

# Illiquidity and stock returns: cross-section and time-series effects<sup>☆</sup>

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## Abstract

This paper shows that over time, expected market illiquidity positively affects ex ante stock excess return, suggesting that expected stock excess return partly represents an *illiquidity premium*. This complements the cross-sectional positive return–illiquidity relationship. Also, stock returns are negatively related over time to contemporaneous unexpected illiquidity. The illiquidity measure here is the average across stocks of the daily ratio of absolute stock return to dollar volume, which is easily obtained from daily stock data for long time series in most stock markets. Illiquidity affects more strongly small firm stocks, thus explaining time series variations in their premiums over time. © 2002 Elsevier Science B.V. All rights reserved.

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## 1. Introduction

The hypothesis on the relationship between stock return and stock liquidity is that return increases in illiquidity, as proposed by Amihud and Mendelson (1986). The positive return–illiquidity relationship has been examined across

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stocks in a number of studies. This study examines this relationship over time. It proposes that *over time, the ex ante stock excess return is increasing in the expected illiquidity of the stock market.*

The illiquidity measure employed here, called *ILLIQ*, is the daily ratio of absolute stock return to its dollar volume, averaged over some period. It can be interpreted as the daily price response associated with one dollar of trading volume, thus serving as a rough measure of price impact. There are finer and better measures of illiquidity, such as the bid ask spread (quoted or effective), transaction-by-transaction market impact or the probability of information-based trading. These measures, however, require a lot of microstructure data that are not available in many stock markets. And, even when available, the data do not cover very long periods of time. The measure used here enables to construct long time series of illiquidity that are necessary to test the effects over time of illiquidity on ex ante and contemporaneous stock excess return. This would be very hard to do with the finer microstructure measures of illiquidity.

The results show that both across stocks and over time, expected stock returns are an increasing function of expected illiquidity. Across NYSE stocks during 1964–1997, *ILLIQ* has a positive and highly significant effect on expected return. The new tests here are on the effects over time of *market* illiquidity on market excess return (stock return in excess of the Treasury bill rate). Stock excess return, traditionally called “risk premium”, has been considered a compensation for risk. This paper proposes that *expected stock excess return also reflects compensation for expected market illiquidity*, and is thus an increasing function of *expected* market illiquidity. The results are consistent with this hypothesis. In addition, *unexpected* market illiquidity lowers contemporaneous stock prices. This is because higher realized illiquidity raises expected illiquidity that in turn raises stock expected returns and lowers stock prices (assuming no relation between corporate cash flows and market liquidity). This hypothesis too is supported by the results. These illiquidity effects are shown to be stronger for small firms’ stocks. This suggests that variations over time in the “size effect”—the excess return on small firms’ stocks—are related to changes in market liquidity over time.

The paper proceeds as follows. Section 2 introduces the illiquidity measure used in this study and employs it in cross-section estimates of expected stock returns as a function of stock illiquidity and other variables. Section 3 presents the time-series tests of the effect of the same measure of illiquidity on ex ante stock excess returns. The section includes tests of the effect of expected and unexpected illiquidity, the effects of these variables for different firm-size portfolios and the effects of expected illiquidity together with the effects of other variables—bonds’ term and default yield premiums—that predict stock returns. Section 4 offers concluding remarks.

## 2. Cross-section relationship between illiquidity and stock return

### 2.1. Measures of illiquidity

Liquidity is an elusive concept. It is not observed directly but rather has a number of aspects that cannot be captured in a single measure.<sup>1</sup> Illiquidity reflects the impact of order flow on price—the discount that a seller concedes or the premium that a buyer pays when executing a market order—that results from adverse selection costs and inventory costs (Amihud and Mendelson, 1980; Glosten and Milgrom, 1985). For standard-size transactions, the price impact is the bid–ask spread, whereas larger excess demand induces a greater impact on prices (Kraus and Stoll, 1972; Keim and Madhavan, 1996), reflecting a likely action of informed traders (see Easley and O’Hara, 1987). Kyle (1985) proposed that because market makers cannot distinguish between order flow that is generated by informed traders and by liquidity (noise) traders, they set prices that are an increasing function of the imbalance in the order flow which may indicate informed trading. This creates a positive relationship between the order flow or transaction volume and price change, commonly called the price impact.

These measures of illiquidity are employed in studies that examine the cross-section effect of illiquidity on expected stock returns. Amihud and Mendelson (1986) and Eleswarapu (1997) found a significant positive effect of quoted bid–ask spreads on stock returns (risk-adjusted).<sup>2</sup> Chalmers and Kadlec (1998) used the amortized effective spread as a measure of liquidity, obtained from quotes and subsequent transactions, and found that it positively affects stock returns.<sup>3</sup> Brennan and Subrahmanyam (1996) measured stock illiquidity by price impact, measured as the price response to signed order flow (order size), and by the fixed cost of trading, using intra-day continuous data on transactions and quotes.<sup>4</sup> They found that these measures of illiquidity

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<sup>1</sup> See discussion in Amihud and Mendelson (1991b).

<sup>2</sup> Amihud and Mendelson (1986) study is on NYSE/AMEX stocks, 1961–1980, and Eleswarapu’s (1997) study is on Nasdaq stocks, 1974–1990. Bond yields are also found to be increasing in the bid–ask spread, after controlling for maturity and risk. See Amihud and Mendelson (1991a) and Kamara (1994).

<sup>3</sup> The effective spread is the absolute difference between the mid-point of the quoted bid–ask spread and the transaction price that follows, classified as being a buy or sell transaction. The spread is divided by the stock’s holding period, obtained from the turnover rate on the stock, to obtain the amortized spread.

<sup>4</sup> This measure, based on Kyle’s (1985) model, is estimated by the methods proposed by Glosten and Harris (1988) and Hasbrouck (1991). Basically, it is the slope coefficient in a regression of transaction-by-transaction price changes on the signed order size, where orders are classified into “buy” or “sell” by the proximity of the transaction price to the preceding bid and ask quotes. Adjustments are made for prior information (on price changes and order size) and fixed order placement costs.

positively affect stock returns. Easley et al. (1999) introduced a new measure of microstructure risk, the probability of information-based trading, that reflects the adverse selection cost resulting from asymmetric information between traders, as well as the risk that the stock price can deviate from its full-information value. This measure is estimated from intra-daily transaction data. They found that across stocks, the probability of information-based trading has a large positive and significant effect on stock returns.

These fine measures of illiquidity require for their calculation microstructure data on transactions and quotes that are unavailable in most markets around the world for long time periods of time. In contrast, the illiquidity measure used in this study is calculated from daily data on returns and volume that are readily available over long periods of time for most markets. Therefore, while it is more coarse and less accurate, it is readily available for the study of the time series effects of liquidity.

Stock illiquidity is defined here as the average ratio of the daily absolute return to the (dollar) trading volume on that day,  $|R_{iyd}|/VOLD_{iyd}$ .  $R_{iyd}$  is the return on stock  $i$  on day  $d$  of year  $y$  and  $VOLD_{iyd}$  is the respective daily volume in dollars. This ratio gives the absolute (percentage) price change per dollar of daily trading volume, or the daily price impact of the order flow. This follows Kyle's concept of illiquidity—the response of price to order flow—and Silber's (1975) measure of thinness, defined as the ratio of absolute price change to absolute excess demand for trading.

