Illiquidity and Stock Returns: Cross-Section and Time-Series Effects: A Replication

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This paper replicates and extends the Amihud (2002) study that links liquidity to asset pricing. Using the current version of the CRSP dataset, we obtain essentially the same results that Amihud presents. The same methods applied to more recent data show a much weaker relation between liquidity and asset pricing. Finally, we compare the explanatory power of Amihud's illiquidity measure to that of other simple measures that use the same data for their calculation. We find that the Amihud illiquidity measure is no better than substantially simpler measures.

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Abstract

This paper replicates and extends the Amihud (2002) study that links liquidity to asset pricing. Using the current version of the CRSP dataset, we obtain essentially the same results that Amihud presents. The same methods applied to more recent data show a much weaker relation between liquidity and asset pricing. Finally, we compare the explanatory power of Amihud's illiquidity measure to that of other simple measures that use the same data for their calculation. We find that the Amihud illiquidity measure is no better than substantially simpler measures.

1. Introduction

Much of today's research in academic finance relies and builds upon empirical results presented in earlier studies. Many highly cited studies have influenced entire lines of subsequent research. Assessing the accuracy of these early results is essential to maintaining the integrity of the field. And understanding whether they remain valid in subsequent data is necessary if we are to continue to rely upon them. To this end, replication studies that authenticate and update previous studies increase confidence in the received body of financial knowledge.

This study replicates and updates Yakov Amihud's 2002 seminal paper "Illiquidity and stock returns: cross-section and time-series effects," which is among the most cited papers in asset pricing, both by academics and practitioners.[1] At the time of this writing, this paper has garnered over 5,000 Google scholar citations. The results in this paper deeply influenced the asset pricing literature as they helped establish the importance of liquidity in asset pricing models.

The remainder of this study appears in two sections. In the first section, we briefly introduce Amihud's paper and discuss our efforts to exactly replicate his results using his methods. Using the same methods does not guarantee that we will obtain identical results due to differences in the versions of the CRSP database that we both used. We find that the original and replicated results are quantitatively very close and qualitatively the same.

In this section, we also present results of an out-of-sample analysis that applies Amihud's exact methods to more recent data. We find that the importance of illiquidity as a pricing factor has diminished over the years, and that only its unexpected component still strongly affects stock returns.

[1] Amihud's paper appears in the *Journal of Financial Markets*, 2002, Volume 5, Issue 1.

In the following section, we assess the robustness of the results under alternative assumptions, paying particular attention to the choice of the illiquidity variable. We find little value-added in Amihud's illiquidity measure over other simpler illiquidity measures. In a horserace between several alterative measures that also are computed from absolute returns and dollar volumes, Amihud's measure runs with the pack. No evidence suggests that the daily ratio between absolute return and dollar volume conveys unique information about asset returns. Lou and Shu (2017) find a similar result.

2. Replication

Amihud examines the effect of stock illiquidity on stock returns. Where many previous studies only examine this relation across stocks, he also analyzes the relation over time. He proposes that stock excess returns and expected market illiquidity covary over time. His empirical results strongly support this conjecture and thus suggest that a component of a stock's risk premium may reflect compensation for expected market illiquidity.

Amihud uses the average of the ratio of a stock's daily absolute return to its daily dollar volume to measure stock illiquidity. This measure, which he introduced to the literature, has two main advantages over other, possibly more accurate, illiquidity measures. First, it has a straightforward interpretation as the cumulative price response per dollar of trading volume during the day. Second, it is easy to compute from return and volume data that, in contrast to the far more voluminous transaction data, are readily available over long time periods.

Amihud divides his analysis into two parts: the first involves a traditional cross-sectional analysis of stock returns as a function of stock illiquidity and other characteristics; the second shows how market returns vary with average stock market illiquidity over time. We structure our replication the same way.

Amihud uses market data from 1963 to 1997. At the time of this replication, the same data are available through 2015. For every result that we replicate using the 1963-1997 data, we also replicate using the 1998-2015 data.

All tables that we present in this section have three panels. The first panel presents Amihud's results copied verbatim from his paper. The second and third panels present our replication results respectively for his sample period and the subsequent period.

2.1. Data and Stock Characteristics

Our attempt to replicate Amihud's results uses his same data definitions and sample selection filters including those that appear in the footnotes to the study. We refrain from discussing and explaining the main results as Amihud provides these discussions in the original paper.

We obtain daily and monthly data on US securities from the CRSP database. For our exact replication study, we use only securities that traded on the NYSE in the period from 1963 to 1997 as did Amihud. When extending these results to later data, we continue to use only NYSE securities.

Amihud's paper does not specify the exact methods he used to identify NYSE securities. Following some experimentation, we determined that the following specifications yield the closest replications of Amihud's results: For statistics collected from daily data, we identify as a NYSE security any security that traded on the NYSE on the first trading day of the following year. Accordingly, for those stocks that moved from AMEX to the NYSE in a given year, the first observations for that year will include days on which the stock traded on the AMEX. We exclude NASDAQ trades because during Amihud's sample period (as Amihud explains in his paper), NASDAQ market volume figures are inflated relative to those on the NYSE. For monthly data analyses, each month we identify whether a security traded at the NYSE using the field "Exchange Code" of the CRSP database.

In the cross-sectional analysis, we measure the impact of illiquidity and other stock characteristics on monthly stock returns. Following Amihud, in each year we compute annual illiquidity and stock characteristics from daily market data. We then match these variables to the twelve monthly stock returns of the following year.

Stocks must satisfy three conditions to be included in the cross-sectional analysis of the following year:

1. The price of the security on the last trading day of the year must be strictly greater than 5;
2. The security must have information on both price and number of shares outstanding on the last trading day of the year so that we can compute market capitalization; and
3. The number of daily observations that report both return and volume must be strictly greater than 200 for the year.

Following Amihud, among all securities that pass the above three filters, we remove outliers based on Amihud's annual mean stock illiquidity measure: for each month, we eliminate stocks whose annual mean illiquidity falls in either the upper or the lower 1% of the cross-sectional distribution of this variable in that month.

After applying these filters and removing outliers, Amihud reports a minimum of 1,061 and a maximum of 2,291 stocks in the various months in his 1963-1996 sample. Following the same procedure, we find a slightly smaller value of 1,040 for the minimum of the monthly counts, and the same value for the maximum. Our minimum occurred early in the sample in November 1964. Our maximum count occurred in January 1997, which we presume corresponds to Amihud's maximum, but we cannot be sure that the two maxima occurred in the same month or reflect the exact same list of securities. The likely explanation for the earlier difference is that CRSP backfilled some relevant data that affect the sample selection filters. Amihud also may have made some small coding decisions that he did not identify.

Following Amihud, we compute the following variables (all named as in Amihud) for each security:

- BETA: The Scholes-Williams beta calculated with reference to CRSP's equal-weighted NYSE market index. We create ten cap-based equal-weighted portfolios from the securities included in the cross-sectional analysis. We then compute the Scholes-Williams beta for each portfolio and for each year, using daily data. Finally, we assign the beta of each portfolio to all securities in that portfolio.
- SDRET: The standard deviation of daily returns.
- ILLIQ: The annual mean of the stock's daily illiquidity measure. Because the illiquidity measure varies substantially over the years, and in particular, decreases substantially during the sample period, in the cross-sectional analysis we normalize all values by dividing them by their cross-sectional mean in each month. This monthly rescaling has no effect on the monthly cross-sectional regressions, but stabilizes the estimated regression coefficient. Amihud calls the mean-adjusted version of the illiquidity variable "ILLIQMA."
- R100: The cumulative return during the last 100 trading days of the year, computed as the compounded daily return over this interval.
- R100YR: The cumulative return between the first recorded trade day and 100 trading days before yearend.
- DIVYLD: The sum of the annual split-adjusted cash dividends (as presented in the CRSP daily file) distributed during the year, divided by the stock price on the last trading day of the year.
- SIZE: The market capitalization equal to the price per share times the number of shares outstanding, both observed on the last trading day of the year.

