Role of Liquidity in Asset Pricing

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Abstract

Relationship between liquidity and asset prices has attracted considerable attention since Amihud and Mendelson (1986). A number of proxies have been used to measure liquidity but a direct objective measure is lacking. This paper introduces a directly observable measure of liquidity and compares its performance to the widely used bid ask spread measure of liquidity introduced by Amihud and Mendelson's (1986) seminal work. The results indicate that this measure of liquidity substantially outperforms the traditional measure and may be useful in predicting market level price changes.

Role of Liquidity in Asset pricing

Introduction

Standard equilibrium asset pricing models have traditionally ignored one important and distinctive characteristic of assets: Liquidity, or the ability to quickly convert an asset to a medium of exchange without cost or delay. This neglect is not surprising since most asset pricing models are single period models and assume away transaction costs. However, It is widely recognized that rational investors anticipating liquidity shocks associated with divesting of assets should be willing to pay (demand) a premium (discount) for assets where transaction costs are lower (higher) and market conditions favor quick (slow) conversion to cash.

While there appears to be a general consensus that liquidity is priced by investors, a generally accepted measure of liquidity appears to be missing. This paper introduces a directly observable measure of liquidity and compares its performance to the widely used bid ask spread measure of liquidity introduced by Amihud and Mendelson's (1986) seminal work.

This paper is organized as follows. Section II presents the literature survey, followed by Section III describing the research methodology and data sample used for analysis. Section IV presents results of empirical analysis and section V concludes the paper with a discussion of research implications.

Section II. Literature Survey

Researchers have primarily employed two groups of proxies for liquidity. Following Amihud and Mendelson (1986) Bid-ask spread based measures are frequently used to proxy trading costs and turnover measures, suggested by Brennan and Subrahmanyam (1996), are used to proxy the trading delays. Lower bid ask spread and higher volume/turnover are taken to be indicators of higher liquidity. Both of these measures are suitable for studying the liquidity effects of selling a very small number of shares, but do not necessarily measure well the cost of selling many shares. Bid ask quotes are binding for only one round lot trade and are subject to quick and costless revision by the market maker in response to an order imbalance. Turnover based measures have been found to be very sensitive to market conditions and are a measure of current liquidity rather than expected liquidity. Additionally, while theory would suggest that expected future liquidity should affect prices, the empirical literature has almost exclusively focused on current liquidity.

Amihud and Mendelson (1986), has been followed by a number of studies exploring the link between liquidity and returns for stocks. Relationship between lower liquidity and higher returns has been explored by Brennan and Subrahmanyam (1996), Brennan, Chordia, and Subrahmanyam (1998), Datar, Naik, and Radcliffe (1998), and Fiori (2000). Using a variety of liquidity measures, this group of researchers has demonstrated that generally less liquid stocks have higher average returns. Amihud and Mendelson (1986), Constantinides (1986), Heaton and Lucas (1996), Vayanos (1998), and Lo, Mamaysky, and Wang (2001), among others explore the relationship between liquidity and asset

prices and show that significant price discounts exist for less liquid but otherwise comparable assets.

A cross-sectional analysis of relationship between liquidity and returns can be potentially contaminated by existence of risk factors other than liquidity. Any discussion of a liquidity premium, therefore, would be incomplete without accounting for security risk, Amihud and Mendelson (1986), for example adjust for risk by analyzing asset returns in a CAPM framework. Fama-French three-factor model (Fama and French, 1993, 1996), adjustment for risk factors is used by Brennan and Subrahmanyam (1996). Both studies find that asset returns include a significant premium for illiquidity, even after accounting for the market risk and in case of Brennan and Subrahmanyam, adjusting for market risk, size premium and market value/book value ratio. I follow the risk factor adjustment protocol established by Brennan and Subrahmanyam (1996). I form a set of Low liquidity minus high liquidity portfolios and test for significance of the resulting LMH factor in a Fama French framework.

Section III. Data Sample and Methodology

Data Description

The data set consists of 795,118 firm- month observations spanning all listed securities for the three equity markets (NYSE, AMEX, and NASDAQ) for January 1993 to December 2003. Market capitalization, bid, ask, closing price, total returns, shares outstanding, and trading volume for all stocks traded on the three exchanges were obtained from CRSP data base provided by the Center for Research in Security Prices at the University of Chicago. Monthly trading volumes and outstanding shares were used to

avoid the distortions introduced by infrequent trading in smaller market value stocks. This time period was selected since the reporting of trading volume was standardized across the three equity markets only in June 1992. The trading volume reported by NASDAQ before June 1992 was the aggregate of volume reported by all dealers in the security, leading to inflated counts as dealers/market makers reported each buy and sell transaction separately.