The cross-sectional study employs for each stock  $i$  the annual average

$$ILLIQ_{iy} = 1/D_{iy} \sum_{t=1}^{D_{iy}} |R_{iyd}|/VOLD_{iyd}, \quad (1)$$

where  $D_{iy}$  is the number of days for which data are available for stock  $i$  in year  $y$ . This illiquidity measure is strongly related to the liquidity ratio known as the Amivest measure, the ratio of the sum of the daily volume to the sum of the absolute return (e.g., Cooper et al., 1985; Khan and Baker, 1993). Amihud et al. (1997) and Berkman and Eleswarapu (1998) used the liquidity ratio to study the effect of changes in liquidity on the values of stocks that were subject to changes in their trading methods. The liquidity ratio, however, does not have the intuitive interpretation of measuring the average daily association between a unit of volume and the price change, as does  $ILLIQ$ .<sup>5</sup>

$ILLIQ$  should be positively related to variables that measure illiquidity from microstructure data. Brennan and Subrahmanyam (1996) used two measures

<sup>5</sup> Another interpretation of  $ILLIQ$  is related to disagreement between traders about new information, following Harris and Raviv (1993). When investors agree about the implication of news, the stock price changes without trading while disagreement induces increase in trading volume. Thus,  $ILLIQ$  can also be interpreted as a measure of consensus belief among investors about new information.

of illiquidity, obtained from data on intraday transactions and quotes: Kyle's (1985)  $\lambda$ , the price impact measure, and  $\psi$ , the fixed-cost component related to the bid–ask spread. The estimates are done by the method of Glosten and Harris (1988). Using estimates<sup>6</sup> of these variables for 1984, the following cross-sectional regression was estimated:

$$ILLIQ_i = -292 + 247.9\lambda_i + 49.2\psi_i$$

$$(t =) \quad (12.25) \quad (13.78) \quad (17.33) \quad R^2 = 0.30.$$

These results show that *ILLIQ* is positively and strongly related to microstructure estimates of illiquidity.

Size, or the market value of the stock, is also related to liquidity since a larger stock issue has smaller price impact for a given order flow and a smaller bid–ask spread. Stock expected returns are negatively related to size (Banz, 1981; Reinganum, 1981; Fama and French, 1992), which is consistent with it being a proxy for liquidity (Amihud and Mendelson, 1986).<sup>7</sup> The negative return-size relationship may also result from the size variable being related to a function of the reciprocal of expected return (Berk, 1995).

There are other measures of liquidity that use data on volume. Brennan et al. (1998) found that the stock (dollar) volume has a significant negative effect on the cross-section of stock returns and it subsumes the negative effect of size. Another related measure is turnover, the ratio of trading volume to the number of shares outstanding. By Amihud and Mendelson (1986), turnover is negatively related to illiquidity costs, and Atkins and Dyl (1997) found a strong positive relationship across stocks between the bid–ask spread and the reciprocal of the turnover ratio that measures holding period. A number of studies find that cross-sectionally, stock returns are decreasing in stock turnover, which is consistent with a negative relationship between liquidity and expected return (Haugen and Baker, 1996; Datar et al., 1998; Hu, 1997a; Rouwenhorst, 1998; Chordia et al., 2001).

These measures of liquidity as well as the illiquidity measure presented in this study can be regarded as empirical proxies that measure different aspects of illiquidity. It is doubtful that there is one single measure that captures all its aspects.

<sup>6</sup>I thank M. Brennan and Avaniidhar Subrahmanyam for kindly providing these estimates. The estimated variables are multiplied here by  $10^3$ . Outliers at the upper and lower 1% tails of these variables and of *ILLIQ* are discarded (see Brennan and Subrahmanyam, 1996).

<sup>7</sup>Barry and Brown (1984) propose that the higher return on small firms' stock is compensation for less information available on small firms that have been listed for a shorter period of time. This is consistent with the illiquidity explanation of the small firm effect since illiquidity costs are increasing in the asymmetry of information between traders (see Glosten and Milgrom, 1985; Kyle, 1985).

## 2.2. Empirical methodology

The effect of illiquidity on stock return is examined for stocks traded in the New York Stock Exchange (NYSE) in the years 1963–1997, using data from daily and monthly databases of CRSP (Center for Research of Securities Prices of the University of Chicago). Tests are confined to NYSE-traded stocks to avoid the effects of differences in market microstructures.<sup>8</sup> The test procedure follows the usual Fama and MacBeth (1973) method. A cross-section model is estimated for each month  $m = 1, 2, \dots, 12$  in year  $y$ ,  $y = 1964, 1965, \dots, 1997$  (a total of 408 months), where monthly stock returns are a function of stock characteristics:

$$R_{im_y} = k_{omy} + \sum_{j=1}^J k_{jmy} X_{ji,y-1} + U_{im_y}. \quad (2)$$

$R_{im_y}$  is the return on stock  $i$  in month  $m$  of year  $y$ , with returns being adjusted for stock delistings to avoid survivorship bias, following Shumway (1997).<sup>9</sup>  $X_{ji,y-1}$  is characteristic  $j$  of stock  $i$ , estimated from data in year  $y - 1$  and known to investors at the beginning of year  $y$ , during which they make their investment decisions. The coefficients  $k_{jmy}$  measure the effects of stock characteristics on expected return, and  $U_{im_y}$  are the residuals. The monthly regressions of model (2) over the period 1964–1997 produce 408 estimates of each coefficient  $k_{jmy}$ ,  $j = 0, 1, 2, \dots, J$ . These monthly estimates are averaged and tests of statistical significance are performed.

Stocks are admitted to the cross-sectional estimation procedure in month  $m$  of year  $y$  if they have a return for that month and they satisfy the following criteria:

(i) The stock has return and volume data for more than 200 days during year  $y - 1$ . This makes the estimated parameters more reliable. Also, the stock must be listed at the end of year  $y - 1$ .

(ii) The stock price is greater than \$5 at the end of year  $y - 1$ . Returns on low-price stocks are greatly affected by the minimum tick of \$1/8, which adds noise to the estimations.<sup>10</sup>

<sup>8</sup> See Reinganum (1990) on the effects of the differences in microstructure between the NASDAQ and the NYSE on stock returns, after adjusting for size and risk. In addition, volume figures on the NASDAQ have a different meaning than those on the NYSE, because trading on the NASDAQ is done almost entirely through market makers, whereas on the NYSE most trading is done directly between buying and selling investors. This results in artificially higher volume figures on NASDAQ.

<sup>9</sup> Specifically, the last return used is either the last return available on CRSP, or the delisting return, if available. Naturally, a last return for the stock of  $-100\%$  is included in the study. A return of  $-30\%$  is assigned if the deletion reason is coded by 500 (reason unavailable), 520 (went to OTC), 551–573 and 580 (various reasons), 574 (bankruptcy) and 584 (does not meet exchange financial guidelines). Shumway (1997) obtains that  $-30\%$  is the average delisting return, examining the OTC returns of delisted stocks.

<sup>10</sup> See discussion on the minimum tick and its effects in Harris (1994). The benchmark of \$5 was used in 1992 by the NYSE when it reduced the minimum tick. Also, the conventional term of “penny stocks” applies to stocks whose price is below \$5.

(iii) The stock has data on market capitalization at the end of year  $y - 1$  in the CRSP database. This excludes derivative securities like ADRs of foreign stocks and scores and primes.

(iv) Outliers are eliminated—stocks whose estimated  $ILLIQ_{iy}$  in year  $y - 1$  is at the highest or lowest 1% tails of the distribution (after satisfying criteria (i)–(iii)).

There are between 1061 and 2291 stocks that satisfy these four conditions and are included in the cross-section estimations.

