ILLIQUIDITY AND STOCK RETURNS:
Cross-Section and Time-Series Effects

by

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Abstract

New tests are presented on the effects of stock illiquidity on stock return. Over time, expected market illiquidity positively affects *ex ante* stock excess return (usually called “risk premium”). This complements the positive cross-sectional return-illiquidity relationship. The illiquidity measure here is the average 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 firms stocks, suggesting an explanation for the changes “small firm effect” over time. The impact of market illiquidity on stock excess return suggests the existence of *illiquidity premium* and helps explain the equity premium puzzle.

1. Introduction

The hypothesis on the return-liquidity relationship is that stock expected return is an increasing function of stock illiquidity, as proposed by Amihud and Mendelson (1986). This study contributes to the study of this hypothesis in two ways. First, it tests the return-liquidity relationship not only across stocks, as was done by a number of studies in the past, but also over time. In particular, this paper proposes that *over time, expected market illiquidity of stocks has a positive effect on the ex ante stock excess return.* Second, this paper employs a new measure of illiquidity from daily stock data, which makes it feasible to obtain it for most stock markets where microstructure data are unavailable, and also enables to construct long time series necessary to study the time series illiquidity-return relationship.

The measure of stock illiquidity employed here, called *ILLIQ*, is the daily ratio of absolute stock return to its dollar volume, averaged over some period (here: a year). 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. This measure can be obtained from data on daily stock returns and volume that is readily available. Finer measures of illiquidity, such as the bid ask spread (quoted or effective), transaction-by-transaction market impact or the probability of information-based trading require data on transactions and quotes which is practically unavailable in stock markets outside the U.S. Importantly, this measure enables to construct long time series of illiquidity that are necessary to test the effects over time of illiquidity – both expected and unexpected – on ex ante and contemporaneous stock excess return. This would be quite impossible to do with 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, the proposed illiquidity measure has a positive and highly significant effect on the expected return. In addition, stock turnover, a measure of liquidity, has a negative and significant effect. These results reaffirm the importance of liquidity in asset pricing.

The new test here is on the effects over time of expected *market* illiquidity on *ex ante* 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* illiquidity. The results support 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 strongly 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 the 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.[1] 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 Mendelosn (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 (see Kraus and Stoll (1972), Keim and Madhavan (1996)), reflecting a likely action of informed traders (Easley and O'Hara (1987)). Kyle (1985) proposes 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 order flow because greater order flow is more likely to result from informed traders. 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) find a significant positive effect of quoted bid-ask spreads on stock returns (risk-adjusted).[2] Chalmers and Kadlec (1998) use the amortized effective spread as a measure of liquidity, obtained from quotes and subsequent transactions, and find that it positively affects stock returns.[3] Brennan and Subrahmanyam (1996) measure stock illiquidity by price impact,

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[1] See discussion in Amihud and Mendelson (1991b).

[2] Amihud and Mendelson (1986) study is on NYSE/ AMEX stocks, 1961-1980. Eleswarapu's 9197) 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).

[3] 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

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.[4] They find that these measures of illiquidity positively affect stock returns. Easley, Hvidjkjaer and O'Hara (1999) introduce 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 find 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 is largely unavailable in most markets around the world. Even in the U.S. these data are not available for long time periods. The illiquidity measure proposed here uses daily data on return and volume which is readily available for most markets and over long periods of time. This enables to study the time series effects of illiquidity.

The measure employed is based on the idea that illiquidity is the relationship between the price change and the associated order flow or trading volume. This follows Kyle's concept of illiquidity – the response of price to order flow, and Silber's (1975) measure of thinness – the ratio of absolute price change to absolute excess demand for trading. Stock illiquidity is defined here as the average ratio of the daily absolute return to the (dollar) trading volume on that day, $|R_{iyt}|/VOLD_{iyt}$. R_{iyt} is the return on stock i on day t of year y and $VOLD_{iyt}$ is the respective daily volume in dollars. This ratio gives the absolute (percentage) price change per dollar of daily

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holding period, obtained from the turnover rate on the stock, to obtain the amortized spread.

[4] 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-ask quote. Adjustments are made for prior information (on price changes and order size) and fixed order placement costs.

trading volume, or the daily price impact of the order flow. For each year y, the illiquidity measure of stock i is calculated as the average

$$(1) \qquad ILLIQ_{iy} = 1/D_{iy} \sum_{t=1}^{Diy} |R_{iyt}|/VOLD_{iyt} ,$$

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, see Cooper et al. (1985), Khan and Baker (1993)). Amihud, Mendelson and Lauterbach (1997) and Berkman and Elsewarapu (1998) use the liquidity ratio to study the effect of changes in liquidity on the values of stocks that were subject to changes in their reading 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*.

Stock liquidity can also be measured by the turnover ratio:

$$(2) \qquad TRNOVR_{iy} = 1/D_{iy} \sum_{t=1}^{Diy} VOLSHS_{iyt}/NSHRS_{iyt} .$$

$VOLSHS_{iyt}$ is the trading volume in shares of stock i on day t in year y, and $NSHRS_{iyt}$ is the number of shares outstanding of stock i on that day. Amihud and Mendelson (1986) propose that turnover is negatively related to illiquidity costs. Assets each have a different liquidation cost and each investor j has a different expected trading frequency per unit time, denoted by μ_j. In equilibrium, the more illiquid stocks are allocated to investors with lower trading frequency who amortize the illiquidity cost over a longer period, thus mitigating the loss due to the asset's illiquidity costs. Thus in equilibrium, there is a negative relationship between asset illiquidity costs and trading frequency. This proposition is tested by Atkins and Dyl (1997) who find a strong positive relationship across stocks between the bid-ask spread and the holding period, measured as the reciprocal of the turnover ratio (controlling for stock capitalization). The effect on stock return of stock liquidity, thus measured, is tested by Haugen and Baker (1996), Datar et al. (1998), Hu (1997a,b) Rouwenhorst (1998) and Chordia, Subrahmanyam and Anshuman (2000). They all find that the cross section of stock return is decreasing in stock turnover.

Another measure of stock liquidity is size or the market capitalization of the stock, since a larger stock issue has smaller price impact for a given order flow and a smaller bid-ask spread.[5] Size is known to negatively affect stock return (Banz (1981), Reinganum (1981), Fama and French (1992)), which is consistent with it being a proxy for liquidity (Amihud and Mendelson (1986)). The negative return-size relationship may also result from the size variable being functionally related to the reciprocal of expected return (Berk (1995)).

Trading volume is a natural measure of stock liquidity. Brennan, Chordia and Subrahmanyam (1998) find that the cross-section of stock return is negatively related to the stock (dollar) volume, and that volume subsumes the negative effect of size.

These measures of illiquidity can all be regarded as empirical proxies that measure different aspects of illiquidity. It is hard – and unnecessary – to capture liquidity in a single variable, and it may well be described as a function of a number of variables, each being a proxy for that elusive concept of liquidity.

2.2 Empirical methodology

The effect of illiquidity on stock return is examined for stocks traded in the New York Stock Exchange (NYSE) for the years 1963-1997, using data from daily and monthly databases

[5] 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

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.[6] The test procedure follows the usual Fama-MacBeth (1973) method. A cross-section model is estimated of monthly stock returns as a function of stock characteristics, for each month m=1, 2, … 12 in year y, y=1964, 1965, …. 1997 (a total of 408 months):

$$(3) \qquad R_{imy} = k_{0my} + \sum_{j=1}^{J} k_{jmy} \; X_{ji,y-1} + U_{imy} \,.$$

R_{imy} is the return on stock i in month m of year y. Returns are adjusted for stock delisting to avoid survivorship bias, following Shumway (1997).[7] $X_{ji,y-1}$ is characteristic j of stock i, estimated from data in year $y-1$ and known to investors at the beginning of year y, when they make their investment decisions for the coming year. The coefficients k_{jmy} measure the effects of stock characteristics on stock expected return, and U_{imy} are the residuals. The monthly regressions of model (3) over the period 1964-1997, produce 408 estimates of each coefficient k_{jmy}, j=0, 1, 2, ..., 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 150 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

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traders (see Glosten and Milgrom (1985), Kyle (1985)).

[6] 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 on the NASDAQ trading is done almost entirely through market makers, whereas on the NYSE most trading is done directly between buying and selling investors.

[7] 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

greatly affected by the minimum tick of \$1/8, which adds noise to the estimations.[8]

(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) Excluded are stocks whose estimated $ILLIQ_{iy}$ (defined in (1)) or $TRNOVR_{iy}$ (defined in (2)) is at the highest or lowest 1% tails of the distribution in year *y-1*. (The distribution is calculated for stocks that satisfy criteria *(i)*-*(iii)*.) This eliminates outliers.

