Title

An Empirical Analysis of Stock and Bond Market Liquidity: Forthcoming in the Review of Financial Studies

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An Empirical Analysis of Stock and Bond Market Liquidity

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Abstract

An Empirical Analysis of Stock and Bond Market Liquidity

We study the joint time-series of daily liquidity in government bond and stock markets over the period 1991 to 1998. Innovations in liquidity are positively and significantly correlated across stock and bond markets. Further, order imbalances in the stock market impact bond and stock liquidity, even after controlling for order imbalances in the bond market. Both results suggest the existence of a common liquidity factor in stock and bond markets. We consider monetary conditions and mutual fund flows as sources of order flow and as primitive determinants of liquidity. Monetary expansion enhances stock market liquidity during crises. U.S. government bond funds see higher inflows and equity funds see higher outflows during financial crises, and these flows are associated with decreased liquidity in stock and bond markets. Our results establish a link between "macro" liquidity, or money flows, and "micro" or transactions liquidity.

JEL CODES: G10, G14, G23, E52

1 Introduction

A number of important theorems in finance rely on the ability of investors to trade any amount of a security without affecting the price. However, there exist several frictions,[1] such as trading costs, short sale restrictions, circuit breakers, etc. that impact price formation. The influence of market imperfections on security pricing has long been recognized. Liquidity, in particular, has attracted a lot of attention from traders, regulators, exchange officials as well as academics.

Liquidity, a fundamental concept in finance, can be defined as the ability to buy or sell large quantities of an asset quickly and at low cost. The vast majority of equilibrium asset pricing models do not consider trading and thus ignore the time and cost of transforming cash into financial assets or vice versa. Recent financial crises, however, suggest that, at times, market conditions can be severe and liquidity can decline or even disappear.[2] Such liquidity shocks are a potential channel through which asset prices are influenced by liquidity. Amihud and Mendelson (1986) and Jacoby, Fowler, and Gottesman (2000) provide theoretical arguments to show how liquidity impacts financial market prices. Jones (2001) and Amihud (2002) show that liquidity predicts expected returns in the time-series. Pastor and Stambaugh (2001) find that expected stock returns are cross-sectionally related to liquidity risk.[3]

Until recently, studies on liquidity were focused principally on its cross-sectional determinants, and were restricted to equity markets (e.g., Benston and Hagerman, 1974,

[1] See Stoll (2000).

[2] "One after another, LTCM's partners, calling in from Tokyo and London, reported that their markets had dried up. There were no buyers, no sellers. It was all but impossible to maneuver out of large trading bets." – *Wall Street Journal*, November 16, 1998.

[3] Note that Amihud and Mendelson (1986), Brennan and Subrahmanyam (1996), Brennan, Chordia and Subrahmanyam (1998), Jones (2001), and Amihud (2002) view liquidity in a transaction costs context, while Pastor and Stambaugh (2001) relate liquidity risk to expected stock returns.

and Stoll, 1978). As more data has become available, recent work has shifted focus on studying time-series properties of liquidity in equity markets as well as in fixed-income markets. Hasbrouck and Seppi (2001), Huberman and Halka (2001), and Chordia, Roll and Subrahmanyam (2000) document commonality in equity market liquidity by showing that spreads and depths of individual stocks co-move with market- and industry-wide liquidity. Chordia, Roll, and Subrahmanyam (2001) study daily aggregate equity market spreads, depths and trading activity over an extended period to document weekly regularities in liquidity and the influence of market returns, volatility and interest rates on liquidity. Fleming (2001), and Brandt, Edelen, and Kavajecz (2001) study liquidity in the US government bond market while Jones, Lamont, and Lumsdaine (1998), Fleming and Remolona (1999) and Balducci, Elton, and Green (2001) analyze returns, spreads, and trading volume in bond markets around economic announcements.

So far the literature on stock and bond liquidities has developed in separate strands. Yet, the cross-sectional determinants of bond liquidity share many similarities to that of stocks (Chakravarty and Sarkar, 2001 and Schultz, 2001). Since, in practice, a number of asset allocation strategies shift wealth between stock and bond markets,[4] a reasonable hypothesis is that order flows between stocks and bonds impact liquidity in both markets. A negative information shock in stocks often causes a "flight to quality" as investors substitute safe assets for risky assets.[5] The resulting outflow from stocks into government bonds may cause dealers in both markets to adjust their inventory positions, impacting stock and bond liquidity. In other situations, stock and bond order flows may be complementary. For example, if the Federal Reserve pursues an expansionary mone-

[4]See, for example, Amman and Zimmerman (2001) and Fox (1999) for practical considerations, and Barberis (2000) or Xia (2001) for more academic studies.

[5]"When stocks are expected to show weakness, investment funds often flow to the perceived haven of the bond market, with that shift usually going into reverse when, as yesterday, equities start to strengthen." John Parry, *The Wall Street Journal*, August 1 2001, page C1.

tary policy, the increase in funds could cause higher order inflows into both stocks and government bonds and potential changes in their liquidity. This discussion implies that bond and stock liquidities can exhibit co-movement and also can be jointly driven by common factors such as monetary policy.

Motivated by these observations, in this paper we jointly study the time-series of liquidity in the stock and U.S. Government bond markets. We first analyze the influence of order flows on liquidity and document co-movements in stock and bond liquidity. The natural question that arises from this analysis is the following: What primitive factors cause day-to-day movements and co-movements in bond and stock liquidity?

To address the above issue, we take a step back and seek to identify forces that generate order flow in stock and bond markets and, possibly, induce correlated movements in liquidity. Specifically, we study monetary factors and mutual fund flows and their associations with stock and bond liquidity. In this manner, we link microstructure liquidity (in the sense of transaction costs) and "macro liquidity" (in the sense of fund flows between sectors of the economy).

Since stocks and bonds are the main vehicles by which funds are raised for long-term investments by firms and governments, understanding the correlation between money flows and transactions liquidity is important for enhancing the efficacy of resource allocation. At a more practical level, we provide insight into the optimal way for portfolio managers to shift between stocks and bonds so as to minimize trading costs. In particular, timing these allocations or sequencing them in a certain way can reduce trading costs associated with these strategies. For example, if the nature of calendar regularities across stock and bond markets is different, then staggering allocation strategies may lead to lower trading costs. Addressing this issue requires the analysis of the joint time-series of stock and bond liquidity, and in particular, the question of whether these series have common determinants assumes importance.

Our consideration of the joint time-series of stock and bond market liquidity thus sheds light on the following specific research questions that have not yet been addressed in the literature:

- What is the extent of co-movement between stock and bond liquidity and how does the nature of this co-movement change during financial crises?
- Are there spillover effects from bond liquidity to stock liquidity or vice versa?
- Is financial market liquidity predictable using publicly available information? If so, what variables help forecast future stock and bond market liquidity?
- Are unexpected liquidity shocks correlated across markets?
- How does Federal Reserve monetary policy affect financial market liquidity during crises?
- What happens to money flows in and out of stock and bond mutual funds during financial crises and how does this impact stock and bond market liquidity?

We address these questions by considering the joint time-series of bond and stock market liquidity over a fairly long time-period of over 1850 trading days.

The results indicate that the time series properties of stock and bond liquidity possess similarities, such as similar weekly regularities. Lagged spreads and lagged order imbalances are predictors of the bid-ask spreads and depth. In particular, a sell imbalance in stocks adversely affects stock and bond liquidity. Since we control for order imbalance in bonds, the result is indicative of a common determinant of bond and stock order flow.

Further, we find that the correlation between innovations in bond and stock liquidity is positive and significantly different from zero, again suggesting a common factor. Results from forecasting regressions indicate that bond and stock spreads are predictable to a considerable degree within our sample. Out-of-sample predictability is also better relative to a naïve model where the current spread depends only on the lagged spread.

We consider money flows and mutual fund flows as factors that determine stock and bond order flow and, hence, liquidity. Specifically, we examine the relation between liquidity and a proxy for monetary tightening, namely, net borrowed reserves. We distinguish between normal and crisis periods (i.e., the Asian financial crisis of 1997 and the Russian default crisis of 1998) since significant changes in monetary conditions tend to occur in crisis periods. The results are consistent with the notion that monetary loosening enhances liquidity in financial markets during crisis periods. Finally, we examine how monthly money flows in and out of stock and bond funds affect liquidity during crises as well as in normal periods. We find that during periods of crises, there are substantial flows into government bond funds and out of equity funds. This "flight to quality" is associated with decreased equity market liquidity, as well as reduced liquidity in the bond markets. Overall, our results identify a clear link between money flows (in the form of bank reserves and mutual fund investments) and liquidity in stock and bond markets.

The rest of the paper is organized as follows. Section 2 describes the data. Section 3 presents summary statistics, while Section 4 performs daily predictive regressions. Section 5 analyzes liquidity around periods of financial crises: namely the Asian and the Russian crises. Section 6 presents the analysis of mutual fund flows and monetary policy. Section 7 concludes.

2 Data

Bond and stock liquidity data were obtained for the period June 17, 1991 to December 31 1998. The sample period reflects the availability of tick-by-tick government bond data, obtained from GovPX Inc., which covers trading activity among primary dealers in the interdealer broker market. The stock data sources are the Institute for the Study of Securities Markets (ISSM) and the New York Stock Exchange TAQ (trades and automated quotations). The ISSM data cover 1991-1992 inclusive while the TAQ data are for 1993-1998. We use only NYSE stocks to avoid any possibility of the results being influenced by differences in trading protocols between NYSE and Nasdaq.

Our focus in this paper is on analyzing stock and bond liquidity measures that have been the focus of attention in the previous literature, viz., quoted and effective spreads as well as market depth. We use order imbalances as predictive determinants of liquidity, rather than volume, because our view is that imbalances bear a stronger relation to liquidity as they represent aggregate pressure on the inventories of market makers.[6]

2.1 Measures of Bond Liquidity

GovPX, Inc. consolidates data from the primary brokers and transmits the data in real-time to subscribers through on-line vendors. The service reports the best bid and offer quotes, the associated quote sizes, the price and amount (in million dollars) of each trade, and whether the trade is buyer or seller-initiated. The time of each trade is also reported to the second.[7] The GovPX data pertains to inter-dealer trades only.

We use trading data for the 10-year, on-the-run Treasury note. Although on-the-run

[6]See Chordia, Roll, and Subrahmanyam (2002).

[7]Fleming (2001) provides a detailed account of the format of GovPX data.

securities are a small fraction of Treasury securities, they account for 71% of activity in the interdealer market (Fabozzi and Fleming, 2000). We choose the 10-year note for two reasons. First, it is among the most actively traded fixed-income securities. Second, GovPX data is representative of the overall market for 10-year notes during our sample period. For other long-term Treasury notes (such as the 30-year Treasury bond), the GovPX data captures a smaller and variable fraction of aggregate bond market activity since a major broker, Cantor Fitzgerald/eSpeed, does not report its data.[8]

The bond liquidity measures are based on data from New York trading hours (7:30 AM to 5:00 PM Eastern Time). We construct the following measures of bond liquidity:
QSPRB: the daily average quoted bid-ask spread, calculated as the difference between the best bid and best ask for the trade. Only quotes that are matched with trades are retained in the sample. The trade price is matched with the most recently available quote record on the same day.
ESPRB: the daily average effective spread, i.e., the difference between the execution price and the mid-point of the prevailing bid-ask quote.
DEPTHB: Average of each set of posted bid and ask depth in notional terms, averaged over the trading day
CLIQB: A composite measure of liquidity, defined as quoted spread divided by market depth.
The last two variables are available only starting 1995. Since there is quantity negotiation in government bond markets, the depth measure in bond markets is likely to be an imperfect estimate of the actual quantity supplied by dealers. The quoted depth is often an initial point for negotiation, from which the order is "worked" up. Nevertheless, we include the variable for the sake of completeness, and to complement the stock depth

[8] Boni and Leach (2001) document the share of GovPX in aggregate bond market volume.

variable that we use.