Table 1 contains descriptive statistics of the variables ILLIQ, SIZE, DIVYLD, and SDRET. We compute these variables each year for all stocks in that year's sample. We then compute the cross-sectional mean, standard deviation, and skewness for each year. The table presents the time-series means of the annual cross-sectional means, standard deviations, and skewnesses, as well as the time-series median, maximum, and minimum of the annual cross-sectional means.

<Place Table 1 here>

Panels A and B respectively show Amihud's results and those obtained in the replication for the period 1963-1996. The two sets of results are qualitatively similar and generally quite close with one exception. (We do not present any measures of closeness such as *t*-statistics as it is not obvious what the null hypothesis would be given that both sets of results presumably are obtained from near identical data sets.) The exception is ILLIQ for which Amihud finds a higher average value (less liquidity) than we do. The difference may be due to the inclusion of more stocks in his sample than ours in the early years.

Results for the 1997-2015 period appear in Panel C. When compared to Panels A and B, the differences in SIZE and ILLIQ stand out. In the more recent data, the time-series mean of the annual cross-sectional means of SIZE is five times bigger than the equivalent mean in the previous period, and the time-series mean for the ILLIQ variable is only one tenth as large as before. These differences are not surprising as firms have grown through time and trading has become more liquid.

2.2. Cross-Sectional Results

Using the Fama and MacBeth (1973) method, we estimate 408 cross-section regressions of monthly stock returns on previous year's characteristics for each month in the years 1964 to 1997; for the subsequent period, from 1998 to 2015, the estimation consists of 216 monthly cross-section regressions. As in Amihud, we examine two model specifications. The first includes only the characteristics BETA, ILLIQMA, R100, and R100YR as regressors, while the second adds SDRET, DIVYLD, and the natural logarithm of SIZE to the set of regressors. After estimating each monthly regression, we compute the time-series mean and associated *t*-statistics for each variable's estimated coefficient for four different sets of months: all months in entire sample, all months except Januarys, and all months in the years 1964-1980, and 1981-1997.

Amihud's results and our replication of these results for the 1963-1997 sample period are qualitatively similar and generally quite close (Table 2, Panels A and B). Panel C shows the results for 1998-2015. The mean of the illiquidity variable coefficients remains positive and statistically significant; however, it is considerably smaller than the means that appear in Panels A and B. These results confirm the trend identified in the comparison between 1963-1980 and 1981-1997 subperiod results. As a pricing factor, ILLIQ has become less important over time.

The mean of the remaining variables' estimated coefficients are no longer statistically significant, except for those of DIVYLD and BETA in some sets of months and regression specifications.

<Place Table 2 here>

2.3. Time-Series Results

The cross-sectional results identify a positive relation between stock returns and stock illiquidity. We now turn our attention to the effect of market illiquidity on stock index returns over time. We test the proposition that expected market illiquidity positively affects returns to various stock indices. As Amihud explains in his paper, the pricing of illiquidity implies two effects: first, expected market illiquidity should positively affect future stock returns; and second, unexpected market illiquidity should have a negative impact on contemporaneous stock returns.

To identify these two effects, we first characterize market-wide illiquidity by aggregating the stock-specific illiquidity variable ILLIQ across stocks. Using a time-series AR(1) regression model, we then decompose the log of this variable into predicted and residual components, after adjusting the regression coefficients using the Kendall (1954) bias-correction method. Amihud identifies current unexpected illiquidity with the residual component of this regression, and he identifies expected illiquidity with lagged market-wide illiquidity, which in a AR(1) regression is a linear transformation of the predicted component. Finally, we regress excess index returns (in excess of the risk-free rate) on the expected illiquidity and on current unexpected illiquidity to identify the two effects.

Amihud examines this regression at both annual and monthly differencing intervals. The steps for computing the market illiquidity series differ slightly depending on the interval. Amihud computes the annual illiquidity series as the average of the annual illiquidity measures across all stocks, excluding stocks whose annual illiquidity is in the upper 1% tail of the distribution for the year. He computes the monthly illiquidity series by first computing a daily market illiquidity measure as the cross-sectional average of each stock's daily illiquidity measure. He then averages this daily market illiquidity measure over each day in the month.[2]

Amihud estimates this regression for the excess returns to the equal-weighted NYSE market portfolio and also for the excess returns to each of the five even-numbered decile portfolios of NYSE stocks based on

[2] Amihud sent us the monthly illiquidity series that he used in his study. (Due to a request made years ago by another author for a different purpose, this series is the only original data that he could confidently provide us.) After some experimentation, we found that Amihud computed this series from Amex stocks as well as NYSE stocks. Our replication results accordingly use both sets of stocks for computing this series.

fmarket capitalization. The CRSP database provides the raw returns for these series at both annual and monthly frequencies.

At annual frequency, we estimate Amihud's equations 10 and 10sz:

$$(RM - Rf)_y = g_0 + g_1 lnALLIQ_{y-1} + g_2 lnALLIQ_y^U + w_y \quad (1)$$

$$(RSZ_i - Rf)_y = g_0^i + g_1^i lnALLIQ_{y-1} + g_2^i lnALLIQ_y^U + w_y \quad (2)$$

where RM is the return of the equal-weighted NYSE market portfolio, RSZ_i is the return of the i-th size based portfolios (i = 2, 4, 6, 8, 10 with size increasing in i), Rf is the one-year Treasury bill yield as of the beginning of the year, $lnALLIQ_{y-1}$is the lagged natural logarithm of the illiquidity variable, and $lnALLIQ_t^U$is the unexpected illiquidity. The predictions are $g_{1,}, g_1^i > 0$ and $g_2, g_2^i < 0$.

Amihud suggests that the effect of Illiquidity on a stock's return depends on whether investors regard the stock as liquid or illiquid. When illiquidity rises unexpectedly, all stocks should drop in value. However, liquid ones should drop less than illiquid ones because investors value liquid stocks more than illiquid ones, especially during periods of illiquidity. He calls this effect "flight to liquidity." Flight to liquidity also affects the subsequent relation between expected illiquidity and future returns. In particular, the relation should be stronger for illiquid stocks than liquidity ones.

Because high capitalization stocks usually are more liquid than smaller stocks, the size-based portfolio coefficient estimates should identify the flight to liquidity effect. Amihud predicts that the coefficients g_1^i and g_2^i should have magnitudes that decrease in absolute value in i, i.e. as capitalization increases.

Amihud's regression results and our replication of these results for the 1963-1997 sample period are qualitatively similar and generally quite close (Table 3, Panels A and B). Panel C shows the analysis for the period 1998-2015. While the effect of unexpected illiquidity is still present and the variable shows negative and statistically significant coefficients (although smaller in size relative to the previous period), expected illiquidity loses the positive explanatory power that appeared in the two other panels. Moreover, the estimated coefficients do not show any monotonic pattern.

<Place Table 3 here>

At monthly frequency, we estimate Amihud's equation 10m:

$$(RM - Rf)_m = g_0 + g_1 lnMILLIQ_{m-1} + g_2 lnMILLIQ_m^U + g_3 JANDUM_m + u_m \quad (3)$$

$$(RSZ_i - Rf)_m = g_0^i + g_1^i lnMILLIQ_{m-1} + g_2^i lnMILLIQ_m^U + g_3 JANDUM_m + u_m \quad (4)$$

where the variables are the monthly-equivalents of those used in the previous analysis, and $JANDUM_m$ is a January dummy. The predictions for the coefficients $g_{1,}, g_1^i, g_2, g_2^i$ are the same as in the annual analysis.