### 2.3. Stock characteristics

#### 2.3.1. Liquidity variables

The measure of liquidity is  $ILLIQ_{iy}$  that is calculated for each stock  $i$  in year  $y$  from daily data as in (1) above (multiplied by  $10^6$ ). The average market illiquidity across stocks in each year is calculated as

$$AILLIQ_y = 1/N_y \sum_{i=1}^{N_y} ILLIQ_{iy}, \quad (3)$$

where  $N_y$  is the number of stocks in year  $y$ . (The stocks that are used to calculate the average illiquidity are those that satisfy conditions (i)–(iv) above.) Since average illiquidity varies considerably over the years,  $ILLIQ_{iy}$  is replaced in the estimation of the cross-section model (2) by its mean-adjusted value

$$ILLIQMA_{iy} = ILLIQ_{iy} / AILLIQ_y. \quad (4)$$

The cross-sectional model (2) also includes  $SIZE_{iy}$ , the market value of stock  $i$  at the end of year  $y$ , as given by CRSP. As discussed above,  $SIZE$  may also be a proxy for liquidity. Table 1 presents estimated statistics of  $ILLIQ$  and  $SIZE$ . In each year, the annual mean, standard deviation across stocks and skewness are calculated for stocks admitted to the sample, and then these annual statistics are averaged over the 34 years. The correlations between the variables are calculated in each year across stocks and then the yearly correlation coefficients are averaged over the years. As expected,  $ILLIQ_{iy}$  is negatively correlated with size:  $\text{Corr}(ILLIQ_{iy}, \ln SIZE_{iy}) = -0.614$ .

#### 2.3.2. Risk variables

Model (2) includes  $BETA_{iy}$  as a measure of risk, calculated as follows. At the end of each year  $y$ , stocks are ranked by their size (capitalization) and divided into ten equal portfolios. (Size serves here as an instrument.) Next, the portfolio return  $R_{p|y}$  is calculated as the equally-weighted average of stock returns in portfolio  $p$  on day  $t$  in year  $y$ . Then, the market model is estimated

Table 1  
Statistics on variables

The illiquidity measure,  $ILLIQ_{iy}$ , is the average for year  $y$  of the daily ratio of absolute return to the dollar volume of stock  $i$  in year  $y$ .  $SIZE_{iy}$  is the market capitalization of the stock at the end of the year given by CRSP,  $DIVYLD_{iy}$ , the dividend yield, is the sum of the annual cash dividend divided by the end-of-year price,  $SDRET_{iy}$  is the standard deviation of the stock daily return. Stocks admitted in each year  $y$  have more than 200 days of data for the calculation of the characteristics and their end-of-year price exceeds \$5. Excluded are stocks whose  $ILLIQ_{iy}$  is at the extreme 1% upper and lower tails of the distribution.

Each variable is calculated for each stock in each year across stocks admitted to the sample in that year, and then the mean, standard deviation and skewness are calculated across stocks in each year. The table presents the means over the 34 years of the annual means, standard deviations and skewness and the medians of the annual means, as well as the maximum and minimum annual means.

Data include NYSE stocks, 1963–1996.

Variable	Mean of annual means	Mean of annual S.D.	Median of annual means	Mean of annual skewness	Min. annual mean	Max. annual mean
<i>ILLIQ</i>	0.337	0.512	0.308	3.095	0.056	0.967
<i>SIZE</i> (\$million)	792.6	1,611.5	538.3	5.417	263.1	2,195.2
<i>DIVYLD</i> (%)	4.14	5.48	4.16	5.385	2.43	6.68
<i>SDRET</i>	2.08	0.75	2.07	1.026	1.58	2.83

for each portfolio  $p, p = 1, 2, \dots, 10$ ,

$$R_{pty} = a_{py} + BETA_{py} \cdot RM_{ty} + e_{pty}. \quad (5)$$

$RM_{ty}$  is the equally-weighted market return and  $BETA_{py}$  is the slope coefficient, estimated by the Scholes and Williams (1977) method. The beta assigned to stock  $i$ ,  $BETA_{iy}$ , is  $BETA_{py}$  of the portfolio in which stock  $i$  is included. Fama and French (1992), who used similar methodology, suggested that the precision of the estimated portfolio beta more than makes up for the fact that not all stocks in the size portfolio have the same beta.<sup>11</sup>

The stock total risk is  $SDRET_{iy}$ , the standard deviation of the daily return on stock  $i$  in year  $y$  (multiplied by  $10^2$ ). By the asset pricing models of Levy (1978) and Merton (1987),  $SDRET$  is priced since investors' portfolios are constrained and therefore not well diversified. However, the tax trading option (due to Constantinides and Scholes, 1980) suggests that stocks with higher volatility should have lower expected return. Also,  $SDRET_{iy}$  is included in the model since  $ILLIQ_{iy}$  may be construed as a measure of the stock's risk, given that its numerator is the absolute return (which is related to  $SDRET_{iy}$ ),

<sup>11</sup>The models were re-estimated using betas of individual stocks in lieu of betas of size portfolios. These betas have an insignificant effect in the cross-section regressions. The results on  $ILLIQ$  remained the same. Also, omitting  $BETA$  altogether from the cross-section regression has very little effect on the results.

although the correlation between *ILLIQ* and *SDRET* is low, 0.278. Theoretically, risk and illiquidity are positively related. Stoll (1978) proposed that the stock illiquidity is positively related to the stock's risk since the bid–ask spread set by a risk-averse market maker is increasing in the stock's risk. Copeland and Galai (1983) modeled the bid–ask spread as a pair of options offered by the market maker, thus it increases with volatility. Constantinides (1986) proposed that the stock variance positively affects the return that investors require on the stock, since it imposes higher trading costs on them due to the need to engage more frequently in portfolio rebalancing.

### 2.3.3. Additional variables

The cross-sectional model (2) includes the dividend yield for stock *i* in year *y*,  $DIVYLD_{iy}$ , calculated as the sum of the dividends during year *y* divided by the end-of-year price (following Brennan et al., 1998).  $DIVYLD$  should have a positive effect on stock return if investors require to be compensated for the higher tax rate on dividends compared to the tax on capital gains. However,  $DIVYLD$  may have a negative effect on return across stocks if it is negatively correlated with an unobserved risk factor, that is, stocks with higher dividend are less risky. The coefficient of  $DIVYLD$  may also be negative following Redding's (1997) suggestion that large investors prefer companies with high liquidity and also prefer receiving dividends.<sup>12</sup>

Finally, past stock returns were shown to affect their expected returns (see Brennan et al., 1998). Therefore, the cross-sectional model (2) includes two variables:  $R100_{iy}$ , the return on stock *i* during the last 100 days of year *y*, and  $R100YR_{iy}$ , the return on stock *i* over the rest of the period, between the beginning of the year and 100 days before its end.

The model does not include the ratio of book-to-market equity,  $BE/ME$ , which was used by Fama and French (1992) in cross-section asset pricing estimation. This study employs only NYSE stocks for which  $BE/ME$  was found to have no significant effect (Easley et al., 1999; Loughran, 1997).<sup>13</sup> Also, Berk (1995) suggested that an estimated relation between expected return and  $BE/ME$  is obtained due to the functional relation between expected return and the market value of equity.

## 2.4. Cross-section estimation results

In the cross-sectional model (2), stock returns in each month of the year are regressed on stock characteristics that are estimated from data in the previous

<sup>12</sup>Higher dividend yield may be perceived by investors to provide greater liquidity (ignoring tax consequences). This is analogous to the findings of Amihud and Mendelson (1991a) that Treasury notes with higher coupon provide lower yield to maturity.

