

# **Stock Market Liquidity, Financial Crisis and Quantitative Easing**

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# **Stock Market Liquidity, Financial Crisis and Quantitative Easing**

## **Abstract**

We study linkages among Federal Reserve Bank (FED) monetary policy, commercial bank lending and stock market liquidity. Using 2003-2013 data for sequential monthly changes in FED assets, bank credit and stock quotes, we find that liquidity for each listed US stock varies with regard to FED asset changes, caused by monetary policy actions, but more highly related to changes in bank credits. The relationships between FED asset changes and stock liquidity was positive and significant during the 2007-09 recession and QE-1 time periods; however, decreases in liquidity were observed during QE-2, and no impact on market liquidity was found during QE-3. Also, during QE-2 and 3, there were no appreciable changes in bank lending. These observations support our hypothesis that market liquidity enhancements generally occur when FED stimulus coincides with increases in bank lending. We also find evidence that increases in the FED's Stress Indicator, reductions bank credits and increases in individual stock short sales negatively impact market liquidity.

**Key words:** Monetary Policy, Bank Credit, Stock Liquidity, Short Sale.

**JEL Code:** E52, E58, G12, G14

# **Stock Market Liquidity, Financial Crisis and Quantitative Easing**

## **1. Introduction**

Commercial bank lending, in synergy with broker/dealer and market maker operations facilitate stock market liquidity, increase market efficiency and benefit equity investors. However, questions persist regarding the U.S. Federal Reserve's (FED's) monetary policy effectiveness in impacting stock market liquidity.

Bernanke and Kuttner (2005), Rigobans and Sacks (2004), among others, study impacts of FED policy actions on stock markets with consistent results that the impact of unanticipated changes in the monetary policy on expected excess returns account for the largest part of stock price responses. Also, relationships between commercial bank liquidity and FED monetary policy are generally understood and have been studied extensively. However, the mechanism by which the FED's targeting of Federal Funds (FF) rates and open market operation impacts on the FED's balance sheet influence commercial bank lending that, in turn, influence stock market liquidity is less well understood.

During normal market conditions, commercial banks support stock market liquidity by providing short-term financing for investors, broker/dealers and market makers facilitating smooth trading & payments system operations. The FED's mechanism for affecting stock market liquidity, efficiency and market capital availability stems, in part, from its impact on commercial bank liquidity and marginal impacts on bank lending to stock market participants (Gertler and Kiyotaki; 2010).

Fundamentally, commercial bank liquidity results from adequate reserves, including those on deposit at the FED, and banks' ability to achieve asset and liability liquidity. Liquidity facilitates the banking industry's ability to lend and provide services to stock market participants,

and, in turn, their adequate market participation enhances stock market liquidity by providing efficient and successful order executions. However, during market crisis periods, the role of commercial banks, as major funding institutions, increases in importance (Brunnemeier and Pedersen; 2009, Hameed et al.; 2010). During crisis periods, when both market and banking liquidity may be deficient, the marginal impact of FED stimulus may be most substantial. However, during crisis periods, banking system illiquidity may result in their being criticized for exacerbating or at least not ameliorating market crises in performing their intended function as lenders of last resort.

At times, especially during recessions and during market downturns, equity markets may to become one-sided creating problems in finding opposite market traders. Under these conditions, liquidity of normally liquid stocks declines, exacerbating asset/collateral risk and aggravating market liquidity. Increased asset/collateral risk may lead to higher investor or broker/dealer bank borrowing costs (Brunnemeier; 2008, Brunnemeier and Pedersen; 2009). Also during crisis periods, borrowing rate increases may be intensified by lack of bank funding and liquidity (Borio and Zhu; 2012).

The FED's stated objective is market amelioration especially during market crisis periods when reduced asset liquidity and market dry-ups may occur. Market dry-ups occur either when market participants engage in panic selling (a demand effect) and financial intermediaries, including market makers, specialists, floor traders, limit order providers, other institutions such as hedge funds, mutual funds and commercial banks, fail to provide adequate liquidity (a supply effect) or a combination of both. Thus, we study the mechanism and effectiveness of FED actions with respect to market amelioration during crisis and non-crisis periods by comparing FED monetary policy impacts on market liquidity during the 2007-09 financial crisis and

Quantitative Easing periods (QE) 1, 2 and 3 sub-periods with non-crisis/non-quantitative easing periods.

Evaluating Diamond and Rajan's (2000; 2001) supposition that the FED's QE, policies, implemented through the banking system, may alleviate investors' and borrowers' liquidity problems, we evaluate the FED's monetary policy role, its linkages with commercial bank credits and resulting impacts on market liquidity during market sub-period anomalies.<sup>1</sup>

We augment the debate regarding the extent to which the FED should intervene or the type of intervention during market crises. Specifically, we investigate how the FED's liquidity infusion marginally affected commercial bank lending and, in turn, market liquidity for each stock during the 2007-09 financial crisis, QE-1, QE-2 and QE-3 and whether impacts on market liquidity differ among the four FED policy iterations.

We use two market liquidity measures for each U.S. traded stock, Amihud Illiquidity measure (Amihud),<sup>2</sup> and Percentage Relative Spread (Spread). We also employ a two-stage instrumental variable (2SLS) approach where changes in FED Assets are used to predict bank credit changes that are then used in the second stage of the 2SLS model.

During the full study period, January 1, 2003 through December, 2013, we find that increases in bank credits generally reduce both Amihud and Spread measures, thus increasing market liquidity. This indicates that increases in bank lending generally increases stock market liquidity by providing a reliable source of finding. This is illustrated during the 2007-09 recession and QE-1 sub-periods when bank credit increases significantly, thus reducing both

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<sup>1</sup> Different studies (Brunnermeier and Pedersen; 2009, Hameed et al.; 2010) have shown that liquidity was completely absent during the 2007-09 crisis which exacerbated the crisis.

<sup>2</sup> Amihud measure (2002), subsequently defined, is one of the most widely used liquidity proxies in finance literature. It has advantages over other liquidity measures because it is easily constructed, uses the absolute value of individual stock daily return-to-volume ratios that capture price impacts, and has a strong positive relation to expected stock return (see, e.g., Chordia, Huh, and Subrahmanyam (2009)).

Amihud and Spread measures. However, during QE-2 and QE-3, bank credit increases failed to consistently or significantly reduce either liquidity measure, but instead may have reduced market liquidity. Therefore, our initial assessment regarding monetary policy and QE impacts on stock market liquidity is that it had positive liquidity effects during the recession and QE-1, but possibly deleterious or no effect on liquidity during QE-2 and QE-3.

We contribute to the literature in number of ways. First, we demonstrate inconsistent impacts of QE on equity market liquidity. Second, we find evidence that only when FED monetary policy stimulus significantly increases bank lending does FED actions also increase stock market liquidity. Third, under low interest rate regimes when further FED stimulus fails to marginally increase bank lending, such as during QE-2 and 3, market liquidity may be unaffected or possibly decreased. Fourth, we find evidence that market sentiment improvements (reduced uncertainty), resulting from QE implementation, may have positively affected market liquidity during the 2007-09 recession and QE-1; however, QE-2 and QE-3 failed to generate the same positive impact on liquidity. Fifth, we find that continuous expansionary monetary policy that creates excess, unused bank reserves and liquidity may, at the margin, be relatively ineffective at increasing bank lending and improving stock market liquidity. In fact, unused or substantial excess bank liquidity may have no or possibly deleterious impacts on market sentiment and resulting market liquidity.

The paper is structured as follows. Section 2 provides a brief review of the literature on QE, banking liquidity and market liquidity, and Section 3 discusses the 2007-09 crisis and the three iterations of QEs. Section 4 discusses data, variables and methodology, results are discussed in Section 5, and section 6 concludes.