<Place Table 4 here>

Our replication of the monthly analysis shows results very close to those in Amihud's text (Table 4, Panels A and B). The more recent results (Panel C) are similar to those that we observed for the annual analysis. Unexpected illiquidity is the only variable that remains statistically significant for every series of portfolio-index returns, but the coefficient estimates are smaller than those observed in the earlier period. Moreover, the January dummy that appeared with a positive and statistically significant coefficient for the 1963-1997 sample period is no longer significant.

Amihud repeats the monthly analysis by controlling for two factors widely believed to affect ex-ante stock returns over time: the default yield premium and the term-structure yield premium. The resulting specifications appear in Amihud's equations 11 and 11sz:

$$\begin{aligned}(RM - Rf)_m = {} & g_0 + g_1 lnMILLIQ_{m-1} + g_2 lnMILLIQ_m^U + g_3 JANDUM_m + \alpha_1 DEF_{m-1} \\ & + \alpha_2 TERM_{m-1} + u_m\end{aligned} \quad (5)$$

$$\begin{aligned}(RSZ_i - Rf)_m = {} & g_0^i + g_1^i lnMILLIQ_{m-1} + g_2^i lnMILLIQ_m^U + g_3 JANDUM_m + \alpha_1^i DEF_{m-1} \\ & + \alpha_2^i TERM_{m-1} + u_m\end{aligned} \quad (6)$$

where DEF is the difference between the yields to maturity of long-term corporate bonds rated BAA and AAA by Moody's, and $TERM$ is the difference between the composite yield of long-term Treasury bonds and the yield of the three-month Treasury bill[3].

Our replication results are very close to those in Amihud's paper (Table 5, Panels A and B). However, in more recent data, unexpected illiquidity is the only variable that appears priced. The default yield

[3] We obtained these four series from Federal Reserve Publication H.15 (Selected Daily Interest Rates) at http://www.federalreserve.gov/releases/h15/data.htm. Amihud obtained his data from Basic Economics, a source that we could not find. Since these yields vary little, any differences in the data from these two different sources will not likely have much effect on the results.

premium and the term-structure yield premium variables that appears with positive and often statistically significant coefficients in the earlier period, are not statistically significant in the subsequent one. Ben-Rephael, Kadan, and Wohl (2015) report similar results. They find that the liquidity premium of U.S. stocks significantly declined over the past four decades.

<Place Table 5 here>

In summary, we were able to replicate Amihud's results quite closely using data similar to the data that he used. However, in more recent data, we found that only unexpected illiquidity appears to have been priced.

3. An Additional Analysis

As mentioned in the introduction, the illiquidity measure introduced by Amihud has had a big impact on the academic financial literature. It also is now used by practitioners. Its attractiveness comes from its simplicity, as its computation does not require transaction level data. It also is easily interpreted as the price impact of one dollar of trading volume.

These two strengths, although appealing, do not necessarily imply that Amihud's measure is the best available measure of stock or market illiquidity, a point that Amihud himself made in his paper. Other illiquidity measures may provide an equivalent or even a better fit to the data, and as a result may be better proxies for illiquidity, which analysts widely believe is a strong determinant of stock returns. Many alternative proxies appear in the financial literature that differ in their degrees of complexity and in the information required for their calculation.

In this section, we compare the Amihud measure to other simple illiquidity measures to determine which has greater explanatory power for stock returns. Like Amihud, we limit ourselves to simple measures that we can construct using only daily return and volume data.

Amihud's illiquidity measure is the mean of the daily ratio of absolute return to dollar volume. One of our simple alternative illiquidity measures is the ratio of mean absolute return to mean dollar volume. We expect that this ratio may provide equal explanatory value to Amihud's because the correlation between volume and absolute return is quite small. Our other measures include the average absolute return and the inverse average volume. These two measures, when multiplied together form our first alternative measure. Finally, we also consider log mean dollar volume and the Kyle-Obizhaeva (2016) market microstructure invariance illiquidity measure, which is the third root of the ratio of the variance of returns to the average dollar volume.

With one exception, these alternative illiquidity measures are all correlated with Amihud's illiquidity measure. The cross-sectional average correlation for the ratio of mean absolute return to mean dollar volume with Amihud's illiquidity measure is 92%. The corresponding average correlations for the average absolute return, the inverse volume, and the invariance measures are 21%, 83%, and 83%. The exception is log mean dollar volume for which the average correlation is -70%. The negative correlation reflects the fact that we expect that volume would measure liquidity, and not illiquidity.

For each of our alternative measures, we repeat the cross-section analysis presented in section 2.2 using the alternative measure in place of Amihud's ILLIQ variable.

Panel A of Table 6 presents the means and *t*-statistics of the estimated coefficients for the various alternative measures; the average R^2 of the regressions appear in Panel B.[4] The table examines only the data period that Amihud examined as liquidity does not appear to be priced in later data.

<Place Table 6 here>

Three observations are worth discussing. First, the average R^2 obtained using Amihud's measure is among the lowest in all subgroups and in both model specifications. Most of the differences are not large and thus not likely meaningful.[5] Although the *t*-statistic for this variable is consistently among the highest, its inclusion does not provide a better fit to the data relative to other measures. Second, the ratio of the average absolute return to average volume is almost equivalent to the Amihud's measure. The mean of their coefficients, the *t*-statistics, and the average R^2 of the regressions are essentially the same. This result suggests that perhaps only the numerator or the denominator drives the result.

Unfortunately, no clear answer to this question is apparent. In these analyses, average absolute return and inverse average volume behave very differently. In particular, the mean of the coefficients of the average absolute return is negative and often not statistically significant; the mean of the coefficients of the average volume is instead positive but statistically significant only in the first model specification. The former result is simply a re-identification of the low-volatility effect. Finally, the best proxies of illiquidity in terms of average R^2 are the invariance illiquidity measure and the logarithm of average dollar

[4] All R^2 statistics reported in this paper are unadjusted. Since all comparisons of R^2 involve models with the same numbers of observations and independent variables, the statistics are comparable.

[5] We do not provide formal tests of the differences among the R^2 because the models are not nested.

volume. Average Absolute Return has the highest R^2 in the first specification, but it probably acts more as a proxy for volatility than as a proxy for illiquidity, which would also explain why it performs poorly in the second specification which includes the return's standard deviation among the independent variables. The strong average dollar volume result is similar to results that Lou and Shu (2017) report, but based on additional analyses, they conclude that the result is likely due to mispricing rather than compensation for illiquidity.

Table 7 presents a summary of results from repeating the time-series analyses of section 2.3 for each of the alternative illiquidity measures.[6] The three data columns present the R^2 statistic from the annual, monthly and monthly-with-control-variables regressions of excess market returns on the various alternative illiquidity measures.[7] These columns correspond to the analyses presented in the first columns of Tables 3, 4 and 5, respectively. These analyses all decompose the log illiquidity variable into expected and unexpected components as described above, and like Table 6, they examine only Amihud's data period. Since Amihud examined the log of Illiquidity, we likewise log the various alternative illiquidity measures. Since the log inverse mean dollar volume is the negative of log mean dollar, the inverse alternative does not appear in this analysis.

<Place Table 7 here>

Before discussing the results, note that, except for the invariance measure, the unexpected changes in these various alternative measures of liquidity are not closely correlated with the unexpected changes in the log of Amihud's illiquidity measure. The correlations of the unexpected component of the log ratio of the means with the unexpected component of log Amihud illiquidity is 31%. The corresponding correlations for log mean absolute return, log invariance and log dollar volume, are 6%, 66%, and -26%. The low correlations suggest that the unexpected values of these variables convey different information.

The results show that the log ratio of mean absolute return to mean dollar volume produces the best fitting regressions for all three analyses. For the monthly analyses, the Amihud measure performs particularly poorly in comparison, most probably because an occasional low volume or a high return day has a large effect on the monthly illiquidity measure that data from the other 20 trading days in a typical month cannot significantly reduce. Note that the log ratio of the means is equal to the difference between the

[6] We computed the monthly invariance measure by averaging monthly estimates of the stock invariance measures for each month.

