in Table 6. In general, we find that the signs of the estimated coefficients are the same as those in Table 4 based on 48 event days. However, the magnitude of the marginal effects typically increases when we examine only the largest liquidity events. For example, based on the definition of liquidity crises according to the proportional quoted bid–ask, a one standard deviation increase in liquidity beta is now associated with a negative abnormal return of −1.80% ($-4.10 * 0.44$).

Next, we compare the results for liquidity crises with results using days with no significant liquidity events. Table 7 reports the estimates from regressions of non-event-day abnormal returns on risk measures and lagged stock characteristics. In the first column, we examine the relative performance of stocks on 48 days with the largest positive shocks to market liquidity during 1993–2011, where market liquidity is measured by the proportional quoted bid–ask spread. We find that both the liquidity beta and the market beta are significantly positively related to abnormal re-

Table 7
Regressions of non-event day abnormal returns on risk measures and stock characteristics.

Liquidity Measure	Positive Liquidity Shocks	No Liquidity Shocks	Large Market Declines
Market Beta	0.08***	0.05**	−0.29***
	(0.02)	(0.02)	(0.03)
Liquidity Beta	1.96***	−0.12	−0.09
	(0.31)	(0.22)	(0.30)
PIN	−0.30	−0.45	−0.03
	(0.22)	(0.29)	(0.60)
Investment Company Ownership	−0.24	0.01	−0.64**
	(0.18)	(0.12)	(0.26)
Bank Ownership	−0.37	−0.51	0.12
	(0.44)	(0.61)	(1.15)
Other Ownership	−0.29	0.18	−0.41
	(0.23)	(0.19)	(0.36)
Ownership Concentration	0.09	−0.34	−0.24
	(0.36)	(0.33)	(0.55)
Bid–Ask Spread	−0.34**	0.00	0.01
	(0.15)	(0.01)	(0.02)
Amihud Illiquidity	−0.96***	−0.39	0.41
	(0.30)	(0.73)	(0.45)
Momentum	0.10	−0.13	0.07
	(0.18)	(0.21)	(0.36)
Standard Deviation	0.06***	0.01	−0.01**
	(0.02)	(0.01)	(0.00)
Leverage	−0.18	−0.19	−0.30
	(0.16)	(0.13)	(0.37)
Book-to-Market Equity	−0.04	0.01	−0.29
	(0.14)	(0.10)	(0.22)
Market Capitalization (log)	0.03	0.01	−0.09*
	(0.03)	(0.03)	(0.05)
R^2	0.04	0.00	0.01
No. of observations	156,052	122,820	143,481

The table shows the estimates from panel regressions of non-event-day market-adjusted returns on risk measures and lagged stock characteristics. Positive liquidity shocks are defined as the 48 days (1% of sample days) with the largest positive shocks to market liquidity from 1993 to 2011, and no liquidity shocks are the 48 trading days with the smallest changes in market liquidity. Market liquidity is measured by the proportional quoted bid–ask spread. The last column covers the 48 days with the largest declines in CRSP value-weighted market index from 1993 to 2011. Standard errors adjusted for clustering by day are in parentheses. Coefficients significant at the 10%, 5%, or 1% level are marked with one, two, or three asterisks, respectively.

turn on these days. In the second column in Table 7, we examine days with no significant liquidity events, defined the 48 trading days with the smallest changes in market liquidity measured by the proportional quoted bid–ask spread. With the exception of the market beta, the results reveal no significant relationship between the risk measures and abnormal stock returns on such days. Also, the *R*-squared of the regression is close to zero. We obtain similar results if we examine other non-event periods, such as January 2007 or November 2009. Finally, in the third column of Table 7, we examine the 48 days with the largest declines in the CRSP value-weighted market index during 1993–2011. We find that abnormal stock returns on such days are significantly negatively related to investment company ownership and the market beta. These results are consistent with those reported in Dennis and Strickland (2002) for large market declines. In contrast to liquidity crises, neither the liquidity beta nor the PIN measure explain the relative performance of stocks during large market declines.

3.3. Liquidity risk management and expected returns

In this section, we provide an application of the findings in this paper to liquidity risk management. We start by sorting stocks into 10 portfolios based on their expected returns during liquidity crises. The expected crisis-day returns are calculated as a linear function of risk measures and stock characteristics, using coefficients from Eq. (3). The estimation and sorting procedure at each quarter uses only data available at that time, and the sorting begins in 1998 to provide sufficient observations for coefficient estimation.