<sup>13</sup>Loughran (1997) finds that when the month of January is excluded, the effect of  $BE/ME$  becomes insignificant.

year (following the Fama and MacBeth (1973) method). The model is estimated for 408 months (34 years), generating 408 sets of coefficients  $k_{jmy}$ ,  $m = 1, 2, \dots, 12$ , and  $y = 1964, 1965, \dots, 1997$ . The mean and standard error of the 408 estimated coefficients  $k_{jmy}$  are calculated for each stock characteristic  $j$ , followed by a  $t$ -test of the null hypothesis of zero mean. Tests are also performed for the means that exclude the January coefficients since by some studies, excluding January makes the effects of beta, size and the bid–ask spread insignificant (e.g., Keim, 1983; Tinic and West, 1986; Eleswarapu and Reinganum, 1993). Finally, to examine the stability over time of the effects of the stock characteristics, tests are done separately for two equal subperiods of 204 months (17 years) each.

The results, presented in Table 2, strongly support the hypothesis that illiquidity is priced, consistent with similar results in earlier studies. The coefficient of  $ILLIQMA_{iy}$ , denoted  $k_{ILLIQmy}$ , has a mean of 0.162 that is statistically significant ( $t = 6.55$ ) and its median is 0.135, close to the mean. Of the estimated coefficients, 63.4% (259 of the 408) are positive, a proportion that is significantly different from 1/2 (the chance proportion). The serial correlation of the series  $k_{ILLIQmy}$  is quite negligible (0.08).

The illiquidity effect remains positive and highly significant when January is excluded: the mean of  $k_{ILLIQmy}$  is 0.126 with  $t = 5.30$ . The illiquidity effect is positive and significant in each of the two subperiods of 17 years.

The effect of  $BETA$  is positive, as expected, and significant (the statistical significance is lower when January is excluded). However, it becomes insignificant when  $SIZE$  is included in the model, since beta is calculated for size-based portfolios. Past returns— $R100$  and  $R100YR$ —both have positive and significant coefficients.

Table 2 also presents estimation results of a model that includes additional variables. The coefficient of  $ILLIQMA$  remains positive and significant for the entire period, for the non-January months and for each of the two subperiods. In addition, the coefficient of  $\ln SIZE$  is negative and significant, although its magnitude and significance is lower in the second subperiod. Size may be a proxy for liquidity, but its negative coefficient may also be due to it being a proxy for the reciprocal of expected return (Berk, 1995). The risk variable  $SDRET$  has a negative coefficient (as in Amihud and Mendelson, 1989), perhaps accounting for the value of the tax trading option. The negative coefficient of  $DIVYLD$  may reflect the effect of an unobserved risk factor that is negatively correlated with  $DIVYLD$  across stocks (less risky companies may choose to have higher dividend yield). The negative coefficient of  $DIVYLD$  is also consistent with the hypothesis of Redding (1997) about dividend preference by some types of investors. These effects could offset the positive effect of  $DIVYLD$  that results from the higher personal tax on dividends.

Table 2

Cross-section regressions of stock return on illiquidity and other stock characteristics<sup>a</sup>

The table presents the means of the coefficients from the monthly cross-sectional regression of stock return on the respective variables. In each month of year  $y$ ,  $y = 1964, 1965, \dots, 1997$ , stock returns are regressed cross-sectionally on stock characteristics that are calculated from data in year  $y - 1$ . *BETA* is the slope coefficient from an annual time-series regression of daily return on one of 10 size portfolios on the market return (equally weighted), using the Scholes and Williams (1977) method. The stock's *BETA* is the beta of the size portfolio to which it belongs. The illiquidity measure *ILLIQ* is the average over the year of the daily ratio of the stock's absolute return to its dollar trading volume. *ILLIQ* is averaged every year across stocks, and *ILLIQMA* is the respective mean-adjusted variables, calculated as the ratio of the variable to its annual mean across stocks (thus the means of all years are 1). *Ln SIZE* is the logarithm of the market capitalization of the stock at the end of the year, *SDRET* is the standard deviation of the stock daily return during the year, and *DIVYLD* is the dividend yield, the sum of the annual cash dividend divided by the end-of-year price. *R100* is the stock return over the last 100 days and *R100YR* is the return during the period between the beginning of the year and 100 days before its end.

The data include 408 months over 34 years, 1964–1997, (the stock characteristics are calculated for the years 1963–1996). Stocks admitted have more than 200 days of data for the calculation of the characteristics in year  $y - 1$  and their end-of-year price exceeds \$5. Excluded are stocks whose *ILLIQ* is at the extreme 1% upper and lower tails of the respective distribution for the year.

Variable	All months	Excl. January	1964–1980	1981–1997	All months	Excl. January	1964–1980	1981–1997
<i>Constant</i>	−0.364 (0.76)	−0.235 (0.50)	−0.904 (1.39)	0.177 (0.25)	1.922 (4.06)	1.568 (3.32)	2.074 (2.63)	1.770 (3.35)
<i>BETA</i>	1.183 (2.45)	0.816 (1.75)	1.450 (1.83)	0.917 (1.66)	0.217 (0.64)	0.260 (0.79)	0.297 (0.59)	0.137 (0.30)
<i>ILLIQMA</i>	0.162 (6.55)	0.126 (5.30)	0.216 (4.87)	0.108 (5.05)	0.112 (5.39)	0.103 (4.91)	0.135 (3.69)	0.088 (4.56)
<i>R100</i>	1.023 (3.83)	1.514 (6.17)	0.974 (2.47)	1.082 (2.96)	0.888 (3.70)	1.335 (6.19)	0.813 (2.33)	0.962 (2.92)
<i>R100YR</i>	0.382 (2.98)	0.475 (3.70)	0.485 (2.55)	0.279 (1.59)	0.359 (3.40)	0.439 (4.27)	0.324 (2.04)	0.395 (2.82)
<i>Ln SIZE</i>					−0.134 (3.50)	−0.073 (2.00)	−0.217 (3.51)	−0.051 (1.14)
<i>SDRET</i>					−0.179 (1.90)	−0.274 (2.89)	−0.136 (0.96)	−0.223 (1.77)
<i>DIVYLD</i>					−0.048 (3.36)	−0.063 (4.28)	−0.075 (2.81)	−0.021 (2.11)

<sup>a</sup> *t*-statistics in parentheses.

The cross-sectional models are also estimated by the weighted least squares method to account for heteroskedasticity in the residuals of model (2). The results<sup>14</sup> are qualitatively similar to those using the OLS method. In all models, the coefficient of *ILLIQMA* is positive and significant for the entire sample, when January is excluded and for each of the two subperiods.

### 3. The effect over time of market illiquidity on expected stock excess return

The proposition here is that over time, expected market illiquidity positively affects expected stock excess return (the stock return in excess of Treasury bill rate). This is consistent with the positive cross-sectional relationship between stock return and illiquidity. If investors anticipate higher market illiquidity, they will price stocks so that they generate higher expected return. This suggests that *stock excess return, traditionally interpreted as “risk premium,” includes a premium for illiquidity*. Indeed, stocks are not only riskier, but are also less liquid than short-term Treasury securities. First, both the bid–ask spread and the brokerage fees are much higher on stocks than they are on Treasury securities.<sup>15</sup> That is, illiquidity costs are greater for stocks. Second, the size of transactions in the Treasury securities market is greater: investors can trade very large amounts (tens of millions of dollars) of bills and notes without price impact, but block transactions in stocks result in price impact that implies high illiquidity costs.<sup>16</sup> It thus stands to reason that the expected return on stocks in excess of the yield on Treasury securities should be considered as compensation for illiquidity, in addition to its standard interpretation as compensation for risk.

The relationship between market liquidity and market return was studied by Amihud et al. (1990) for the October 19, 1987 stock market crash. They showed that the crash was associated with a rise in market illiquidity and that the price recovery by October 30 was associated with improvement in stock liquidity.

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<sup>14</sup>The results are available from the author upon request.