## **2. Related Literature**

The perception that monetary policy or specifically unexpected changes in monetary policy impacts stock prices has attracted attention. (Bernanke and Kuttner; 2004, Rigobon and Sack; 2002, Thorbecke; 1997, Jensen and Mercer; 1998, and Jensen, Johnson and Mercer; 1996). Also receiving attention is that market illiquidity negatively impacts stock prices (Amihud; 2002) and Brennan and Subrahmanyam; 1996). However, assuming that market liquidity is desirable because it increases market efficiency, we focus on the literature regarding quantitative easing and monetary policy effects, as implemented by central banks and specifically the U.S. Federal Reserve, on stock market liquidity. We also review the literature on stock market uncertainty that may result from macro-events and major monetary policy shifts and their impacts on asset liquidity and trading behavior of short sellers.

Bernanke and Reinhart (2004) suggest three different ways by which the economy may be stimulated under low interest rate regimes (1) assure investors that future interest rates will not be increased, (2) supply securities matched with the central bank balance sheet, and (3) increase market liquidity using Quantitative Easing (QE). Thus, we focus on QE program effectiveness in increasing stock market liquidity.

Numerous studies exist regarding the implementation and effectiveness of QE programs across different world economies. Stroebel and Taylor (2009), Kohn (2009), Meyer and Bomfim (2010), and Gagnon et al. (2011), study the FED's 2008-09 QE programs. Gagnon et al. (2011) bring attention to the large-scale asset purchase (LSAP) announcements regarding long-term yields, finding that non-conventional monetary policy announcements were effective in reducing U.S. long-term yields.

Joyce et al. (2011 a, b) examine the Bank of England (BOE) 2009 Quantitative program, finding an impact on asset prices through portfolio rebalancing.<sup>3</sup> They document that the BOE's QE program affected United Kingdom long term bond yields similarly to those reported by Gagnon et al. (2011) for U.S. QE programs. Hamilton and Wu (2011) analyze the effects of the FED's 2008-09 QE programs using term structure models indicating that this QE program significantly affected long-term debt yields. Also, Duca et al. (2016) examine the FED's QE stimulus finding strong impacts on corporate bond issuance across emerging and developed economies.

Krishnamurthy and Jorgensen (2011) examine different channels through which QE may be implemented that impact medium and long-term interest rates and their policy implications. They suggested five channels: signaling, impact on mortgage specific risk, corporate bond risk premiums, FED's supply of assets, and inflation rate swaps. In addition to these channels, we examine commercial banks' balance sheet credit expansions, increases in bank lending, and the relationship of banking liquidity with bank lending and lending effects on stock market liquidity.

In related work, Freixas et al. (2000) examine interbank credit lines that may assist with coping with liquidity shocks arising from uncertain pattern of consumers' consumptions. They find that interbank credits lines are beneficial, particularly when demand for money is high as it reduces the cost of maintaining bank reserves. Levine and Zervos (1998) find that stock market liquidity and an effective banking system strengthens overall economic growth.

Morgan (2011) investigates possible impacts of US QE policy on Asian economies and financial markets finding a widespread impact on other economies as well as the United States (US). The FED's implementation of QE policy subsequent to the 2008-09 crisis aroused serious

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<sup>3</sup> Also see Christensen, and Krogstrup, (2014). Transmission of Quantitative Easing: The Role of Central Bank Reserves. *Federal Reserve Bank of San Francisco, Working Paper Series*, (2014-18).



concerns in Asia regarding its possible impact in terms of weakening the US dollar and stimulating capital outflows to emerging economies that may increase inflationary pressures.

Fawley and Neely (2013) examine the impact of QE programs implemented by the FED, the Bank of England (BOE), the European Central Bank (ECB) and the Bank of Japan (BOJ) as a recovery measures after the 2007-09 crisis, observing that the Federal Reserve and Bank of England expanded their monetary bases by purchasing bonds as compare to European Central and Bank of Japan focused on direct lending to banks.

A number of additional studies observe that the 2007-09 financial crisis caused severe implications for many economies, stock markets and credit markets. The FED's QE intervention in late 2008 may have helped stimulate the economy by providing market liquidity and supporting credit markets. For example, Bernanke (2012) provides an overview of the effectiveness of FED's QE program and identifies drawbacks of this form of monetary policy. He posits that QE measures improve functioning in financial markets. Alternatively, Fullwiler and Randall (2010) examine the FED's role as a regulator and monetary policy implementer during the 2008 crisis finding that the FED unsuccessfully fulfill its responsibility in regulating and supervising financial markets during QE; where, FED actions, including QE, failed to improve private sector real income. They suggest that private and public spending was insufficient to create higher employment levels and higher private sector income. Therefore, the 2007-09 recession remains a serious problem despite QE programs.

The FED's implementation of QE during and subsequent to the 2007-09 crisis was expected to ease credit restrictions and increase commercial bank lending and improve capital formation. Pariente et al. (2011) analyze the effectiveness of the FED's QE stimulus program in assisting the US economy's recover subsequent to the 2007-09 crisis finding that the recession

was a combination of economic downturn and a banking system financial crises. They suggest a mixed stimulus of fiscal and countercyclical monetary policies to help improve the economy.

Shirakawa (2001) examines the effectiveness of QE stimulus in Japan when nominal short-term interest rates are essentially zero documenting that the continuation of non-conventional monetary policy fails to contribute to economic recovery but instead delays natural structural reforms. Also, Kawai (2015) examines non-conventional monetary policy influences in developed economies (Japan and US) as compared to emerging economies finding that expected future changes in monetary policies affects exchange rates and stock prices in more fully integrated financial markets.

Few studies have investigated the root cause of the 2007-09 financial crisis and the extent to which the FED was involved in either causing or ameliorating it; however, Spahr and Sunderman (2014) find that mandated political objectives legislated through Fannie Mae and Freddie Mac (GSE's) with complicit FED intervention, resulting in low interest rates, exacerbating the financial crisis. They find that FED policies had little impact on causing the 2007-09 financial crisis other than intensifying its magnitude through sustained below market interest rates. The FED's most important action was to ameliorate the impact of the crisis by applying QE to mortgage back securities (MBS) to moderate GSE insolvency problems and improve MBS liquidity.

The 2007-09 financial crisis resulted in multifold impacts across asset classes by first, increasing financial market uncertainty that resulted in sharp liquidity declines (Brunnermeier and Pedersen; 2008, Hameed et al.; 2010), second, because of increased market uncertainty, forced regulators to partially ban short sale (Autore et al.; 2011, Battalio and Schultz; 2011) and third, market crisis resulting reductions in stock returns (Patelis; 1997, Zhang; 2006).

Given findings of the previous studies, we include the joint impact of short-sales, along with other control variables, on stock market liquidity.

### **3. Background: Global Financial Crisis 2007-09 and QEs**

The 2007-09 global financial crisis incentivized the FED and many countries' central banks to consider various monetary policy stimuli to ameliorate crisis damages (Cecchetti; 2008, Goodhart; 2008, Rose and Spiegel; 2012). Former FRB Chair, Ben Bernanke, initiated QE-1 in 2008; whereas, in 2014 new FRB Chair, Janet Yellen, effectively discontinued QE as a monetary policy tool,<sup>4</sup> suggesting that Japan and other countries also end monetary policy based on QE as it tampers the currency values.<sup>5</sup> A major subject of debate is the desirability and effectiveness of the FED's implementation of QE to stimulate economic growth and stabilize markets. Another debate subject is whether potential market distortion side effects are justified by the achievements gained by routing QE through the banking system, resulting in substantially unused bank reserves and increasing the money supply. (Fratzscher et al.; 2013, and Krishnamurthy and Jorgensen; 2011).

**<Insert Table 1 here>**

Each QE displayed unique characteristics in terms of asset targeted for purchase (Table 1). The implementation of QE-1 arguably improved the economy, thus triggering the FED's continuation with QE-2 and QE-3 in subsequent time periods.