There are between 1113 and 2267 stocks that satisfy these four conditions and are included in the cross-section estimations.

2.3 Stock characteristics

2.3.1. Liquidity variables

The following variables are employed as measures of liquidity.

1. $ILLIQ_{iy}$ is calculated for stock *i* in year *y* from daily data as in (1) above (multiplied by 10^6.)
2. $TRNOVR_{iy}$, the turnover ratio, is calculated for each stock *i* in year *y* as in (2). The calculation from daily data accounts for mid-year changes in the number of shares outstanding due to stock splits, stock dividends, stock issues and stock repurchase. (This variable is multiplied by 10^4.)
3. $VOLD_{iy}$, the dollar volume of stock *i* during year *y*, is the sum over the year of the daily product of share volume by the price. (This variable is divided by 10^3.)
4. $SIZE_{iy}$, the market capitalization of stock *i* at the end of year *y*, is given by CRSP. (This variable is divided by 10^3.)

average delisting return, examining the OTC returns of delisted stocks.

[8] 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

5. P_{iy}, the stock price at the end of the year, may be related to liquidity because the minimum tick affects the minimum bid-ask spread as percentage of price (Harris (1994), Anshuman and Kalay (1998)), and used by Brennan et al. (1998) in their cross-section estimations.

In the cross-section estimation models, $lnVOLD_{iy}$, $lnSIZE_{iy}$ and lnP_{iy} are the logarithmic transformation of the respective variables (see Brennan et al. (1998)).

INSERT TABLE 1 HERE

Table 1 presents estimated statistics of these liquidity variables. For each variable, the annual mean, standard deviation across stocks and median are calculated in each year 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 variables that are known proxy measures of liquidity. Corr($ILLIQ_{iy}$,$lnVOLD_{iy}$)= –0.668, Corr($ILLIQ_{iy}$,$lnSIZE_{iy}$)= –0.611, Corr($ILLIQ_{iy}$,lnP_{iy})= –0.459 and Corr($ILLIQ_{iy}$,$TRNOVR_{iy}$)= –0.144. The correlations suggest that each liquidity variable contains information that is not included in the other. For example, the correlation between $ILLIQ_{iy}$ and $lnVOLD_{iy}$ means that *lnVOLD* explains less than half (0.446) of the variability in *ILLIQ*.

ILLIQ, which is calculated from daily data, should be positively related to variables that measure illiquidity from microstructure data. Brennan and Subrahmanyam (1996) use two measures of illiquidity, obtained from data on inraday transactions and quotes: Kyle's (1985) λ, the price impact measure, and ψ, the fixed-cost component related to the bid-ask spread. The estimates are done using the Glosten-Harris (1988) method. Using estimates[9] of these variables

price is below $5.

[9] I thank Michael Bennan and Avanidhar Subrahmnaym 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

for 1984, the following cross-sectional regression was estimated:

$$ILLIQ_i = -292 + 247.9\,\lambda_i + 49.2\,\psi_i$$
$$(t =) \quad (12.25)\ (13.78) \quad (17.33) \qquad R^2 = 0.30$$

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

In each year, the average market illiquidity across stocks is calculated as

$$(4) \qquad AILLIQ_y = 1/N_y \sum_{t=1}^{Ny} ILLIQ_{iy} \,,$$

where N_y is the number of stocks in year *y*. The average illiquidity varies considerably over the years. In estimating the cross-section model (3), $ILLIQ_{iy}$ is replaced by its mean-adjusted values,

$$(5) \qquad ILLIQMA_{iy} = ILLIQ_{iy} / AILLIQ_y \,.$$

The stocks that are used to calculate the average illiquidity are those that enter the cross-sectional regression (3) for each month and satisfy conditions *(i)-(iv)* above. Turnover is mean-adjusted in the same way,

$$(6) \qquad TRNOVRMA_{iy} = TRNOVR_{iy} / ATRNOVR_y,$$

where $ATRNOVR_y$ is the average turnover across stocks that enter the cross-sectional regression. Clearly, the means of $ILLIQMA_{iy}$ and $TRNOVRMA_{iy}$ are constant and equal 1.0.

2.3.2. Risk variables

Model (3) includes $BETA_{iy}$ as a measure of risk. It is 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 instrumental variable. Next, the portfolio return R_{pty} is calculated as the

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discarded (see Brennan and Subrahmanyam (1996)).

equally-weighted average for portfolio *p* on day *t* in year *y*. Then, the following market model is estimated for each portfolio *p*, *p* = 1, 2, …, 10,

$$(7) \qquad R_{pty} = a_{py} + BETA_{py} \cdot RM_{ty} + e_{pty}.$$

RM_{ty} is the equally-weighted market return. $BETA_{py}$ is the slope coefficient, estimated by the Scholes and Williams (1977) method. The beta of stock *i*, $BETA_{iy}$, is the portfolio $BETA_{py}$ assigned to each stock *i* in portfolio *p*. Fama and French (1992), who use similar methodology, suggest 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.[10]

The stock total risk is $SDRET_{iy}$, the standard deviation of the daily return on stock *i* during year *y*. (This variable is multiplied by 10^2.) This risk variable is considered since empirically, $ILLIQ_{iy}$ may be construed as a measure of the stock's risk, given that its numerator is the absolute return which is directly related to $SDRET_{iy}$. Theoretically, the stock total risk is related to illiquidity by Stoll's (1978) model, where the bid-ask spread set by a risk-averse market maker is increasing in the stock's risk. Constantinides (1986) proposes that when the stock variance is higher, traders incur higher trading costs because they need to engage more frequently in portfolio rebalancing, and this positively affects the return that they require on the stock. The evidence, however, is that the correlation between *ILLIQ* and *SDRET* is low, 0.289 (see Table 1, Panel B), suggesting that *ILLIQ* is not a measure of risk. The inclusion of *SDRET* in the model is also because some asset pricing models show that it is priced, since investors' portfolios are constrained and therefore not well diversified (Levy (1978), Merton (1987)).

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[10] The models were re-estimated using betas of individual stocks in lieu of betas of size portfolios. These betas has 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.

2.3.3. *Additional variables*

The estimation model 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, dividend yield may have a negative effect on return across stocks if it is negatively correlated with an unobserved risk factor, that is, high dividend paying stocks are less risky. The coefficient of dividend yield may also be negative following Redding's (1997) suggestion that large investors prefer companies with high liquidity and also prefer receiving dividends.[11]

Finally, past stock returns may affect their expected returns due to momentum in the market, as found by Brennan et al. (1998). Therefore, the cross-sectional model (3) includes two variables: $R100_{iy}$, the return on stock *i* during the last 100 days of year *y*, and RYR_{iy}, the return on stock *i* over the entire year *y*.

The model does not includes the variable BE/ME, the ratio of book-to-market equity, which is used by Fama and French (1992) in cross-section asset pricing estimation. This is because this study employs only NYSE stocks, for which BE/ME is found to have no significant effect (Easley, Hvidkjaer and O'Hara (1999), Loughran (1997)[12]). Also, Berk (1995) suggests that an estimated relation between expected return and BE/ME is obtained by construction, given the functional relation between expected return and equity.

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[11] 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.

2.4. Cross section estimation results

In the cross-sectional model (3), monthly returns in each month of the year are regressed on stock characteristics that are estimated from data in the previous year (following the Fama-MacBeth (1973) method). The model is estimated for all 408 months (34 years), generating 408 sets of coefficients k_{jmy}, m=1, 2, …. 12, and y=1964, 1965, …. 1997. For each stock characteristic j, the mean and standard error of the 408 estimated coefficients k_{jmy} are calculated, followed by a t-test of the null hypothesis of zero mean. Tests are also performed for 374 monthly estimates excluding the month of January. This is because some studies find that when excluding the January, the effects of beta, size and the bid-ask spread become insignificant (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 (17 years) each.

INSERT TABLE 2 HERE

Table 2, Panel A, presents the results of a parsimonious cross-sectional model that includes $BETA_{iy}$, $ILLIQMA_{iy}$ and past returns $R100_{iy}$ and RYR_{iy}. The results strongly support the hypothesis that illiquidity is priced. The coefficient of $ILLIQMA_{iy}$, denoted $k_{ILLIQmy}$, has a mean of 0.163 that is statistically significant (t = 6.90). The median of $k_{ILLIQmy}$ is 0.141, close to the mean, indicating that the result on the mean is not driven by a few extreme values. Of the 408 monthly estimated coefficients $k_{ILLIQmy}$, 275 are positive which constitutes 2/3 of the sample – a proportion that is significantly different from 1/2 (the chance proportion). The serial correlation of the series $k_{ILLIQmy}$ is 0.05, insignificantly different from zero.