We also define the following terms related to order imbalance in the bond market ($OIBB$), defined as the notional value of buys less the notional value of sells each day, divided by the total value of buys and sells (recall that GovPX data indicates whether a trade is buyer or seller initiated; hence, trades can be signed directly):

$OIB+B$: max($OIBB$,0).

$OIB-B$: min($OIBB$,0).

Note that since bond data is from the inter-dealer market, the imbalance measures represent inter-dealer order imbalances. It is highly likely, however, that inter-dealer order imbalances arise in response to customer imbalances as dealers lay off customer orders in the dealer market. Inter-dealer imbalances thus are likely to represent an estimate, albeit a noisy one, of customer imbalances.

To obtain reliable estimates of the bid-ask spread and imbalance, the following filters are used:

1. Bid or offer quotes with a zero value are deleted.

2. Trade prices that deviate more than 20 percent from par value ($100) are deleted. These prices are grossly out of line with surrounding trade prices, and are most likely to be reporting errors.

3. A quoted or effective bid-ask spread that is negative or more than 50 cents per trade (a multiple of about 12 to 15 times the sample average) is deleted.

4. Trades with effective spreads in the upper five percentile of its distribution for a particular calendar year are deleted. These trades are clearly outliers, since their effective spreads are several times greater than its standard deviation and, further, greatly exceed the maximum quoted spread for the calendar year.

2.2 Stock Liquidity Data

Stocks are included or excluded during a calendar year depending on the following criteria:

1. To be included, a stock had to be present at the beginning and at the end of the year in both the CRSP and the intraday databases.

2. If the firm changed exchanges from Nasdaq to NYSE during the year (no firms switched from the NYSE to the Nasdaq during our sample period), it was dropped from the sample for that year.

3. Because their trading characteristics might differ from ordinary equities, assets in the following categories were also expunged: certificates, ADRs, shares of beneficial interest, units, companies incorporated outside the U.S., Americus Trust components, closed-end funds, preferred stocks and REITs.

4. To avoid the influence of unduly high-priced stocks, if the price at any month-end during the year was greater than $999, the stock was deleted from the sample for the year.

Intraday data were purged for one of the following reasons: trades out of sequence, trades recorded before the open or after the closing time, and trades with special settlement conditions (because they might be subject to distinct liquidity considerations). Our preliminary investigation revealed that auto-quotes (passive quotes by secondary market dealers) were eliminated in the ISSM database but not in TAQ. This caused the quoted spread to be artificially inflated in TAQ. Since there is no reliable way to filter out auto-quotes in TAQ, only BBO (best bid or offer)-eligible primary market (NYSE) quotes are used. Quotes established before the opening of the market or after the close were discarded. Negative bid-ask spread quotations, transaction prices, and quoted depths were discarded. Following Lee and Ready (1991), any quote less than five seconds prior to the trade is ignored and the first one at least five seconds prior to the trade is retained.

For each stock we define the following variables:

QSPRS: the daily average quoted spread, i.e., the difference between the ask and the bid quote, averaged over the trading day.

ESPRS: the daily average effective spread, i.e., the difference between the execution price and the mid-point of the prevailing bid-ask quote.

DEPTHS: Average of the posted bid and ask depths in shares, averaged over the trading day

CLIQS: A composite measure of liquidity, defined as quoted spread divided by market depth.

$OIBS$: the daily order imbalance (the dollar value of shares bought less the dollar value of shares sold each day, as a proportion of the total value traded).[9]

$OIB+S$: max($OIBS$,0)

$OIB-S$: min($OIBS$,0)

Our initial scanning of the intraday data revealed a number of anomalous records that appeared to be keypunching errors. We thus applied filters to the transaction data by deleting records that satisfied the following conditions:[10]

1. Quoted spread>$5
2. Effective spread / Quoted spread > 4.0
3. Proportional effective spread / Proportional quoted spread > 4.0
4. Quoted spread/Mid-point of bid-ask quote > 0.4

[9]The Lee and Ready (1991) method was used to sign trades. Of course, there is inevitably some assignment error, so the resulting order imbalances are estimates. Yet, as shown in Lee and Radhakrishna (2000), and Odders-White (2000), the Lee/Ready algorithm is accurate enough as to not pose serious problems in our large sample study.

[10]The proportional spreads in condition 3 are obtained by dividing the unscaled spreads by the mid-point of the prevailing bid-ask quote.

These filters removed less than 0.02% of all stock transaction records. The above variables are averaged across the day to obtain stock liquidity measures for each day. Days for which stock return data was not available from CRSP were dropped from the sample. The daily dollar trading volume is obtained from CRSP. The daily spread measures are first averaged within the day for each stock, then averaged equal-weighted across stocks to obtain the aggregate market liquidity measures that we use in this study (for convenience we use the same variable names for the aggregate liquidity and volume measures).

3 Summary Statistics

Table 1 presents the levels of quoted and effective spreads and absolute order imbalances for stocks and bonds.

Please insert Table 1 here.

The average quoted and effective spreads are \$0.032 and \$0.030, respectively for bonds, but \$0.20 and \$0.13, respectively, for stocks. The median spread measures are almost the same as the means suggesting little skewness in the daily distribution of liquidity. The daily absolute imbalance in percentage terms is 13% for bonds and about 5% for stocks. Bond spreads are lower than those for stocks even though the absolute order imbalances and the transaction sizes in bond markets are larger.[11] This is possibly due to the fact that the minimum tick size is smaller in the bond market. There may, however, be more fundamental informational-based reasons for the smaller spreads in the bond market. US government bond prices are impacted by broad macro-economic information shocks such as inflation, monetary policy, unemployment, and adverse selection is unlikely to be a

[11]The minimum lot size in the US government bond market is \$1,000,000 whereas the lot size in the stock market is 100 shares.

major issue in bond markets. But, adverse selection is likely to be far more important in stock prices due to private information about idiosyncratic shocks. Also, recall that the bond data pertains to the inter-dealer trades only. Thus, the bond spreads that we see are those for the wholesale market with large transaction sizes.

Panel B presents summary statistics for depth and the composite liquidity measures for the subperiod for which the bond depth is available (1995-1998). Note that in the bond inter-dealer market the size of the trades are negotiated and thus the posted depth may be far smaller than the actual depth. As long as the quoted depth is an unbiased estimate of the actual depth, however, all our inferences for depth will retain their validity.

Both Panels A and B indicate that bond liquidity exhibits more variability than stock liquidity, as indicated by higher coefficients of variation for the bond liquidity measures. This is consistent with our finding that absolute order imbalance is, on average, greater in the bond market. A major issue in this paper is the search for the primitive sources of this variability. Our contention is that variability in liquidity is possibly caused by order imbalance (which is directly related to return volatility) and order imbalance is possibly driven by macroeconomic sources such as money supply and mutual fund flows.

Table 2 presents the correlations between the contemporaneous bond and stock liquidity and imbalance variables. Because of possible structural changes in the price formation process in equities following the tick size change from 1/8 to 1/16 on June 24, 1997, we chose to examine stock liquidity data only up to June 23, 1997; hence the stock market data for Table 2 (and Table 3) does not go beyond this date.

Please insert Table 2 here.

While the time-series correlation between stock and bond quoted spreads is high (about 21%), that between effective spreads is insignificantly different from zero. Depth in each market is also positively correlated with the other (about 10%) giving rise to the strong correlation between the composite liquidity measures (quoted spread divided by depth) for stocks and bonds (31%). Depth in each market is significantly negatively correlated with the quoted and the effective spreads. Depth in the bond market is negatively related to the quoted and effective spreads in the stock market while depth in the stock market is negatively related only to quoted spreads in the bond market.

Recall that the order imbalance measures in both markets are divided into two components, $OIB+$ and $OIB-$ in order to capture differences in the impact on liquidity of positive and negative order imbalances. The correlation between $OIB+S$ and the quoted or effective spread in the stock market is significantly positive and the correlation between $OIB-S$ and the two spread measures is significantly negative suggesting that stock market liquidity declines (spreads increase) with order flow in or out of the stock market. The correlation between quoted as well as effective bond spreads and $OIB+B$ is negative suggesting that the bond market liquidity improves with order flow into the bond market.

The buy imbalance in the stock market, $OIB+S$ is positively correlated with sell imbalance in the bond market, $OIB-B$, and with the bond quoted and effective spreads. Further, the sell imbalance in the bond market ($OIB-B$) is positively correlated with a buy imbalance in the stock market ($OIB+S$) and with quoted and effective spreads in the stock market. This is consistent with positive information shocks in the stock market resulting in money flowing out of bonds, into stocks, and causing higher bond and stock spreads. Thus, order flow seems to be a venue through which both bond and stock market liquidity are impacted.

Table 2 presents univariate correlations between the different variables. The next section, in contrast, examines the impact of own and cross-market order flow on liquidity within the context of a predictive regression framework.

4 Predictive Regressions

In this section, we provide a parsimonious model that captures time-series movements in stock and bond liquidity. We choose to adopt a pure forecasting model for stock and bond quoted and effective spreads, depths, and the composite liquidity variable, because we seek a causality that runs from imbalances to liquidity. We expect such causality because overnight imbalances could reflect pressures on market maker inventories and consequently impact the subsequent days' bid-ask spread.[12] Furthermore, we also are interested in examining whether unexpected liquidity shocks are systemic in nature, and a forecasting specification allows us to address this issue.[13]

It is possible that a negative imbalance could induce relatively more pronounced changes in liquidity to the extent that market makers find it more difficult to adjust inventory to order flows out of the market. We therefore use our imbalance decompositions into positive and negative components in the forecasting regressions. Also, asset allocation strategies that require shifting of wealth between stock and bond markets on a periodic basis may be spread out over time across both markets, for the purposes of minimizing price impact. This implies that imbalances in the stock market on a given day could be predictors of future bond market liquidity, and vice versa. We therefore include cross-market imbalances as well as cross-market liquidity measures in our regressions.

[12] See Chordia and Subrahmanyam (1995) for a simple model of how spread levels depend on inventory.

[13] We do not use the vector autoregression approach (e.g., Hasbrouck, 1991) because our conversations with microstructure scholars indicated that the VAR, while good at capturing the short-run effects, is not effective at capturing lower frequency dynamics.

Liquidity may also be influenced by the opportunity cost of devoting time to trading decisions, which could vary across days of the week. To investigate such regularities, we include indicator variables for days of the week as well as for days preceding and following holiday closures. Further, to capture portfolio rebalancing around major public information releases, we include dummy variables for macroeconomic announcements about GDP, the employment rate, and the Consumer Price Index. Separate dummies are provided for the day of the announcement and for the two days preceding the announcement.

Our explanatory variables are as follows:

The four imbalance variables, $OIB + B$, $OIB - B$, $OIB + S$, and $OIB - S$.

Holiday: a dummy variable that equals one if a trading day satisfies the following conditions. (1) Independence day, Veterans' Day, Christmas or New Year's Day falls on a Friday, then the preceding Thursday, (2) a holiday falls on a weekend or on a Monday then the following Tuesday, (3) a holiday falls on a weekday then the preceding and the following days. Otherwise the dummy variable is zero.

Monday-Thursday: equals one if the trading day is Monday, Tuesday, Wednesday, or Thursday, and zero otherwise.

GDP: dummy variable that equals one on the day of the GDP announcement and zero otherwise.

GDP12: dummy variable that equals one on two days prior to the GDP announcement and zero otherwise.

Emp, Emp12, CPI, and CPI12: corresponding dummy variables for employment and CPI announcements respectively.