**<Insert Figure 1 here>**

**<Insert Figure 2 here>**

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<sup>4</sup> Charity Gap, The Economist, accessed on April 22, 2014. <http://www.economist.com/news/finance-and-economics/21599373-federal-reserves-new-forward-guidance-hazy-clarity-gap>

<sup>5</sup> Fed Chair Yellen Demands Japan End QE, accessed on April 24, 2014. [http://www.americanthinker.com/blog/2014/04/fed\\_chair\\_yellen\\_demands\\_japan\\_end\\_qe.html](http://www.americanthinker.com/blog/2014/04/fed_chair_yellen_demands_japan_end_qe.html)

Figures 1 and 2 illustrate that each QE implementation resulted in substantial increases in FED balance sheet assets that were not fully replicated in commercial bank credits/lending. January, 2014, book value FED assets were approximately five times the value in 2008, prior to this crisis (\$4.2 trillion as compare to \$894 billion in 2008). Similarly, commercial bank credits increased only 10 percent from \$9,428.3bn in October 2008. Thus, the FED's effectiveness in implementing all three QEs and subsequent influences on commercial bank lending may be disputed (Figure 1); although, increases in FED balance sheet assets during QE 1 and QE 3 may have had a slight stimulating effect on commercial bank total credits. The FED, in an effort to stabilize market condition during and after the fall of Lehman Brother's, introduced new stimulus supporting deteriorating market conditions. The FED's policy shift is reflected in the sudden increase in its total assets and somewhat in commercial bank total credits (Figure 2).

Figure 2 indicates that the FED's sharp increases in assets during the Lehman collapse may have impacted bank lending; however, the cumulative impact of all three QEs appear to be relatively ineffective at stimulating bank lending.

**<Insert Figure 3 here>**

Both graphs of Amihud measure (Figure 3) and Percentage Spread (Figure 4) indicate low levels of stock liquidity across all industries during the 2007-09 crisis; however, it is apparent that financial stock liquidity was more adversely affected as compare to non-financial stocks, suggesting increased financial stock liquidity sensitive to market/economic condition.

**<Insert Figure 5 here>**

Figure 5 plots average Short Interest for all firms, financial firms and non-Financial firms. As expected, short interests increased substantially at the beginning of the 2007-09 crisis, but subsequently decreased due to the partial ban on short sales and stabilized during the QE periods.

#### **4. Data source and basic analysis**

Our dataset is constructed from three major sources- Center for Research in Security Prices (CRSP), Compustat and the U.S. Federal Reserve database. CRSP data include variables for all U.S. listed stocks from January 2003-December 2013 including daily bid-ask prices, ticker symbols, trading volume, shares outstanding, and market capitalization. We winsorize the CRSP variables, deleting the top 1% and bottom 1% of each distribution to reduce the impact of extreme values. Each stock's short position for each two-week interval is collected from Compustat.<sup>6</sup> Data from the Federal Reserve's (FRB) website includes total asset, total credit of commercial banks, monthly Fed Financial Stress indicator and 3 month T-bill rates.

We compute Amihud illiquidity measure (Amihud) and relative percentage quoted spreads (Spread)<sup>7</sup> for daily observations for each U.S. common stock for our study period.<sup>8</sup> Amihud is multiplied by one million to avoid scale problems. Each liquidity proxy, as well as other CRSP variables, are averaged monthly resulting in a final sample that includes monthly observations for each liquidity proxy. Short interest ratios for each firm are calculated as the ratio of average monthly short interests divided by market capitalization. Finally, we merge CRSP monthly averaged dataset, Compustat monthly short interest ratio and the monthly dataset

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<sup>6</sup> Compustat provides monthly observations for "share shorted" variable till December 2006. From January 2007 onwards, data is available at fortnightly basis.

<sup>7</sup> Spread= (Ask-Bid)/Mid Quote, where Mid Quote= (Ask + Bid)/2.

<sup>8</sup> We dropped stocks which fall under ETF, ADR, mutual funds and REITs.

obtained from the FRB website. More than 4,100 firms existed each year, where non-financial firms proportions ranges from 52-65% while financial firm proportions range between 35-48%.<sup>9</sup>

**<Insert Table 2 here>**

For most variables, Table 2 presents monthly descriptive statistics for more than 596,109 firm-month observations except for the fed stress indicator with 515,392 observations. Amihud and Spread (%) mean values are 33.86 and 0.73 percent respectively. The FED's total asset mean and maximum are \$1,702.57 and \$3,991.81 billion, the individual stock market capitalization mean is \$4.12 million and the Fed Stress indicator index varies from -1.52 to 5.31 with a mean of -0.19.<sup>10</sup>

**<Insert Table 3 here>**

Table 3 displays each variable's pairwise correlation, including a correlation between Spread and Amihud Illiquidity of 30%. In general, we find relatively low correlation between independent and control variables. All correlation coefficients are statistically significant.

#### **4.1 Mean Difference t-tests**

Table 4 indicates how variables of interest adjust to changing monetary environments by displaying mean difference t-test results for all firms, non-financial and financial firms across the entire sample period, the 2007-09 crisis and each QE sub-period. Also, Panel A displays mean difference t-tests for Amihud, Spread and Short Interest ratios between Non-QE and QE periods for all firms, non-financial and financial firms. Mean differences for all Amihud and Spread variables are positive and highly statistically significant indicating considerably higher market liquidity during QE periods as compare to non-QE periods. Also, we find statistically significant

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<sup>9</sup> In appendix (Figure A1), we plot a graph which shows the distribution of financial firms and non-financial firms on a year by year basis in our dataset.

<sup>10</sup> In appendix (Table A1), we define each and every variable used in this study.

increases in short interest ratios for all firms, financial and non-financial firms during QE periods.

Table 4, Panel B indicates statistically significant sequential improvements in stock liquidity across the three QE periods. Short interest ratio t-tests indicate higher short selling during QE-1 and QE-3, suggesting increased short selling during higher market uncertainty periods.

**<Insert Table 4 here>**

## **4.2 Regression Model Descriptions**

The generally considered objective of FED monetary policy is to enhance stock market liquidity. As suggested by Levine and Zervos (1998), we believe that the FED initiated QE activity with an objective to increase market liquidity, increase trading efficiency and activity and reduce market uncertainty. Further, we posit that reductions in market uncertainty results in short selling reductions, as short sellers tend to trade more heavily in informational asymmetric markets.

Similar to Freixas et al. (2000), we concur that both bank lending and lines of credit increases improve market liquidity; where, monetary theory suggests that commercial bank lending should increase as a result of QE programs. We empirically examine the impact of the FED's implementation of monetary policy during the 2007-09 recession and each QE-1, 2, 3 sub-period using the following regression model (base model):

$$LIQ_{j,t} = \alpha + \beta_1 BnkCrd_t + \beta_2 SHint_{j,t} + \beta_3 ExRet_{j,t} + \beta_4 MCap_{j,t} + \beta_5 FSInd_t + \beta_6 RetVar_t + \varepsilon_{j,t} \dots\dots\dots (1)$$

where,  $LIQ_{j,t}$  is either Amihud or Spread for stock 'j' in the month 't'.  $SHint_{j,t}$  is short interest ratio,  $ExRet_{j,t}$  is excess stock return,  $BnkCrd_t$  is percentage change in commercial bank total credits in month 't',  $MCap_{j,t}$  natural log of market capitalization of stock 'j' in month 't',  $FSInd_t$  is Federal Stress Indicator in month 't', and  $RetVar_{j,t}$  is stock 'j' return variance in month 't'. Following the existing literature, we include control variables, Market capitalization, Federal Stress Indicator<sup>11</sup> and return variance, in the regression model. Our base model is estimated for the entire study period, the 2007-09 crisis period and the three different QE sub-periods for all firms and for either Financial and Non-financial firms.