<sup>15</sup>The bid–ask spread on Treasury securities was about \$1/128 per \$100 of face value of bills (0.008%), \$1/32 on short-term notes (0.031%) and \$2/32 on long-term Treasury bonds (0.0625%) (see Amihud and Mendelson, 1991a). In recent estimates, the trade-weighted mean of the bid–ask spread of Government bonds is 0.081% (Chakravarti and Sarkar, 1999). For stocks, the bid–ask spread was much higher. The most liquid stocks had a bid–ask spread of \$1/8 dollar or 0.25% for a stock with a price of \$50. The average bid–ask spread on NYSE stocks during 1960–1979 was 0.71% (value weighted) or 1.43% (equally weighted; see Stoll and Whaley, 1983). In addition, brokerage fees are much lower for Treasury securities than they are for stocks. The fee was \$12.5 (or \$25) per million dollar for institutions trading T-bills and \$78.125 per million for notes, that is, 0.00125% and 0.00781%, respectively (Stigum, 1983, p. 437). For stocks, brokerage fees for institutions were no less than 6–10 cents per share, 0.12–0.20% for a \$50 stock. Fees for individuals were of the order of magnitude of the bid–ask spreads (Stoll and Whaley, 1983).

<sup>16</sup>See Chakravarti and Sarkar (1999) on the bond market and Kraus and Stoll (1972) and Keim and Madhavan (1996) on the stock market.

The proposition tested here is that expected stock excess return is an increasing function of expected market illiquidity. The tests follow the methodology of French et al. (1987) who tested the effect of risk on stock excess return. Expected illiquidity is estimated by an autoregressive model, and this estimate is employed to test two hypotheses:

- (i) ex ante stock excess return is an increasing function of expected illiquidity, and
- (ii) unexpected illiquidity has a negative effect on contemporaneous unexpected stock return.

### 3.1. Estimation procedure and results

The ex ante effect of market illiquidity on stock excess return is described by the model

$$E(RM_y - Rf_y | \ln AILLIQ_y^E) = f_0 + f_1 \ln AILLIQ_y^E. \quad (6)$$

$RM_y$  is the annual market return for year  $y$ ,  $Rf_y$  is the risk-free annual yield, and  $\ln AILLIQ_y^E$  is the expected market illiquidity for year  $y$  based on information in  $y - 1$ . The hypothesis is that  $f_1 > 0$ .

Market illiquidity is measured by  $AILLIQ_y$  (see (3)), the average across all stocks in each year  $y$  of stock illiquidity,  $ILLIQ_{iy}$  (defined in (1)), excluding stocks whose  $ILLIQ_{iy}$  is in the upper 1% tail of the distribution for the year. There are 34 annual values of  $AILLIQ_y$  for the years 1963–1996.  $AILLIQ_y$  peaked in the mid-1970s and rose again in 1990. It had low values in 1968, the mid-1980s and in 1996. The tests use the logarithmic transformation  $\ln AILLIQ_y$ .

Investors are assumed to predict illiquidity for year  $y$  based on information available in year  $y - 1$ , and then use this prediction to set prices that will generate the desired expected return in year  $y$ . Market illiquidity is assumed to follow the autoregressive model

$$\ln AILLIQ_y = c_0 + c_1 \ln AILLIQ_{y-1} + v_y, \quad (7)$$

where  $c_0$  and  $c_1$  are coefficients and  $v_y$  is the residual. It is reasonable to expect  $c_1 > 0$ .

At the beginning of year  $y$ , investors determine the expected illiquidity for the coming year,  $\ln AILLIQ_y^E$ , based on information in year  $y - 1$  that has just ended:

$$\ln AILLIQ_y^E = c_0 + c_1 \ln AILLIQ_{y-1}. \quad (8)$$

Then, they set market prices at the beginning of year  $y$  that will generate the expected return for the year. The assumed model is

$$(RM - Rf)_y = f_0 + f_1 \ln AILLIQ_y^E + u_y = g_0 + g_1 \ln AILLIQ_{y-1} + u_y, \quad (9)$$

where  $g_0 = f_0 + f_1c_0$  and  $g_1 = f_1c_1$ . Unexpected excess return is denoted by the residual  $u_y$ . The hypothesis is that  $g_1 > 0$ : higher expected market illiquidity leads to higher ex ante stock excess return.

The effect of unexpected market illiquidity on contemporaneous unexpected stock return should be *negative*. This is because  $c_1 > 0$  (in (8)) means that higher illiquidity in one year raises expected illiquidity for the following year. If higher expected illiquidity causes ex ante stock returns to rise, stock prices should *fall* when illiquidity unexpectedly rises. (This assumes that corporate cash flows are unaffected by market illiquidity.) As a result, there should be a negative relationship between unexpected illiquidity and contemporaneous stock return.

The two hypotheses discussed above are tested in the model

$$(RM - Rf)_y = g_0 + g_1 \ln AILLIQ_{y-1} + g_2 \ln AILLIQ_y^U + w_y, \tag{10}$$

where  $\ln AILLIQ_y^U$  is the *unexpected* illiquidity in year  $y$ ,  $\ln AILLIQ_y^U = v_y$ , the residual from (7). The hypotheses therefore imply two predictions:

H-1 :  $g_1 > 0$ , and

H-2 :  $g_2 < 0$ .

In estimating model (7) from finite samples, the estimated coefficient  $\hat{c}_1$  is biased downward. Kendall’s (1954) proposed a bias correction approximation procedure by which the estimated coefficient  $\hat{c}_1$  is augmented by the term  $(1 + 3\hat{c}_1)/T$ , where  $T$  is the sample size.<sup>17</sup> This procedure is applied here to adjust the estimated coefficient  $c_1$ .

The estimation of model (7) provides the following results:

$$\begin{aligned} \ln AILLIQ_y = & -0.200 + 0.768 \ln AILLIQ_{y-1} + residual_y \\ (t =) & (1.70) \quad (5.89) \qquad R^2 = 0.53, D - W = 1.57. \end{aligned} \tag{7a}$$

By applying Kendall’s (1954) bias correction method, the bias-corrected estimated slope coefficient  $c_1$  is 0.869 (the intercept is adjusted accordingly). The estimated parameters of the model are found to be stable over time, as indicated by the Chow test. It is therefore reasonable to proceed with the coefficients that are estimated using the entire data.<sup>18</sup>

The structure of models (7) and (9) resembles the structure analyzed by Stambaugh (1999). Since by hypothesis H-2 it is expected that  $Cov(u_y, v_y) < 0$ , it follows from Stambaugh’s (1999) analysis that in estimating (9), the estimated coefficient  $g_1$  is biased upward. This bias can be eliminated by including in

<sup>17</sup>Sawa (1978) suggests that “Kendall’s approximation is virtually accurate in spite of its simplicity” (p. 164).

<sup>18</sup>This approach is similar to that in French et al. (1987).

model (9) the residual  $v_y$ , as in model (10).<sup>19</sup> The procedure first calculates the residual  $v_y$  from model (7) after its coefficients are adjusted by Kendall's (1954) bias-correction method, and then it is used in model (10) as  $\ln AILLIQ_y^U$  to estimate  $g_1$  and  $g_2$ . In model (10),  $RM_y$  is the annual return on the equally weighted market portfolio for NYSE stocks (*source*: CRSP), and  $R_f$  is the one-year Treasury bill yield as of the beginning of year  $y$  (*source*: Federal Reserve Bank).

The estimation results of model (10), presented in Table 3, strongly support both hypotheses:

H-1: The coefficient  $g_1$  is positive and significant, suggesting that *expected stock excess return is an increasing function of expected market illiquidity*.