The illiquidity effect remains positive and highly significant when January is excluded:

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[12] Loughran (1997) finds that when the month of January is exluded, the effect of BE/ME becomes insignificant.

the mean of $k_{ILLIQmy}$ is 0.131 with t = 5.73. The stability of the illiquidity effect is evident from the estimation results of the model over two subperiods of 17 years each. The mean coefficients $k_{ILLIQmy}$ are 0.204 and 0.123 for the first and second subperiod, respectively, and the corresponding t values are 4.78 and 6.04.

The effect of *BETA* is positive, as expected, and significant (the statistical significance is lower when January is excluded and in the first subperiod). Its effect, however, becomes insignificant[13] when the size variable is included in the model, since beta is calculated for size-based portfolios (see Panel B). Past returns – *R100* and *RYR* – both have positive and significant coefficients (*R100* is insignificant in the first subperiod).

Table 2, Panel B presents estimation results of models that include additional variables. The results show that liquidity is priced in the market. First, *ILLIQMA* has a positive and significant coefficient for the entire period, for the non-January months and for each of the two subperiods. The effect of *ILLIQMA* remains positive and significant in all three models in this table that include different sets of variables, with its coefficient and significance changing very little. Second, the other liquidity measure, *TRNOVRMA* (turnover, mean-adjusted), has a negative and generally significant coefficient for the entire period, for the non-January months and for each of the two subperiods. The coefficients of *TRNOVRMA* show stability and do not vary much in all these estimations. In addition, the coefficient of *lnSIZE* is negative and significant, although its magnitude and significance is low in some specifications of the model. Size may measure liquidity, but its negative coefficient may also be due to it being a proxy for the reciprocal of expected return (Berk (1995)).

The effect of *lnVOLD* (dollar volume), which measures liquidity, is expected to be

[13] As pointed out earlier, when using individual stock beta, its effect is insignificant.

negative, which is the case (as in Brennan et al. (1998)) when *ILLIQMA* and *TRNOVRMA* are excluded from the model. Yet, its sign turns positive when these liquidity variables are included. The effect of volume on expected return is, however, captured trough both *ILLIQMA* and *TRNOVRMA* which include volume in their calculation.

The effect of the price variable *lnP* is insignificant. Risk, measured by *SDRET* (the return standard deviation), also has an insignificant effect. The sign of its coefficient is negative as in Amihud and Mendelson (1989), contrary to predictions of a positive effect. Importantly, the coefficient of *ILLIQ* remains positive and significant when *SDRET* is included. This suggests that the illiquidity measure *ILLIQ*, whose numerator includes absolute return, is distinct in its effect from that of risk.

The negative coefficient of *DIVYLD* may reflect the effect of an unobserved risk factor that is negatively correlated with dividend yield across stocks (less risky companies may choose to have higher dividend). The negative coefficient is also consistent with the hypothesis of Redding (1997) about the preference for dividends by some types of investors. These effects could offset the positive effect of *DIVYLD* that results from the higher personal tax on dividends.

In conclusion, the evidence strongly shows that liquidity affects expected stock returns. Stock liquidity can be represented by the variables *ILLIQ* and *TRNOVR*, which have significant effects on the cross-section of stock returns, in addition to the effect of *lnSIZE*.

The cross-sectional models are also estimated by the weighted least squares method to account for hetersokedasticity in the residuals of model (3). The results, presented in detail in the Appendix, are qualitatively similar to those using the OLS method. In all models, the coefficient of *ILLIQMA* is positive and highly significant. Its effect remains positive and significant when estimated for all months excluding January 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. It thus stands to reason that the expected stock return 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 difference in liquidity between stocks and Treasury securities is quite large. 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)). For stocks, the bid-ask spread was much higher. The most liquid stocks had a bid-ask spreads of $ 1/8 dollar or 0.25% for a stock whose price is $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-$25 per million dollar transaction value 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, or 0.12%-0.20% for a $50 stock. For individuals, brokerage fees were of the order of magnitude of the bid-ask spreads (Stoll and Whaley (1983)). And, while investors can trade very large amounts (tens of millions of dollars) of bills and notes without price impact, block transactions in stocks result in price impact that implies high illiquidity costs (Kraus and Stoll (1972), Keim and Madhavan (1996)).

The effect of market illiquidity on stock return is studied by Amihud, Mendelson and Wood (1990) for the October 19, 1987 stock market crash. They show that the crash occurred (in part) because of a rise in market illiquidity before and during October 19, and that the price recovery by October 30 was associated with improvement in stock liquidity.

The proposition tested here is that expected stock excess return is an increasing function of expected market illiquidity. This is done in two steps, following the methodology of French, Schwert and Stambaugh (1987) who examine the "risk premium" interpretation of stock excess return. First, an expected illiquidity is estimated by an autoregressive model. The second step employs the estimate from the first step and tests the hypothesis that ex ante stock excess return is an increasing function of expected illiquidity, as well as the hypothesis that unexpected illiquidity has a negative effect on contemporaneous unexpected stock return.

3.1. Expected market illiquidity and its effect on ex ante stock excess return

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

$$(8) \qquad E(RM_y - Rf_y \mid lnAILLIQ_y^E) = f_0 + f_1\, lnAILLIQ_y^E .$$

RM_y is the annual market return for year y, Rf_y is the risk-free annual yield, and $lnAILLIQ_y^E$ 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 here by average illiquidity $AILLIQ_y$ (see (4)), the average across all stocks in each year y of stock illiquiidty, $ILLIQ_{iy}$ (defined in (1)). The calculation of $AILLIQ_y$ here excludes values of $ILLIQ_{iy}$ 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 results presented here are for the logarithmic transformation $lnAILLIQ_y$; they are qualitatively similar when using $AILLIQ_y$ instead.

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

$$(9) \qquad lnAILLIQ_y = c_0 + c_1 \cdot lnAILLIQ_{y-1} + v_y ,$$

where c_0 and c_1 are coefficients and v_y is the residual. It is reasonable to expect that $c_1 > 0$. At the beginning of year y, investors determine the expected illiquidity for the coming year, $lnAILLIQ_y^E$, based on information in the year that has just ended: $lnAILLIQ_y^E = c_0 + c_1 \cdot lnAILLIQ_{y-1}$. Then, they set prices in the market at the beginning of year y that will generate the expected return for the year. The assumed model is

$$(10) \qquad (RM\text{-}Rf)_y = f_0 + f_1 \cdot lnAILLIQ_y^E + u_y = g_0 + g_1 \cdot lnAILLIQ_{y-1} + u_y,$$

where $g_0 = f_0 + f_1 \cdot c_0$ and $g_1 = f_1 \cdot c_1$. Unexpected excess return is denoted by the residual u_y. The hypothesis here is that $g_1 > 0$: higher expected market illiquidity leads to higher ex ante stock excess return.

The effect of *un*expected market illiquidity on contemporaneous unexpected stock return should be *negative*. This is because $c_1 > 0$ (in model (9)) means that higher illiquidity in one year raises expected illiquidity for the following year. If higher expected illiquidity leads to higher ex ante stock return, stock prices should *fall* when illiquidity unexpectedly rises, so that ex ante stock returns rise (assuming that corporate cash flows are unaffected by market illiquidity). Thus, higher realized illiquidity should lower stock price, generating a negative relationship between unexpected illiquidity and contemporaneous stock return.

The two hypotheses discussed above are tested by the model

$$(11)\quad (RM\text{-}Rf)_y = g_0 + g_1\, lnAILLIQ_{y\text{-}1} + g_2\, lnAILLIQ_y^U + w_y\,,$$

where $lnAILLIQ_y^U$ is the *un*expected illiquidity in year y, defined as $lnAILLIQ_y^U = v_y$, the residual from (9). The hypotheses imply two predictions:

(H-1) $g_1 > 0$, and

(H-2) $g_2 < 0$.

In estimating model (9) from finite samples, especially from a small sample as here, the estimated coefficient $\hat{c}_1$ is downward biased. Following Kendall's (1954) proposed bias correction approximation procedure, the estimated coefficient $\hat{c}_1$ is augmented by the term $(1+3\hat{c}_1)/T$, where T is the sample size.[14] This procedure is applied here to adjust the estimated coefficient c_1.