A second model incorporates interaction, “dummy,” variables, for each sub-period to simultaneously examine influences of QEs and recession period on the market liquidity.

$$\begin{aligned}
 LIQ_{j,t} = & \alpha + \beta_1 SHint_{j,t} + \beta_2 ExRet_{j,t} + \beta_3 MCap_{j,t} + \beta_4 FSInd_t + \beta_5 RetVar_t \\
 & + \beta_6 DummyQE1 * BnkCrd_t + \beta_7 DummyQE2 \\
 & * BnkCrd_t + \beta_8 DummyQE3 * BnkCrd_t + \beta_9 DummyRecess * BnkCrd_t \\
 & + \varepsilon_{j,t}
 \end{aligned}
 \tag{2}$$

where, recession and QE dummy variables (*DummyRecess*, *DummyQE1*, *DummyQE2*, and *DummyQE3*) each take values of 1 for respective 2007-09 recession and QE periods, 0. Dummy variable products with percentage changes in commercial bank credits ( $BnkCrd_t$ ) simultaneously measure liquidity interaction effects.<sup>12</sup>

<sup>11</sup> For details, see Hakkio and Keeton (2009)

<sup>12</sup> We follow NBER definition of recessionary periods.



## 5. Results

Tables 5 and 6 present results for two basic regression models where dependent variables are Amihud and Spread, respectively. Each OLS model in Panel A is run with heteroscedastic standard errors. Panel B models include Firm, Industries and Year Fixed Effects for each stock during the full time period January 2003 through December 2013 and for non-QE, each QE and recession sub-periods. Panel C and Panel D separate firms by financial and non-financial and run ordinary least square with heteroscedastic standard Errors.

**<Insert Table 5 here>**

**<Insert Table 6 here>**

Table 5 (Amihud) first column, shows results for the entire time period January 2003 through December 2013, the second column reports results for all non-QE periods, and the remaining columns show results for sub-periods including all QE periods, QE-1, QE-2, QE-3 and the recession. Table 6 displays the same models with Spread as the dependent variable.

Table 5 (Amihud) and Table 6 (Spread) indicate that bank credit change coefficients are negative and statistically significant except for the all QE and QE-2 periods (Amihud) and QE-2 (Spread). Although differences exist between Amihud and Spread models, preliminary indications are that during QE-2, when bank credit changes coefficients are not statistically significant, increases in FED assets failed to provide commensurate stimulation for commercial bank lending. This suggests that QE-2, FED asset expansions resulting from expansionary monetary policy is ineffective at increasing stock market liquidity in the absence of increases in bank credits. During other sub-periods, increases in bank credits generally increases stock market liquidity.

As previously posited, Amihud and Spread differences result from their measuring different elements of stock market liquidity. Amihud only the average daily price impact, in our case each month, (Goyenko et al., 2009); whereas, percentage bid-ask spread measures volume effects of overall liquidity. Spread is large when order flow is scarce and a lack of resiliency exists when the order flow fails to rapidly adjust in response to price swings (Stoll, 2000).

Percentage changes in bank credits (Bank Credits), is a measure of the impact of FED monetary policy and asset changes on commercial bank lending and correspondingly bank lending impacts on stock market liquidity. Over the three QE stages, we tentatively conclude that, given an objective of supporting stock market liquidity, results are, at best, inconclusive. There appears to be little or marginal support that the QE-2 objective of increasing stock market liquidity was attained.

In general, the three QE periods resulted in the creation of substantial quantities of additional bank reserves resulting in very low interest rate levels. This, according to monetary theory, should stimulate commercial bank lending that should be reflected in increasing levels of bank credit. It is expected that increased bank credit levels manifest into increased lending to market makers and investors facilitating increases in stock market liquidity. Tables 5 and 6 results appear to support a linkage between increases in bank credits generating increases in market liquidity except during QE-2.

Other variables coefficients in Tables 5 and 6 are generally highly statistically significant. However, the statistical significance of Short Interests is inconsistent, where increase in short sales during non-QE periods tends to increase Amihud, but reduce Spread. This suggests that short sales tend to reduce market liquidity as measured by Amihud during most sub-periods; however, reduce spreads, increasing market liquidity, except for the QE-3 and 2007-09 recession

time periods. Table 6 suggests that, during the recession, when some short selling was curtailed, short selling increased spreads, thus reducing market liquidity. This suggests that limiting or suspending short sales during crisis periods may be counterproductive.

The FED Stress Indicator, except for the QE-2 sub-period, indicates that market liquidity is significantly reduced with higher stress levels. Also, unsurprisingly, stocks with higher market capitalizations consistently have higher levels of market liquidity.

Excess Returns appears to be a measure of market performance, where during normal times, positive excess returns are generally associated with lower market liquidity. Alternatively, during QE periods and the recession, representing bear markets, positive excess returns tended to increase market liquidity. A similar argument may be made for Return Variance. During non-QE sub-periods, higher variance tends to increased liquidity; however, during the 2007-09 recession and QE periods, increases in variance either reduced liquidity or results were statistically insignificant.

Among other Robustness Checks, Table 7 reports both OLS and GLM regressions with dummy variables interacting with percentage changes in bank credit for the 2007-09 recession and QE sub-periods. We suppress intercept terms, thus allowing each dummy to serve as a quasi-intercept term. This allows our regression model to shift with regime changes.

Table 7 reaffirms and provides additional insights with regard to previous findings that bank credit increases during the 2007-09 recession and QE-1 were effective at increasing market liquidity; however, subsequent QE-2 and QE-3 tended to reduced market liquidity (increasing market illiquidity), where results are highly statistically significant.

Overall, assuming that an objective of QE was to stimulate bank liquidity and lending (bank credits), it appears that increasing bank liquidity was achieved, but the impact on bank

lending and stock market liquidity was erratic. This may have resulted from the economy's weak recovery, uncertainty in the market about further change in the FED's monetary policy and resulting weak bank commercial and industrial loan demand. With insufficient loan demand, FED actions of further increasing bank liquidity by further increasing excess reserves has very little effect on bank lending or market liquidity.

**<Insert Table 7 here>**

Since QE may be considered a last resort instrument of non-conventional monetary policy, enacted because of the ineffectiveness of previous, more conventional policy actions, it appears that QE was marginally, if at all, effective in increasing stock market liquidity or consequently, stimulating the economy. Thus, as previously discussed in the literature section, QE which was tried in Japan, UK and other countries with little success, appears to be a relatively ineffective tool. This leaves fiscal policy as possibly the only other approach for economic stimulation.

### **5.1 Instrumental Variable Approach**

Monetary policy theory posits a causal relationship between the FED's open market operations, including quantitative easing, and increases or decreases in FED assets, changes in bank reserves, changes in bank credits and commensurate changes in stock market liquidity. We find, however, that the theoretical relationship between FED asset level changes and changes in bank credit levels fails to follow a consistent relationship, especially during recent quantitative easing periods. It appears that once commercial banks have attained sufficiently high levels of reserves to support their lending activities that additional reserves, at the margin, result in minimal levels of additional lending. We observe, however, that changes in bank lending (changes in bank credits) significantly affect stock market liquidity. Thus, we test the relationship between stock market liquidity and bank credit levels using a two-stage econometric model (2SLS), an instrumental variable approach that reflects the theoretical relationship

between FED asset changes and changes in bank credit. Results support a causal relationship between the FED's total assets and total commercial bank credits because of their high correlation ( $\rho=0.81$ ).<sup>13</sup> The first stage of 2SLS estimation regresses bank credit changes on the previous one-month changes in FED assets while including the other control variables. Predicted values for bank credit changes are used as the variable of interest in the second stage. The 2SLS model also addresses endogeneity issues between changes in FED asset and changes in the commercial bank credits.

Table 8 present both first and second stage results for the 2SLS model. Second stage interaction variables for the QE-1 sub-period are negative and significant; however, estimates for QE-2 and QE-3 interaction variables are positive and significant. This indicates that QE-1 monetary policy tended to increase market liquidity through increases in commercial bank credits; however, QE-2 and QE-3 actions resulted in increased stock market illiquidity. Further, the interaction dummy variable for the recession period is negative and statistically significant for Spread, but not significant for Amihud. Thus the FED's monetary policy, on average, improved market liquidity during the 2007-09 recession and QE-1 periods, but tended to have the opposite impact of reducing market liquidity during both QE-2 and QE-3. Coefficients for control variables are as expected.