Table 8 reports the average realized returns in excess of the market during subsequent liquidity crises for the 10 portfolios sorted on expected crisis-day returns. The table reveals that there is a positive monotonic relation between the actual and the expected crisis-day returns for all three measures of market liquidity. When we regress the actual returns on crisis days on the expected returns, we find that the expected returns explain between 50 to 76 percent of the cross-sectional variation in crisis-day returns during 1998–2011. These findings demonstrate that investors can construct portfolios that earn significantly positive excess returns during liquidity crises.

Next, we examine the unconditional average performance of portfolios with different expected returns during liquidity crises. Table 9 provides the average annualized market-adjusted returns during the post-ranking quarter for portfolios sorted on expected returns during liquidity crises. The portfolios' post-ranking returns appear to be decreasing in predicted crisis-day returns, although the *t*-test for the difference in mean abnormal returns is insignificant during the 1998–2011 period. However, the difference is negative and significant at the 10% level in the pre-crisis period 1998–2007 if market liquidity is measured by the proportional quoted or the proportional effective bid–ask spread, suggesting that stocks with greater expected returns during liquidity crises earn lower average returns in normal times. Stocks in the highest decile of expected crisis-day returns earned an average market-adjusted return that is 12–13% lower than stocks in the lowest decile of expected crisis-day returns during 1998–2007. This finding sug-

Table 8
Crisis-day returns of portfolios sorted on expected returns during liquidity crises.

Liquidity Measure	Decile Portfolio											R^2
	1 (low)	2	3	4	5	6	7	8	9	10 (high)	Slope coeff.	
Quoted Spread	−2.57	−1.35	−0.88	−0.52	−0.27	−0.05	0.18	0.48	0.84	1.79	1.33***	0.64
Effective Spread	−2.92	−1.55	−0.96	−0.62	−0.32	−0.03	0.30	0.58	0.98	2.31	1.25***	0.76
Amihud Illiquidity	−1.66	−0.92	−0.51	−0.32	−0.06	0.08	0.30	0.47	0.63	0.98	0.86***	0.50

The table shows the realized crisis-day abnormal returns of 10 portfolios sorted on expected returns during liquidity crises. The expected returns during liquidity crises are calculated as linear functions of risk measures and stock characteristics, using coefficients from Eq. (3). The table reports the average crisis-day realized returns in excess of the market from 1998 to 2011. Liquidity crises are defined as the 48 days (1% of sample days) with the most adverse shocks to market liquidity from 1993 to 2011. Market liquidity is measured using the proportional quoted bid–ask spread. The estimation and sorting procedure at each quarter uses only data available at that time, and the sorting begins in 1998. The last two columns show the slope coefficients and the *R*-squares from regressions of crisis-day portfolio returns against the expected crisis-day return for each portfolio. Slope coefficients significant at the 10%, 5%, or 1% level are marked with one, two, or three asterisks, respectively.

Table 9
Average returns on portfolios sorted on expected returns during liquidity crises.

Liquidity Measure	Decile Portfolio										10–1	*t*-stat.
	1 (low)	2	3	4	5	6	7	8	9	10 (high)		
1998–2011												
Quoted Spread	1.85	1.16	0.49	2.66	0.90	1.20	−0.35	−1.56	−2.22	−4.13	−5.98	0.90
Effective Spread	0.76	0.79	0.61	1.53	1.15	1.01	0.02	0.38	−1.78	−4.46	−5.22	0.78
Amihud Illiquidity	4.77	0.81	1.27	0.37	−0.37	−1.15	−1.10	−1.38	−2.46	−1.76	−6.53	0.82
1998–2007												
Quoted Spread	6.20	3.16	0.55	3.73	0.87	0.38	−0.65	−2.60	−4.45	−7.18	−13.37*	1.58
Effective Spread	4.75	2.54	0.81	1.63	0.78	0.63	−0.44	−0.25	−2.92	−7.52	−12.27*	1.44
Amihud Illiquidity	8.65	1.35	1.92	−0.09	−0.96	−2.41	−1.94	−1.02	−3.83	−1.66	−10.31	0.96

The table shows the unconditional average abnormal returns of 10 portfolios sorted on the expected returns during liquidity crises. The expected returns during liquidity crises are calculated in each quarter as linear functions of risk measures and stock characteristics according to Eq. (3). The table reports for each portfolio the average annualized market-adjusted return during the post-ranking quarter. Liquidity crises are defined as the 48 days (1% of sample days) with the most adverse shocks to market liquidity from 1993 to 2011. Market liquidity is measured using the proportional quoted bid–ask spread. The estimation and sorting procedure at each quarter uses only data available at that time, and the sorting begins in 1998. The last columns show the difference in average post-ranking returns between portfolios with high and low predicted returns during liquidity crises, and the *t*-statistic for the difference. Differences significant at the 10% level are marked with an asterisk.