H-2: The coefficient  $g_2$  is negative and significant, suggesting that *unexpected market illiquidity has a negative effect on stock prices*. This result is consistent with the findings of Amihud et al. (1990).<sup>20</sup>

### 3.2. Market illiquidity and excess returns on size-based portfolios

The effect of market illiquidity on stock return over time varies between stocks by their level of liquidity. In an extreme case of a rise in illiquidity during the October 1987 crash there was a “flight to liquidity”: that were more liquid stocks declined less in value, after controlling for the market effect and the stocks’ *beta* coefficients (see Amihud et al., 1990). This suggests the existence of two effects on stock return when expected market illiquidity rises:

- (a) A decline in stock price and a rise in expected return, common to all stocks.
- (b) Substitution from less liquid to more liquid stocks (“flight to liquidity”).

For low-liquidity stocks the two effects are complementary, both affecting stock returns in the same direction. However, for liquid stocks the two effects work in *opposite* directions. Unexpected rise in market illiquidity, which negatively affects stock prices, also increases the relative demand for liquid stocks and mitigates their price decline. And, while higher expected market illiquidity makes investors demand higher expected return on stocks, it makes liquid stocks relatively more attractive, thus weakening the effect of expected illiquidity on their expected return.

<sup>19</sup>Simulation results of this bias-correction methodology using the actual sample parameters show that the bias in  $g_1$  is about 4% of its value. Simulation results are available from the author upon request.

<sup>20</sup>The model is tested for stability and the results show that it is stable over time.

Table 3

The effect of market illiquidity on expected stock excess return—annual data<sup>a</sup>

Estimates of the models:

$$(RM - Rf)_y = g_0 + g_1 \ln AILLIQ_{y-1} + g_2 \ln AILLIQ_y^U + w_y, \tag{10}$$

$RM_y$  is the annual equally-weighted market return and  $Rf$  is the one-year Treasury bill yield as of the beginning of year  $y$ .  $\ln AILLIQ_y$  is market illiquidity, the logarithm of the average across stocks of the daily absolute stock return divided by the daily dollar volume of the stock (averaged over the year).  $\ln AILLIQ_y^U$  is the unexpected market illiquidity, the residual from an autoregressive model of  $\ln AILLIQ_y$ .

The table also presents regression results of the excess returns on five size-based portfolios as a function of expected and unexpected illiquidity. The estimated model is

$$(RSZ_i - Rf)_y = g_0 + g_1^i \ln AILLIQ_{y-1} + g_2^i \ln AILLIQ_y^U + w_{iy}, \tag{10sz}$$

$RSZ_i, i = 2, 4, 6, 8$  and  $10$ , are the annual returns on CRSP size-portfolio  $i$  (the smaller number indicates smaller size).

Period of estimation: 1964–1996.

	$RM - Rf$	Excess returns on size-based portfolios				
		$RSZ_2 - Rf$	$RSZ_4 - Rf$	$RSZ_6 - Rf$	$RSZ_8 - Rf$	$RSZ_{10} - Rf$
<i>Constant</i>	14.740 (4.29) [4.37]	19.532 (4.53) [5.12]	17.268 (4.16) [5.04]	14.521 (4.02) [4.32]	12.028 (3.78) [3.55]	4.686 (1.55) [1.58]
$\ln AILLIQ_{y-1}$	10.226 (2.68) [2.74]	15.230 (3.18) [3.92]	11.609 (2.52) [3.31]	9.631 (2.40) [2.74]	7.014 (1.98) [1.84]	-0.447 (0.13) [0.14]
$\ln AILLIQ_y^U$	-23.567 (4.52) (4.11)	-28.021 (4.29) [3.91]	-24.397 (3.88) [3.63]	-20.780 (3.80) [3.41]	-18.549 (3.84) [3.50]	-14.416 (3.14) [3.39]
$R^2$	0.512	0.523	0.450	0.435	0.413	0.249
$D - W$	2.55	2.42	2.64	2.47	2.39	2.28

<sup>a</sup>  $t$ -statistics. [ $t$ -statistics calculated from standard errors that are robust to heteroskedasticity and autocorrelation, using the method of Newey and West, 1987.]

As a result, small, illiquid stocks should experience stronger effects of market illiquidity—a greater positive effect of expected illiquidity on ex ante return and a more negative effect of unexpected illiquidity on contemporaneous return. For large, liquid stocks both effects should be weaker, because these stocks become relatively more attractive in times of dire liquidity.

This hypothesis is tested by estimating model (10) using returns on size-based portfolios, where  $RSZ_i$  is the return on the portfolio of size-decile  $i$ :

$$(RSZ_i - Rf)_y = g_0^i + g_1^i \ln AILLIQ_{y-1} + g_2^i \ln AILLIQ_y^U + w_{iy}. \tag{10sz}$$

The estimation is carried out on size portfolios  $i = 2, 4, 6, 8$  and 10 (size increases in  $i$ ).<sup>21</sup> The proposition that the illiquidity effect is stronger for small illiquid stocks implies two hypotheses:

(SZ1) The coefficients  $g_1^i$  in model (10sz), which are positive, decline in size:

$$g_1^2 > g_1^4 > g_1^6 > g_1^8 > g_1^{10} > 0.$$

(SZ2) The coefficients  $g_2^i$  in model (10sz), which are negative, rise in size:

$$g_2^2 < g_2^4 < g_2^6 < g_2^8 < g_2^{10} < 0.$$

The results, presented in Table 3, are consistent with both hypotheses (SZ1) and (SZ2). First, the coefficients  $g_1^i$  decline monotonically in size. Second, the coefficients  $g_2^i$  rise monotonically in size (i.e., the effect of unexpected illiquidity becomes weaker).

The results suggest that the effects of market illiquidity—both expected and unexpected—are stronger for small firm stocks than they are for larger firms. These findings may explain the variation over time in the “small firm effect”. Brown et al. (1983) who documented this phenomenon “reject the hypothesis that the ex ante excess return attributable to size is stable over time” (p. 33). The findings here explain why: small and large firms react differently to changes in market illiquidity over time.

The greater sensitivity of small stock returns to market illiquidity—both expected and unexpected—means that they have greater *illiquidity risk*. If this risk is priced in the market, then stocks with greater illiquidity risk should earn higher illiquidity risk premium, as shown by Pastor and Stambaugh (2001). This may explain why small stocks earn, on average, higher expected return. The way that illiquidity affects expected stock returns can be therefore measured either by using illiquidity as a stock characteristic (as done in Amihud and Mendelson (1986) and others since), or by using the stock’s sensitivity to an illiquidity factor, which is shown here to vary systematically across stocks by their size or liquidity.

### 3.3. Monthly data: the effect of illiquidity on stock excess returns

The methodology of the previous two sections is replicated here using monthly data. There are 408 months in the period 1963–1996. Monthly illiquidity,  $MILLIQ_m$ , is the average across stocks of  $|R_{idm}|/VOLD_{idm}$ , the illiquidity measure of stock  $i$  on day  $d$  in month  $m$ , and then averaged over the days of month  $m$ . An autoregressive model similar to (7) is estimated for the monthly data as follows:

$$\ln MILLIQ_m = 0.313 + 0.945 \ln MILLIQ_{m-1} + residual_m$$

( $t =$ ) (3.31) (58.36)  $R^2 = 0.89, D - W = 2.34.$

(7m)

<sup>21</sup>The results are qualitatively similar when using the odd-numbered portfolios 1, 3, 5, 7 and 9.

Applying Kendall's (1954) bias correction method, the adjusted slope coefficient is 0.954. The estimated parameters are stable over time, as indicated by the Chow test. Next, the monthly unexpected illiquidity is calculated,  $MILLIQ_m^U$ , the residual from model (7m) after the coefficients are adjusted.