The 2SLS results overall affirms and strengthens previous results; where, we find that the FED's non-conventional monetary policy, QE, was not consistently effective in supporting market liquidity conditions. The inconsistent results for QE, particularly QE-2 and QE-3, may be explained by the marginal impact of additional bank liquidity on bank lending. Once the banking system had adequate excess reserves to support loan demand, further economic stimulus, with no

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<sup>13</sup> We have not reported correlation between Federal Reserve total asset and commercial banks total credit in the table.

commensurate increase in lending, had very little and possibly negative impact on stock market liquidity.

**<Insert Table 8 here>**

## **6. Conclusions**

We examine the FED's implementation of monetary policy and quantitative easing (QE) to ameliorate impacts of the 2007-09 financial crisis and the subsequent stagnant economy on US equity market liquidity. Our results suggest that the FED's application of non-conventional monetary policy (QE), substantially expanded the FED's balance sheet, significantly increased commercial bank reserves, but to a lesser extent increased bank credits (bank lending), inconsistently impacted stock market liquidity. FED expansionary monetary policy during and subsequent to the 2007-09 financial crisis was only marginally effective at increasing equity market liquidity and during QE-2 and QE-3 possibly reduced stock market liquidity. The ineffectiveness of QE-2 and QE-3 in increasing market liquidity, an objective on monetary policy, resulted from the banking system already possessing substantial excess reserves to support loan demand and abundant liquidity resulting from expansionary monetary policy during the recession and QE-1. Thus further stimulus provided by QE-2 and 3 had very little and possibly negative impact on stock market liquidity. Financial stocks appear to be more sensitive to FED monetary policy and QE stimulus as compare to non-financial stock.

Our results indicate that values for each stock market liquidity measures, Amihud and Spread, were statistically different between QE sub-periods and non-QE sub-periods and between each pairwise QE sub-periods. Thus, results indicate that liquidity varied across each of the sub-period; however, we cannot attribute that changes in market liquidity were entirely due to the effects of QE.

We find, across all models, a very strong positive relationship between common stock short-sales and both market liquidity measures, thus we suggest that the FED's curtailing common stock short-sales, particularly during QE-1, tended to be counterproductive and reduced liquidity. Some reductions in short selling, however, may be attributed to reductions in market uncertainty predominant during QE-1 and QE-2 sub-periods.

Although not examined specifically in this study, the lack of the effectiveness of FED monetary policy affecting market liquidity may be, at least partially, attributed to US financial market being highly integrated with global markets. Thus, the impact of the U.S. FED's monetary policy may be sufficiently diluted to weaken its impact on stock market liquidity. Thus, we agree with Aktan, and Masood (2011) who suggest the need for a mixed fiscal and monetary policy for economic stimulation and sustainability.

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## Tables and Figures

**Table 1: Target Security during each QE time period**

This table illustrates the array of securities purchased by the FED during each of the three Quantitative Easing time intervals

Quantitative Easing	Major Asset Purchased	Start Period	End Period
QE1	Longer-term Treasury securities as well as the debt and the mortgage-backed securities (MBS) of Fannie Mae and Freddie Mac	Nov. 2008	Mar. 2010
QE2	Long Term Treasury Securities	Nov. 2010	June. 2011
QE3	Combination of securities like long-term Treasuries, government-sponsored enterprises (GSEs) debt, and MBS	Sep. 2012	Nov. 2014

**Table 2: Summary Statistics**

This table provides summary statistics for the independent and dependent variables used in the study. Amihud is defined as absolute return over daily trading volume. Spread is the percentage difference between bid and ask price over ask price. Turnover is defined as the ratio of total shares traded over shares outstanding. Trade Volume is volume of shares traded. Market Cap (MN) is market capitalization of a given stock. Short Interest is number of shares held short. Fed Stress Indicator is the St Louis FED Financial Stress Index, which measures the degrees of financial stress in the markets. Total Commercial Bank Credits (BN) is the bank credit held by all commercial banks in United States. All Federal Bank Total Assets (BN) is the assets held by all the Federal Reserve Banks in United States. T Bill (%) is the 3 month Treasury Bill quoted rate. Return Variance measures the volatility of stock returns. Std Dev is the Standard Deviation, Min is Minimum, and Max is Maximum.

Variables	Observations	Mean	Std Dev	Min	Max
Amihud <sup>#</sup>	599,661	33.86	371.18	0.00	130,492.79
Spread (%)	599,661	0.73	1.26	0.00	51.43
Daily Turnover	599,661	8.95	21.74	0.00	2153.21
Trade volume	599,661	842,381	2,644,144	10	87,907,056
Market Cap (MN)	599,661	4.12	13.23	0.00	513.01
Short Interest(MN)	599,661	34.14	14.64	8.06	62.60
Fed Stress Indicator	515,392	-0.19	1.23	-1.52	5.31
Total Commercial Bank Credits (BN)	599,661	8,341.21	1,355.79	5642.78	10,083.83
All Federal Bank Total Assets (BN)	599,661	1,702.57	994.34	721.33	3,991.81
T Bill (%)	599,661	1.45	1.74	0.00	5.05
Return Variance	597,743	6.17	9.96	0.00	2,748.69
Change in Bank Credits (%)	599,661	0.43	0.75	-1.12	4.79
Change in Federal Assets (%)	596,109	1.51	6.66	-8.50	71.14

**Note:** Amihud illiquidity measure is multiplied by one million to avoid scale problem.

**Table 3: Correlation Table**

This table provides summary statistics for variables defined in the previous in Table 3. Column variables are: I – Amihud (MN), II- Spread(%), III- Daily Turnover, IV – Trade Volume, V- Market Cap (MN), VI – Short Interest (BN), VII- Fed Stress Indicator, VIII- Total Commercial Bank Credits (BN), IX – All Federal Banks Total Assets (BN), X- T Bill (%), XI – Returns Variance, XII – Change in Bank Credits (%), XIII – Change in Federal Assets (%). All coefficients are statistically significant at 1% level.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
I	1.00												
II	0.30	1.00											
III	-0.03	-0.17	1.00										
IV	-0.03	-0.17	0.93	1.00									
V	-0.03	-0.16	0.18	0.26	1.00								
VI	0.03	0.04	0.15	0.16	-0.06	1.00							
VII	0.08	0.44	-0.19	-0.20	-0.05	0.28	1.00						
VIII	0.01	-0.05	0.29	0.30	-0.04	0.89	0.09	1.00					
IX	-0.03	-0.20	0.44	0.46	0.08	0.58	-0.18	0.81	1.00				
X	0.01	0.09	-0.22	-0.22	-0.09	-0.41	-0.11	-0.44	-0.72	1.00			
XI	0.03	0.16	-0.03	-0.03	-0.01	0.10	0.38	0.05	-0.01	-0.09	1.00		
XII	0.00	0.01	-0.12	-0.12	-0.01	-0.29	0.02	-0.27	-0.31	0.34	0.01	1.00	
XIII	0.03	0.24	0.04	0.04	-0.01	0.13	0.47	0.14	0.08	-0.11	0.23	0.37	1.00

**Table 4: Difference in Means Test**

This table reports difference in means student t tests for dependent variables: Amihud, Spread (%), and independent variables: Daily turnover, Volume (mn), Short Interest (bn) and Excess Returns (%) between quantitative easing period and non-quantitative easing period. Tests are performed on observations for All Firms, Non Financials firms and Financial firms. Panel A tests for differences in means between quantitative easing and non-quantitative easing periods. Panel B tests for difference in means between different QE periods. In parenthesis are reported T – Values are reported in parentheses, and \*\*\*, \*\*, \* indicates statistical significance at 1% , 5% and 10 % levels, respectively