Table 10
Acharya and pedersen liquidity betas.

Liquidity Measure	Proportional Quoted Spread	Proportional Effective Spread	Amihud Illiquidity
Market Beta	0.01	−0.01	−0.13***
	(0.02)	(0.03)	(0.04)
Liquidity Beta	−3.23***	−3.88***	−1.29***
	(0.52)	(0.41)	(0.36)
Liquidity Commonality	−0.43	0.55	0.19
	(2.68)	(2.62)	(3.14)
Liquidity Beta 2	−0.14	−0.13	0.01
	(0.11)	(0.11)	(0.01)
PIN	−2.34**	−2.15**	−2.01*
	(0.96)	(1.05)	(1.00)
Investment Company Ownership	−1.01***	−0.82***	−0.82***
	(0.14)	(0.15)	(0.25)
Bank Ownership	2.90***	2.13**	2.78**
	(0.56)	(0.87)	(1.27)
Other Ownership	−0.40*	−0.36	−0.28
	(0.21)	(0.27)	(0.33)
Ownership Concentration	1.16***	1.47***	1.14**
	(0.38)	(0.39)	(0.56)
Bid–Ask Spread	−0.03	−0.02	0.05
	(0.13)	(0.01)	(0.03)
Amihud Illiquidity	−0.35	−0.16	0.35
	(0.41)	(0.67)	(0.80)
Momentum	0.18	0.07	−0.16
	(0.27)	(0.27)	(0.30)
Standard Deviation	−0.03**	−0.01	−0.01
	(0.01)	(0.01)	(0.01)
Leverage	−0.12	−0.07	−0.57*
	(0.13)	(0.15)	(0.30)
Book-to-Market Equity	0.06	0.10	0.60**
	(0.19)	(0.19)	(0.30)
Market Capitalization (log)	−0.10	−0.09	−0.01
	(0.06)	(0.08)	(0.07)
R^2	0.09	0.14	0.03
No. of observations	149,656	134,952	140,537

The table shows the estimates from panel regressions of crisis-day market-adjusted returns on risk measures and lagged stock characteristics. The risk measures include the market beta and the three liquidity betas proposed by Acharya and Pedersen (2005), i.e. the covariance between market liquidity and firm-specific returns (Liquidity Beta), the covariance of firm-specific liquidity with market liquidity (Commonality in Liquidity), and the covariance of firm-specific liquidity with market returns (Liquidity Beta 2). Crisis days are defined as the 48 days (1% of sample days) with the most adverse shocks to market liquidity from 1993 to 2011. Market liquidity is measured using three alternative measures: the proportional quoted bid–ask spread, the proportional effective bid–ask spread, and Amihud illiquidity. Standard errors adjusted for clustering by event day are in parentheses. Coefficients significant at the 10%, 5%, or 1% level are marked with one, two, or three asterisks, respectively.

Table 11
Fama–MacBeth regressions of crisis-day abnormal returns on risk measures and stock characteristics.