Finally, the monthly version of model (10) is estimated:

$$(RM - Rf)_m = g_0 + g_1 \ln MILLIQ_{m-1} + g_2 \ln MILLIQ_m^U + g_3 JANDUM_m + w_m. \quad (10m)$$

This model adds  $JANDUM_m$ , a January dummy, that accounts for the well-known January effect.  $RM_m$  is the monthly return on the equally weighted market portfolio (for NYSE stocks) and  $Rf$  is the one-month Treasury bill rate.

The results for the monthly data, presented in Table 4, are qualitatively similar to those using annual data. In particular,  $g_1 > 0$  and  $g_2 < 0$ , both statistically significant.

As a robustness check, the sample of 408 months is divided into six equal subperiods of 68 months each and model (10m) is estimated for each subperiod. The following is a summary of the results:

1. All six coefficients  $g_1$  are positive, with mean 0.871 and median 0.827.
2. All six coefficients  $g_2$  are negative with mean  $-7.089$  and median  $-5.984$ .

This shows consistency in the effect of illiquidity.

The differences in the effects of illiquidity on different size-based stock portfolios is tested by estimating model (10m) using excess returns on portfolios corresponding to deciles 2, 4, 6, 8 and 10 (decile 10 contains the largest firms). The results, presented in Table 4, are again similar to those for the yearly data:  $g_1$  is decreasing in company size, and  $g_2$  is increasing in company size.

### 3.4. Illiquidity effect, controlling for the effects of bond yield premiums

Two bond yield premiums are known to have a positive effect on ex ante stock returns over time: the default yield premium (the excess yield on risky corporate bonds) and the term yield premium (long-term minus short-term bond yield) (see Keim and Stambaugh, 1986; Fama and French, 1989; Fama, 1990).<sup>22</sup> The following are tests of the effects of illiquidity on stock excess returns after controlling for the effects of these two yield premiums.

<sup>22</sup>Fama and French (1989) and Fama (1990) study separately the effect of the default premium and the term premium on ex ante excess stock return. Keim and Stambaugh (1986) combine the two in a single measure, the difference between the yield on corporate bonds with rating below BAA and on short-term treasury bills. Boudoukh et al. (1993) study the effect of the term yield on subsequent stock excess return.

The default yield premium is defined as

$$DEF_m = YBAA_m - YAAA_m,$$

where  $YBAA_m$  and  $YAAA_m$  are, respectively, the yield to maturity on long-term  $BAA$ -rated and  $AAA$ -rated bonds.  $DEF_m$  is naturally positive, reflecting the premium on risky corporate bonds.

The term yield premium is

$$TERM_m = YLONG_m - YTB3_m,$$

Table 4

The effect of market illiquidity on expected stock excess return—monthly data<sup>a</sup>

This table presents regression results of the excess returns on the market return and on five size-based portfolios:

$$(10m) \quad (RM - Rf)_m = g_0 + g_1 \ln MILLIQ_{m-1} + g_2 \ln MILLIQ_m^U + g_3 JANDUM_m + w_y.$$

$RM$  is the monthly equally-weighted market return (NYSE stocks),  $Rf$  is the one-month Treasury bill rate,  $MILLIQ_m$  is the monthly illiquidity, the average across stocks and over days of the absolute stock return divided by the daily dollar volume of the stock,  $MILLIQ_m^U$  is the unexpected illiquidity, the residual from an autoregressive model of  $\ln MILLIQ_m$ , and  $JANDUM_m$  is a dummy variable that equals 1 in the month of January and zero otherwise.

In the size-related model, the dependent variable is  $(RSZ_i - Rf)_m$ , the monthly excess return on CRSP size-based portfolio  $i$ ,  $i = 2, 4, 6, 8$  and 10 (size rises with  $i$ ). The period of estimation is 1964–1996.

	$RM - Rf$	Excess returns on size-based portfolios				
		$RSZ_2 - Rf$	$RSZ_4 - Rf$	$RSZ_6 - Rf$	$RSZ_8 - Rf$	$RSZ_{10} - Rf$
<i>Constant</i>	-3.876 (2.33) [1.97]	-4.864 (2.54) [2.03]	-4.335 (2.45) [2.12]	-4.060 (2.42) [2.13]	-3.660 (2.27) [2.05]	-1.553 (1.12) [0.99]
$\ln MILLIQ_{m-1}$	0.712 (2.50) [2.12]	0.863 (2.64) [2.11]	0.808 (2.67) [2.33]	0.761 (2.65) [2.36]	0.701 (2.55) [2.30]	0.319 (1.35) [1.18]
$\ln MILLIQ_m^U$	-5.520 (6.21) [4.42]	-6.513 (6.37) [4.53]	-5.705 (6.04) [4.34]	-5.238 (5.84) [4.12]	-4.426 (5.15) [4.04]	-3.104 (4.19) [3.38]
$JANDUM_m$	5.280 (5.97) [4.20]	8.067 (7.94) [5.03]	5.446 (5.80) [4.08]	4.232 (4.74) [3.45]	3.000 (3.51) [2.64]	1.425 (1.93) [1.47]
$R^2$	0.144	0.188	0.140	0.119	0.089	0.049
$D - W$	1.98	1.99	1.96	1.99	2.03	2.14

<sup>a</sup>  $t$ -statistics. [ $t$ -statistics calculated from standard errors that are heteroskedastic-consistent, following White, 1980.]

where  $YLONG_m$  and  $YTB3_m$  are, respectively, the yields on long-term Treasury bonds and three-month Treasury bills. The data source is Basic Economics. The correlations between the variables are low:  $\text{Corr}(\ln MILLIQ_m, DEF_m) = -0.060$ ,  $\text{Corr}(\ln MILLIQ_m, TERM_m) = 0.021$ , and  $\text{Corr}(TERM_m, DEF_m) = 0.068$

The following model tests the effects of illiquidity on stock excess return, controlling for the effects of the default and term yield premiums:

$$(RM - Rf)_m = g_0 + g_1 \ln MILLIQ_{m-1} + g_2 \ln MILLIQ_m^U + g_3 JANDUM_m + a_1 DEF_{m-1} + a_2 TERM_{m-1} + u_m. \quad (11)$$

The model is predictive since lagged illiquidity and bond yields are known to investors at the beginning of month  $m$  during which  $(RM - Rf)_m$  is observed. The hypothesis that expected illiquidity has a positive effect on ex-ante stock excess return implies that  $g_1 > 0$  and  $g_2 < 0$ . In addition, the positive effects of the default and term yield premiums imply  $a_1 > 0$  and  $a_2 > 0$ .

The results, presented in Table 5, show that  $\ln MILLIQ_{m-1}$  retains its positive and significant effect on ex ante stock excess return after controlling for the default and the term yield premiums. Also,  $\ln AILLIQ_m^u$  retains its negative effect on contemporaneous stock seen returns. Consistent with Fama and French (1989), the two yield premiums have a positive effect on ex ante stock excess return.

The differences in the effects of illiquidity on different size-based stock portfolios is tested again here in the following model, controlling for the effects of the bond-yield premiums:

$$(RSZ_i - Rf)_m = g_0^i + g_1^i \ln MILLIQ_{m-1} + g_2^i \ln MILLIQ_m^U + g_3^i JANDUM_m + a_1^i DEF_{m-1} + a_2^i TERM_{m-1} + u_{im}, \quad (11sz)$$

where  $(RSZ_i - Rf)_m$  is the monthly return on CRSP size-portfolio  $i$  in excess of the one-month T-bill rate,  $i = 2, 4, 6, 8, 10$ .