[7] The full results are available by request.

logs means. The two log means both appear in the table, but neither produce as good a fit as their difference.

We also note that unexpected illiquidity reduces returns in all these regressions except for log mean volume (Panel B). The positive volume coefficient reflects the well-known volume leverage effect in which volumes tend to rise when the market rises, and vice versa. Unexpectedly, the lagged expected ratio of mean absolute return to mean dollar volume has a statistically significant negative coefficient in the annual data (Panel A) whereas theory predicts otherwise (it is not statistically significant in the monthly analyses). This result suggests this ratio is not identifying liquidity pricing.

We provide one final result that shows that the explanatory power of Amihud's Illiquidity measure for asset prices is due to the ratio of volatility to dollar trading volume and not to the correlation of daily absolute returns with daily dollar trading volumes. To this end, we decompose Amihud's illiquidity measure into the sum of the ratio of mean absolute return to mean dollar volume plus the difference between Amihud's measure and this ratio of means. Any information about a correlation between daily returns and volumes will appear only in the difference.[8] We then repeat the cross-sectional regression analyses of Table 2 using the ratio of the means and the difference instead of Amihud's illiquidity measure. The results (Table 8) confirm that almost all the explanatory power of Amihud's illiquidity measure is due to its ability to characterize the ratio of the two means and not to the correlation of daily absolute returns with daily trading volumes.

<Place Table 8 here>

4. Conclusion

This replication of Amihud's seminal (2002) study relating illiquidity to asset pricing in the cross-section and through time finds that his results can be obtained from the current version of the CRSP data set. We note some small differences, but none that causes us to question the integrity of the published study.

Our application of his methods to more recent data shows that the results that Amihud identified in his analyses are time dependent. We find that illiquidity appears to have been priced in the cross-section during the later period, but its relation to asset prices is much less strong than in the earlier period. The

[8] This result can be seen easily by considering the bivariate Taylor series expansion of the ratio of daily absolute return to daily volume around the mean of these two variables. The expected value of the order 0 term is the ratio of the means; that of the order 1 term is zero, and that of the order 2 term depends on covariance (and hence correlation) between the two variables.

time-series results show that only unexpected illiquidity is related to index returns in the latter period whereas Amihud finds that both unexpected and expected illiquidity are related in the earlier period.

Finally, we consider whether Amihud's novel measure of illiquidity—the now famous mean ratio of daily absolute return to daily dollar volume—produces information that other simple measures of illiquidity do not. We find that this intuitively attractive measure does not explain equity index returns better than other simple measures that use the same data for their construction. The ratio of the mean daily absolute return (a measure of volatility) to mean daily trading volume (a measure of activity) provides essentially the same explanatory value.

References

Amihud, Y. 2002. "Illiquidity and stock returns: cross-section and time-series effects". *Journal of Financial Markets*. *5*(1): 31–56.

Ben-Rephael, A., O. Kadan, and A. Wohl 2015. "The diminishing liquidity premium." *Journal of Financial and Quantitative Analysis* 50.1-2: 197-229.

Fama, E. F. and J. D. MacBeth. 1973. "Risk, return, and equilibrium: Empirical tests." *Journal of Political Economy*. 607-636.

Kendall, M.G. 1954. Note on bias in the estimation of autocorrelation. *Biometrica* 41: 403–404.

Kyle, A. S. and A. A. Obizhaeva. 2016. "Market microstructure invariance: empirical hypotheses". forthcoming *Econometrica*. Available at SSRN: http://ssrn.com/abstract=2722524 or http://dx.doi.org/10.2139/ssrn.2722524.

Lou, X and T. Shu. 2017. "Price impact or trading volume: why is the Amihud (2002) illiquidity measure priced?". Available at SSRN: http://ssrn.com/abstract=2291942 or http://dx.doi.org/10.2139/ssrn.2291942.

Newey, W.K. and West, K.D., 1987. "A simple, positive semi definite, heteroskedasticity and autocorrelation consistent covariance matrix." *Econometrica* 55: 703–706.

Table 1

Statistics on variables

Description: *ILLIQ* is the average of the daily ratio of absolute return to the dollar volume for a stock in a given year; *SIZE* is the market capitalization equal to the price per share times the number of shares outstanding, both observed on the last trading day of the year; *DIVYLD* is the sum of the annual split-adjusted cash dividends divided by the stock price on the last trading day of the year. *SDRET* is the return standard deviation. Stocks admitted to the sample each year satisfy the conditions described in Section 2.1. We compute these variables each year for all stocks in that year's sample. We then compute the cross-sectional mean, standard deviation, and skewness for each year. The table presents the time-series means of the annual cross-sectional means, standard deviations, and skewnesses, as well as the time-series median, maximum, and minimum of the annual cross-sectional means.
Panels A and B respectively show Amihud's results and the replication results for 1963-1996. Panel C shows the replication results for 1997-2015.

Interpretation: The results of panels A and B show that the sample that we collected in our attempt to replicate Amihud's results has similar properties those in his sample. With the growth in capitalization and volumes, the most noticeable differences between the two sample periods are in the variables *SIZE* and *ILLIQ*.

Panel A (Amihud's Results, 1963-1996)

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

Panel B (Replication Results, 1963-1996)

	Mean of annual means	**Mean of annual S.D.**	**Median of annual means**	**Mean of annual skewness**	**Min. annual mean**	**Max. annual mean**
ILLIQ	0.282	0.404	0.271	2.945	0.054	0.891
***SIZE* ($million)**	868.2	1,710.7	560.4	5.219	265.9	2,209.2
***DIVYLD* (%)**	3.90	5.48	3.70	6.129	2.39	6.76
SDRET	2.02	0.73	2.01	1.035	1.51	2.76

Panel C (Replication Results, 1997-2015)

	Mean of annual means	**Mean of annual S.D.**	**Median of annual means**	**Mean of annual skewness**	**Min. annual mean**	**Max. annual mean**
ILLIQ	0.030	0.071	0.021	4.973	0.006	0.065
***SIZE* ($million)**	4355.5	10,090.4	4161.6	5.336	2810.4	6,886.9
***DIVYLD* (%)**	3.31	4.67	3.22	7.271	2.62	5.77
SDRET	2.16	1.01	1.97	1.309	1.56	3.98

Table 2

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

Description: This table presents time-series means of the coefficients from monthly cross-sectional regressions of stock return on previous year stock characteristics. *BETA* is the Scholes-Williams beta calculated with reference to CRSP's equal-weighted NYSE market index; *ILLIQ* is the average of the daily ratio of absolute return to the dollar volume for a stock in a given year; *ILLIQMA* is a normalized version of *ILLIQ* obtained by dividing all values by their cross-sectional mean in each month; *R100* is the cumulative return during the last 100 trading days of the year; *R100YR* is the cumulative return between the first recorded trade day and 100 trading days before yearend; *LnSIZE* 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; *DIVYLD* is the sum of the annual split-adjusted cash dividends divided by the stock price on the last trading day of the year. Stocks admitted to the sample each year satisfy the conditions described in paragraph 2.1.
Panels A and Panel B show respectively Amihud's results and the replication results for the period 1964-1997. The results in these panels are collected from 408 monthly regressions. Panel C shows the replication results for the period 1998-2015, obtained from 216 monthly regressions.

Interpretation: The results in Panel A and B show that we obtain very similar cross-sectional results to those in Amihud: *ILLIQMA* appears with a positive and statistically significant average coefficient. The Panel C results show that the average of *ILLIQMA* estimated coefficient is still positive and statistically significant in the new period, but its size is now smaller. The effect of illiquidity on asset returns weakened through time.