We include five lagged values of the dependent liquidity variable for stocks as well as for bonds. We also include lags of the imbalance variables.[14] To mitigate the impact of outliers, we eliminate the top 0.5% and the bottom 0.5% of the sample. In order to correct for heteroskedasticity and any remaining serial correlation in the residuals, for estimation we use the Generalized Method of Moments with the Newey-West correction.

4.1 Regression Results

The regression results are presented in Table 3.

Please insert Table 3 here.

We present results in turn for quoted spreads (Panel A), effective spreads (Panel B), depths (Panel C) and the composite liquidity measure (Panel D).[15]

Quoted bond spreads are lowest on Mondays and highest on Fridays. Further, consistent with previous research (Fleming and Remolona, 1999), bond spreads increase on days of CPI and Employment announcements. In addition, bond spreads decrease over the two days leading up to the Employment announcements. Bond spreads do not respond to the GDP announcement. This is probably due to the fact that, as Fleming and Remolona (1999) document, the increase in the bid-ask spread is limited to a 10-minute window surrounding the announcement. Since the magnitude of the spread increase from a GDP announcement is much smaller than that from CPI and Employment announcements (Fleming and Remolona, 1997), these effects may not be statistically discernible with daily data. Overall, our variables explain about 55% of the daily variation in bond quoted spreads.[16]

[14]Our exploratory analysis indicated that longer lags were largely irrelevant in predicting liquidity.

[15]Our results are qualitatively similar when we use proportional quoted and effective spreads instead of unscaled spreads. We use unscaled spreads to avoid any apprehension that our results are driven by the use of price levels in the dependent variables.

[16]A plot of the quoted spreads seems to indicate an increase in bond spreads and volatility around March 1995 suggesting a structural break. Using a dummy for the post March 1995 period, however,

Our variables explain a much greater fraction of the daily variation in stock spreads (about 95%). Stock spreads also exhibit stronger lagged dependence than bond spreads. This could be an artifact of the feature of our data that aggregate stock spreads are those on a portfolio of stocks and are therefore less noisy, whereas the bond spreads are those on a single bond. Also, the tick size in the bond market is far smaller than that in the bond market. A larger tick size in the stock market implies that the information shocks have to be larger to have an impact on stock spreads.[17] Bond spreads are thus likely to be more variable because with a smaller tick size, small information shocks can have a larger impact. Interestingly, while bond spreads are lowest on Mondays, stock spreads appear to be lowest on Tuesdays. Friday is the lowest liquidity day for both markets. Unlike bond spreads, stock spreads are not significantly related to the macroeconomic announcements.

While the lagged spreads on the bond or the stock market have no impact on the spreads in the other market, the impact of order flow, as measured by the order imbalance, is discernible on the quoted spread. Stock and bond quoted spreads increase with order flows out of the stock market, $OIB - S$. The cross effect of order flow out of the stock market on bond quoted spreads seems initially surprising because order flow out of the stock market should be related to order flow into the bond market which should lead to lower spreads in the bond market. However, note that the bond order imbalances are included in the regression and the negative impact of stock order flow is over and above that of the bond order flow. This suggests that there may be some underlying economic factor that drives the impact of stock order flow on both bond and stock liquidity. We will examine the money supply posture of the Federal reserve as one such underlying

does not change any of the underlying results. We thank Joel Hasbrouck for pointing this out.

[17]Ball and Chordia (2001) show that most the spread on large stocks is due to rounding onto a discrete grid.

factor.

The effective spread results in Panel B are essentially the same as those for the quoted spreads. The only exception is that bond effective spreads are higher on days when the GDP, CPI as well as the unemployment statistics are announced. The stock effective spreads are higher on the days of the CPI and the employment announcements.

Panel C presents the results for depth in the stock and the bond market. Depth in both the bond and the stock market is highest on Tuesdays and Wednesdays as compared to other days. Bond market depth decreases substantially on the day unemployment numbers are announced while stock market depth increases in the one to two days prior to the unemployment announcement. While the contemporaneous univariate correlations in Table 2 indicate that bond and stock depths are positively correlated, an increase in the lagged stock market depth results in lower bond market depth. Order flow out of the stock market results in significantly lower depths in the stock market. The composite liquidity results in Panel D are similar to those for the spreads.

Overall, the results suggest that the in-sample predictability is driven mainly by the lagged values of the dependent variables, and the day of the week seasonalities. An important result is that the lagged selling imbalances in the stock market have an impact on both the bond and the stock market liquidity, even after controlling for order imbalances in the bond market.

4.2 Volatility

Return volatility is known to have an impact on spreads. We confirm this by using the positive and negative component of returns in the regressions of Table 3 in lieu of the order imbalances. The returns used are the Lehman Brothers' aggregate daily bond index return for bonds and the daily CRSP value-weighted index return for stocks. The positive and negative component of returns are defined analogous to the order imbalances, $RET+ = max(Ret, 0)$ and $RET- = min(Ret, 0)$, where Ret is the daily return. The coefficient on $RET-$ for both bonds and stocks is significantly negative for both bond and stock spreads suggesting that spreads increase when returns decline. In the stock quoted spread regression, $RET+$ is significantly positive suggesting that the quoted spreads increase with returns. However, the market movements in the value weighted stock market return and the Lehman aggregate bond index return are significantly positively correlated with order flow. This is not surprising because buy (sell) orders lead to an increase (decrease) in returns.

We also use the absolute value of returns as an additional explanatory variable in the regression of Table 3. The results show that, although the coefficient on volatility is significant, there is no substantive increase in the adjusted R-square in any regression. The qualitative results remain unchanged from before with one exception: the sell imbalance is no longer significant in the quoted stock spread regression (although it continues to be significant in the quoted bond spread, the effective bond and stock spread, the stock depth and the stock composite liquidity regressions). The lack of significance of the selling imbalance in the quoted stock regression is most likely due to the relatively high correlation (about 25 percent) between volatility and sell imbalances in the stock market. We conclude that adding volatility does not provide any more information than that contained in the order imbalances.

Thus, order imbalances and volatility are both important in explaining liquidity, and they are closely linked. High order imbalances (positive or negative) are related to volatility.

4.3 Liquidity shocks

The regression results in Table 3 indicate that liquidity is quite predictable. Yet unexpected arrival of information, as well as unexpected shocks to investors' liquidity, can cause unanticipated trading needs, and, in turn, unanticipated fluctuations in liquidity. It is of interest to examine whether such fluctuations are correlated across stock and bond markets, both from an academic and a practical standpoint. From an academic standpoint, we know nothing about the time-series properties of aggregate liquidity innovations. For example, are liquidity shocks systemwide in nature or unique to a particular market? From a practical standpoint, asset allocation strategies could be designed to take advantage of increased liquidity, e.g., if shocks are positively correlated, it suggests contemporaneous execution of orders in both markets on unusually high liquidity days in one market.

We define liquidity shocks to be the residuals from the regressions in Table 3 (which include own- and cross-market variables). The correlations in these liquidity shocks across the two markets are documented in Table 4.

Please insert Table 4 here.

Panel A of Table 4 presents the results for the full sample. Liquidity shocks show a reasonably high degree of correlation across markets. Quoted (effective) spread innovations across markets have a correlation of 0.13 (0.08), while the correlation for the composite liquidity innovations in stock and bond markets is 0.15. All these correlations are statistically different from zero.

This evidence suggests strongly that liquidity shocks have a systemic component. We plot liquidity innovations for quoted and effective spreads, and the composite measure of liquidity in Figures 1 through 3. The figures show that shocks to liquidity appear to have become larger in magnitude towards the end of the sample period, when the Russian and Asian crises took place. We will return to this issue in Section 5, where we will also discuss Panels B and C of Table 4.

4.4 Out-of-sample Predictions

We use the model in Table 3 to predict daily liquidity one step ahead one day at a time. We employ rolling regressions which use the preceding 250 days of data to make one-day ahead forecasts to compare the mean-squared error (MSE) from this approach to a naïve model which predicts tomorrow's spread to be equal to today's spread.

The MSE's from these rolling regressions are listed in Table 5.

Please insert Table 5 here.

Panel A shows the result for the entire sample. Interestingly, our model is much more useful in predicting bond market liquidity than stock market liquidity in that the MSE reductions relative to the naïve model are far greater for the bond regressions. Specifically, the MSE reduction relative to the naïve model for bond spreads is about 37% while that for stock spreads is about 2%. Panel B of Table 5 is discussed in the next section.

5 Crisis periods

Several recent articles have suggested that financial crises affect liquidity.[18] For Treasury bonds, Fleming (2001) finds that price impacts and quoted bid-ask spreads are higher

[18]See, for example, Greenspan, 1999, and "Finance and Economics: Alan Greenspan's miracle cure," Economist, October 24, 1998, pp.75-76. and "A Review of Financial Market Events in Autumn 1998," CGFS Reports No. 12, October 1999, available at http://www.bis.org/publ/cgfspubl.htm.

during crisis periods. Thus, it is plausible that the time-series properties of bond and stock liquidity may be different during periods of crises as compared to normal circumstances. We identified two crisis periods in our sample - the Asian financial crisis (October 1 to December 31, 1997) and the Russian default crisis (July 6 to December 31, 1998). The dates for the Asian crisis are from Choe, Kho, and Stulz (1997) and those for the Russian default crisis are from the Bank of International Settlements.[19] The non-crisis period is defined as spanning the days from June 25, 1997 through the end of 1998 that did not include the crisis.[20]

In Panels B and C of Table 4, we document the cross-correlations in liquidity innovations for the crisis and non-crisis periods. The innovations are obtained from re-estimating the regressions discussed in Table 3, but for the full sample ending December 31, 1998. Forbes and Rigobon (2002) show that crisis correlations may be upwardly biased due to the higher volatility of variables in the crisis period and compute an adjustment for this bias. We use the Forbes and Rigobon (2002) formula to correct the bias in the crisis correlations in Panel C. The table indicates that the bias-adjusted correlations in liquidity innovations increase during periods of crises. For instance, the correlation between stock and bond quoted (effective) spread innovations increases from 0.18 (0.17) in the non-crisis period to 0.35 (0.27) in the crisis period, and the increase is statistically significant for the quoted spreads. This indicates that shocks to spreads were more likely to be systemic in nature during crisis periods, suggesting greater investor uncertainty in aggregate during these periods. However, the correlation between depth innovations is lower during periods of crises.

[19] "A Review of Financial Market Events in Autumn 1998", CGFS Reports No. 12, October 1999, available at http://www.bis.org/publ/cgfspubl.htm.

[20] We commenced the non-crisis period immediately after the stock market tick size change from 1/8 to 1/16 was introduced on June 14, 1997, because this change had an immediate and permanent impact on the stock market spread (see Chordia, Roll, and Subrahmanyam, 2001).

Panel B of Table 5 documents MSE's of our predictive model during crisis and non-crisis periods. MSE's are sharply higher during crisis periods for all liquidity measures except stock depth. Overall, the results of this table and those of Table 4 indicate that liquidity was harder to predict and cross-market correlations in liquidity shocks increase during the crises periods, suggesting a greater propensity for systemic shocks to occur during these periods.

6 The Role of Mutual Fund Flows and Monetary Policy

Until now we have used order imbalances as proxies for order flows into the bond and stock markets. Order imbalances and return volatility are related to each other and to liquidity. But what drives order flows? Possibly, portfolio rebalancing needs of investors due to macroeconomic shocks. In this section we examine the role of money supply and mutual fund flows as primitive determinants of liquidity.

With regard to monetary policy, while several studies have informally discussed the notion that the Federal Reserve steps in to enhance financial market liquidity by loosening credit constraints during periods of market turbulence,[21] to date there has been no empirical study on the impact of changes in monetary policy on aggregate liquidity in financial markets.[22] Monetary conditions may affect asset prices through their effect on interest rates, the equity cost of capital or the expected corporate profitability. Smirlok and Yawitz (1985) and Cook and Hahn (1988) show that an expansionary monetary policy increases stock prices in the short-run and thus lowers expected return. Moreover,

[21]See Garcia (1989) "Monetary Policy Report to Congress," *Federal Reserve Bulletin*, March 1995, pp. 219-243.