Fama French factors, for size (SMB) and ratio of market value and book value (HML) for each month were obtained from the data set provided by Professor Kenneth French at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

The analysis was carried out for all securities listed on the NYSE, AMEX, and NASDAQ exchanges. The securities ineligible for continued listing (priced at less than one dollar per share, less than 750,000 shares outstanding, or number of shareholders fewer than 300), were deleted from the sample in order to avoid any delisting bias. There is an important institutional difference between the reported volume for stocks traded on NYSE/AMEX and on the NASDAQ. Dealer market-makers on NASDAQ intervene in the trade as buyer from the seller and as seller for the buyer, in effect doubling the reported volume. Therefore, in order to create a uniform measure of traded volume the reported volumes for NASDAQ stocks were adjusted by 50% to account for this double counting in NASDAQ. Further, if a security changed its listing from NASDAQ to NYSE during a given month the firm was dropped from the sample for that month to insure consistency.

The resulting sample ranges from a low of 4645 to a high of 6750 firms for a given month with a median of 6068. Each month as new stocks are listed, de-listed, merged, or

acquired, this count changes. The data set is partitioned further by size deciles by ranking all stocks each month by market capitalization and assigning a capital rank (CRANK). Similarly the stocks are ranked by deciles based on the calculated lambda (LRANK) and Spread (SRANK).

Analysis Methodology

Two measures of liquidity are used to distinguish between low and high liquidity stocks. A standard bid ask spread measure of liquidity is used as a default measure and a new statistical measure of Liquidity λ is introduced. Performance of both measures is assessed in a risk adjusted Fama French framework.

A. One standard measure of liquidity used in finance literature is the bid ask spread calculated as (Ask-Bid)/ Price at the end of each month. This spread is a measure of trading costs associated with acquiring/divesting a share of stock. A larger spread is indicative of low liquidity.

B. A new direct measure of liquidity λ is defined as follows

Given
The stock holding at time t is S_t

Volume for one time period time t is V_t

The stock holding at time t +1 is $S_{t+1} = S_t - V_t$

Assuming that the rate of deal flow is constant (λ)
at time t

$S_{t+1} = S_t \, e^{-\lambda}$
Or $\lambda = \text{Log}_n (S_t) - \text{Log}_n (S_{t+1})$

λ is a measure of the observed level of liquidity, with higher levels signifying that the current order flow in the market can absorb larger volumes of trading without impacting prices. An additional advantage of this specification of λ is that the expected half life or average holding period can be calculated directly by dividing the value of Log normal (2) by the calculated value of λ. If 50% of the stock changes hands over a period n , $\text{Log}_n(S_t) - \text{Log}_n(S_{t+n})$ is $\text{Log}_n(S_t / 0.5\ S_t) = \text{Log}_n(2)$.

Liquidity premiums for both measures of liquidity are calculated each month following the Fama French factor methodology. The LMH (low minus high) premium is the difference between the mean returns for the three lowest liquidity portfolios and three highest liquidity portfolios formed at the end of t-1. This is calculated for each month by subtracting the monthly returns on the high liquidity portfolio (lower spread/ higher λ) from the returns on the low liquidity portfolio (higher spread/ lower λ) . Summary data for the aggregate sample as well as each capital decile are presented in table 1. below

Capital Size deciles		Sample Size	Mean Monthly returns	Mean Market Capitalization $'000	Relative Spread	lambda	Average Months Holding period
	0	79457	-0.12%	$8,035.55	13.54%	0.1248	5.55
	1	79514	0.81%	$19,660.98	9.50%	0.1106	6.27
	2	79525	1.32%	$34,988.70	7.98%	0.1237	5.60
	3	79527	1.35%	$57,627.52	7.02%	0.1405	4.93
	4	79506	1.76%	$94,251.38	6.59%	0.1737	3.99
	5	79536	1.97%	$158,684.06	6.54%	0.2155	3.22
	6	79542	2.29%	$277,565.50	6.92%	0.2533	2.74
	7	79508	2.47%	$527,470.89	7.85%	0.2748	2.52
	8	79531	2.46%	$1,242,053.76	9.10%	0.2840	2.44
	9	79472	2.13%	$12,795,578.55	10.55%	0.2422	2.86
Total Sample		795118	1.64%	$1,520,994.54	8.56%	0.1943	3.57

Relative spread is seen to decline from smallest sizes to the middle of the decile market capitalization distribution and then increase with firm size. In contrast, the λ measure , and its imputed average holding period measure show a monotonic increase in liquidity with size of the firm except for the largest decile, which may be explained by the increased institutional holdings for the largest firms.