The estimation of model (9) provides the following results:

$lnAILLIQ_y$ =	–0.200	+	0.764 $lnAILLIQ_{y-1}$ + $residual_y$	
(t =)	(1.70)		(5.89)	R^2=0.53, D-W = 1.57

The model seems to fit the data well. Applying Kendall's (1954) method, the bias-corrected estimated slope coefficient c_1 is 0.869 (the intercept is adjusted accordingly). The estimated parameters are found to be stable over time, as indicated by a Chow test.[15] It is therefore reasonable to assume that investors know them and the analysis proceeds using the coefficients that are estimated using the entire data.[16]

The structure of models (9) and (10) resembles the structure analyzed by Stambaugh

[14] Sawa (1978) suggests that "Kendall's approximation is virtually accurate in spite of its simplity" (p. 164).
[15] Also, the following model is estimated:

$$(9)'\quad lnAILLIQ_y = c_0 + c_1\cdot lnAILLIQ_{y\text{-}1} + c_0'\cdot DUMT + c_1'\cdot lnAILLIQ_{y\text{-}1}\cdot DUMT + v_y\,,$$

where $DUMT$ = 1 for the last 16 years of the sample, 1981-1996, and zero otherwise. The estimated coefficients c_0' and c_1' are not significantly different from zero (their t-statistics are below 1.0), suggesting that the parameters of model (9) are stable over the two subperiods.

(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 (10), the estimated coefficient g_1 is upward biased. However, when the an additional variable – the residual v_y from (9) – is added to the right hand side of (10), as it is in model (11), the estimated coefficient g_1 is unbiased. Therefore results will be presented for model (11) only. The residual v_y is calculated from the estimated model (9) after its coefficients are adjusted by Kendall's (1954) bias-corrected method, and then it is used in model (11) to estimate g_1 and g_2.[17]

In estimating model (11), RM_y is the annual return on the equally weighted market portfolio (source: CRSP), and Rf is the one-year Treasury bill yield as of the beginning of year y (source: Federal Reserve Bank).

INSERT TABLE 3 HERE

The estimation results of model (11) are presented in Table 3. These results strongly support both hypotheses:

(H-1): The coefficient g_1 is positive and significant, meaning 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 *un*expected market illiquidity has a *negative* effect on stock prices. This result is consistent with the findings of Amihud, Mendelson and Wood (1990).

The model is tested for stability and the results show that it is stable over time.[18]

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[16] This approach is similar to that in French et al. (1987).

[17] Simulations conducted using parameters of the estimated models show that the bias in g_1 can amount to about 2% of its estimated value.

[18] The model estimated is

$(11)'\ (RM\text{-}Rf)_y = g_0 + g_0{}' \cdot DUMT + g_1\ ILLIQM_{y-1} + g_1{}'\ ILLIQM_{y-1} \cdot DUMT + g_2\ ILLIQM_y^U + f_2{}'\ ILLIQM_y^U \cdot DUMT + w_y$,
where $DUMT$ = 1 for the last 16 years of the sample, 1981-1996, and zero otherwise. The estimated coefficients $g_1{}'$ and $g_2{}'$ are not significantly different from zero (their t-statistics are below 1.0), and the coefficients g_1 and g_2 hardly change.

3.2 Market illiquidity and firm size excess returns

The effect of market illiquidity on stock return over time varies between stocks by their level of liquidity. Amihud, Mendelson and Wood (1990) find that during the October 1987 crash, the rise in illiquidity instigated a "flight to liquidity:" more liquid stocks declined less in value, after controlling for the market effect and the stocks' β. 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 stocks with low liquidity, the two effects are complementary, both resulting in the same effect on stock return (both expected and unexpected). However, for liquid stocks the two effects work in opposite directions. 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. However, for large, liquid stocks both effects should be weaker, because these stocks become relatively more attractive in times of dire liquidity. Thus, unexpected rise in market illiquidity, which has negative effect on contemporaneous stock prices, also increases the demand for liquid stocks and mitigates their price declines. And, while higher expected market illiquidity makes investors demand higher *ex ante* return, it also increases the attractiveness of liquid stocks and reduces the expected return that investors demand on them, thus weakening the effect of expected illiquidity on their expected return.

This hypothesis is tested by estimating model (11) using returns on size-based portfolios, where RSZ_i is the return on the portfolio of size-decile i:

$$(11sz)\quad (RSZ_i\text{-}Rf)_y = g_0^{\,i} + g_1^{\,i}\, lnAILLIQ_{y-1} + g_2^{\,i}\, lnAILLIQ_y^{\,U} + w_{iy}\,.$$

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

(SZ1) The coefficients g_1^i in model (11sz), 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 (11sz), which are negative, rises in size:

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

INSERT TABLE 4 HERE

As seen in Table 4, both hypotheses (SZ1) and (SZ2) are strongly supported by the estimation results of model (11sz).

(SZ1) The coefficients g_1^i decline monotonically in size: 15.230 > 11.609 > 9.631 > 7.014 > –0.447. The statistical significance of the coefficients is declining in firm size; the last coefficient is statistically insignificant (t = 0.13).

(SZ2) The coefficients g_2^i rise monotonically in size (i.e., the effect becomes weaker): –28.021 < –24.397 < –20.780 < –18.549 < –14.416. All coefficients are statistically significant.

The results mean that the effects of market illiquidity – both expected and unexpected – are stronger for small firm stocks and become weaker for large firms. These findings explain the variation over time in the "small firm effect," i.e., the excess return of small firm return over the return on large firms. Brown, Kleidon and Marsh (1983) who document that “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, both expected and unexpected.

A convenient way to present small firms’ excess return is through the return differential

$(12) \quad SR_y = RMEW_y - RMVW_y,$

where *RMEW* and *RMVW* denote, respectively, equally-weighted and value-weighted market return. The estimation results are presented in Table 3. They show that the small firm excess return varies over time as a function of liquidity: it is an increasing function of expected illiquidity and a decreasing function of unexpected illiquidity.

3.3 Illiquidity and other variables that predict stock excess return

3.3.1 The effects of volatility

The stock excess return $(RM\text{-}Rf)_y$ is traditionally considered as risk premium. Therefore, the model is extended to test the effects of both illiquidity and volatility on ex ante stock excess return. Since the illiquidity measure contains in its numerator the stock absolute return, it could be argued that its effect results from the effect of volatility on ex ante stock return. Define $lnSD_y$ as the (logarithm of) standard deviation of daily return on the market portfolio (equally weighted) in year *y*. The standard deviation of daily return is used by French et al. (1987) to examine the effect of monthly market volatility on ex ante stock excess return. Indeed, volatility and illiquidity are related, but the correlation is low: Corr($lnAILLIQ_y$, $lnSD_y$) = 0.307.

The analysis here follows the procedure applied above to illiquidity. It is assumed that investors estimate expected volatility for year *y*, based on information in year *y-1*, from the model

$$(13) \quad lnSD_y = a_0 + a_1\, lnSD_{y-1} + e_y\,.$$

The estimated slope coefficient is adjusted applying Kendall's (1954) bias-correction method. Using the adjusted parameters, the residual e_y is used as unexpected market volatility, denoted $lnSD^U{}_y$, in the model

$$(14) \quad (RM\text{-}Rf)_y = g_0 + g_1\, lnAILLIQ_{y-1} + g_2\, lnAILLIQ_y^U + h_1\, lnSD_{y-1} + h_2\, lnSD_y^U + w_y\,.$$

Given investors' risk aversion, the following results are expected (see French et al. (1987)): expected volatility has a positive effect on ex ante stock excess return, i.e., $h_1 > 0$, and the effect of unexpected volatility on contemporaneous stock return is negative, i.e., $h_2 < 0$. The hypotheses on the effect of illiquidity imply, as before, that $g_1 > 0$ and $g_2 < 0$.

An estimate of expected $lnSD_y$ is obtained from model (13):

$$SDM_y = -0.164 + 0.448\, lnSD_{y-1} + residual_y$$
$$(t =) \quad (2.23) \quad (2.86) \qquad R^2 = 0.21,\ DW = 1.84$$

The slope coefficient, adjusted by Kendall's (1954) method, is 0.520. Unexpected volatility, denoted $lnSD_y^U$, is calculated by using the adjusted coefficients. Then $lnSD_y$ and $lnSD_y^U$ are used to estimate model (14).

The estimation results of model (14) are presented in Table 3. For the model where the dependent variable is the stock excess return $(RM – Rf)_y$, the effect of expected volatility is positive and the effect of unexpected volatility is negative, both as hypothesized., but only the effect of expected volatility is significant. Importantly, the effect of illiquidity remains significant when the volatility variables are included in the model.