[22]At 9am on the day following the 1987 stock market crash, the following statement hit the wires, "The Federal Reserve, consistent with its responsibilities as the nation's central bank, affirmed today its readiness to serve as a source of liquidity to support the economic and financial system."

a loose monetary policy facilitates trading by enhancing the ability of dealers to finance their positions. Hence, liquidity may be a function of the monetary stance of the Federal Reserve. Further, it has been conjectured that money flows in and out of mutual funds may have an important impact on financial market liquidity, especially during periods of financial turbulence (see, for example, Edelen, 1999), but this issue also remains to be explored. These are the issues to which we now turn.

The caveat is that, unlike the daily order imbalance data, the data on mutual funds and for the borrowed reserves (our indicator of monetary tightness) is available at a lower frequency. The mutual fund data is available only monthly while the net borrowed reserves are available at a fortnightly frequency. We use bi-weekly borrowed reserves data from the Federal Reserve and monthly equity and government bond net flows from the Investment Company Institute for our analysis in this subsection.

Please insert Table 6 here.

Net borrowed reserves are defined as total borrowings minus extended credit minus excess reserves. Thus, net borrowed reserves represent the difference between the amount of reserves banks need to have to satisfy their reserve requirements and the amount which the Fed is willing to supply. Since, over a long time period, net borrowed reserves may change simply due to different reserve requirements by the Federal Reserve, we divide net borrowed reserves by the required reserves. Higher values of this ratio indicate increased monetary tightness. Strongin and Tarhan (1990), among others, use this measure of monetary tightness. Market participants also use net borrowed reserves as a measure of monetary tightness.[23] For example, Melton (1985) notes that "...since late 1979, the key

[23] "In the aftermath of the [September 11] crisis, the Fed pumped tens of billions of dollars into the economy. As a result, the banks excess reserves soared. But as the financial markets returned to some semblance of normality, the Fed gradually began mopping up much of that excess money. Bank reserves

link between the Fed and the federal funds rate is the amount of reserves that the banks must borrow from the Fed's discount window. Consequently, the best single indicator of the degree of pressure the Fed is putting on the reserves market is the amount of borrowed reserves."

Table 6 presents the biweekly net borrowed reserves, as well as money flows (in millions of dollars) into equity and bond funds each month. Net borrowed reserves declined significantly in the crisis period relative to the non-crisis period, suggesting a loose monetary stance of the Federal Reserve. In our sample, equity flows decline from an average of $21 billion during normal periods to about $10 billion during periods of crises while the bond funds change from an outflow of $155 million to an inflow of $871 million. The decrease in cash inflows to equity funds combined with the increase in cash inflows to government bond funds illustrates the "flight to quality" often alluded to by financial market commentators during periods of crises.

6.1 Monetary Policy

In this subsection, we examine the effects of monetary policy on stock and bond market liquidity during crises. The independent variables include the lag of the dependent variable (liquidity measure) in both markets, the net borrowed reserves and its lag and the lag of the stock market order imbalances (positive and negative). We include the contemporary value of the net borrowed reserves in our regressions because it is unlikely that the bid-ask spread or depth contemporaneously influence the reserve requirements, so that there is likely not an endogeneity problem in this regression. Since the bond market imbalances in Table 3 had no impact on liquidity, they are not included in this

have now fallen back significantly, and in the process, short-term interest rates have moved back up to their intended target level." Why the Fed Should Stick to Rate Cutting, by Rich Miller, Business Week, October 15 2001.

regression. A dummy for the tick size change in the stock market is used for the period after June 24, 1997. A dummy for crises is also used and all the above variables are interacted with a crisis dummy for the time period of the two crises. The tick size and crisis dummies are lagged to ensure that investors actually knew about these events when trading. However, the lagging makes no substantive difference to the results, which are presented in Table 7.

Please insert Table 7 here.

Panel A presents the results for quoted spreads. The dummy for the crises is positive and significant, pointing to an increase in the quoted spread during the crises. While, a decrease in the net borrowed reserves (which represents monetary loosening) during non-crises periods has no impact on liquidity, during crises it leads to an decrease in stock market quoted spreads. The marginal impact of an increase in the lagged stock quoted spreads is a decrease in the stock and bond quoted spreads. The effective spread results in Panel B are similar except that the lagged order flow into and out of the stock market during crises results in higher bond effective spreads. The depth results are presented in Panel C. Monetary expansion leads to reduced stock market depth during normal periods but increased depth during crises. The effect of reserves on bond depth is the opposite, higher reserves are associated with higher bond depth.

Overall, the effect of a looser monetary stance supply during crises (Table 6) has a beneficial impact on the stock market with decreased spreads and increased depth. The loose money supply stance during crises generally has little or no impact on the bond market liquidity.

It may be argued that so long as market participants can construct accurate forecasts of monetary variables, only the surprise in money supply should affect financial liquidity.

One potential drawback of borrowed reserves is that data on the market's expectations of the amount of borrowed reserves is not available. Therefore, as an alternative, we consider the Fed funds rate for which futures prices are available. In principle, one can use these futures prices to compute the surprise in the Fed funds rate. A caveat is that the Fed funds rate surprise is a noisy indicator of monetary policy since changes in the surprise may simply indicate the market's anticipation of the Fed's behavior. In fact, Rigobon and Sacks (2001) argue that stock returns predict changes in the Fed funds rate. Also, the futures price is based on an average of the effective funds rate, rather than the target rate.

Keeping the above caveats in mind, we use Bloomberg data to compute the surprise in the funds rate as the target funds rate (when it changes) minus the market's expectation of the rate. The market's expectation is computed as 100 minus the futures price of the spot contract on the day before the market comes to know of the rate change.[24] Since there are only 3 rate changes during our crisis periods, we focus on the normal period only. Hence, we exclude the post-June 24 1997 sample. We use the same regression specification as with borrowed reserves, except that we replace NETBOR with FFSUR, the Fed funds surprise. The results (not shown for the sake of brevity) indicate that a positive surprise (an actual funds rate increase exceeding the market's expectation) increases the bid-ask spread in the stock and bond markets.

6.2 Fund flows

We re-estimate the regression model of Table 7 using monthly mutual fund flow data. For the liquidity and order imbalance variables, we compute monthly averages of the daily

[24]See Kuttner (2001) for details of the futures data, the timing of rate announcements and the market's knowledge of the rate change.

data. The difference from Table 7 is that net borrowed reserves are replaced by one lag each of the equity and bond mutual fund flows. The results are presented in Table 8.

Please insert Table 8 here.

Since most of the results in this table are similar to those in Table 7, we will focus our discussion only on the mutual fund flows. During normal periods, mutual fund flows have no impact on liquidity in any of the panels of Table 8. During crises, quoted and effective bond spreads rise and depth in the bond market decreases with inflows into government bond funds. This suggests that, with the flight to quality and the large amount of cash inflows into the government bond funds during crises, liquidity in the bond market is adversely affected. In addition, increased inflows into government bond funds also increases the effective stock spread, perhaps because bond inflows are associated with outflows from stock funds in crises periods.

In our bi-weekly and monthly regressions, we have a relatively small number of observations. Stambaugh (1999) shows that the small-sample distribution of the coefficient estimates may depart substantially from the usual t-distribution due to the autocorrelation in the predictor variables (the lagged bid-asked spread, depth or order imbalances in our case). To check whether this is a problem, we drop all the liquidity variables and use only one lag of returns (which exhibit insignificant serial correlation), plus NETBOR and one lag of NETBOR for the bi-weekly regressions. For the monthly regressions, we use one lag of returns, plus one lag of EFLOW and one lag of BFLOW as the explanatory variables. Qualitatively, the results remain unchanged in both cases.

7 Conclusion

We examine common determinants of stock and bond liquidity over the period 1991 through 1998, and study the effect of money flows (bank reserves and mutual fund investments) on transactions liquidity. Thus, our study takes a step towards linking microstructure liquidity with macro-level liquidity as embodied in money flows. The analysis helps enhance our understanding of the economic factors driving liquidity across different markets.

Our principal findings are as follows:

- Weekly regularities in stock and bond market liquidities closely mimic each other except that bond spreads are lowest Mondays while stock spreads are lowest Tuesdays. Friday is the lowest-liquidity day of the week for both markets.

- Out-of-sample predictability of bond market liquidity is substantially improved by the inclusion of lagged bid-ask spread and order imbalances. However, predictability worsens considerably during crisis periods for both stocks and bonds.

- Unexpected liquidity shocks are positively and significantly correlated across stock and bond markets, which suggests that liquidity shocks are often systemic in nature. The cross-market correlation is significantly higher during crises. The results are consistent with increased investor uncertainty leading to frequent and correlated portfolio reallocations during financial crises.

- Analysis of the relation between a proxy for monetary policy and liquidity is consistent with the notion that monetary policy appears to have an ameliorative effect on stock market liquidity during crises.

- There is a net inflow into government bond funds (a flight to quality) and outflow from equity funds in crisis periods, reducing liquidity in both bond and stock markets.

Our work suggests a fertile research agenda. Little theoretical work has been done on time-series movements in liquidity, and there is no theory on linking movements in liquidity across equity and fixed-income markets. A model of market equilibrium with endogenous trading across stock and bond markets would seem to be desirable. Further, the theoretical link between monetary policy, fund flows, and stock and bond market liquidity also represents a research issue that has largely remained unexplored. We hope our work serves to stimulate research in these areas.

References

Amihud, Y., 2002, Illiquidity and stock returns: Cross-section and time-series effects, *Journal of Financial Markets* 5, 31-56.

Amihud, Y., and H. Mendelson, 1986, Asset pricing and the bid-ask spread, *Journal of Financial Economics* 17, 223-249.

Amann, M., and H. Zimmermann, 2001, Tracking error and tactical asset allocation, *Financial Analysts Journal* 57, 32-43 (March/April).

Balducci, P., E. Elton, and T. Green, 2001, Economic News and Bond Prices: Evidence from U.S. Treasury Market, forthcoming, *Journal of Financial and Quantitative Analysis.*

Ball, C., and T. Chordia, 2001, True Spreads and Equilibrium Prices, *Journal of Finance* 56, 1801-1836.

Barberis, N., 2000, Investing for the long run when returns are predictable, *Journal of Finance* 55, 225-264.

Benston, G., and R. Hagerman, 1974, Determinants of bid-asked spreads in the over-the-counter market, *Journal of Financial Economics* 1, 353-364.

Boni, L., and J. Leach, 2001, Supply contractions and Trading Protocol: An examination of recent changes in the U.S. Treasury Market, Working Paper, University of New Mexico.

Brandt, M., R. Edelen, and K. Kavajecz, 2001, Liquidity in the U.S. treasury market: Asymmetric information, inventory, and supply shifts, working paper, University of Pennsylvania.

Brennan, M., and A. Subrahmanyam, 1996, Market microstructure and asset pricing: On the compensation for illiquidity in stock returns, *Journal of Financial Economics* 41, 441-464.

Brennan, M., T. Chordia, and A. Subrahmanyam, 1998, Alternative factor specifications, security characteristics, and the cross-section of expected stock returns, *Journal of Financial Economics* 49, 345-373.

Chakravarty, S., and A. Sarkar, 2001, A comarison of the bid-ask spread in the U.S. Corporate, Municipal and Treasury markets, Working paper, the Federal Reserve Bank of New York.

Choe, H., B. Kho, and R. Stulz, 1999, Do foreign investors destabilize stock markets? The Korean experience in 1997, *Journal of Financial Economics* 54, 227-264.