Panel A (Amihud's Results, 1964-1997)

Variable	**All months**	**Excl. January**	**1964–1980**	**1981–1997**	**All months**	**Excl. January**	**1964–1980**	**1981–1997**
Constant	-0.364	-0.235	-0.904	0.177	1.922	1.568	2.074	1.770
	(0.76)	(0.50)	(1.39)	(0.25)	(4.06)	(3.32)	(2.63)	(3.35)
BETA	1.183	0.816	1.45	0.917	0.217	0.26	0.297	0.137
	(2.45)	(1.75)	(1.83)	(1.66)	(0.64)	(0.79)	(0.59)	(0.30)
ILLIQMA	0.162	0.126	0.216	0.108	0.112	0.103	0.135	0.088
	(6.55)	(5.30)	(4.87)	(5.05)	(5.39)	(4.91)	(3.69)	(4.56)
R100	1.023	1.514	0.974	1.082	0.888	1.335	0.813	0.962
	(3.83)	(6.17)	(2.47)	(2.96)	(3.70)	(6.19)	(2.33)	(2.92)
R100YR	0.382	0.475	0.485	0.279	0.359	0.439	0.324	0.395
	(2.98)	(3.70)	(2.55)	(1.59)	(3.40)	(4.27)	(2.04)	(2.82)
LnSIZE					-0.134	-0.073	-0.217	-0.051
					(3.50)	(2.00)	(3.51)	(1.14)
SDRET					-0.179	-0.274	-0.136	-0.223
					(1.90)	(2.89)	(0.96)	(1.77)
DIVYLD					-0.048	-0.063	-0.075	-0.021
					(3.36)	(4.28)	(2.81)	(2.11)

Panel B (Replication's Results, 1964-1997)

Variable	All months	Excl. January	1964–1980	1981–1997	All months	Excl. January	1964–1980	1981–1997
Constant	-0.574	-0.340	-0.567	-0.581	1.627	1.430	1.866	1.387
	(1.29)	(0.77)	(0.96)	(0.87)	(3.25)	(2.79)	(2.27)	(2.41)
BETA	1.322	0.889	1.014	1.631	0.347	0.354	0.275	0.419
	(2.97)	(2.02)	(1.44)	(2.98)	(1.02)	(1.01)	(0.61)	(0.82)
ILLIQMA	0.112	0.083	0.173	0.052	0.071	0.059	0.099	0.042
	(4.16)	(3.15)	(3.54)	(2.30)	(3.35)	(2.73)	(2.64)	(2.21)
R100	1.076	1.567	1.047	1.106	1.012	1.456	0.968	1.057
	(4.07)	(6.57)	(2.72)	(3.04)	(4.38)	(7.03)	(2.93)	(3.26)
R100YR	0.41	0.51	0.62	0.20	0.38	0.46	0.46	0.31
	(2.59)	(3.25)	(2.61)	(0.95)	(2.87)	(3.54)	(2.21)	(1.83)
LnSIZE					-0.100	-0.052	-0.172	-0.027
					(2.54)	(1.33)	(2.63)	(0.63)
SDRET					-0.249	-0.365	-0.178	-0.321
					(2.74)	(4.01)	(1.32)	(2.61)
DIVYLD					-0.028	-0.050	-0.050	-0.005
					(1.55)	(2.74)	(1.52)	(0.38)

Panel C (Replication's Results, 1998-2015)

Variable	All months	Excl. January	All months	Excl. January
Constant	0.073	-0.409	0.617	0.223
	(0.18)	(0.98)	(1.62)	(0.59)
BETA	0.366	0.942	0.541	0.953
	(0.61)	(1.51)	(1.37)	(2.39)
ILLIQMA	0.031	0.03	0.024	0.028
	(2.28)	(2.09)	(1.71)	(1.83)
R100	0.567	0.842	0.557	0.847
	(1.03)	(1.48)	(1.25)	(1.86)
R100YR	0.066	0.025	0.309	0.263
	(0.27)	(0.10)	(1.42)	(1.23)
LnSIZE			-0.023	-0.003
			(0.61)	(0.09)
SDRET			-0.177	-0.201
			(1.28)	(1.38)
DIVYLD			-0.033	-0.049
			(2.68)	(3.79)

Table 3

The eff ect of market illiquidity on expected stock excess return—annual data

Description: Estimates of the model in equations 1 and 2. RM is the return of the equal-weighted NYSE market portfolio, RSZ_i is the return of the i-th size-based portfolio (i = 2, 4, 6, 8, 10 with size increasing in i); Rf is the one-year Treasury bill yield as of the beginning of the year; $lnALLIQ_{y-1}$is the lagged natural logarithm of the illiquidity variable; and $lnALLIQ_t^U$is the unexpected illiquidity, the residual from an autoregressive model of $lnALLIQ_y$. Standard t-statistics appear in parenthesis, those calculated from standard errors robust to heteroskedasticity and autocorrelation using the Newey and West (1987) method appear in square brackets.

Interpretation: The results in panels A and B show that we obtain very similar time-series results to those in Amihud's paper. Expected and unexpected illiquidity respectively appear with a positive and a negative coefficient, and both are statistically significant. The panel C results show that in later data, expected illiquidity loses its explanatory power for stocks index returns.

Panel A (Amihud's Results, 1963-1996)

	RM - Rf	**RSZ2 - Rf**	**RSZ4 - Rf**	**RSZ6 - Rf**	**RSZ8 - Rf**	**RSZ10 - Rf**
Constant	14.740	19.532	17.268	14.521	12.028	4.686
	(4.29)	(4.53)	(4.16)	(4.02)	(3.78)	(1.55)
	[4.37]	[5.12]	[5.04]	[4.32]	[3.55]	[1.58]
$\boldsymbol{lnAILLIQ_{y-1}}$	10.226	15.230	11.609	9.631	7.014	-0.447
	(2.68)	(3.18)	(2.52)	(2.40)	(1.98)	(0.13)
	[2.74]	[3.92]	[3.31]	[2.74]	[1.84]	[0.14]
$\boldsymbol{lnAILLIQ_y^U}$	-23.567	-28.021	-24.397	-20.780	-18.549	-14.416
	(4.52)	(4.29)	(3.88)	(3.80)	(3.84)	(3.14)
	[4.11]	[3.91]	[3.63]	[3.41]	[3.50]	[3.39]
$\boldsymbol{R^2}$	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

Panel B (Replication's Results, 1963-1996)

	RM - Rf	**RSZ2 - Rf**	**RSZ4 - Rf**	**RSZ6 - Rf**	**RSZ8 - Rf**	**RSZ10 - Rf**
Constant	18.780	25.494	22.350	18.187	14.581	3.780
	(3.98)	(4.39)	(3.91)	(3.65)	(3.28)	(0.89)
	[3.34]	[4.27]	[3.85]	[3.28]	[2.62]	[0.79]
$\boldsymbol{lnAILLIQ_{y-1}}$	11.320	16.566	13.157	10.529	7.745	-0.610
	(2.70)	(3.22)	(2.60)	(2.38)	(1.97)	(0.16)
	[2.34]	[3.34]	[2.73]	[2.25]	[1.61]	[0.14]
$\boldsymbol{lnAILLIQ_y^U}$	-25.074	-29.357	-25.393	-22.262	-19.614	-15.294
	(4.40)	(4.19)	(3.68)	(3.70)	(3.66)	(3.00)
	[4.39]	[4.25]	[3.87]	[3.70]	[3.60]	[3.33]
$\boldsymbol{R^2}$	0.503	0.518	0.438	0.425	0.395	0.232
D - W	2.46	2.33	2.52	2.37	2.29	2.28

Panel C (Replication's Results, 1997-2015)