3.3.2 The effects of bond yields: default premium and term premium

Two bond yield premiums are known to have a positive effect on expected 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) and Fama (1990)).[19] The question is whether expected illiquidity remains a

[19] 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

significant predictor of ex ante stock excess return after controlling for the predictive effects of these two yield premiums.

The default yield premium is defined as

(15) $DEF_y = YBAA_y – YAAA_y$

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

The term yield premium is

(16) $TERM_y = YLONG_y – YTB3_y$,

where $YLONG_y$ and $YTB3_y$ are, respectively, the yields on long-term Treasury bonds and three-month Treasury bills. All yields are as of the end of year y (December). The data source on bond yields is Basic Economics.

The model that estimates the determinants of ex ante stock excess return is

(17) $(RM\text{-}Rf)_y = g_0 + g_1\, lnAILLIQ_{y-1} + g_2\, lnAILLIQ_y^U + a_1\, \Delta DEF_{y-1} + a_2\, \Delta TERM_{y-1} + u_y$.

$\Delta DEF_y = DEF_y – DEF_{y-1}$, $\Delta TERM_y = TERM_y – TERM_{y-1}$. Model (18) is *predictive* since all data on yields and illiquidity are known to investors at the beginning of year y during which $(RM\text{-}Rf)_y$ is observed. Bond yields are observed at the end of year $y\text{-}1$, and expected illiquidity is a function of past illiquidity, $lnAILLIQ_{y-1}$.

The hypothesis on the positive effect of expected illiquidity on ex-ante stock excess return implies that $g_1 > 0$ as well as $g_2 < 0$, controlling for the effects of the default and term yield premiums, i.e., $a_1 > 0$ and $a_2 > 0$. The correlations between the variables are low: Corr($lnAILLIQ_y$, ΔDEF_y) = 0.227, Corr($lnAILLIQ_y$, $\Delta TERM_y$) = 0.214, and Corr($\Delta TERM_y$, ΔDEF_y) = 0.113.

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difference between the yield on corporate bonds with rating below BAA and on short-term treasury bills. Boudoukh,

INSERT TABLE 5 HERE

The results in Table 5 show that $lnAILLIQ_{y-1}$ retains its positive and significant effect on ex ante stock excess return after controlling for the default and the term yield premiums. As in Fama and French (1989), the two yield premiums affect positively the ex ante stock excess return. Illiquidity thus emerges as a strong determinant of ex ante excess return on stocks.

The differences in the effects of illiquidity on different size-based stock portfolios is tested again here in the model

$$(17sz) \quad (RSZ_i - Rf)_y = g_0^i + g_1^i\, lnAILLIQ_{y-1} + g_1^i\, lnAILLIQ_y^U + a_1^i\, \Delta DEF_{y-1} + a_2^i\, \Delta TERM_{y-1} + u_{iy}$$

RSZ_i is the annual return on CRSP size-decile portfolio i, i=2, 4, 6, 8 and 10 (size increases in i). Table 5 presents estimation results of model (17sz). As before, the estimated coefficients of $lnAILLIQ_{y-1}$ decline monotonically in the firm size and the estimated coefficients of $lnAILLIQ_y^U$ rise monotonically in the firm size, indicating that the effect of illiquidity is smaller for larger firms. The model is also tested with the dependent variable $SR_y = RMEW_y – RMVW_y$, which reflects the excess return on small firms stocks. The results strongly show that liquidity – both expected and unexpected – affects ex ante stock return, after controlling for the yield premiums.

3.4 The effects of turnover on stock returns

Stock turnover, which measures liquidity, is shown in Section 2 to be a significant determinant of the cross-section of stock expected return. Here, its effect is examined as a factor affecting ex-ante stock excess return. The variable used, $lnATRNOVR_y$, is the average turnover (defined in (2)) across stocks in year y (in logarithm), calculated in the same way as the

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Richardson and Smith (1993) study the effect of the term yield on subsequent stock excess return.

average illiquidity.[20] Then, an autoregressive model is estimated, similar to model (9):

$$(18)\quad lnATRNOVR_y = \underset{(1.56)}{0.384} + \underset{(10.50)}{0.879}\, lnATRNOVR_{y\text{-}1} + v_y\,, \qquad R^2 = 0.781,\ DW = 2.01$$

(*t* =)

The estimation results are used to obtain the unexpected turnover, $lnATRNOVR_y^U$, the residual from model (18), after adjusting the coefficients by Kendall's (1954) method.

The effect of turnover on stock excess return is estimated by a model similar to (11), where stock excess return is regressed on $lnATRNOVR_{y-1}$ and on $lnATRNOVR_y^U$. Turnover being a proxy for stock liquidity, its effect on stock return is hypothesized to be as follows. Higher expected liquidity should lead to lowers ex ante stock excess return, implying a negative coefficient on $lnATRNOVR_{y-1}$. And, the coefficient of $lnATRNOVR_y^U$ should be positive: higher unexpected liquidity in one year raises expected liquidity in the following year, which would make investors require lower stock excess return. Assuming no effect of liquidity on corporate cash flows, this should raise stock price, i.e., contemporaneous stock return is positively related to $lnATRNOVR_y^U$.

In a regression of the stock excess return $(RM\text{-}Rf)_y$ on the turnover variables, the coefficient of $lnATRNOVR_{y-1}$ is negative but insignificant, and the coefficient of $lnATRNOVR_y^U$ is positive and significant, as expected. Since small, illiquid stocks should be more sensitive to market liquidity, the model is estimated using $SR_y = RMEW_y – RMVW_y$ that represents the excess return on small firms stocks. The results are as follows:

$SR_y =$	32.406	– 10.028 $lnATRNOVR_{y-1}$	+ 0.848 $lnATRNOVR_y^U$ + w_y.
(t =)	(2.65)	(2.41)	(2.62)
[t_R =]	[2.93]	[2.66]	[2.47]

$R^2 = 0.354$, $DW = 1.90$.

The negative coefficient of lagged turnover, which is statistically significant, further supports

[20] The calcuation uses the same sample as that used to calculate $lnAILLIQ_y$, that is, eliminating the highest 1% cases.

the proposition that expected market liquidity affects ex-ante stock excess returns, especially for small firm stocks. The coefficient of unexpected turnover is positive, as expected, further supporting the hypothesis on the effect of liquidity on stock return. When both $lnAILLIQ_{y-1}$ and $lnATRNOVR_{y-1}$ are included in the equation (the correlation between them is –0.680), only illiquidity is statistically significant whereas turnover is not. However, the test presented here using an alternative measure of liquidity lends further support to the hypothesis that liquidity is priced in the market.

4. Summary and conclusion

This paper presents new tests of the proposition that asset returns are increasing in illiquidity. In addition to finding that illiquidity explains differences in expected returns *across* stocks, which is known from earlier studies, this paper presents a new test showing that *market illiquidity affects over time the ex ante stock excess return*. The stock excess return *RM-Rf*, 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 return vary over time as a function of changes in market illiquidity.

The study employs a new measure of illiquidity, *ILLIQ*, the ratio of a stock absolute daily return to its daily dollar volume, averaged over some period (here, a year). This measure is interpreted as the daily stock price reaction to a dollar of trading volume. Its virtue is that it can be easily obtained from databases that contain daily data on stock return and volume. This makes *ILLIQ* available for most stock markets that do not have detailed microstructure data on transactions and quotes that are necessary to construct finer measures of illiquidity, used by others.[21] Importantly, since the use of ILLIQ enables to construct a time series of illiquidity over a long period of time, it enables to study the *time series effect* of illiquidity – this would be impossible to do with microstructure data which are available for only short periods of time.

Using data on NYSE stocks for the period 1964-1997, illiquidity is shown to have a positive effect on expected stock return both cross sectionally and over time. In the cross-section estimations, two liquidity variables are strongly priced: *ILLIQ* has a positive effect and turnover (trading volume divided by shares outstanding) has a negative effect, both statistically

[21] 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, Hvidhjaer and O'Hara (1999)) – all shown to have a positive effect on the cross-

significant. Also, size (stock capitalization) has the usual negative effect on stock return.

The new tests presented here are of the hypotheses that over time, expected market illiquidity has a positive effect on ex ante stock excess return and unexpected illiquidity has a negative effect on contemporaneous stock return. Market illiquidity is the average across stocks in each year of their individual *ILLIQ*, and expected illiquidity is obtained from an autoregressive model. The effect of unexpected illiquidity is because higher realized illiquidity raises expected illiquidity for the following year. Then, if higher expected illiquidity raises stock expected return, stock prices should decline (assuming that corporate cash flows are unaffected by market liquidity). The estimation results strongly support these hypotheses. The effect of expected illiquidity on ex ante stock excess return remains positive and significant after including in the model stock volatility or two variables that are known to affect expected stock returns: the default yield premium on risky corporate bonds and the term yield premium on long-term Treasury bonds.