**Panel A: Non Quantitative Easing and Quantitative Easing Period**

Variable	All Firms			Non-Financial Firms			Financial Firms		
	Non QE	QE	Difference	Non QE	QE	Difference	Non QE	QE	Difference
Amihud	35.98	29.61	6.36*** (1.017)	35.59	32.16	3.42** (1.553)	36.53	26.67	9.86*** (1.205)
Spread (%)	0.77	0.63	0.14*** (0.003)	0.75	0.60	0.15*** (0.005)	0.81	0.67	0.14*** (0.005)
Short Interest	29.98	42.49	-12.50*** (0.037)	28.98	42.48	-13.50*** (0.050)	31.40	42.50	-11.10*** (0.054)

**Panel B: Quantitative Easing 1, Quantitative Easing 2 and Quantitative Easing 3**

Variable	All Firms					Non-Financial Firms				
	QE1	QE2	QE3	(QE1-QE2)	(QE2-QE3)	QE1	QE2	QE3	(QE1-QE2)	(QE2-QE3)
Amihud (MN)	63.33	13.94	7.61	49.39*** (3.812)	6.34*** (0.884)	67.65	16.68	8.97	50.96*** (6.702)	7.71 **** (1.218)
Spread (%)	1.37	0.21	0.19	1.15*** (0.013)	0.02*** (0.004)	1.25	0.24	0.22	1.01*** (0.017)	0.02*** (0.006)
Short Interest (BN)	42.82	40.61	43.04	2.21*** (0.011)	-2.44*** (0.006)	42.80	40.61	43.05	2.19*** (0.016)	-2.44*** (0.008)

Variable	Financial Firms				
	QE1	QE2	QE3	(QE1-QE2)	(QE2-QE3)
Amihud (MN)	58.43	10.77	6.01	47.66*** (2.815)	4.76*** (1.282)
Spread (%)	1.50	0.19	0.16	1.31*** (0.019)	0.03*** (0.005)
Short Interest (BN)	42.85	40.61	43.04	2.23*** (0.017)	-2.43*** (0.009)

**Table 5: Regression Analysis- Amihud Measure (Base Model)**

This table presents Ordinary least Square regression in Panel A and Fixed Effects Analysis in Panel B Ordinary least square regression for Financial Firms in Panel C and Ordinary least square regression for Non- Financial Firms in Panel D. Amihud is the dependent variable and the main independent variable of interest is Bank Credit Change percentages. Control variable are excess returns defined as the difference between individual stock return and 3 month T-bill rate, Short Interest is the number of stocks held short in billions, log (Market Cap) is the natural log of Stock Market Capitalization, Fed Stress Indicator measures the level of stress in banking sector and Return Variance captures stock volatility. We report results for all observations: non-Quantitative Easing period, all Quantitative Easing period, recession period and Quantitative Easing periods I, II and III. Standard Errors are reported in parentheses, and \*\*\*, \*\*, and \* indicate statistical significance at 1% level, 5 % level and 10% levels.

**Panel A: Ordinary Least Square and Heteroscedastic Standard Errors**

Variable	All Observations	Non QE Observations	All QE Observations	QE 1 Observations	QE 2 Observations	QE 3 Observations	Recession Observations
Intercept	314.1142*** (6.810)	305.8868*** (7.185)	323.8176*** (4.407)	1296.4299*** (67.656)	490.3863*** (63.827)	27.7940*** (42.313)	832.555*** (42.461)
Bank Credit Changes (%)	-3.7230** (1.578)	-7.0057*** (1.385)	3.0555 (3.761)	-8.0205* (4.342)	-1.6656 (7.493)	-5.8597*** (1.673)	-10.047** (5.065)
Short Interest (billions)	0.4741*** (0.039)	0.3478*** (0.030)	1.9086** (0.0377)	-10.7484*** (1.352)	-0.8793 (1.067)	5.0771*** (1.095)	1.954*** (0.498)
Excess Returns	3.3849*** (0.300)	3.0545*** (0.323)	-0.6789 (0.309)	4.6873 (3.056)	-2.1977* (1.309)	-0.1999 (0.286)	4.826 (3.033)
Log (Market Cap)	-21.5476*** (0.433)	-20.3127*** (0.469)	-26.7277*** (0.287)	-64.9453*** (3.797)	-33.4589*** (2.916)	-15.1857*** (1.109)	-69.902*** (3.264)
Fed Stress Indicator	15.3189*** (1.325)	20.6793*** (1.437)	10.1074*** (0.704)	30.1163*** (3.1560)	-40.1682*** (12.832)	6.5629*** (2.401)	19.254*** (4.961)
Return Variance	-0.0683 (0.0579)	-0.2786*** (0.0745)	0.1021 (0.075)	-0.1655 (0.276)	0.0764 (0.160)	-0.0061 (0.006)	-0.113 (0.252)
No of Observation	513,715	350,368	163,347	65,401	28,815	69,131	71,552
Adjusted R Square	0.0172	0.0200	0.0153	0.0196	0.0659	0.0362	0.0139

**Panel B: Firm, Industries and Year Fixed Effects**

Variable	All Observations	Non QE Observations	All QE Observations	QE 1 Observations	QE 2 Observations	QE 3 Observations	Recession Observations
Intercept	314.3339*** (4.344)	305.88*** (4.410)	324.7443*** (33.364)	1296.4070*** (79.261)	490.4583*** (54.084)	26.5358 (45.352)	832.5761*** (49.972)
Bank Credit Changes (%)	-3.7257*** (0.732)	-7.008*** (0.762)	3.0664 (2.689)	-8.0235* (4.751)	-1.6766 (7.156)	-5.9690*** (2.003)	-10.0474*** (3.167)
Short Interest (billions)	0.4735*** (0.041)	0.347*** (0.038)	1.9105*** (0.786)	-10.7450*** (1.760)	-0.8762 (1.126)	5.1343*** (1.015)	1.9535*** (0.733)
Excess Returns	3.3866*** (0.333)	3.052*** (0.310)	-0.6910 (1.657)	4.6803 (3.475)	-2.1958 (1.734)	-0.2136 (0.694)	4.8255 (3.071)
Log (Market Cap)	-21.5630*** (0.292)	-20.312*** (0.288)	-26.8024*** (0.751)	-64.9532*** (2.114)	-33.4760*** (0.742)	-15.2641*** (0.300)	-69.9036*** (2.281)
Fed Stress Indicator	15.3267*** (0.501)	20.690*** (0.704)	10.0787*** (1.006)	30.1109*** (2.194)	-40.2293*** (12.446)	6.5466** (3.288)	19.2586*** (3.296)
Return Variance	-0.0683 (0.057)	-0.279*** (0.075)	0.1027 (0.095)	-0.1655 (0.268)	0.0759 (0.188)	-0.0063 (0.029)	-0.1126 (0.296)
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No of Observation	512,970	350,116	162,854	65,380	28,764	68,710	71,542
Adjusted R Square	0.0172	0.0199	0.0154	0.0197	0.0661	0.0364	0.0140

### Panel C: Ordinary Least Square and Heteroscedastic Standard Errors Financial Firms

Variable	All Observations	Non QE Observations	All QE Observations	QE 1 Observations	QE 2 Observations	QE 3 Observations	Recession Observations
Intercept	295.6372*** (9.059)	301.4708*** (11.939)	326.8664*** (32.325)	1401.6535*** (67.166)	534.9138*** (91.356)	-44.7455 (74.199)	863.9784*** (52.677)
Bank Credit Changes (%)	-1.8156 (2.387)	-7.1057*** (2.584)	5.7394** (2.252)	-2.5160 (2.640)	-6.1974 (7.714)	-6.3471** (2.549)	-3.4851 (5.987)
Short Interest (BN)	0.4733*** (0.045)	0.3222*** (0.043)	0.5812 (0.961)	-12.1681*** (1.595)	-0.5739 (1.134)	6.6923*** (2.161)	1.7824*** (0.381)
Excess Returns	3.7713*** (0.550)	3.6041*** (0.563)	4.3421** (2.149)	14.0173*** (2.859)	-2.8782 (3.411)	0.9514 (1.393)	10.5595*** (2.305)
Log (Market Cap)	-20.3559*** (0.623)	-19.9337*** (0.756)	-23.1451*** (1.485)	-69.8598*** (3.948)	-37.9280*** (4.612)	-15.0731*** (2.543)	-72.0065*** (4.096)
Fed Stress Indicator	13.4932*** (1.121)	21.0818*** (2.436)	8.6891*** (1.277)	25.5735*** (1.533)	-49.0315*** (14.258)	4.8260 (4.176)	10.6056*** (2.627)
Return Variance	-0.1455* (0.083)	-0.4573*** (0.089)	0.2577* (0.146)	0.4011** (0.189)	-0.0091 (0.266)	-0.2386*** (0.081)	0.3351* (0.285)
No of Observation	221,773	145,767	76,006	30,669	13,341	31,966	32,827
Adjusted R Square	0.0233	0.0179	0.0409	0.0673	0.0786	0.0198	0.0184