	RM - Rf	**RSZ2 - Rf**	**RSZ4 - Rf**	**RSZ6 - Rf**	**RSZ8 - Rf**	**RSZ10 - Rf**
Constant	13.038	22.347	14.360	15.013	6.752	-6.669
	(0.64)	(0.97)	(0.69)	(0.79)	(0.40)	(0.44)
	[1.01]	[1.53]	[1.09]	[1.13]	[0.54]	[0.47]
$\boldsymbol{lnAILLIQ_{y-1}}$	0.991	4.025	1.596	1.380	-0.896	-3.814
	(0.15)	(0.55)	(0.24)	(0.23)	(0.16)	(0.80)
	[0.24]	[0.92]	[0.37]	[0.32]	[0.22]	[0.91]
$\boldsymbol{lnAILLIQ_y^U}$	-19.910	-15.893	-21.365	-21.351	-22.303	-18.157
	(1.86)	(1.32)	(1.96)	(2.15)	(2.51)	(2.31)
	[2.13]	[1.62]	[2.35]	[2.41]	[2.65]	[2.27]
$\boldsymbol{R^2}$	0.233	0.176	0.259	0.294	0.333	0.278
D - W	2.48	2.35	2.24	2.28	2.50	1.96

Table 4

The effect of market illiquidity on expected stock excess return—monthly data

Description: Estimates of the model in equations 3 and 4. RM is the return of the equal-weighted NYSE market portfolio; RSZ_i is the return of the i-th size-based portfolio (i = 2, 4, 6, 8, 10 with size increasing in i); Rf is the one-month risk-free rate, $lnMILLIQ_{m-1}$is the lagged natural logarithm of the illiquidity variable; $lnMILLIQ_m^U$is the unexpected illiquidity computed as the residual from an autoregressive model of $lnMILLIQ_m$; and $JANDUM_m$ is a January dummy. Standard *t*-statistics appear in parenthesis, those calculated from standard errors robust to heteroskedasticity and autocorrelation using the Newey and West (1987) method appear in square brackets.

Interpretation: The results in panels A and B show that we obtain vary similar results to those in Amihud's paper. Expected and unexpected illiquidity appear respectively with a positive and a negative coefficient, both statistically significant. As with the annual illiquidity series, in the new sample period only unexpected illiquidity maintains its explanatory power for stock index returns.

Panel A (Amihud's Results, 1963-1996)

	RM - Rf	**RSZ2 - Rf**	**RSZ4 - Rf**	**RSZ6 - Rf**	**RSZ8 - Rf**	**RSZ10 - Rf**
Constant	-3.876	-4.864	-4.335	-4.060	-3.660	-1.553
	(2.33)	(2.54)	(2.45)	(2.42)	(2.27)	(1.12)
	[1.97]	[2.03]	[2.12]	[2.13]	[2.05]	[0.99]
$\boldsymbol{lnMILLIQ_{m-1}}$	0.712	0.863	0.808	0.761	0.701	0.319
	(2.50)	(2.64)	(2.67)	(2.65)	(2.55)	(1.35)
	[2.12]	[2.11]	[2.33]	[2.36]	[2.30]	[1.18]
$\boldsymbol{lnMILLIQU_m}$	-5.520	-6.513	-5.705	-5.238	-4.426	-3.104
	(6.21)	(6.37)	(6.04)	(5.84)	(5.15)	(4.19)
	[4.42]	[4.53]	[4.34]	[4.12]	[4.04]	[3.38]
$\boldsymbol{JANDUM_m}$	5.280	8.067	5.446	4.232	3.000	1.425
	(5.97)	(7.94)	(5.80)	(4.74)	(3.51)	(1.93)
	[4.20]	[5.03]	[4.08]	[3.45]	[2.64]	[1.47]
$\boldsymbol{R^2}$	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

Panel B (Replication's Results, 1963-1996)

	RM - Rf	RSZ2 - Rf	RSZ4 - Rf	RSZ6 - Rf	RSZ8 - Rf	RSZ10 - Rf
Constant	-3.803	-4.836	-4.218	-3.956	-3.539	-1.379
	(2.35)	(2.61)	(2.46)	(2.43)	(2.25)	(1.01)
	[2.01]	[2.08]	[2.14]	[2.17]	[2.04]	[0.90]
$lnMILLIQ_{m-1}$	0.693	0.848	0.781	0.736	0.674	0.289
	(2.53)	(2.70)	(2.68)	(2.66)	(2.52)	(1.25)
	[2.15]	[2.15]	[2.35]	[2.40]	[2.30]	[1.09]
$lnMILLIQU_m$	-7.378	-8.812	-7.702	-7.064	-5.844	-3.980
	(7.48)	(7.79)	(7.36)	(7.10)	(6.08)	(4.78)
	[7.21]	[7.32]	[7.11]	[6.77]	[6.19]	[4.71]
$JANDUM_m$	5.712	8.620	5.918	4.635	3.326	1.617
	(6.53)	(8.58)	(6.37)	(5.25)	(3.90)	(2.18)
	[4.65]	[5.47]	[4.54]	[3.88]	[2.97]	[1.69]
R^2	0.177	0.223	0.173	0.150	0.111	0.060
D - W	2.04	2.07	2.02	2.04	2.07	2.16

Panel C (Replication's Results, 1997-2015)

	RM - Rf	RSZ2 - Rf	RSZ4 - Rf	RSZ6 - Rf	RSZ8 - Rf	RSZ10 - Rf
Constant	0.861	-0.265	0.450	1.449	2.154	2.958
	(0.54)	(0.18)	(0.27)	(0.83)	(1.34)	(2.14)
	[0.47]	[0.16]	[0.24]	[0.74]	[1.27]	[2.07]
$lnMILLIQ_{m-1}$	-0.021	0.188	0.057	-0.109	-0.273	-0.515
	(0.06)	(0.62)	(0.16)	(0.29)	(0.80)	(1.77)
	[0.05]	[0.49]	[0.13]	[0.24]	[0.71]	[1.55]
$lnMILLIQU_m$	-5.171	-4.592	-5.290	-5.097	-4.928	-3.410
	(5.29)	(5.24)	(5.26)	(4.77)	(4.97)	(4.01)
	[3.02]	[3.11]	[2.98]	[2.64]	[2.83]	[2.58]
$JANDUM_m$	0.374	1.965	0.458	-0.649	-1.239	-1.358
	(0.31)	(1.82)	(0.37)	(0.49)	(1.01)	(1.30)
	[0.37]	[1.94]	[0.41]	[0.56]	[1.27]	[1.51]
R^2	0.118	0.128	0.117	0.099	0.111	0.088
D - W	1.91	1.86	1.94	1.89	1.94	2.06

Table 5

The effects of expected market illiquidity, default yield premium and term yield premium on expected stock excess return—monthly data

Description: Estimates of the model in equations 5 and 6. RM is the return of the equal-weighted NYSE market portfolio; RSZ_i is the return of the *i*-th size based portfolios (*i* = 2, 4, 6, 8, 10 with size increasing in *i*); Rf is the one-month risk free rate; $lnMILLIQ_{m-1}$ is the lagged natural logarithm of the illiquidity variable; $lnMILLIQ_m^U$ is the unexpected illiquidity, the residual from an autoregressive model of $lnMILLIQ_m$; $JANDUM_m$ is a January dummy; DEF_{m-1} is the lag of the difference between the yields to maturity of long-term corporate bonds rated BAA and AAA by Moody's; and $TERM_{m-1}$ is the lag of the difference between the composite yield of long-term Treasury bonds and the yield of the three-month Treasury bill. Standard t-statistics appear in parenthesis, those calculated from standard errors robust to heteroskedasticity and autocorrelation using the Newey and West (1987) method appear in square brackets.

Interpretation: The interpretation of the results in this table is the same as of those in Table 4. Adding two new variables to the model, DEF_{m-1} and $TERM_{m-1}$, does not change the main results of the analysis.