Chordia, T., R. Roll, and A. Subrahmanyam, 2000, Commonality in liquidity, *Journal of Financial Economics* 56, 3-28.

Chordia, T., R. Roll, and A. Subrahmanyam, 2001, Market liquidity and trading activity, *Journal of Finance* 56, 501-530.

Chordia, T., R. Roll, and A. Subrahmanyam, 2002, Order imbalance, liquidity, and market returns, forthcoming, *Journal of Financial Economics.*

Chordia, T., and A. Subrahmanyam, 1995, Market making, the tick size, and payment-for-order flow: Theory and evidence, *Journal of Business* 68, 543-575.

Cook, T., and T. Hahn, 1988, The information content of discount rate announcements and their effect on market interest rates, *Journal of Money, Credit and Banking* 20, 167-180.

Edelen, R., 1999, Investor flows and the assessed performance of open-end mutual funds, *Journal of Financial Economics* 53, 439-466.

Fabozzi, F., and M. Fleming, 2000, U.S. treasury and agency securities, in F. Fabozzi, ed., *The Handbook of Fixed Income Securities* (6th ed.) McGraw Hill, New York, NY.

Fleming, M., 2001, Measuring Treasury market liquidity, Staff Reports No. 33, The Federal

Reserve Bank of New York.

Fleming, M., and E. Remolona, 1997, What moves the bond market? *Economic Policy Review*, Vol. 3, No. 4, December 1997, 31-50.

Fleming, M., and E. Remolona, 1999, Price formation and liquidity in the U.S. Treasury market: The response to public information, *Journal of Finance* 54, 1901-1915.

Forbes, K., and R. Rigobon, 2002, No contagion, only interdependence: Measuring stock market co-movements, forthcoming *Journal of Finance.*

Fox, S., 1999, Assessing TAA manager performance, *Journal of Portfolio Management* 26, 40-49.

Gallant, A., P. Rossi, and G. Tauchen, 1992, Stock prices and volume, *Review of Financial Studies* 5, 199-242.

Garcia, G., 1989, The lender of last resort in the wake of the crash, *American Economic Review* 79, 151-155.

Green, C., 2001, Economic news and the impact of trading on bond prices, working paper, Emory University.

Greenspan, A., 1999, Risk, liquidity, and the economic outlook, *Business Economics* 34, 20-24.

Harris, L., and E. Gurel, 1986, Price and volume effects associated with changes in the S&P 500 list: New evidence for the existence of price pressures, *Journal of Finance* 41, 815-829.

Hasbrouck, J., 1991, Measuring the information content of stock trades, *Journal of Finance* 56, 179-207.

Hasbrouck, J., and D. Seppi, 2001, Common factors in prices, order flows and liquidity, *Journal of Financial Economics* 59, 383-411.

Hiemstra, C., and J. Jones, 1994, Testing for linear and nonlinear Granger causality in the stock price-volume relation, *Journal of Finance* 49, 1639-1664.

Ho, T., and H. Stoll, 1983, The dynamics of dealer markets under competition, *Journal of Finance* 38, 1053-1074.

Huberman, G., and D. Halka, 2001, Systematic liquidity, working paper, Columbia University.

Jacoby, G., D. Fowler, and A. Gottesman, 2000, The capital asset pricing model and the liquidity effect: A theoretical approach, *Journal of Financial Markets* 3, 69-81.

Jones, C., 2001, A century of stock market liquidity and trading costs, Working paper, Columbia University.

Jones, C., G. Kaul, and M. Lipson, 1994, Transactions, volume, and volatility, *Review of Financial Studies* 7, 631-651.

Jones, C., O. Lamont and R. Lumsdaine, 1998, Macroeconomic news and bond market volatility, *The Journal of Financial Economics* 47, 315-337.

Judge, G., W. Griffiths, R. Hill, H. Lütkepohl, and T. Lee, 1985, *The Theory and Practice of Econometrics*, (New York: Wiley).

Karpoff, J., 1987, The relation between price changes and trading volume: A survey, *Journal of Financial and Quantitative Analysis* 22, 109-125.

Kuttner, K., 2001, Monetary policy surprises and interest rates: Evidence from the Fed funds futures market, *Journal of Monetary Economics* 47, 523-544.

Kyle, A., 1985, Continuous auctions and insider trading, *Econometrica* 53, 1315-1335.

Lee, C., and B. Radhakrishna, 2000, Inferring investor behavior: Evidence from TORQ data, *Journal of Financial Markets* 3, 83-111.

Lee, C., and M. Ready, 1991, Inferring trade direction from intraday data, *Journal of Finance* 46, 733-747.

Lo A., and J. Wang, 2000, Trading volume: definitions, data analysis, and implications of portfolio theory, *Review of Financial Studies* 13, 257-300.

Pastor, L., and R. Stambaugh, 2001, Liquidity risk and expected stock returns, Working paper, University of Chicago and the Wharton School, the University of Pennsylvania.

Melton, W., 1985, *Inside the Fed*, Dow-Jones Irwin (Homewood, IL).

Odders-White, E., 2000, On the occurrence and consequences of inaccurate trade classification, *Journal of Financial Markets* 3, 205-332.

O'Hara, M., and G. Oldfield, 1986, The microeconomics of market making, *Journal of Financial and Quantitative Analysis* 21, 361-376.

Rigobon, R., and B. Sacks, 2001, Measuring the reaction of monetary policy to the stock market, NBER Working Paper Series 6252.

Schultz, P., 2001, Corporate bonds: A peek behind the veil, *Journal of Finance* 56, 677-698.

Smirlok, M., and J. Yawitz, 1985, Asset returns, discount rate changes, and market efficiency, *Journal of Finance* 40, 1141-1158.

Spiegel, M., and A. Subrahmanyam, 1995, On intraday risk premia, *Journal of Finance* 50, 319-339.

Stoll, H., 1978, The pricing of security dealer services: An empirical study of NASDAQ stocks, *Journal of Finance* 33, 1153-1172.

Stambaugh, R., 1999, Predictive regressions, *Journal of Financial Economics* 54, 375-421.

Stoll, H., 2000, Presidential address: Friction, *Journal of Finance* 55, 1479-1514.

Strongin, S. and V. Tarhan, 1990, Money supply announcements and the Market's perception of Federal Reserve Policy, *Journal of Money, Credit and Banking* 22, 135-153.

Xia, Y., 2001, Learning about predictability: The effects of parameter uncertainty on dynamic asset allocation, *Journal of Finance* 56, 205-246.

Table 1: Levels of stock and bond market liquidity

Bond liquidity estimates are based on the daily mean of the best bid and ask offer quotes by dealers on the 10-year Treasury note, as reported in the GovPX data set. The stock liquidity series are constructed by first averaging all transactions for each individual stock on a given trading day and then cross-sectionally averaging all individual stock daily means that satisfy the data filters described in the text. The sample period spans the period June 17, 1991 to December 31, 1998. QSPR stands for quoted spread, ESPR for effective spread, OIB for the order imbalance, DEPTH for depth, and CLIQ for composite liquidity (defined as QSPR divided by DEPTH). OIB is measured as the dollar value of buys minus the dollar value of sales, divided by the total dollar volume. DEPTH is in 1,000 share units for stocks and $1 million face value for bonds. The suffixes B and S refer to bond and stock variables, respectively, and ABS is notation for absolute value.

Panel A: Bid-ask spread and order imbalance 1991-1998 **(Number of observations: 1865 for bonds and 1862 for stocks)**

	Mean	Standard Deviation	Median	Coefficient of variation (%)
QSPRB	0.0318	0.0063	0.0307	19.7053
ESPRB	0.0302	0.0077	0.0301	25.3642
ABS OIBB (%)	0.1272	0.1068	0.1019	83.9759
QSPRS	0.1984	0.0237	0.1998	11.9576
ESPRS	0.1309	0.0122	0.1323	9.3466
ABS OIBS (%)	0.0455	0.0371	0.0377	81.5684

Panel B: Depth and composite liquidity 1995-1998 **(Number of observations: 982 for bonds, 986 for stocks)**

	Mean	Standard Deviation	Median	Coefficient of variation
DEPTHB ($ millions)	6.7503	1.8898	6.4091	27.9954
CLIQB	0.0052	0.0024	0.0048	45.37
DEPTHS (‘000 shares)	6.2521	1.3690	6.6698	21.8970
CLIQS	0.0331	0.0065	0.0323	19.8029

Table 2: Correlations in stock and bond market liquidity. The table presents the correlation matrix for the time series of market-wide liquidity and trading activity. Bond liquidity estimates are based on the daily mean of the best bid and ask offer quotes by dealers on the 10-year Treasury note, as reported in the GovPX data set. The stock liquidity series are constructed by first averaging all transactions for each individual stock on a given trading day and then cross-sectionally averaging all individual stock daily means that satisfy the data filters described in the text. The whole sample period spans the period June 17, 1991 to June 25, 1997 for stocks, June 17, 1991 to December 31, 1998 for bond spreads and January 1 1995 to December 31, 1998 for bond depth and CLIQ. QSPR stands for quoted spread, ESPR for effective spread, OIB+ is the order imbalance if it was positive and zero otherwise, and OIB- is defined analogously, DEPTH stands for depth, and CLIQ for composite liquidity (defined as QSPR divided by DEPTH). OIB is measured as the dollar value of buys minus the dollar value of sales, divided by the total dollar volume. DEPTH is in 1,000 share units for stocks and $1 million face value for bonds. The suffixes or subscripts B and S refer to bond and stock variables, respectively.

Spread and order imbalance **(Number of observations: 1885 for bonds and 1506 stocks).** Depth and composite liquidity **(Number of observations: 999 for bonds and 1506 for stocks)**

	QSPRB	ESPRB	OIB+B	OIB-B	DEPTHB	CLIQB	QSPRS	ESPRS	OIB+S	OIB-S	DEPTHS	CLIQS
QSPRB	1.000											
ESPRB	0.510 (0.0001)	1.000										
OIB+B	-0.101 (0.0001)	-0.133 (0.0001)	1.000									
OIB-B	-0.053 (0.0210)	0.109 (0.0001)	0.236 (0.0001)	1.000								
DEPTHB	-0.406 (0.0001)	-0.500 (0.0001)	0.007 (0.8190)	-0.050 (0.1132)	1.000							
CLIQB	0.826 (0.0001)	0.539 (0.0001)	-0.026 (0.4090)	-0.049 (0.1253)	-0.729 (0.0001)	1.000						
QSPRS	0.205 (0.0001)	0.005 (0.8341)	-0.230 (0.0001)	0.194 (0.0001)	-0.357 (0.0001)	0.399 (0.0001)	1.000					
ESPRS	0.204 (0.0001)	0.038 (0.1407)	-0.159 (0.0001)	0.140 (0.0001)	-0.098 (0.0148)	0.202 (0.0001)	0.912 (0.0001)	1.000				
OIB+S	0.073 (0.0044)	0.048 (0.0604)	-0.010 (0.7084)	0.060 (0.0196)	-0.013 (0.7535)	0.053 (0.1882)	0.076 (0.0033)	0.080 (0.0018)	1.000			
OIB-S	0.008 (0.7653)	0.023 (0.372)	-0.012 (0.6370)	0.068 (0.0079)	0.081 (0.0435)	-0.066 (0.0991)	-0.074 (0.0042)	-0.105 (0.0001)	0.440 (0.0001)	1.000		
DEPTHS	-0.159 (0.0001)	0.023 (0.3778)	0.163 (0.0001)	-0.079 (0.0021)	0.101 (0.0116)	-0.188 (0.0001)	-0.680 (0.0001)	-0.692 (0.0001)	-0.066 (0.0106)	0.129 (0.0001)	1.000	
CLIQS	0.201 (0.0001)	-0.013 (0.6152)	-0.200 (0.0001)	0.131 (0.0001)	-0.215 (0.0001)	0.307 (0.0001)	0.882 (0.0001)	0.859 (0.0001)	0.076 (0.0033)	-0.118 (0.0001)	-0.934 (0.0001)	1.000