### Panel D: Ordinary Least Square and Heteroscedastic Standard Errors- Non Financial Firms

Variable	All Observations	Non QE Observations	All QE Observations	QE 1 Observations	QE 2 Observations	QE 3 Observations	Recession Observations
Intercept	330.3715*** (10.571)	310.9306*** (9.146)	322.7361*** (45.585)	1272.7454*** (111.033)	477.5091*** (92.900)	92.7292** (46.849)	873.5586*** (66.042)
Bank Credit Changes (%)	-5.3085** (2.133)	-6.8118*** (1.400)	0.4451 (4.750)	-12.9682 (7.975)	2.4698 (12.346)	-5.2846*** (1.832)	-15.8175** (7.967)
Short Interest (BN)	0.4799*** (0.060)	0.3774*** (0.0436)	3.0182** (1.341)	-9.3035*** (2.129)	-1.3189 (1.755)	3.6808*** (1.060)	2.0260** (0.829)
Excess Returns	3.1446*** (0.342)	2.7920*** (0.399)	-2.7356 (2.205)	-0.2829 (4.621)	-1.9077 (1.361)	-0.2090 (0.282)	1.8037 (4.641)
Log (Market Cap)	-22.5615*** (0.629)	-20.6804*** (0.607)	-29.7793*** (1.745)	-66.3501*** (6.040)	-31.0240*** (3.741)	-15.3443*** (0.8961)	-72.8258*** (5.061)
Fed Stress Indicator	17.4229*** (2.304)	20.8627*** (1.624)	11.9393*** (2.683)	36.6996*** (6.638)	-34.9905* (20.040)	8.8229*** (2.969)	29.5407*** (9.631)
Return Variance	-0.1075 (0.080)	-0.2985*** (0.109)	0.0155 (0.097)	-1.2701** (0.618)	0.1441 (0.192)	0.013 (0.009)	-1.1125** (0.545)
No of Observation	291,942	204,601	87,341	34,732	15,474	37,135	38,725
Adjusted R Square	0.0150	0.0218	0.0117	0.0145	0.0588	0.0734	0.0132



**Table 6: Regression Analysis- Spread (Base Model)**

This table presents Ordinary least Square regression in Panel A, Fixed Effects Analysis in Panel B, Ordinary least square regression for Financial Firms in Panel C and Ordinary least square regression for Non- Financial Firms in Panel D. Percentage Spread is the dependent variable and the main independent variable of interest is Bank Credit Change percentages. Control variable are excess returns defined as the difference between individual stock return and 3 month T-bill rate, Short Interest is the number of stocks held short in billions, log (Market Cap) is the natural log of Stock Market Capitalization, Fed Stress Indicator measures the level of stress in banking sector and Return Variance captures stock volatility. We report results for all observations: non-Quantitative Easing period, all Quantitative Easing period, recession period and Quantitative Easing periods I, II and III. Standard Errors are reported in parentheses, and \*\*\*, \*\*, and \* indicate statistical significance at 1% level, 5 % level and 10% levels.

**Panel A: Ordinary Least Square and Heteroscedastic Standard Errors**

Variable	All Observations	Non QE Observations	All QE Observations	QE 1 Observations	QE 2 Observations	QE 3 Observations	Recession Observations
Intercept	5.1060*** (0.016)	4.9970*** (0.015)	6.0120*** (0.097)	22.8860*** (0.196)	5.2490*** (0.203)	0.4199*** (0.1975)	8.0730*** (0.098)
Bank Credit Changes (%)	-0.0855*** (0.003)	-0.0345*** (0.003)	-0.2430*** (0.009)	-0.4850*** (0.010)	0.0244 (0.023)	-0.1151*** (0.0096)	-0.3250*** (0.007)
Short Interest (billions)	-0.0042*** (0.000)	-0.0061*** (0.000)	-0.0125*** (0.002)	-0.2740*** (0.004)	-0.0223*** (0.004)	0.0001 (0.0026)	0.0311*** (0.001)
Excess Returns	0.0401*** (0.001)	0.0285*** (0.001)	-0.0298*** (0.007)	0.0280*** (0.010)	0.0018 (0.004)	0.0748*** (0.0047)	-0.1700*** (0.006)
Log (Market Cap)	-0.3070*** (0.001)	-0.2990*** (0.001)	-0.3440*** (0.003)	-0.8570*** (0.008)	-0.2990*** (0.007)	-0.2248*** (0.0038)	-0.7870*** (0.006)
Fed Stress Indicator	0.3540*** (0.003)	0.4000*** (0.003)	0.2830*** (0.006)	0.5770*** (0.006)	-0.1470*** (0.040)	0.0259* (0.0145)	0.7960*** (0.008)
Return Variance	0.0024*** (0.000)	-0.0005*** (0.000)	0.0043*** (0.001)	0.0065*** (0.001)	0.0001 (0.001)	0.0001 (0.0001)	0.0006*** (0.001)
No of Observation	513,715	350,368	163,347	65,401	28,815	69,131	71,552
Adjusted R Square	0.3944	0.4686	0.3545	0.4427	0.336	0.2908	0.448

**Panel B: Firm, Industries and Year Fixed Effects**

Variable	All Observations	Non QE Observations	QE Observations	QE 1 Observations	QE 2 Observations	QE 3 Observations	Recession Observations
Intercept	5.1079*** (0.011)	4.998*** (0.010)	6.0260*** (0.096)	22.8818*** (0.195)	5.2484*** (0.181)	0.4160*** (0.202)	8.0729*** (0.096)
Bank Credit Changes (%)	-0.0860*** (0.002)	-0.035*** (0.002)	-0.2430*** (0.008)	-0.4850*** (0.012)	0.0245 (0.024)	-0.1150*** (0.009)	-0.3250*** (0.006)
Short Interest (billions)	-0.0043*** (0.000)	-0.006*** (0.0001)	-0.0130*** (0.002)	-0.2740*** (0.004)	-0.0220*** (0.004)	0.0750*** (0.005)	0.0311*** (0.001)
Excess Returns	0.0401*** (0.001)	0.028*** (0.001)	-0.0300*** (0.005)	0.0279*** (0.009)	0.0018 (0.006)	0.0000 (0.003)	-0.1700*** (0.006)
Log (Market Cap)	-0.3070*** (0.001)	-0.299*** (0.001)	-0.3450*** (0.002)	-0.8570*** (0.005)	-0.2990*** (0.002)	-0.2250*** (0.001)	-0.7870*** (0.004)
Fed Stress Indicator	0.3541*** (0.001)	0.400*** (0.002)	0.2829*** (0.003)	0.5768*** (0.005)	-0.1460*** (0.042)	0.0271* (0.015)	0.7956*** (0.006)
Return Variance	0.0024*** (0.000)	-0.001*** (0.0002)	0.0043*** (0.000)	0.0065*** (0.001)	0.0001*** (0.001)	0.0001 (0.000)	0.0006 (0.001)
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No of Observation	512,970	350,116	162,854	65,380	28,764	68,710	71,542
Adjusted R Square	0.39437	0.46853	0.35451	0.44271	0.33586	0.29193	0.44797