Panel A (Amihud's Results, 1963-1996)

	RM - Rf	**RSZ2 - Rf**	**RSZ4 - Rf**	**RSZ6 - Rf**	**RSZ8 - Rf**	**RSZ10 - Rf**
Constant	-5.583	-6.986	-6.170	-6.010	-5.191	-2.693
	(3.15)	(3.43)	(3.28)	(3.37)	(3.03)	(1.83)
	[2.63]	[2.58]	[2.73]	[2.90]	[2.71]	[1.68]
$\boldsymbol{lnMILLIQ_{m-1}}$	0.715	0.912	0.846	0.803	0.731	0.332
	(2.53)	(2.80)	(2.82)	(2.82)	(2.67)	(1.41)
	[2.18]	[2.20]	[2.41]	[2.48]	[2.38]	[1.23]
$\boldsymbol{lnMILLIQU_m}$	-5.374	-6.281	-5.492	-5.014	-4.242	-2.940
	(6.08)	(6.18)	(5.84)	(5.63)	(4.95)	(3.99)
	[4.39]	[4.48]	[4.27]	[4.05]	[3.97]	[3.26]
$\boldsymbol{JANDUM_m}$	4.981	7.943	5.351	4.128	2.925	1.395
	(5.67)	(7.86)	(5.73)	(4.66)	(3.44)	(1.91)
	[4.40]	[5.11]	[4.11]	[3.46]	[2.64]	[1.48]
$\boldsymbol{DEF_{m-1}}$	1.193	1.558	1.293	1.386	1.054	0.663
	(2.35)	(2.66)	(2.39)	(2.70)	(2.14)	(1.56)
	[2.39]	[2.52]	[2.30]	[2.76]	[2.13]	[1.54]
$\boldsymbol{TERM_{m-1}}$	0.281	0.185	0.228	0.227	0.221	0.316
	(1.84)	(1.05)	(1.40)	(1.48)	(1.50)	(2.49)
	[1.70]	[1.00]	[1.31]	[1.39]	[1.36]	[2.30]
$\boldsymbol{R^2}$	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

Panel B (Replication's Results, 1963-1996)

	RM - Rf	RSZ2 - Rf	RSZ4 - Rf	RSZ6 - Rf	RSZ8 - Rf	RSZ10 - Rf
Constant	-5.526	-6.764	-5.894	-5.768	-4.977	-2.506
	(3.22)	(3.43)	(3.22)	(3.33)	(2.96)	(1.72)
	[2.67]	[2.58]	[2.71]	[2.92]	[2.69]	[1.60]
$\boldsymbol{lnMILLIQ_{m-1}}$	0.732	0.894	0.820	0.778	0.707	0.312
	(2.69)	(2.86)	(2.83)	(2.83)	(2.66)	(1.36)
	[2.28]	[2.25]	[2.46]	[2.54]	[2.42]	[1.20]
$\boldsymbol{lnMILLIQU_m}$	-7.068	-8.510	-7.413	-6.752	-5.581	-3.722
	(7.18)	(7.52)	(7.08)	(6.80)	(5.80)	(4.47)
	[7.11]	[7.29]	[7.01]	[6.65]	[6.05]	[4.49]
$\boldsymbol{JANDUM_m}$	5.590	8.470	5.796	4.503	3.226	1.555
	(6.43)	(8.48)	(6.26)	(5.13)	(3.79)	(2.11)
	[4.69]	[5.55]	[4.56]	[3.89]	[2.95]	[1.66]
$\boldsymbol{DEF_{m-1}}$	1.210	1.474	1.212	1.311	0.998	0.640
	(2.42)	(2.56)	(2.28)	(2.60)	(2.04)	(1.51)
	[2.37]	[2.45]	[2.21]	[2.67]	[2.04]	[1.49]
$\boldsymbol{TERM_{m-1}}$	0.206	0.116	0.167	0.180	0.183	0.279
	(1.41)	(0.69)	(1.07)	(1.22)	(1.28)	(2.26)
	[1.34]	[0.67]	[1.01]	[1.16]	[1.20]	[2.17]
$\boldsymbol{R^2}$	0.194	0.237	0.187	0.169	0.124	0.079
D - W	2.08	2.11	2.04	2.08	2.10	2.20

Panel C (Replication's Results, 1997-2015)

	RM - Rf	**RSZ2 - Rf**	**RSZ4 - Rf**	**RSZ6 - Rf**	**RSZ8 - Rf**	**RSZ10 - Rf**
Constant	0.719	-0.541	0.212	1.290	2.070	3.109
	(0.44)	(0.37)	(0.12)	(0.72)	(1.25)	(2.19)
	[0.38]	[0.32]	[0.11]	[0.63]	[1.18]	[2.12]
$\boldsymbol{lnMILLIQ_{m-1}}$	-0.125	0.042	-0.020	-0.101	-0.251	-0.455
	(0.34)	(0.12)	(0.05)	(0.25)	(0.67)	(1.42)
	[0.34]	[0.13]	[0.05]	[0.26]	[0.71]	[1.34]
$\boldsymbol{lnMILLIQU_m}$	-5.118	-4.505	-5.228	-5.072	-4.920	-3.452
	(5.20)	(5.12)	(5.16)	(4.71)	(4.93)	(4.03)
	[2.97]	[3.05]	[2.93]	[2.64]	[2.83]	[2.65]
$\boldsymbol{JANDUM_m}$	0.308	1.873	0.411	-0.641	-1.222	-1.321
	(0.25)	(1.73)	(0.33)	(0.48)	(0.99)	(1.25)
	[0.29]	[1.72]	[0.35]	[0.55]	[1.26]	[1.52]
$\boldsymbol{DEF_{m-1}}$	0.526	0.709	0.335	-0.108	-0.163	-0.271
	(0.63)	(0.95)	(0.39)	(0.11)	(0.19)	(0.37)
	[0.36]	[0.53]	[0.22]	[0.07]	[0.13]	[0.25]
$\boldsymbol{TERM_{m-1}}$	0.041	0.106	0.114	0.104	0.064	-0.068
	(0.17)	(0.50)	(0.47)	(0.40)	(0.27)	(0.33)
	[0.21]	[0.54]	[0.54]	[0.47]	[0.34]	[0.41]
$\boldsymbol{R^2}$	0.120	0.135	0.119	0.100	0.112	0.090
D - W	1.90	1.86	1.94	1.89	1.94	2.07

Table 6

Alternative measures in cross-section

Description: The table presents results from monthly cross-sectional regressions of stock return on previous year stock characteristics similar to those in Table 2. The stock characteristics are the same as those in Table 2, except that for each line of this table, *ILLIQMA* is replaced with the indicated alternative proxy measure of illiquidity. Each row of this table corresponds to the *ILLIQMA* row in Table 2, computed using the alternative proxy measure. The table shows the time-series means for the coefficients of these variables, the *t*-statistics, and the average R^2 of the cross-sectional regressions. The Invariance Illiquidity Measure is the Kyle-Obizhaeva (2016) market microstructure invariance illiquidity measure, *V*.

Interpretation: While the average coefficient of Amihud's measure often has the highest *t*-statistic among the illiquidity proxies, the average R^2 of the regressions that include this variable is not higher than those that include the other variables. We conclude that Amihud's measure does not add relevant information for asset pricing relative to other proxies for illiquidity.