The estimation results in Table 5 show the same pattern as before. The coefficient  $g_1$  declines as size increases and the coefficient  $g_2$  increases (becomes less negative) as size increases. That is, the illiquidity effect is stronger for smaller firms.

Interestingly, the effect of the default premium varies systematically with firm size. Since the default premium signifies default risk and future adverse economic conditions, it should have a greater effect on the expected return of smaller firms that are more vulnerable to adverse conditions. This is indeed the result: the coefficient of the default premium is declining as the firm size rises.

Table 5

The effects of expected market illiquidity, default yield premium and term yield premium on expected stock excess return—monthly data<sup>a</sup>

Estimation results of the model

$$(RM - Rf)_m = g_0 + g_1 \ln MILLIQ_{m-1} + g_2 \ln MILLIQ_m^U + g_3 JANDUM_m + a_1 DEF_{m-1} + a_2 TERM_{m-1} + u_m \tag{11}$$

$(RM - Rf)_m$ , the equally-weighted market return in excess of the one month treasury-bill rate for month  $m$ .  $\ln MILLIQ_m$  is market illiquidity in month  $m$ , calculated as the logarithm of the average across stocks over the days of the month of daily absolute stock return divided by the daily dollar volume of the stock.  $\ln MILLIQ_m^U$  is the unexpected market illiquidity, the residual from an autoregressive model of  $\ln MILLIQ_m$ .  $DEF_m = YBAA_m - YAAA_m$ , where  $YBAA_m$  and  $YAAA_m$  are, respectively, the yield to maturity on long term, BAA-rated and AAA-rated corporate bonds.  $TERM_m = YLONG_m - YTB3_m$ , where  $YLONG_m$  and  $YTB3_m$  are, respectively, the yields on long-term treasury bonds and three-month Treasury bills.  $JANDUM_m$  is a dummy variable that equals 1 in the month of January and zero otherwise.

Also estimated is the following model:

$$(RSZ_i - Rf)_m = g_0^i + g_1^i \ln MILLIQ_{m-1} + g_2^i \ln MILLIQ_m^U + g_3^i JANDUM_m + a_1^i DEF_{m-1} + a_2^i TERM_{m-1} + u_{im} \tag{11sz}$$

where  $(RSZ_i - Rf)_m$  is the monthly return on CRSP size-portfolio  $i$  in excess of the one-month T-bill rate,  $i = 2, 4, 6, 8, 10$ . The estimation period is 1963–1996.

	$RM - Rf$	Excess returns on size-based portfolios				
		$RSZ_2 - Rf$	$RSZ_4 - Rf$	$RSZ_6 - Rf$	$RSZ_8 - Rf$	$RSZ_{10} - Rf$
<i>Constant</i>	-5.583 (3.15) [2.63]	-6.986 (3.43) [2.58]	-6.170 (3.28) [2.73]	-6.010 (3.37) [2.90]	-5.191 (3.03) [2.71]	-2.693 (1.83) [1.68]
$\ln MILLIQ_{m-1}$	0.715 (2.53) [2.18]	0.912 (2.80) [2.20]	0.846 (2.82) [2.41]	0.803 (2.82) [2.48]	0.731 (2.67) [2.38]	0.332 (1.41) [1.23]
$\ln MILLIQ_m^U$	-5.374 (6.08) [4.39]	-6.281 (6.18) [4.48]	-5.492 (5.84) [4.27]	-5.014 (5.63) [4.05]	-4.242 (4.95) [3.97]	-2.940 (3.99) [3.26]
$JANDUM_m$	4.981 (5.67) [4.40]	7.943 (7.86) [5.11]	5.351 (5.73) [4.11]	4.128 (4.66) [3.46]	2.925 (3.44) [2.64]	1.395 (1.91) [1.48]
$DEF_{m-1}$	1.193 (2.35) [2.39]	1.558 (2.66) [2.52]	1.293 (2.39) [2.30]	1.386 (2.70) [2.76]	1.054 (2.14) [2.13]	0.663 (1.56) [1.54]
$TERM_{m-1}$	0.281 (1.84) [1.70]	0.185 (1.05) [1.00]	0.228 (1.40) [1.31]	0.227 (1.48) [1.39]	0.221 (1.50) [1.36]	0.316 (2.49) [2.30]
$R^2$	0.161	0.205	0.157	0.141	0.106	0.070
$D - W$	2.00	2.03	1.99	2.03	2.06	2.18

<sup>a</sup>  $t$ -statistics. [ $t$ -statistics calculated from standard errors that are heteroskedastic-consistent following White, 1980.]

#### 4. Summary and conclusion

This paper presents new tests of the proposition that asset expected returns are increasing in illiquidity. It is known from earlier studies that illiquidity explains differences in expected returns *across* stocks, a result that is confirmed here. The new tests in this paper propose that *over time*, market expected illiquidity affects the ex ante stock excess return. This implies that the stock excess return  $RM - R_f$ , usually referred to as “risk premium”, also provides compensation for the lower liquidity of stocks relative to that of Treasury securities. And, expected stock excess returns are not constant but rather vary over time as a function of changes in market illiquidity.

The measure of illiquidity employed in this study is *ILLIQ*, the ratio of a stock absolute daily return to its daily dollar volume, averaged over some period. This measure is interpreted as the daily stock price reaction to a dollar of trading volume. While finer and better measures of illiquidity are available from market microstructure data on transactions and quotes,<sup>23</sup> *ILLIQ* can be easily obtained from databases that contain daily data on stock return and volume. This makes *ILLIQ* available for most stock markets and enables to construct a time series of illiquidity over a long period of time, which is necessary for the study of the effects of illiquidity over time.

In the cross-section estimations, *ILLIQ* has a positive effect, consistent with earlier studies. This is in addition to the usual negative effect of size (stock capitalization), which is another proxy for liquidity.

The new tests of the effects of illiquidity over time show that expected market illiquidity has a positive and significant effect on ex ante stock excess return, and *unexpected* illiquidity has a negative and significant effect on contemporaneous stock return. Market illiquidity is the average *ILLIQ* across stocks in each period, and expected illiquidity is obtained from an autoregressive model. The negative effect of unexpected illiquidity is because higher realized illiquidity raises expected illiquidity, which in turn leads to higher stock expected return. Then, stock prices should decline to make the expected return rise (assuming that corporate cash flows are unaffected by market liquidity). The effects of illiquidity on stock excess return remain significant after including in the model two variables that are known to affect expected stock returns: the default yield premium on low-rated corporate bonds and the term yield premium on long-term Treasury bonds.

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<sup>23</sup>Other measures of illiquidity are the bid–ask spread (Amihud and Mendelson, 1986, the effective bid–ask spread (Chalmers and Kadlec, 1998), transaction price impact (Brennan and Subrahmanyam, 1996) or the probability of information-based trading (Easley et al., 1999)—all shown to have a positive effect on the cross-section of stock expected return.

The effects over time of illiquidity on stock excess return differ across stocks by their liquidity or size: the effects of both expected and unexpected illiquidity are stronger on the returns of small stock portfolios. This suggests that the variations over time in the “small firm effect”—the excess return on small firms’ stock—is partially due to changes in market illiquidity. This is because in times of dire liquidity, there is a “flight to liquidity” that makes large stocks relatively more attractive. The greater sensitivity of small stocks to illiquidity means that these stocks are subject to greater illiquidity risk which, if priced, should result in higher illiquidity risk premium.

The results suggest that the stock excess return, usually referred to as “risk premium”, is in part a premium for stock illiquidity. This contributes to the explanation of the puzzle that the equity premium is too high. The results mean that stock excess returns reflect not only the higher risk but also the lower liquidity of stock compared to Treasury securities.

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