Liquidity Measure	Proportional Quoted Spread	Proportional Effective Spread	Amihud Illiquidity
Market Beta	0.01	−0.01	−0.07**
	(0.02)	(0.02)	(0.03)
Liquidity Beta	−2.78***	−3.36***	−0.71**
	(0.36)	(0.31)	(0.31)
PIN	−1.95***	−2.05***	−3.53***
	(0.63)	(0.64)	(0.95)
Investment Company Ownership	−0.84***	−0.72***	−0.73***
	(0.12)	(0.17)	(0.21)
Bank Ownership	2.65***	2.40***	3.19***
	(0.48)	(0.56)	(0.71)
Other Ownership	−0.43	−0.13	−0.44
	(0.26)	(0.32)	(0.32)
Ownership Concentration	0.65**	0.39	0.72**
	(0.25)	(0.31)	(0.34)
Bid–Ask Spread	0.01	0.03	0.13
	(0.11)	(0.12)	(0.13)
Amihud Illiquidity	−0.54**	−0.60**	−0.42
	(0.21)	(0.25)	(0.31)
Momentum	−0.16	−0.24	−0.06
	(0.15)	(0.16)	(0.15)
Standard Deviation	−0.02**	−0.03***	−0.06***
	(0.01)	(0.01)	(0.02)
Leverage	−0.03	0.03	−0.27
	(0.11)	(0.12)	(0.18)
Book-to-Market Equity	0.25*	0.19	0.38
	(0.14)	(0.14)	(0.21)
Market Capitalization (log)	−0.08**	−0.09**	−0.07*
	(0.04)	(0.04)	(0.04)
R^2	0.13	0.18	0.14
No. of observations	149,656	134,952	140,537

The table shows the estimates from Fama–MacBeth cross-sectional regressions of crisis-day market-adjusted returns on risk measures and lagged stock characteristics. Crisis days are defined as the 48 days (1% of sample days) with the most adverse shocks to market liquidity from 1993 to 2011. Market liquidity is measured using three alternative measures: the proportional quoted bid–ask spread, the proportional effective bid–ask spread, and Amihud illiquidity. Coefficients significant at the 10%, 5%, or 1% level are marked with one, two, or three asterisks, respectively.

gests that hedging against liquidity risk in equity portfolios comes at a cost of reduced performance during periods of relatively stable liquidity conditions.

3.4. Robustness analysis

In this section we examine the robustness of the results to alternative measures of liquidity risk and alternative regression specifications. We also present the results of a subsample analysis.

Acharya and Pedersen (2005) propose a liquidity-adjusted capital asset pricing model with three measures of liquidity risk: (1) The liquidity beta which measures return sensitivity to market liquidity, cov(R_i, L_m); (2) the commonality of firm-specific liquidity with market liquidity, cov(L_i, L_m); and (3) the sensitivity of firm-specific liquidity to market returns cov(L_i, R_m). We estimate the additional liquidity betas (2) and (3) over the pre-event period and examine if they help explain stocks' abnormal performance during liquidity crises. The results of the analysis using the Acharya and Pedersen (2005) liquidity betas are presented in Table 10. Abnormal stock returns on crisis days are not significantly related to the two additional liquidity betas. For example, if liquidity crises are defined as the 48 days with the largest increases in the market-wide proportional effective bid–ask spread (see the fist column in Table 10), crisis-day abnormal returns are not significantly related to liquidity commonality or the sensitivity of firm-specific liquidity to market returns (Liquidity Beta 2) at the 10% level. In contrast, crisis-day returns remain strongly negatively related to the liquidity beta which measures the sensitivity of firm-specific returns to market-wide liquidity. Along with return sensitivity to market-wide liquidity shocks, the probability of informed trading, and institutional ownership continue to be the principal determinants of abnormal stock returns during liquidity crises. In summary, including additional liquidity betas proposed by Acharya and Pedersen (2005) in the model does not alter the main results reported in previous sections.

In Table 11, we confirm that the results are robust to an alternative estimation procedure. We estimate the cross-sectional regression model in Eq. (3) on each event day, and use the Fama–MacBeth (1973) procedure to compute the coefficient estimates and standard errors. The cross-sectional regression estimates in Table 11 are very similar those from panel regressions shown in Table 4. The liquidity beta, the PIN measure, and institutional ownership are the main determinants of stock returns during liquidity crises according to these estimates.

Next, we split the sample into two groups according to the exchange where the stocks are listed and repeat the analysis for each subsample. Table 12 reports the regression estimates for stocks listed on NYSE or AMEX and stocks listed on NASDAQ. The last column in Table 12 shows the difference between the coefficient estimates for the subsamples. In general, the coefficient estimates are quite similar for NYSE and NASDAQ stocks. The liquidity beta is significantly negatively related to crisis-day returns in both subsamples, while the market beta is insignificant for both NYSE and NASDAQ stocks. Bank ownership has a larger positive effect on NASDAQ stocks.

Finally, in unreported analysis, we find that the conclusions regarding the importance of the liquidity beta and institutional ownership for understanding crisis-day returns do not change when we extend the sample period to 1980. This test is based on the Amihud measure of market liquidity and the subset of explanatory variables that do not require microstructure data.