The variations over time in the "small firm effect" – the excess return on small firms' stock – is shown to be a function of 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 positive effect of expected illiquidity on ex ante stock excess return suggests that the stock excess return, usually referred to as "risk premium," is in part a premium for illiquidity. This contributes to the explanation of the equity premium puzzle which suggests that the excess stock return over Treasury securities is too high. The results mean that stock excess return reflects not only the higher risk but also the lower liquidity of stock compared to Treasury securities.

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section of stock expected return.

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Table 1: Liquidity variables

Statistics of liquidity variables for the years 1963-1996 for NYSE stocks. 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*. The turnover ratio, $TRNOVR_{iy}$, is the average for the year of the stock daily ratio of its trading volume (in shares) to the number of shares outstanding. $VOLD_{iy}$ is the dollar trading volume for the year, the sum of the daily product of share volume and price; $lnVOLD_{iy}$ is its logarithm. $SIZE_{iy}$ is the market capitalization of the stock at the end of the year given by CRSP; $lnSIZE_{iy}$ is its logarithm. P_{iy} is the stock price at the end of the year; lnP_{iy} is its logarithm. $DIVYLD_{iy}$, 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 150 days of data for the calculation of the characteristics and their end-of-year price exceeds $5. Excluded are stocks whose $ILLIQ_{iy}$ and $TRNOVR_{iy}$ are at the extreme 1% upper and lower tails of the respective distribution.

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

Panel A: Means, medians and standard deviations

Variable	Mean of annual Means	Mean of annual Std. Dev.	Median of annual means	Min. annual mean	Max. annual mean
ILLIQ	0.372	0.588	0.319	0.060	1.089
TRNOVR	19.28	14.36	18.90	7.73	32.60
SIZE ($million)	776.9	1,589.4	525.17	245.6	2,163.1
VOLD ($million)	409.9	776.1	186.6	29.3	1,445.2
PRICE ($)	27.8	29.7	27.04	16.9	42.5
DIVYLD (%)	4.15	5.23	4.16	2.43	6.76
SDRET	2.07	0.75	1.94	1.56	2.82

Panel B: Means of the annual cross-stock correlations of the liquidity variables.

	ILLIQ	*TRNOVR*	*lnSIZE*	*lnVOLD*	*LnP*
TRNOVR	-0.144				
LnSIZE	-0.611	-0.092			
LnVOLD	-0.668	0.336	0.869		
LnP	-0.459	-0.058	0.688	0.570	
SDRET	0.289	0.577	-0.393	-0.084	-0.461

Table 2: Cross-section regressions of stock return on illiquidity and other stock characteristics

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, … 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. The stock turnover ratio, *TRNOVR*, is the annual average of the daily ratio of stock volume (in shares) to the number of shares outstanding. *ILLIQ* and *TRNOVR* are each averaged every year across stocks, and *ILLIQMA* and *TRNOVRMA* are the respective mean-adjusted variables, calculated as the ratios of the variable to its annual mean across stocks (thus the means of both variables are 1). *lnVOLD* is the logarithm of the dollar trading volume for the year, the sum of the daily product of share volume and price. *lnSIZE* is the logarithm of the market capitalization of the stock at the end of the year, *lnP* is the logarithm of the stock price 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* and *RYR* are the cumulative stock return over the last 100 days and the entire year, respectively.

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 150 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* and *TRNOVR* are at the extreme 1% upper and lower tails of the respective distribution for the year.

Panel A:

Variable	All months	Excluding January	1964- 1980	1981-1997
Constant	-0.449 (0.94)	-0.242 (0.52)	-0.910 (1.41)	0.013 (0.02)
BETA	1.263 (2.66)	0.826 (1.80)	1.458 (1.87)	1.068 (1.96)
ILLIQMA	0.163 (6.90)	0.131 (5.73)	0.203 (4.78)	0.123 (6.04)
R100	0.530 (1.97)	0.937 (3.56)	0.299 (0.79)	0.762 (1.99)
RYR	0.417 (3.09)	0.526 (3.98)	0.568 (1.47)	0.265 (1.54)

(*t*-statistics in parentheses)

Table 2 (cont.)

Panel B:

Variable	Model (1)				Model (2)				Model (3)			
	All months	Exclude January	1964-1980	1981-1997	All Months	Exclude January	1964-1980	1981-1997	All Months	Exclude January	1964-1980	1981-1997
Constant	0.982	0.632	1.521	0.444	1.730	1.154	2.337	1.123	-0.449	-0.189	-1.143	0.244
	(1.60)	(1.04)	(1.60)	(0.57)	(3.52)	(2.37)	(2.82)	(2.14)	(0.98)	(0.42)	(1.80)	(0.37)
BETA	0.422	0.385	0.423	0.421	0.298	0.286	0.316	0.280	1.683	1.279	2.343	1.023
	(1.25)	(1.18)	(0.84)	(0.93)	(0.86)	(0.87)	(0.60)	(0.62)	(4.18)	(3.32)	(3.86)	(1.94)
ILLIQMA	0.090	0.088	0.074	0.105	0.071	0.063	0.056	0.086	0.119	0.083	0.129	0.108
	(5.26)	(4.94)	(2.42)	(6.94)	(4.32)	(3.80)	(1.91)	(5.85)	(5.75)	(4.28)	(3.58)	(5.41)
TRNOVRMA	-0.294	-0.233	-0.366	-0.222	-0.197	-0.225	-0.242	-0.152	-0.167	-0.212	-0.198	-0.136
	(4.83)	(3.83)	(4.29)	(2.56)	(2.94)	(3.27)	(2.58)	(1.59)	(2.44)	(3.01)	(2.02)	(1.42)
LnSIZE	-0.325	-0.220	-0.402	-0.247	-0.146	-0.069	-0.269	-0.022				
	(4.21)	(2.85)	(3.49)	(2.41)	(3.56)	(1.82)	(4.02)	(0.49)				
LnVOLD	0.208	0.129	0.215	0.202								
	(3.01)	(1.86)	(2.03)	(2.25)								
LnP	-0.088	0.076	-0.167	-0.009								
	(1.17)	(1.11)	(1.33)	(0.12)								
SDRET	-0.141	-0.178	-0.069	-0.214								
	(1.67)	(2.06)	(0.60)	(1.73)								
DIVYLD	-0.054	-0.061	-0.083	-0.025	-0.046	-0.054	-0.077	-0.015	-0.044	-0.053	-0.073	-0.015
	(4.26)	(4.56)	(3.56)	(2.58)	(2.91)	(3.25)	(2.60)	(1.38)	(2.78)	(3.24)	(2.47)	(1.34)
R100	0.574	0.881	0.503	0.645	0.493	0.861	0.343	0.643	0.463	0.862	0.286	0.640
	(2.60)	(4.05)	(1.62)	(2.06)	(2.07)	(3.72)	(1.05)	(1.86)	(1.90)	(3.68)	(0.85)	(1.81)
RYR	0.484	0.505	0.550	0.417	0.404	0.519	0.466	0.343	0.391	0.512	0.447	0.336
	(4.47)	(4.72)	(3.23)	(3.12)	(3.28)	(4.44)	(2.40)	(2.24)	(3.17)	(4.38)	(2.31)	(2.19)

(*t*-statistics in parentheses)

Table 3: The effect of market illiquidity on expected stock excess return

Estimates of the models:

(11) $(RM\text{-}Rf)_y = g_0 + g_1\ lnAILLIQ_{y-1} + g_2\ lnAILLIQ_y^U + w_y$,
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*. $lnAILLIQ_y$ 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). $lnAILLIQ_y^U$ is the unexpected market illiquidity, the residual from an autoregressive model of $lnAILLIQ_y$.

Estimation results are also presented for the model using a volatility variable:
(13) $(RM\text{-}Rf)_y = g_0 + g_1\ lnAILLIQ_{y-1} + g_2\ lnAILLIQ_y^U + h_1\ lnSD_{y-1} + h_2\ lnSD_y^U + e_y$.
$lnSD_y$ is the (logarithm) of standard deviation of daily market return (equally weighted) for year *y*. $lnSD_y^U$ is the unexpected market volatility, the residual from an autoregressive model of $lnSD_y$.

The models are also estimated with the dependent variable being $SR_y = RMEW_y - RMVW_y$, the difference between the equally-weighted and value-weighted market return. This depicts the excess return on small firms' stocks.