Panel A: Parameters and *t*-statistics

	Reduced Model				**Complete Model**			
	All months	**Excl. January**	**1964 - 1980**	**1981 - 1997**	**All months**	**Excl. January**	**1964 - 1980**	**1981 - 1997**
Parameter Mean								
Amihud Measure	0.112	0.083	0.173	0.052	0.071	0.059	0.099	0.042
Ratio of Mean Abs. Ret to Mean Dollar Volume	0.125	0.086	0.199	0.052	0.085	0.065	0.126	0.044
Mean Absolute Return	-0.318	-0.488	-0.064	-0.573	-0.190	-0.424	0.276	-0.656
Inverse Mean Dollar Volume	0.096	0.075	0.133	0.058	0.037	0.025	0.059	0.016
Invariance Illiquidity Measure	0.426	0.248	0.722	0.129	0.523	0.437	0.722	0.324
Log Mean Volume	-1.869	-1.507	-2.563	-1.175	-1.567	-1.301	-2.314	-0.821
***t*-statistics**								
Amihud Measure (Mean of Ratio)	4.161	3.150	3.541	2.304	3.354	2.734	2.643	2.214
Ratio of Mean Abs. Ret to Mean Dollar Volume	4.181	2.919	3.731	1.945	3.575	2.674	3.079	1.835
Mean Absolute Return	-1.379	-2.074	-0.182	-1.930	-0.502	-1.105	0.515	-1.226
Inverse Mean Dollar Volume	2.770	2.142	2.164	1.866	1.618	1.061	1.514	0.633
Invariance Illiquidity Measure	4.433	2.753	4.515	1.260	4.687	3.856	3.861	2.684
Log Mean Volume	-3.039	-2.427	-2.341	-2.098	-2.571	-2.082	-2.446	-1.069

Panel B: Average R^2

	Reduced Model				Complete Model			
	All months	**Excl. January**	**1964 - 1980**	**1981 - 1997**	**All months**	**Excl. January**	**1964 - 1980**	**1981 - 1997**
Average R^2								
Amihud Measure (Mean of Ratio)	0.036	0.032	0.045	0.027	0.067	0.062	0.080	0.055
Ratio of Mean Abs. Ret to Mean Dollar Volume	0.037	0.032	0.046	0.027	0.068	0.063	0.081	0.055
Mean Absolute Return	0.055	0.050	0.065	0.044	0.067	0.062	0.078	0.056
Inverse Mean Dollar Volume	0.039	0.035	0.050	0.028	0.067	0.062	0.079	0.054
Invariance Illiquidity Measure	0.037	0.033	0.045	0.030	0.069	0.064	0.082	0.056
Log Mean Volume	0.042	0.038	0.055	0.030	0.069	0.064	0.082	0.055

Table 7

Alternative measures in time-series

Description: The table presents selected results from annual and monthly time-series regressions of the excess of the return of the equal-weighted NYSE market portfolio over the risk-free rate on the decomposition of various logged illiquidity measures. The three columns respectively repeat the analyses of Tables 3, 4, and 5, except that Amihud's illiquidity measure is replaced with the indicated alternative proxy measure of illiquidity. Each row of this table corresponds to the *ILLIQMA* row in Table 2, computed using the alternative proxy measure. Panels A and B show the indicated estimated regression coefficient with the standard *t*-statistics appearing in parenthesis, and those calculated from standard errors robust to heteroskedasticity and autocorrelation using the Newey and West (1987) method appearing in square brackets. Panel C shows the R^2 of these time-series regressions. The Invariance Illiquidity Measure is the Kyle-Obizhaeva (2016) market microstructure invariance illiquidity measure, *V*.

Interpretation: The R^2 of the regressions indicate that the log ratio of the mean absolute deviation to the mean dollar volume explains more variance than does the log Amihud measure, which is the mean of the ratio. We conclude that Amihud's measure does not add relevant information for asset pricing relative to other proxies for illiquidity.

Panel A: Lag log illiquidity regression coefficient estimates and *t*-statistics

Illiquidity Measure	**Annual**	**Monthly**	**Monthly with covariates**
Log Amihud Measure (Log Mean of Ratio)	11.32	0.693	0.732
	(2.71)	(2.53)	(2.69)
	[2.34]	[2.16]	[2.29]
Log Ratio of Mean Abs. Ret to Mean Dollar Volume	-2.147	-0.135	0.043
	(-5.19)	(-0.98)	(0.25)
	[-2.60]	[-0.97]	[0.26]
Log Mean Absolute Return	2.883	2.748	1.947
	(1.34)	(1.91)	(1.29)
	[1.15]	[1.32]	[0.90]
Log Invariance Illiquidity Measure	-5.642	1.021	1.334
	(-0.91)	(1.79)	(2.19)
	[-1.05]	[1.31]	[1.66]
Log Mean Volume	6.263	0.097	-0.234
	(2.28)	(0.56)	(-1.10)
	[2.82]	[0.56]	[-1.21]

Panel B: Unexpected log illiquidity coefficient estimates and *t*-statistics

Illiquidity Measure	Annual	Monthly	Monthly with covariates
Log Amihud Measure (Log Mean of Ratio)	-25.074	-7.379	-7.069
	(-4.40)	(-7.49)	(-7.19)
	[-4.39]	[-7.22]	[-7.12]
Log Ratio of Mean Abs. Ret to Mean Dollar Volume	-3.088	-25.052	-24.532
	(-62.26)	(-18.92)	(-18.30)
	[-8.40]	[-15.48]	[-15.28]
Log Mean Absolute Return	-7.921	-10.749	-10.705
	(-3.07)	(-4.59)	(-4.59)
	[-3.38]	[-2.31]	[-2.28]
Log Invariance Illiquidity Measure	-123.35	-36.329	-35.270
	(-7.32)	(-13.913)	(-13.33)
	[-8.52]	[-11.557]	[-10.83]
Log Mean Volume	66.597	15.244	14.656
	(5.42)	(10.22)	(9.85)
	[5.08]	[9.04]	[9.09]

Panel C: R^2

Illiquidity Measure	Annual	Monthly	Monthly with covariates
Log Amihud Measure (Log Mean of Ratio)	0.504	0.177	0.194
Log Ratio of Mean Abs. Ret to Mean Dollar Volume	0.706	0.496	0.502
Log Mean Absolute Return	0.286	0.103	0.124
Log Invariance Illiquidity Measure	0.651	0.362	0.370
Log Mean Volume	0.499	0.243	0.262

Table 8

The information in Amihud's Illiquidity measure

Description: The table presents a replication of the results in Panel B of Table 2 for which the independent variable, *ILLIQ* (Amihud's illiquidity measure) is replaced by the ratio of mean absolute return to mean dollar volume and by the difference between Amihud's measure and this ratio of means.

Interpretation: Almost all the explanatory power of Amihud's illiquidity measure is due to its ability to characterize the ratio of mean absolute return and mean dollar volume, and not to the correlation of daily absolute returns with daily trading volumes. Although Amihud motivates his choice of this illiquidity measure by reference to this correlation, the correlation does not meaningfully contribute to the explanatory power of the model.

	All months	**Excl. January**	**1964–1980**	**1981–1997**	**All months**	**Excl. January**	**1964–1980**	**1981–1997**
Constant	-0.549	-0.306	-0.460	-0.639	1.596	1.427	1.794	1.398
	(1.21)	(0.67)	(0.78)	(0.93)	(3.23)	(2.80)	(2.22)	(2.45)
BETA	1.266	0.829	0.872	1.661	0.290	0.290	0.220	0.360
	(2.83)	(1.86)	(1.23)	(3.04)	(0.87)	(0.84)	(0.49)	(0.73)
Ratio of means	0.148	0.100	0.228	0.068	0.133	0.101	0.209	0.057
	(4.04)	(2.75)	(3.73)	(1.72)	(4.22)	(3.18)	(4.26)	(1.46)
The difference	-0.010	-0.002	-0.020	0.000	-0.036	-0.020	-0.075	0.004
	(0.35)	(0.06)	(0.47)	(0.00)	(1.31)	(0.73)	(1.83)	(0.10)
R100	1.09	1.58	1.08	1.11	1.03	1.47	1.00	1.06
	(4.13)	(6.60)	(2.79)	(3.05)	(4.43)	(7.05)	(2.98)	(3.27)
R100YR	0.423	0.518	0.641	0.204	0.393	0.473	0.471	0.315
	(2.68)	(3.35)	(2.70)	(0.98)	(2.95)	(3.63)	(2.28)	(1.86)
LnSIZE					-0.089	-0.043	-0.158	-0.019
					(2.24)	(1.08)	(2.44)	(0.43)
SDRET					-0.243	-0.360	-0.166	-0.321
					(2.68)	(3.97)	(1.24)	(2.62)
DIVYLD					-0.030	-0.052	-0.055	-0.005
					(1.68)	(2.83)	(1.66)	(0.40)