Table 12
Sub-sample analysis: NYSE and NASDAQ stocks.

Liquidity Measure	NYSE Stocks	NASDAQ Stocks	Difference
Market Beta	−0.01	0.01	0.02
	(0.02)	(0.02)	
Liquidity Beta	−3.19***	−3.24***	−0.05
	(0.58)	(0.51)	
PIN	−2.72*	−1.73***	0.99
	(1.61)	(0.55)	
Investment Company Ownership	−1.07***	−0.87***	0.20
	(0.12)	(0.26)	
Bank Ownership	1.91***	3.79***	1.88**
	(0.36)	(0.86)	
Other Ownership	−0.46*	−0.53**	−0.07
	(0.27)	(0.25)	
Ownership Concentration	1.29***	0.73	−0.56
	(0.44)	(0.75)	
Bid–Ask Spread	0.06	0.04	−0.02
	(0.14)	(0.17)	
Amihud Illiquidity	−0.31	−0.80	−0.49
	(0.25)	(0.49)	
Momentum	0.39	0.10	−0.29
	(0.35)	(0.23)	
Standard Deviation	−0.01	−0.03**	−0.01
	(0.01)	(0.01)	
Leverage	−0.10	−0.29**	−0.19*
	(0.10)	(0.12)	
Book-to-Market Equity	−0.11	0.11	0.22**
	(0.25)	(0.16)	
Market Capitalization (log)	−0.14**	−0.06	0.08
	(0.07)	(0.07)	
R^2	0.09	0.09	
No. of observations	69,133	80,523	

The table presents estimates from panel regressions of crisis-day market-adjusted returns on risk measures and lagged stock characteristics for stocks listed on NYSE (or AMEX) and stocks listed on NASDAQ. Crisis days are defined as the 48 days (1% of sample days) with the most adverse shocks to market liquidity from 1993 to 2011. Market liquidity is measured using the proportional quoted bid–ask spread. Standard errors adjusted for clustering by event day are in parentheses. Coefficients significant at the 10%, 5%, or 1% level are marked with one, two, or three asterisks, respectively.

4. Conclusions

We analyze in an event-study context the risk factors that affect the relative performance of stocks during liquidity crises. We find that market risk, as measured by the market beta, is not a good indicator of abnormal stock returns on crisis days. Instead, crisis-day performance is strongly related to the liquidity beta, which measures the sensitivity of stock returns to market-wide liquidity shocks. The liquidity beta alone explains up to 52% of the cross-sectional variation in stock portfolio returns during liquidity crises from 1993 to 2011, suggesting that the liquidity beta is a useful measure of risk for equity portfolios. Furthermore, abnormal stock returns on crisis days are negatively related to the degree of informational asymmetry, as measured by the probability of informed trading. This finding supports the theory that informational asymmetry amplifies financial risks during liquidity crises due to heightened uncertainty.

We further find support for the hypothesis that crisis-day performance is related to the ownership structure of equity and to the concentration of institutional ownership. In particular, a greater investment company ownership at the end of the quarter preceding a liquidity shock leads to a larger negative price reaction on the crisis day. This finding is consistent with the theory that herding by investment company managers increases the downward pressure on asset prices during liquidity crises. In contrast, a greater stock ownership by commercial banks at the end of the quarter preceding a liquidity shock leads to a smaller negative price reaction on the crisis day. This finding supports the view that banks are less likely than individual investors or other types of institutional investors to sell off stocks in times of financial panic. We also find evidence in the multivariate tests that stocks with more concentrated ownership structures outperform the overall market during liquidity crises, suggesting that ownership concentration lowers the liquidity risk of stocks. Finally, we do not find support for the hypothesis that stock returns during liquidity crises depend on the level of short interest.

These findings have important implications for academic research into liquidity risk and for practical liquidity risk management alike. We contribute to the literature on liquidity risk by investigating the determinants of cross-sectional stock returns during liquidity crises. In addition, we analyze liquidity risk from a practical risk management standpoint. We show that that abnormal stock performance during liquidity crises is, in part, predictable, and investors can construct portfolios of stocks that better withstand liquidity shocks. However, our results suggest that liquidity risk management comes at a cost of lower average returns during periods of relatively stable liquidity conditions.

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