Dependent variable	$(RM\text{-}Rf)_y$	SR_y	$(RM\text{-}Rf)_y$	SR_y
Constant	14.740	7.785	17.504	8.349
	(4.29)	(4.51)	(4.52)	(4.04)
	[4.37]	[5.76]	[4.93]	[5.35]
$LnAILLIQ_{y-1}$	10.226	8.256	7.681	8.044
	(2.68)	(4.30)	(1.95)	(3.84)
	[2.74]	[6.90]	[2.19]	[6.34]
$LnAILLIQ_y^U$	-23.567	-7.242	-22.251	-7.820
	(4.52)	(2.76)	(3.66)	(2.41)
	(4.11)	[3.08]	[4.21]	[3.02]
$LnSD_{y-1}$			13.342	2.171
			(1.68)	(0.51)
			[2.28]	[0.71]
$LnSD_y^U$			-8.665	1.206
			(0.82)	(0.21)
			[1.35	[0.25]
R-squared	0.512	0.499	0.572	0.504
DW	2.55	1.85	2.62	1.84

(*t*-statistics are in parentheses)
[Numbers in brackets are *t*-statistic calculated from standard errors that are robust to heteroskedasticity and autocorrelation, using the method of Newey and West (1987).]

Table 4: The effect of market illiquidity on size portfolios

This table presents regression results of the excess returns on five size-based portfolios as a function of expected and unexpected illiquidity. The estimated model is
(11sz) $(RSZ_i - Rf)_y = g_0 + g_1^i\, lnAILLIQ_{y-1} + g_2^i\, lnAILLIQ_y^U + w_{iy}$,
RSZ_i, i=2, 4, 6, 8 and 10, are the annual returns on CRSP size-portfolio *i* (the smaller number indicates smaller size) and *Rf* is the one-year Treasury bill yield as of the beginning of year *y*. $lnAILLIQ_y$ is market illiquidity in year *y*, calculated as the average across stocks of the annual average of daily absolute stock return divided by the daily dollar volume of the stock. $lnAILLIQ_y^U$ is the unexpected market illiquidity, the residual from an autoregressive model of $lnAILLIQ_y$. The period of estimation is 1964-1996.

	Excess return on size portfolio				
	$RSZ_2 - Rf$	$RSZ_4 - Rf$	$RSZ_6 - Rf$	$RSZ_8 - Rf$	$RSZ_{10} - Rf$
Constant	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]
$lnAILLIQ_{y-1}$	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]
$lnAILLIQ_y^U$	-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-squared	0.523	0.450	0.435	0.413	0.249
D-W	2.42	2.64	2.47	2.39	2.28

(*t*-statistics are in parentheses)
[*t*-statistics in brackets use standard errors that are heteroskedastic-consistent and robust to autocorrelation, following White (1980) and Newey and West (1987).]

Table 5: The effects of expected market illiquidity, default yield premium and term yield premium on expected stock excess return

Estimation results of the model

$$R_y = g_0 + g_1\, lnAILLIQ_{y-1} + g_2\, lnAILLIQ_y^U + a_1\, \Delta DEF_{y-1} + a_2\, \Delta TERM_{y-1} + u_y,$$

where R_y takes various values: $(RM\text{-}Rf)_y$ is the annual equally-weighted market return in excess of the one year treasury-bill rate at the beginning of year y; $SR_y = RMEW_y - RMVW_y$, the excess return of the market equally-weighted portfolio return over the value-weighted return (a proxy for the excess return on small firms stocks); $(RSZ_i\text{ -}Rf)_y$, i=2, 4, 6, 8 and 10, are the annual returns on CRSP size-portfolio i (the smaller number indicates smaller size) in excess of the one-year T-bill rate. $lnAILLIQ_y$ is market illiquidity in year y, calculated as the logarithm of the average across stocks of the annual average of daily absolute stock return divided by the daily dollar volume of the stock. $lnAILLIQ_y^U$ is the unexpected market illiquidity, the residual from an autoregressive model of $lnAILLIQ_y$. $\Delta DEF_y = DEF_y – DEF_{y-1}$, $DEF_y = YBAA_y – YAAA_y$, where $YBAA_y$ and $YAAA_y$ are, respectively, the yield to maturity on long term, BAA-rated and AAA-rated corporate bonds. $\Delta TERM_y = TERM_y – TERM_{y-1}$, $TERM_y = YLONG_y – YTB3_y$, where $YLONG_y$ and $YTB3_y$ are, respectively, the yields on long-term treasury bonds and three-month Treasury bills. Yields are as of the end of the year y-1, known to investors at the beginning of year y. The estimation period is 1964-1996.

	Dependent variable						
	RM-Rf	*SR*	RSZ_2 *-Rf*	RSZ_4 *-Rf*	RSZ_6 *-Rf*	RSZ_8 *-Rf*	RSZ_{10} *-Rf*
Constant	13.151	7.177	17.716	15.557	12.718	10.719	3.911
	(4.11)	(4.24)	(4.32)	(3.92)	(3.88)	(3.55)	(1.27)
	[5.63]	[5.30]	[6.00]	[6.05]	[5.43]	[4.38]	[1.55]
$LnAILLIQ_{y-1}$	7.370	7.163	11.966	8.533	6.389	4.663	-1.840
	(2.02)	(3.71)	(2.56)	(1.89)	(1.71)	(1.35)	(0.53)
	[2.71]	[6.38]	[4.23]	[3.21]	[2.59]	[1.60]	[0.62]
$LnAILLIQ_y^U$	-22.016	-6.634	-26.244	-22.736	-19.021	-17.302	-13.675
	(4.58)	(2.61)	(4.26)	(3.82)	(3.86)	(3.81)	(2.96)
	[4.85]	[3.05]	[4.46]	[4.15]	[4.04]	[3.96]	[3.73]
ΔDEF	13.733	3.799	15.235	15.739	15.642	14.193	8.208
	(2.06)	(1.08)	(1.78)	(1.91)	(2.29)	(2.26)	(1.28)
	[2.10]	[1.44]	[1.93]	[2.05]	[2.56]	[2.33]	[1.30]
$\Delta TERM$	2.983	1.539	3.533	2.952	3.370	1.660	1.042
	(1.75)	(1.70)	(1.61)	(1.40)	(1.93)	(1.03)	(0.64)
	[2.41]	[1.86]	[1.94]	[1.75]	[2.61]	[1.48]	[1.04]
R-squared	0.618	0.566	0.609	0.546	0.578	0.523	0.303
D-W	2.39	1.90	2.31	2.49	2.27	2.20	2.09

(*t*-statistics in parentheses.)
[*t*-statistics in brackets use standard errors that are heteroskedastic-consistent and robust to autocorrelation, following White (1980) and Newey and West (1987).]

APPENDIX

Weighted least squares estimation of the cross-sectional model

In model (3), U_{imy} may be heteroskedastic, *i.e.*, VAR(U_{imy}) may vary across stocks. To address this problem, weighted least squares (WLS) estimations are performed, following the procedure in Judge *et al*. (1988, Sec. 9.3.4). First, model (3) is estimated for each month *m* in year *y* by the OLS method. The variance of its residuals U_{imy} is assumed to follow the model

(A-1) $E(U^2_{imy}) = \exp[d_0 + d_1\, SDRET_{i,y-1} + d_2\, lnSIZE_{i,y-1} + d_3\, TRNOVRMA_{i,y-1}].$

The first variable, *SDRET*, is a natural measure of the residual variance and it is expected that $d_1>0$. Indeed, this variable has by far the greatest explanatory power in the estimation. The second variable, *lnSIZE*, is included because the cross-sectional residual variance is assumed to be larger for small firms, *i.e.*, $d_2 < 0$. The third variable, *TRNOVRMA*, controls for liquidity-related heteroskedasticity. Model (A-1) is estimated for each month *m* in year *y* and the estimated values of the variance, $E(U^2_{imy})$, are used as weights to estimate model (3) by the WLS method. Notably, however, while the estimations show that heteroskedasticity exists, the WLS estimation results of the model are not materially different from the OLS results reported earlier. In addition, the WLS estimation results of model (3) are robust to the specification of model (A-1), and they are about the same when only *SDRET* is included in model (A-1).