Table 3: Time-series predictive regressions for stock and bond liquidity Bond liquidity estimates are based on the daily mean of the best bid and ask offer quotes by dealers on the 10-year Treasury note, as reported in the GovPX data set. The stock liquidity series are constructed by first averaging all transactions for each individual stock on a given trading day and then cross-sectionally averaging all individual stock daily means that satisfy the data filters described in the text. The whole sample period spans the period June 17, 1991 to June 25, 1997 for stocks, June 17, 1991 to December 31, 1998 for bond spreads and January 1 1995 to December 31, 1998 for bond depth and composite liquidity. OWN refers to the bond (stock) market when the dependent variable is bond (stock) liquidity. OTHER refers to the bond (stock) market when the dependent variable is stock (bond) liquidity. QSPR stands for quoted spread, ESPR for effective spread, OIB for the order imbalance, DEPTH for depth, and CLIQ for composite liquidity (defined as QSPR divided by DEPTH). OIB+ equals the order imbalance if it was positive, and zero otherwise, and OIB- is defined analogously. The suffixes B and S refer to bond and stock variables, respectively. OIB is measured as the dollar value of buys minus the dollar value of sales, divided by the total dollar volume. DEPTH is in 1,000 share units for stocks and $1 million face value for bonds. Holiday: a dummy variable that equals one if a trading day satisfies the following conditions, (1) if Independence day, Veterans' Day, Christmas or New Year's Day falls on a Friday, then the preceding Thursday, (2) if any holiday falls on a weekend or on a Monday then the following Tuesday, (3) if any holiday falls on a weekday then the preceding and the following days, and zero otherwise. Monday-Thursday: equals one if the trading day is Monday, Tuesday, Wednesday, or Thursday, and zero otherwise. GDP: dummy variable that equals one on the day of the GDP announcement and zero otherwise. GDP12: dummy variable that equals one on two days prior to the GDP announcement and zero otherwise. Emp, Emp12, CPI, CPI12: dummy variables for employment and CPI announcements respectively. The definition of the dummy variables is the same as for GDP announcements. Lags of QSPRS are included in the quoted spread regressions and lags of ESPRS are used in the effective spread regressions. Estimation is done using the Generalized Method of Moments (GMM) procedure with the Newey-West Correction. Estimates marked **(*) are significant at the five (ten) percent level or lower.

Table 3 (continued)

Panel A: Quoted Spreads

	QSPRB Coefficient	t-statistic	QSPRS Coefficient	t-statistic
Intercept	0.0070**	7.46	0.0031**	2.22
Holiday	0.0005	1.07	0.0014**	2.13
Monday	-0.0037**	-12.20	-0.0008**	-2.57
Tuesday	-0.0030**	-10.30	-0.0019**	-6.63
Wednesday	-0.0022**	-7.14	-0.0009**	-3.14
Thursday	-0.0014**	-4.79	-0.0008**	-2.77
GDP	0.0010	1.37	-0.0001	-0.10
GDP12	-0.0001	-0.30	-0.0002	-0.46
CPI	0.0011**	2.96	0.0004	1.01
CPI12	0.0001	0.40	-0.0004	-1.61
EMP	0.0034**	7.24	0.0010*	1.73
EMP12	-0.0011**	-3.86	-0.0002	-0.82
QSPR OWN: lag 1	0.3586**	13.10	0.5087**	17.06
lag 2	0.1801**	7.17	0.1124**	3.93
lag 3	0.0928**	3.72	0.1232**	3.94
lag 4	0.0979**	3.84	0.0666**	2.27
lag 5	0.1236**	5.19	0.1730**	6.89
lag of OIB+ OWN	-0.0015	-1.60	0.0050	1.58
lag of OIB- OWN	-0.0004	-0.32	-0.0081**	-2.88
Lag of QSPR OTHER	-0.0028	-0.68	0.0224	1.48
lag of OIB+ OTHER	0.0019	0.60	-0.0005	-0.42
lag of OIB- OTHER	-0.0066**	-2.35	0.0015	1.00
Adjusted R^2	0.5506		0.9503	

Table 3 (continued)

Panel B: Effective Spreads

	ESPRB Coefficient	t-statistic	ESPRS Coefficient	t-statistic
Intercept	0.0019*	1.72	0.0054**	3.75
Holiday	-0.0002	-0.31	0.0011**	2.31
Monday	-0.0030**	-8.25	-0.0004*	-1.65
Tuesday	-0.0020**	-5.90	-0.0012**	-5.55
Wednesday	-0.0010**	-2.67	-0.0009**	-4.05
Thursday	-0.0003	-0.83	-0.0009**	-3.97
GDP	0.0011**	2.02	0.0004	0.80
GDP12	0.0003	0.90	-0.0001	-0.33
CPI	0.0010**	2.45	0.0006**	2.02
CPI12	0.0002	0.60	0.0002	0.77
EMP	0.0035**	6.21	0.0007*	1.73
EMP12	-0.0014**	-4.83	0.0000	-0.06
ESPR OWN: lag 1	0.3817**	12.08	0.4186**	14.50
lag 2	0.1725**	5.36	0.2060**	7.39
lag 3	0.0801**	2.72	0.0727**	2.48
lag 4	0.1347**	3.90	0.1228**	4.22
lag 5	0.1413**	4.51	0.1415**	5.35
lag of OIB+ OWN	0.0015	1.31	0.0006	0.26
lag of OIB- OWN	0.0014	1.19	-0.0048**	-1.99
Lag of ESPR OTHER	0.0139	1.44	0.0065	0.64
lag of OIB+ OTHER	-0.0003	-0.10	-0.0001	-0.17
lag of OIB- OTHER	-0.0062**	-2.02	0.0009	0.98
Adjusted R^2	0.6985		0.8624	

Table 3 (continued)

Panel C: Depth

	DEPTHB Coefficient	t-statistic	DEPTHS Coefficient	t-statistic
Intercept	2.2031**	5.90	0.9012**	4.90
Holiday	-0.2907	-1.23	-0.2502**	-2.38
Monday	0.2535	1.41	-0.1474**	-3.11
Tuesday	0.8082**	5.25	0.1915**	4.04
Wednesday	0.9270**	5.50	0.1828**	3.83
Thursday	0.4944**	3.01	0.0989**	2.42
GDP	-0.5007	-1.61	-0.0431	-0.44
GDP12	0.1977	0.65	-0.0188	-0.22
CPI	-0.1798	-0.84	0.0834*	1.77
CPI12	0.1993	1.18	0.0396	0.99
EMP	-0.6357**	-3.72	-0.0392	-0.48
EMP12	0.2691	1.55	0.0893**	2.13
DEPTH OWN: lag 1	0.2615**	7.53	0.4648**	10.92
lag 2	0.1930**	5.20	0.1276**	3.10
lag 3	0.0900**	2.56	0.1171**	2.39
lag 4	0.0759**	2.29	0.0228	0.51
lag 5	0.0622*	1.94	0.1504**	3.90
Lag of OIB+ OWN	-0.8410	-1.39	-0.2723	-0.53
Lag of OIB- OWN	0.5292	0.87	2.2060**	5.39
Lag of DEPTH OTHER	-0.0822**	-2.86	-0.0077	-0.87
Lag of OIB+ OTHER	1.8606	1.00	-0.1970	-1.28
Lag of OIB- OTHER	1.7675	1.03	0.1291	0.79
Adjusted R^2	0.3405		0.6902	

Table 3 (continued)

Panel D: Composite liquidity

	CLIQB Coefficient	t-statistic	CLIQS Coefficient	t-statistic
Intercept	0.0019**	5.55	0.0035**	4.72
Holiday	0.0005	1.49	0.0009*	1.73
Monday	-0.0008**	-3.75	0.0005**	2.16
Tuesday	-0.0011**	-5.72	-0.0008**	-3.54
Wednesday	-0.0009**	-4.81	-0.0006**	-2.84
Thursday	-0.0006**	-3.11	-0.0004*	-1.88
GDP	0.0004	1.18	0.0001	0.17
GDP12	-0.0001	-0.53	0.0002	0.52
CPI	0.0003	1.32	-0.0004**	-1.96
CPI12	-0.0001	-0.57	-0.0002	-1.16
EMP	0.0013**	5.27	0.0006	1.26
EMP12	-0.0003*	-1.89	-0.0003*	-1.87
CLIQ OWN: lag 1	0.3683**	9.08	0.4576**	9.95
lag 2	0.1319**	3.14	0.0942**	2.29
lag 3	0.1055**	2.72	0.1271**	2.60
lag 4	0.0838**	2.19	0.0405	0.95
lag 5	0.0770*	1.83	0.1389**	3.69
Lag of OIB+ OWN	0.0003	0.58	-0.0004	-0.16
Lag of OIB- OWN	-0.0008	-1.20	-0.0095**	-4.16
Lag of CLIQ OTHER	-0.0058	-0.90	0.0600	0.97
Lag of OIB+ OTHER	-0.0026	-1.44	0.0008	1.05
Lag of OIB- OTHER	-0.0035*	-1.78	-0.0001	-0.13
Adjusted R^2	0.4230		0.6415	

Table 4: Contemporaneous Correlation between Bond and Stock Liquidity Innovations in Crisis and Non-crisis periods. The table presents the correlation matrix for the innovations in the time series of market-wide liquidity. The innovations are the residuals from the regressions in Table 3. Bond liquidity estimates are based on the daily mean of the best bid and ask offer quotes by dealers on the 10-year Treasury note, as reported in the GovPX data set. The stock liquidity series are constructed by first averaging all transactions for each individual stock on a given trading day and then cross-sectionally averaging all individual stock daily means that satisfy the data filters described in the text. QSPR stands for quoted spread, ESPR for effective spread, OIB for the order imbalance, DEPTH for depth, and CLIQ for composite liquidity (defined as QSPR divided by DEPTH). The suffixes B and S refer to bond and stock variables, respectively. DEPTH is in 1,000 share units for stocks and $1 million face value for bonds. The whole sample period spans the period June 17, 1991 to June 25, 1997 for stocks, June 17, 1991 to December 31, 1998 for bond spreads and January 1 1995 to December 31, 1998 for bond depth and CLIQ. The non-crisis period is from June 25 1997 to September 30 1997 and January 1 1998 to July 5 1998. The two crisis periods are the Asian crisis (October 1 to December 31 1997), and the Russian default crisis (July 6 to December 31, 1998). The crisis correlations are bias-adjusted using the Forbes and Rigobon (1999) formula.

Panel A: Whole sample (Number of observations: QSPRB and ESPRB 1856; QSPRS and ESPRS 1857; DEPTHS and CLIQS 983; DEPTHB 982; CLIQB 984).

	Bond quoted bid-ask spread	Bond effective bid-ask spread	Bond depth	Bond composite liquidity
Stock quoted bid-ask spread	0.130 (0.0001)	0.092 (0.0004)	-0.063 (0.1255)	0.178 (0.0001)
Stock effective bid-ask spread	0.134 (0.0001)	0.077 (0.0031)	-0.042 (0.3029)	0.163 (0.0001)
Stock depth	-0.199 (0.0001)	-0.143 (0.0004)	0.115 (0.0046)	-0.153 (0.0002)
Stock composite liquidity	0.218 (0.0001)	0.168 (0.0001)	-0.110 (0.0001)	0.154 (0.0001)

Panel B: Non-crisis period

	QSPRB	ESPRB	DEPTHB	CLIQB
QSPRS	0.184 (0.0127)	0.148 (0.0474)	-0.081 (0.2762)	0.174 (0.0190)
ESPRS	0.182 (0.0133)	0.172 (0.0206)	-0.051 (0.4944)	0.146 (0.0487)
DEPTHS	-0.196 (0.0068)	-0.242 (0.0008)	0.201 (0.0053)	-0.271 (0.0002)
CLIQS	0.259 (0.0003)	0.278 (0.0001)	-0.194 (0.0073)	0.279 (0.0001)

Panel C: Crisis period (bias-adjusted correlation; p-values correspond to Fisher's z statistic for a test of whether crisis correlation is higher than non-crisis correlation.)