A correlation matrix of the relationships between the three rank variables, capitalization, lambda, and spread presented in table 2 below indicates that the theoretically expected relationships are observed for this data sample. Prior research in finance indicates that the stock of larger firms tends to be more liquid. The relationship between firm size, measured by market capitalization and lambda is positive, indicating that the larger stocks tend to be more liquid. Relationship between lambda and spread is negative , confirming that more liquid stocks tend to exhibit smaller trading costs as measured by bid ask spread. Similarly, the relationship between spread and market capitalization is negative, indicating that larger stocks tend to have lower proportional trading costs. The calculated Pearson Correlation Coefficients for decile ranks for the three variables of interest are all highly significant.

Table 2.

Pearson Correlation Coefficients for Decile ranks
Prob > |r| under H0: Rho=0 Number of Observations

	Lambda	Spread	Capitalization
Lambda	1.00000	-0.28256	0.27925
		<.0001	<.0001
	788723	788723	788723
Spread	-0.28256	1.00000	-0.13835
	<.0001		<.0001
	788723	788724	788724
Capitalization	0.27925	-0.13835	1.00000
	<.0001	<.0001	
	788723	788724	795118

Significance tests for liquidity premium

Using Fama-French framework two sets of decile portfolios were created, ranking securities by the two measures of liquidity (relative bid ask spread and lambda) at the end of every month. The difference between returns of portfolio with low liquidity (higher bid ask spread/ lower lambda) and high liquidity (lower bid ask spread/ higher lambda) is calculated for the returns realized in the following month. The portfolios are rebalanced at the end of each month and the respective LMH, (SprdPrem, premium for portfolios sorted by spread and lambPrem, premium for portfolios sorted by lambda) is calculated

for each month. These LMH factors are merged with the market premium, risk free rate, SMB (size premium), and HML (growth) factor data from Kenneth French web site to create a matrix of explanatory variables. Two research questions are investigated; first question is if a liquidity premium exists, as measured by the two liquidity parameters, and second, if there is a difference between the explanatory powers of the two measures of liquidity (Spread and Lambda).

If there is a significant liquidity premium for the measure then the regression coefficient on the difference between the realized return on the low liquidity and high liquidity portfolios (LMH) should be significant and negative. I test for this difference using portfolios created using the two alternative measures of liquidity. The test is conducted by including the Fama-French factors in the regression and checking if the coefficient for the LMH factor is negative and significant in explaining the observed returns even after the FF factors are included. Two regressions are run with the monthly returns as the Y variable and combinations of individual LMH factors and the FF factors. The coefficients for the factors are negative and significant as expected.

The results indicate that both of these measures are significant in measuring liquidity premium for the stocks included in the sample. A third regression is run by including both LMH factors in the same regression with the FF factors. The results are interesting. While the difference in F statistics between the SpreadPrem and lambPrem regressions is significant the difference between LambPrem and augmented regression is insignificant.

These results indicate that while the spread based measure of liquidity is valid, Lambda based measure is significantly more efficient in explaining the liquidity premium between low and high liquidity securities.

Table 3. Regression results for Fama French regressions

RSQ		Intercept	Mkt_RF	RF	SMB	HML	sprdprem
0.0253	PARMS	0.02554	0.01034	-0.42326	0.00187	0.00138	-0.23766
F Value	STDERR	0.00071622	0.00033040	0.04056	0.00034693	0.00060873	0.00194
4124	T	35.66	31.28	-10.43	5.38	2.27	-122.78

RSQ		Intercept	Mkt_RF	RF	SMB	HML	lambprem
0.054	PARMS	0.03081	0.00898	-1.02746	0.00431	0.00296	-0.21714
F value	STDERR	0.00070345	0.00032558	0.03950	0.00033687	0.00059784	0.00109
9081	T	43.80	27.58	-26.01	12.81	4.96	-199.23

RSQ		Intercept	Mkt_RF	RF	SMB	HML	lambprem	sprdprem
0.0576	PARMS	0.035231	0.008538	-1.52339	0.008114	0.000353	-0.29544	0.172618
1121	STDERR	0.000707	0.000325	0.040437	0.000343	0.000599	0.001788	0.003129
	T	49.85429	26.26678	-37.6734	23.64086	0.590251	-165.217	55.17124

I also tested for sensitivity of the two measures of liquidity to partitioning of the sample across size deciles. The results are qualitatively similar to the aggregate sample results reported in the paper with the lambda based liquidity measure significantly outperforming the spread based measure of liquidity. These regressions are not reported here in interest of brevity but are available from the author.

V. Results and Implications

The risk adjusted Fama French framework analysis demonstrates that Lambda based measure of liquidity performs significantly better than spread based measure of liquidity. Relationship between current liquidity and future returns is negative. This has important implications about the role of observed liquidity as a predictor of future returns. An increase (decrease) in liquidity is expected to be followed by lower (higher) returns, indicating higher lower) prices for the asset portfolio. Changes in liquidity can therefore act as early warning signals for market moves. This is an interesting avenue that may be worth pursuing for security analysts.

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