INSERT TABLE APP-1 HERE

Panels A1 and A2 in Table APP-1 present the results of the WLS regression for the parsimonious model that includes only *BETA*, *ILLIQMA* and lagged returns, and Panels B1 and B2 present the results for the WLS regression models that include all variables. Panels A1 and B1 present the WLS coefficients of model (3), and Panels A2 and B2 present the coefficients of model (A-1), which are the averages of the coefficients obtained from an estimation of the model for each of the 408 months. The results from Panels A2 and B2, showing that the coefficients of model (A-1) are highly significant, suggest that the residuals U_{imy} are heteroskedastic. The residual variance is not constant across stocks. Instead, it is greater for stocks with higher volatility, smaller size and higher liquidity. The most important variable is *SDRET*, and when only this variable is included in the model, the cross-sectional results remain about the same.

As in the OLS results, the estimated mean coefficient of *ILLIQMA* in Table APP-1, Panel A1, is positive and highly significant in the entire estimation period, in all months excluding the month of January, and in each of the two subperiods, demonstrating stability over time. The median of the coefficient of *ILLIQMA*, 0.109, is close to the mean of 0.141, and 2/3 of the 408 estimated coefficients are positive, a proportion which is significantly different from the null proportion of 1/2.

The results in Table APP-1, Panel B1, show again that liquidity strongly affects stock returns when additional variables are included in the model. The coefficient of *ILLIQMA* is positive and highly significant in the entire period, in all months excluding January, and in each of the two subperiods. The coefficient of *TRNOVRMA* is negative and significant as expected, but its effect is weaker in the second subperiod, and when *lnSIZE* is excluded from the model. The size effect is negative and significant, as expected, but its significance declines when January is excluded and it is insignificant in the second subperiod. The effect of *lnVOLD* is positive, but it may reflect the correlation of this variable with the other liquidity variables that are included in the model and which are functions of volume. The effect of stock price is insignificant. The effect of *SDRET* is insignificant, and the effect of *DIVYLD* is negative and significant, as before, except being insignificant in the second subperiod. Notably, *BETA* gains greater significance in the WLS regression, especially when size is excluded.[22] Importantly, including the risk variable *SDRET* in the cross-section model does not change the results on the effect of illiquidity. The results show again that the effect of *ILLIQ* is distinct from that of risk.

Altogether, the results from both the OLS and the WLS are consistent. Liquidity, measured by both *ILLIQ* and *TRNOVR*, is an important determinant of expected return on assets.

[22] Recall that size was an instrument for the formation of portfolios to estimate beta.

Table APP-1: Cross-section weighted-least-squares regressions of stock return on illiquidity and other stock characteristics

The table presents the results of weighted-least-squares regressions, done in three steps. (1) In each month of year *y*, *y* = 1964, 1965, … 1997, a cross-section OLS regression is estimated of stock returns as a function of stock characteristics that are calculated from data in the previous year. (2) The logarithms of the squared residuals from step (1) are regressed on stock characteristics that include *SDRET*, *lnSIZE* and *TRNOVRMA* (and a constant). This follows from model (A-1). The exponential values of the fitted values from this regression, estimates of the stocks' variances, are used as weighting factors in the third step. (3) In each month, the same model as in (1) is estimated by the weighted least squares regression method.
Panel A1 and B1 present the means of the coefficients of the weighted least squares regressions in stage (3).
Panels A2 and B2 present the means of the coefficients from the model in step (2) for the respective models.

The variables: *BETA* is the slope coefficient from a time-series annual regression of daily return on one of 10 size portfolios on the market (equally-weighted) return, 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. The stock turnover ratio, *TRNOVR*, is the annual average of the daily ratio of stock volume (in shares) to the number of shares outstanding. *ILLIQ* and *TRNOVR* are each averaged every year across stocks, and *ILLIQMA* and *TRNOVRMA* are the respective mean-adjusted variables, calculated as the ratios of the variable to its annual mean across stocks (thus the means of both variables are 1). *lnVOLD* is the logarithm of the dollar trading volume for the year, the sum of the daily product of share volume and price. *lnSIZE* is the logarithm of the market capitalization of the stock at the end of the year, *lnP* is the logarithm of the stock price at the end of the year, *SDRET* is the standard deviation of the daily stock 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* and *RYR* are the cumulative stock return over the last 100 days and the entire year, respectively.
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 150 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* and *TRNOVR* are at the extreme 1% upper and lower tails of the respective distribution for the year.

Panel A1:

Variable	All months	Excluding January	1964- 1980	1981-1997
Constant	-0.764 (1.63)	-0.579 (1.30)	-1.310 (2.05)	-0.218 (0.32)
BETA	1.562 (3.41)	1.156 (2.70)	1.842 (2.50)	1.281 (2.35)
ILLIQMA	0.141 (6.24)	0.115 (5.39)	0.163 (4.12)	0.119 (5.45)
R100	0.368 (1.25)	0.862 (3.12)	0.249 (0.65)	0.487 (1.09)
RYR	0.489 (3.24)	0.623 (4.51)	0.607 (2.77)	0.371 (1.79)

(*t*-statistics in parentheses)

Panel A2:

Variable	All months
Constant	1.621 (29.83)
SDRET	0.573 (44.44)
LnSIZE	-0.049 (8.86)
TRNOVRMA	0.099 (15.63)

(*t*-statistics in parentheses)

Table APP-1 (cont.)

Panel B1:

Variable	Model (1)				Model (2)				Model (3)			
	All months	Exclude January	1964-1980	1981-1997	All Months	Exclude January	1964-1980	1981-1997	All Months	Exclude January	1964-1980	1981-1997
Constant	-0.044 (0.07)	-0.144 (0.25)	-0.052 (0.06)	-0.035 (0.05)	1.023 (2.27)	0.612 (1.42)	1.020 (1.30)	1.027 (2.28)	-0.671 (1.48)	-0.425 (1.99)	-1.473 (2.34)	0.132 (0.20)
BETA	0.801 (2.44)	0.708 (2.31)	1.138 (2.25)	0.464 (1.11)	0.702 (2.13)	0.660 (2.19)	1.097 (2.13)	0.307 (0.75)	1.805 (4.62)	1.464 (4.07)	2.503 (4.32)	1.106 (2.12)
ILLIQMA	0.085 (4.86)	0.082 (4.73)	0.068 (2.20)	0.101 (6.36)	0.073 (4.56)	0.065 (4.10)	0.056 (2.02)	0.089 (5.67)	0.110 (5.60)	0.079 (4.34)	0.113 (3.42)	0.107 (5.00)
TRNOVRMA	-0.338 (5.53)	-0.291 (5.00)	-0.392 (4.45)	-0.284 (3.36)	-0.146 (2.06)	-0.185 (2.66)	-0.184 (1.76)	-0.107 (1.13)	-0.123 (1.71)	-0.175 (2.46)	-0.148 (1.35)	-0.098 (1.04)
LnSIZE	-0.305 (4.28)	-0.217 (3.21)	-0.340 (3.19)	-0.270 (2.83)	-0.099 (2.76)	-0.039 (1.19)	-0.187 (3.24)	-0.011 (0.27)				
LnVOLD	0.215 (3.39)	0.151 (2.50)	0.211 (2.17)	0.220 (2.67)								
LnP	-0.024 (0.35)	0.098 (1.53)	-0.100 (0.87)	0.052 (0.63)								
SDRET	-0.043 (0.46)	-0.087 (0.94)	0.038 (0.31)	-0.123 (0.86)								
DIVYLD	-0.044 (3.16)	-0.057 (4.04)	-0.065 (2.52)	-0.024 (2.17)	-0.041 (2.30)	-0.055 (3.13)	-0.064 (1.94)	-0.018 (1.31)	-0.038 (2.12)	-0.054 (3.11)	-0.058 (1.77)	-0.017 (1.26)
R100	0.424 (1.86)	0.827 (3.84)	0.492 (1.65)	0.357 (1.03)	0.323 (1.26)	0.771 (3.22)	0.284 (0.89)	0.360 (0.90)	0.302 (1.16)	0.776 (3.19)	0.244 (0.75)	0.359 (0.88)
RYR	0.530 (4.54)	0.578 (5.34)	0.564 (3.36)	0.495 (3.05)	0.438 (3.21)	0.569 (4.74)	0.464 (2.45)	0.412 (2.19)	0.441 (3.24)	0.574 (4.79)	0.460 (2.33)	0.423 (2.24)

(*t*-statistics in parentheses)

Panel B2:

Variables	Model (1) All months	Model (2) All months	Model (3) All months
Constant	2.196 (53.69)	1.377 (27.57)	1.333 (26.76)
SDRET	0.110 (47.74)	0.646 (55.61)	0.653 (55.91)
LnSIZE	-0.064 (11.72)	-0.039 (7.12)	-0.0363 (6.00)
TRNOVRMA	0.161 (23.90)	0.085 (13.08)	0.082 (12.52)

(*t*-statistics in parentheses)