	QSPRB	ESPRB	DEPTHB	CLIQB
QSPRS	0.347* (0.0976)	0.259 (0.2768)	-0.113 (0.7617)	0.250 (0.4478)
ESPRS	0.353* (0.0838)	0.273 (0.3160)	-0.118 ((0.5206)	0.238 (0.3674)
DEPTHS	-0.100 (0.3515)	-0.137 (0.3083)	0.002* (0.0548)	-0.019** (0.0145)
CLIQS	0.270 (0.9146)	0.249 (0.7617)	-0.075 (0.2516)	0.214 (0.5118)

Table 5: Mean-squared errors for out-of-sample predictions of aggregate bond and stock market liquidity. The table presents the mean-squared errors for rolling 250-day forecasts of the time series of market-wide liquidity. Each forecast is based on the most recent 250-day trading history. The naïve model predicts liquidity to be the preceding day's liquidity. MSE is multiplied by 100,000 except for bond and stock depth which are multiplied by 100. We also present the average of the adjusted R-squares from the forecasting regressions. Bond liquidity estimates are based on the daily mean of the best bid and ask offer quotes by dealers on the 10-year Treasury note, as reported in the GovPX data set. The stock liquidity series are constructed by first averaging all transactions for each individual stock on a given trading day and then cross-sectionally averaging all individual stock daily means that satisfy the data filters described in the text. QSPR stands for quoted spread, ESPR for effective spread, OIB for the order imbalance, DEPTH for depth, and CLIQ for composite liquidity (defined as QSPR divided by DEPTH). The suffixes B and S refer to bond and stock variables, respectively. DEPTH is in 1,000 share units for stocks and $1 million face value for bonds. The whole sample period spans the period June 17, 1991 to June 25, 1997 for stocks, June 17, 1991 to December 31, 1998 for bond spreads and January 1 1995 to December 31, 1998 for bond depth and CLIQ. The non-crisis period is from June 25 1997 to September 30 1997 and January 1 1998 to July 5 1998 (number of observations: 195). The two crisis periods are the Asian crisis (October 1 to December 31 1997), and the Russian default crisis (July 6 to December 31, 1998)---a total of 185 observations.

Panel A: Whole sample

	Bond and stock market variables	Naïve Model
Bond quoted spread	1.43	2.28
Stock quoted spread	1.70	1.73
Bond effective spread	2.03	2.82
Stock effective spread	0.99	1.00
Bond depth	268.89	377.91
Stock dollar depth	7.96	8.92
Bond composite liquidity	0.25	0.33
Stock composite liquidity	0.49	0.51

Panel B: Crisis and non-crisis periods

	Non-crisis period: January 1 1997 to September 30 1997 and January 1 1998 to July 5 1998	Crisis period: (Oct. 1-Dec 31, 1997, and July 6 to Dec. 31, 1998**)**
Bond quoted spread	0.71	2.67
Stock quoted spread	1.95	4.40
Bond effective spread	1.60	3.24
Stock effective spread	1.07	2.98
Bond depth	270.19	337.61
Stock dollar depth	5.17	2.93
Bond composite liquidity	0.13	0.44
Stock composite liquidity	0.56	0.76

Table 6: Net borrowed reserves and mutual fund flows during crisis and non-crisis periods The table presents monthly equity mutual fund net flows (EFLOW) and monthly government bond mutual fund net flows (BFLOW) during crisis and non-crisis periods. Monthly mutual fund data are from the Investment Company Institute. NETBOR is equal to net borrowed reserves divided by required reserves, where net borrowed reserves equal total borrowings minus extended credit minus excess reserves. Reserves data is from the Federal Reserve. The sample period spans the period June 25, 1997 to December 31, 1998. The two crisis periods are the Asian crisis (October 1 to December 31 1997), and the Russian default crisis (July 6 to December 31, 1998). A **(*) indicates that the difference in the mean between the normal and crisis periods is significant at the 5% (10%) level or below.

Panel A: Non-crisis (normal) period (Number of observations: 19 for NETBOR; 10 months for EFLOW and BFLOW)

	NETBOR	EFLOW	BFLOW
Mean	-0.0253	21,367.43	-154.78
Std	0.0081	4,881.13	689.06
Median	-0.0262	22,941.60	-228.60

Panel B: Crisis period (Oct. 1-Dec 31, 1997, and July 6 to Dec. 31, 1998)
(Number of observations: 21 for NETBOR; 9 months for EFLOW and BFLOW)

	NETBOR	EFLOW	BFLOW
Mean	-0.0309**	9,552**	870.66**
Std	0.0054	10,470	1,048
Median	-0.0312	12,571	694

Table 7: Biweekly regressions: The impact of net borrowed reserves on financial market liquidity. Bond liquidity estimates are based on the daily mean of the best bid and ask offer quotes by dealers on the 10-year Treasury note, as reported in the GovPX data set. The stock liquidity series are constructed by first averaging all transactions for each individual stock on a given trading day and then cross-sectionally averaging all individual stock daily means that satisfy the data filters described in the text. The sample period spans the period June 17, 1991 to December 31, 1998. QSPR stands for quoted spread, ESPR for effective spread, OIB for the order imbalance, DEPTH for depth, and CLIQ for composite liquidity (defined as QSPR divided by DEPTH). OIB is the order imbalance and measured as the dollar value of buys minus the dollar value of sales, divided by the dollar value of total volume. OIB+ equals the order imbalance if positive, and zero otherwise, and OIB- is defined analogously. The suffixes B and S refer to bond and stock variables, respectively. DEPTH is in 1,000 share units for stocks and $1 million face value for bonds. The two crisis periods are the Asian crisis (October 1 to December 31 1997), and the Russian default crisis (July 6 to December 31, 1998). The variable "crisis" takes on the value 1 if the date falls within each of these crisis periods, and is zero otherwise. The variable NETBOR is the ratio of net borrowed reserves to required reserves, where net borrowed reserves equal total borrowings minus extended credit minus excess reserves. The data is from the Federal Reserve. Since these variables are available only on a bi-weekly frequency, bi-weekly averages are used in these regressions. Estimation is done using the Generalized Method of Moments (GMM) procedure with the Newey-West Correction.

Panel A: Biweekly regressions: Quoted Spreads (Number of observations is 195)

	QSPRB Coefficient	t-statistic	QSPRS Coefficient	t-statistic
Intercept	0.0061	2.44	-0.0028	-0.48
Lag of tick size change dummy	---	---	0.0015	0.75
Lag of QSPR-OWN	0.7002**	11.23	1.0033**	41.81
Lag of OIB+S	-0.0127	-0.63	0.0071	0.22
Lag of OIB-S	0.0061	0.54	-0.0215	-1.01
Lag of QSPR-OTHER	0.0173*	1.69	0.0554	0.68
NETBOR	-0.0017	-0.05	-0.0219	-0.46
Lag of NETBOR	-0.0096	-0.30	0.0718	1.55
Lag of Russian or Asian crisis	0.0828**	2.04	0.1961**	7.54
Lag of QSPR-OWN*crisis	0.1822	0.95	-1.1880**	-8.58
Lag of OIB+S*crisis	0.0819	0.57	0.0186	0.27
Lag of OIB-S*crisis	-0.1920	-1.36	-0.0609	-0.98
Lag of QSPR-OTHER*crisis	-0.6255**	-2.40	0.0391	0.34
NETBOR*crisis	-0.0572	-0.30	0.3658**	2.20
Lag of NETBOR*crisis	-0.2218	-0.72	-0.1036	-0.51
Adjusted R^2	0.6035		0.9794	

Table 7 (continued)

Panel B: Biweekly regressions: Effective Spreads (Number of observations is 195)

	ESPRB Coefficient	t-statistic	ESPRS Coefficient	t-statistic
Intercept	0.0023	0.82	0.0026	0.51
Lag of tick size change dummy	----	---	0.0000	0.02
Lag of ESPR-OWN	0.8801**	26.84	0.9759**	25.88
Lag of OIB+S	-0.0245	-1.24	0.0135	0.62
Lag of OIB-S	0.0217*	1.81	-0.0155	-1.04
Lag of ESPR-OTHER	0.0257	1.17	0.0115	0.45
NETBOR	0.0346	0.94	-0.0140	-0.47
Lag of NETBOR	0.0231	0.62	0.0507	1.56
Lag of Russian or Asian crisis	0.1187**	3.74	0.1232**	6.39
Lag of ESPR-OWN*crisis	-0.0162	-0.13	-1.0177**	-5.96
Lag of OIB+S*crisis	0.2483**	2.04	-0.0125	-0.19
Lag of OIB-S*crisis	-0.3494**	-3.07	0.0072	0.11
Lag of ESPR-OTHER*crisis	-1.2189**	-4.36	0.0591	0.66
NETBOR*crisis	0.1818	0.84	0.3672**	2.89
Lag of NETBOR*crisis	-0.3688	-1.55	-0.0074	-0.05
Adjusted R^2	0.8102		0.9622	

Panel C: Biweekly regressions: Depth (Number of observations is 195 for stock depth; and 104 for bond depth)

	DEPTHB Coefficient	t-statistic	DEPTHS Coefficient	t-statistic
Intercept	3.8593**	2.19	1.2493	0.95
Lag of tick size change dummy	---	---	-0.4373	-0.67
Lag of DEPTH-OWN	0.4293**	4.26	0.8345**	5.02
Lag of OIB+S	5.7728	0.59	7.6328	1.12
Lag of OIB-S	-2.5527	-0.22	-2.5435	-0.34
Lag of DEPTH-OTHER	-0.1357	-1.09	-0.0102	-0.24
NETBOR	5.3135	0.17	16.5699**	2.56
Lag of NETBOR	-41.5265*	-1.97	-2.0930	-0.32
Russian or Asian crisis	1.9069	0.42	-0.6052	-0.53
Lag of DEPTH-OWN*crisis	0.3706**	2.06	-0.0328	-0.14
Lag of OIB+S*crisis	-33.5048	-1.55	-5.1210	-0.69
Lag of OIB-S*crisis	17.1797	0.73	2.8276	0.34
Lag of DEPTH-OTHER*crisis	-0.6810	-1.03	-0.0028	-0.06
NETBOR*crisis	-70.5940	-1.49	-29.4080**	-3.45
Lag of NETBOR*crisis	128.8513**	3.70	-3.7943	-0.45
Adjusted R^2	0.4647		0.9550	

Table 7(continued)

Panel D: Biweekly regressions: Composite liquidity (Number of observations is 194 for stock depth; and 105 for bond depth)

	CLIQB Coefficient	t-statistic	CLIQS Coefficient	t-statistic
Intercept	0.0035**	5.06	0.0082**	3.77
Lag of tick size change dummy	---	---	0.0047**	2.98
Lag of CLIQ-OWN	0.5553**	5.41	0.6463**	7.04
lag of OIB+S	-0.0060	-0.62	-0.0268	-1.25
lag of OIB-S	0.0021	0.20	-0.0024	-0.11
Lag of CLIQ-OTHER	-0.0198	-0.91	0.0536	0.30
NETBOR	-0.0047	-0.17	-0.1004**	-2.77
Lag of NETBOR	0.0329	1.39	0.0007	0.02
Russian or Asian crisis	-0.0044	-0.67	0.0131	1.15
Lag of CLIQ-OWN*crisis	0.0673	0.37	-0.0138	-0.08
lag of OIB+S*crisis	0.0835	1.65	-0.0119	-0.17
lag of OIB-S*crisis	-0.0573	-0.99	0.0194	0.24
Lag of CLIQ-OTHER*crisis	-0.0564	-0.46	-0.1124	-0.41
NETBOR*crisis	0.1110	1.49	0.3374**	2.58
Lag of NETBOR*crisis	-0.2708**	-2.94	0.0359	0.30
Adjusted R^2	0.4958		0.9482	

Table 8: Monthly regressions - mutual fund flows and financial market liquidity
Bond liquidity estimates are based on the daily mean of the best bid and ask offer quotes by dealers on the 10-year Treasury note, as reported in the GovPX data set. The stock liquidity series are constructed by first averaging all transactions for each individual stock on a given trading day and then cross-sectionally averaging all individual stock daily means that satisfy the data filters described in the text. The sample period spans the period June 17, 1991 to December 31, 1998, for the quoted spread regressions and January 1, 1995 to December 31, 1998 for regressions involving market depth. Monthly averages of liquidity measures are used for this regression. QSPR stands for quoted spread, ESPR for effective spread, and CLIQ for a composite measure of liquidity that is the ratio of quoted spread to depth. OIB is the order imbalance and measured as the dollar value of buys minus the dollar value of sales, divided by the dollar value of total volume. OIB+ equals the order imbalance if positive and is zero otherwise, and OIB- is defined analogously. The suffixes B and S refer to bond and stock variables, respectively. DEPTH is in 1,000 share units for stocks and $1 million face value for bonds. The two crisis periods are the Asian crisis (October 1 to December 31 1997), and the Russian default crisis (July 6 to December 31, 1998). The variable "crisis" takes on the value 1 if the date falls within each of these crisis periods, and is zero otherwise. The variable EFLOW (BFLOW) measures monthly equity (government bond) mutual fund net flows as reported by the Investment Company Institute. Since these variables are available only on a monthly frequency, monthly averages are used in these regressions. Estimation is done using the Generalized Method of Moments (GMM) procedure with the Newey-West Correction.

Panel A: Monthly regressions: Quoted Spreads

	QSPRB Coefficient	t-statistic	QSPRS Coefficient	t-statistic
Intercept	0.0086**	2.27	-0.0141	-0.72
Lag of tick size change dummy	---	---	0.0042	0.90
Lag of QSPR-OWN	0.5912**	7.89	1.0592**	12.42
Lag of OIB+S	-0.0208	-0.51	-0.1671	-1.63
Lag of OIB-S	0.0147	0.48	0.0017	0.04
Lag of QSPR-OTHER	0.0228	1.25	0.1200	0.67
Lag of EFLOW	0.0000	0.60	0.0001	0.93
Lag of BFLOW	0.0003	1.32	0.0001	0.26
Lag of Russian or Asian crisis	0.3695**	11.62	0.2208**	4.11
Lag of QSPR-OWN*crisis	1.3077**	7.86	-1.3621**	-3.87
Lag of OIB+S*crisis	0.1894**	2.51	0.2045	1.56
Lag of OIB-S*crisis	-0.2189**	-3.13	0.0447	0.59
Lag of QSPR-OTHER*crisis	-2.6637**	-10.80	-0.1729	-0.93
Lag of EFLOW*crisis	0.0002**	2.02	-0.0002	-1.50
Lag of BFLOW*crisis	0.0071**	9.46	0.0009	1.23
Adjusted R^2	0.5477		0.9608	

Table 8 (continued)

Panel B: Monthly regressions: Effective Spreads

	ESPRB Coefficient	t-statistic	ESPRS Coefficient	t-statistic
Intercept	-0.0081	-0.81	-0.0028	-0.16
Lag of tick size change dummy	----	---	0.0015	0.36
Lag of ESPR-OWN	0.8037**	12.56	1.0177**	8.40
Lag of OIB+S	-0.0261	-0.51	-0.0706	-1.35
Lag of OIB-S	0.0049	0.15	0.0024	0.09
Lag of ESPR-OTHER	0.1047	1.41	0.0499	0.74
Lag of EFLOW	0.0001	0.69	0.0000	-0.05
Lag of BFLOW	0.0001	0.44	0.0000	0.17
Lag of Russian or Asian crisis	0.2053*	1.78	0.2309**	3.24
Lag of ESPR-OWN*crisis	0.0893	0.32	-2.1942**	-3.15
Lag of OIB+S*crisis	0.3333	1.05	0.1913	1.01
Lag of OIB-S*crisis	0.1668	0.95	-0.1013	-1.01
Lag of ESPR-OTHER*crisis	-1.9495*	-1.69	0.1532	1.22
Lag of EFLOW*crisis	0.0000	0.20	0.0000	0.37
Lag of BFLOW*crisis	0.0047*	1.95	0.0018**	2.05
Adjusted R^2	0.6877		0.9351	

Panel C: Monthly regressions: Dollar depth

	DEPTHB Coefficient	t-statistic	DEPTHS Coefficient	t-statistic
Intercept	4.4252**	2.21	3.4478	0.83
Lag of tick size change dummy	---	---	-1.1484	-0.56
Lag of DEPTH-OWN	0.5660**	3.19	0.5819	1.12
Lag of OIB+S	6.9399	0.35	6.7750	0.55
Lag of OIB-S	-14.0633	-0.99	0.7752	0.04
Lag of DEPTH-OTHER	-0.1975	-1.32	-0.0874	-0.72
Lag of EFLOW	-0.0175	-0.50	-0.0147	-0.64
Lag of BFLOW	0.3012	0.89	-0.1125	-0.75
Lag of Russian or Asian crisis	14.9474**	3.30	0.6212	0.28
Lag of DEPTH-OWN*crisis	0.1432	0.62	-0.0093	-0.02
Lag of OIB+S*crisis	-30.9652	-0.99	-19.7557	-1.51
Lag of OIB-S*crisis	-56.8616**	-2.78	-1.3668	-0.06
Lag of DEPTH-OTHER*crisis	-4.7819**	-3.63	-0.0451	-0.37
Lag of EFLOW*crisis	0.0788*	1.76	0.0149	0.64
Lag of BFLOW*crisis	-1.0606**	-2.45	0.0841	0.49
Adjusted R^2	0.6215		0.8861	

Table 8 (continued)

Panel D: Monthly regressions: Composite liquidity

	CLIQB Coefficient	t-statistic	CLIQS Coefficient	t-statistic
Intercept	0.0036**	2.51	0.0178**	3.61
Lag of tick size change dummy	---	---	0.0100**	2.51
Lag of CLIQ-OWN	0.6709**	5.34	0.2924	1.65
Lag of OIB+S	-0.0163	-0.86	-0.0115	-0.27
Lag of OIB-S	0.0206	1.53	-0.0369	-0.73
Lag of CLIQ-OTHER	-0.0491	-1.49	-0.0381	-0.08
Lag of EFLOW	0.0000	0.43	0.0001**	2.33
Lag of BFLOW	0.0000	-0.07	0.0004	0.61
Lag of Russian or Asian crisis	0.0133	1.58	-0.0017	-0.08
Lag of CLIQ-OWN*crisis	0.1993	0.63	0.2200	0.45
Lag of OIB+S*crisis	0.0228	0.49	0.1133	0.79
Lag of OIB-S*crisis	0.1180**	4.42	0.1526	0.74
Lag of CLIQ-OTHER*crisis	-0.2808	-1.24	-1.0041	-1.58
Lag of EFLOW*crisis	0.0000	-0.61	-0.0002	-1.08
Lag of BFLOW*crisis	0.0015*	1.76	0.0006	0.20
Adjusted R^2	0.5597		0.8982	

Figure 1: Shocks to Stock and Bond Quoted Bid-Ask Spreads

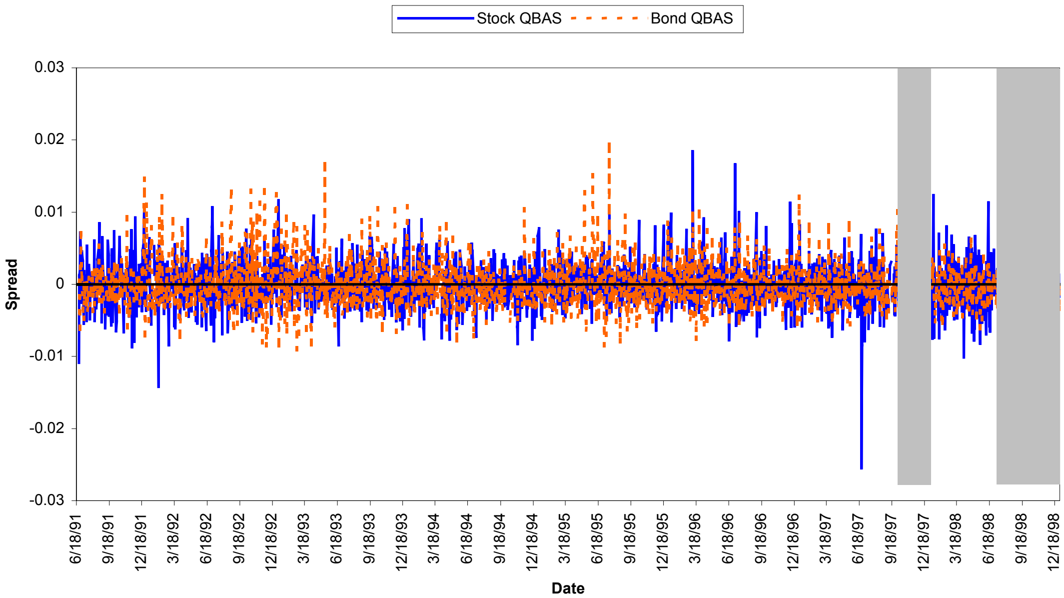

Figure 2: Shocks to Stock and Bond Effective Bid-Ask Spreads

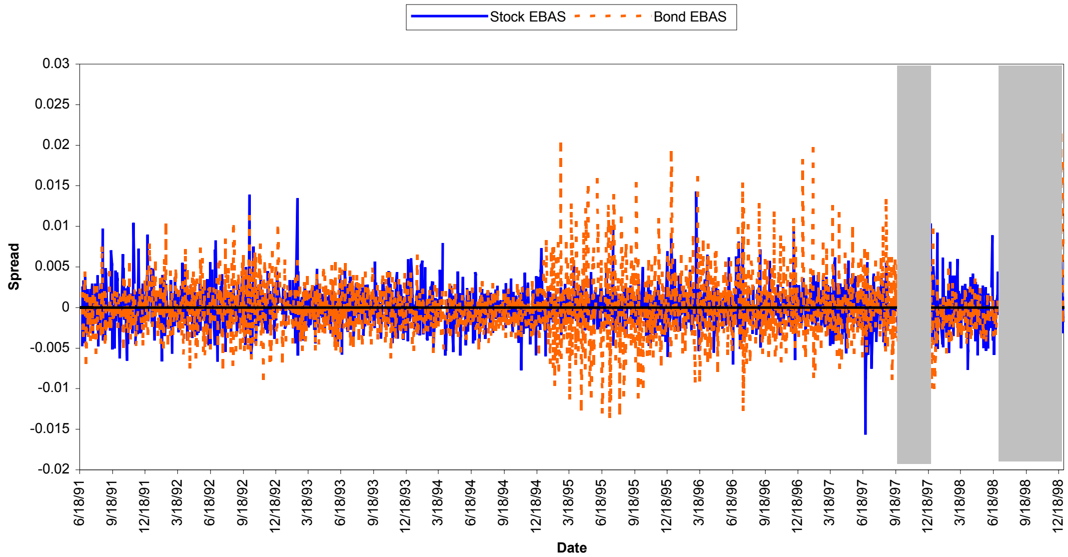

Figure 3: Shocks to Stock and Bond Composite Liquidity