### Panel C: Ordinary Least Square and Heteroscedastic Standard Errors- Financial Firms

Variable	All Observations	Non QE Observations	All QE Observations	QE 1 Observations	QE 2 Observations	QE 3 Observations	Recession Observations
Intercept	5.1171 *** (0.025)	5.0907 *** (0.024)	6.3908 *** (0.144)	27.5542 *** (0.304)	5.4428 *** (0.279)	-0.1083 (0.222)	8.9194 *** (0.175)
Bank Credit Changes (%)	-0.0970 *** (0.005)	-0.0266 *** (0.004)	-0.3116 *** (0.013)	-0.5803 *** (0.015)	0.0029 (0.032)	-0.1268 *** (0.011)	-0.3857 *** (0.010)
Short Interest (BN)	-0.0051 *** (0.000)	-0.0065 *** (0.000)	-0.0332 *** (0.004)	-0.3281 *** (0.005)	-0.0209 *** (0.005)	0.0784 *** (0.006)	0.0330 *** (0.001)
Excess Returns	0.0453 *** (0.001)	0.0355 *** (0.001)	-0.0565 *** (0.015)	0.0698 *** (0.017)	0.0039 (0.012)	0.0029 (0.007)	-0.2372 *** (0.010)
Log (Market Cap)	-0.3016 ** (0.002)	-0.3025 *** (0.002)	-0.3056 *** (0.005)	-1.0633 *** (0.015)	-0.3241 *** (0.013)	-0.2015 *** (0.006)	-0.8997 *** (0.011)
Fed Stress Indicator	0.4063 *** (0.004)	0.4458 *** (0.004)	0.3475 *** (0.008)	0.6573 *** (0.009)	-0.2643 *** (0.059)	0.0099 (0.017)	0.9458 *** (0.010)
Return Variance	0.0021 *** (0.001)	-0.0017 *** (0.000)	0.0057 *** (0.001)	0.0070 *** (0.001)	0.0009 (0.001)	-0.0014 *** (0.000)	-0.0006 (0.001)
No of Observation	221,773	145,767	76,006	30,669	13,341	31,966	32,827
Adjusted R Square	0.4260	0.5201	0.3836	0.5045	0.3488	0.2935	0.4962

### Panel D: Ordinary Least Square and Heteroscedastic Standard Errors- Non Financial Firms

Variable	All Observations	Non QE Observations	All QE Observations	QE 1 Observations	QE 2 Observations	QE 3 Observations	Recession Observations
Intercept	5.0524 *** (0.022)	4.9111 *** (0.020)	5.6565 *** (0.130)	19.7142 *** (0.264)	5.2227 *** (0.291)	0.9264 *** (0.318)	7.8669 *** (0.127)
Bank Credit Changes (%)	-0.0752 *** (0.004)	-0.0418 *** (0.004)	-0.1903 *** (0.012)	-0.3913 *** (0.014)	0.0440 (0.032)	-0.0963 *** (0.015)	-0.2724 *** (0.010)
Short Interest (BN)	-0.0037 *** (0.000)	-0.0058 *** (0.000)	0.0015 (0.003)	-0.2260 *** (0.005)	-0.0246 *** (0.005)	0.0689 *** (0.007)	0.0273 *** (0.002)
Excess Returns	0.0357 *** (0.001)	0.0239 *** (0.001)	-0.0172 ** (0.008)	0.0060 (0.013)	0.0009 (0.005)	0.0005 (0.003)	-0.1287 *** (0.008)
Log (Market Cap)	-0.3073 *** (0.001)	-0.2950 *** (0.001)	-0.3642 *** (0.004)	-0.7568 *** (0.009)	-0.2852 *** (0.009)	-0.2402 *** (0.005)	-0.7303 *** (0.007)
Fed Stress Indicator	0.3087 *** (0.004)	0.3620 *** (0.004)	0.2321 *** (0.008)	0.4875 *** (0.009)	-0.0604 (0.054)	0.0442 ** (0.022)	0.6585 *** (0.010)
Return Variance	0.0032 *** (0.000)	0.0007 *** (0.000)	0.0045 *** (0.002)	0.0085 *** (0.001)	-0.0006 (0.001)	0.0003 * (0.000)	0.0034 *** (0.001)
No of Observation	291,942	204,601	87,341	34,732	15,474	37,135	38,725
Adjusted R Square	0.3701	0.4330	0.3318	0.4001	0.3284	0.2905	0.4131

**Table 7: Regression Analysis Using Interaction (Robustness Check- Dummy Variable Approach)**

This table presents Ordinary least Square regressions and Fixed Effect Analysis. Panel A reports results for all observation and Panel B reports for Financial and Non-Financial Firms. In Panel A, Spread is the dependent variable for column II, IV, VI, and VIII; and Amihud Illiquidity for column I, III, V and VII. The main independent variable of interest is the interaction term of Bank Credit Changes with each Quantitative Easing period. Models I, II, V and VI also include interaction terms of Bank Credit Change interactions with the Recession Period. Control variable are excess returns defined as the difference between individual stock return and 3 month T-bill rate, Short Interest is number of stocks held short in billions, Log (Market Cap) is the natural log of Stock Market Capitalization, Fed Stress Indicator measures the level of stress in banking sector and Return Variance captures stock volatility. Results are reported for all observations using OLS with heteroscedastic standard errors for column I , II, III and IV; and Fixed effect analysis for column V, VI, VII and VIII . In Panel B we reports results for financial firms and non-financial firms using OLS with heteroscedatic standard errors. Standard Errors are reported in parenthesis, and \*\*\*, \*\*, and \* indicates statistical significance at 1% level, 5 % level and 10% levels.

**Panel A : All Observations**

Variable	I Amihud (OLS)	II Spread (OLS)	III Amihud (OLS)	IV Spread (OLS)	V Amihud (GLM)	VI Spread (GLM)	VII Amihud (GLM)	VIII Spread (GLM)
Excess Return	-8.4094*** (0.184)	-0.1530*** (0.001)	-8.2760*** (0.177)	-0.1520*** (0.001)	-8.4069*** (0.284)	-0.1529*** (0.001)	-8.2733*** (0.283)	-0.1517*** (0.001)
Short Interest (BN)	1.4530*** (0.042)	0.0115*** (0.000)	1.4477*** (0.042)	0.0114*** (0.000)	1.4529*** (0.038)	0.0114*** (0.000)	1.4477*** (0.038)	0.0114*** (0.000)
Log(Stock Market Cap)	-2.3024*** (0.118)	0.0037*** (0.001)	-2.3354*** (0.109)	0.0034*** (0.001)	-2.3010*** (0.118)	0.0038*** (0.000)	-2.3339*** (0.118)	0.0035*** (0.000)
Fed Stress Indicator	18.7137*** (1.500)	0.3780*** (0.007)	17.2532*** (1.279)	0.3650*** (0.006)	18.7146*** (0.558)	0.3781*** (0.002)	17.2537*** (0.523)	0.3646*** (0.002)
Return Variance	0.3729*** (0.093)	0.0091*** (0.002)	0.3588*** (0.091)	0.0090*** (0.002)***	0.3725*** (0.057)	0.0091*** (0.000)	0.3583*** (0.057)	0.0090*** (0.000)
QE1 Dummy* Bank Credit Changes (%)	-12.8182*** (3.575)	-0.6860*** (0.012)	-17.3442*** (4.462)	-0.7280 (0.012)	-12.8173*** (2.262)	-0.6861*** (0.007)	-17.3425*** (2.182)	-0.7278*** (0.007)
QE2 Dummy* Bank Credit Changes (%)	4.5231 (3.583)	0.0859*** (0.014)	4.6808 (3.580)	0.0874*** (0.013)	4.5118 (7.697)	0.0856*** (0.024)	4.6720 (7.697)	0.0871*** (0.024)
QE3 Dummy* Bank Credit Changes (%)	10.101*** (3.277)	0.2750*** (0.011)	8.0804*** (3.069)	0.2560*** (0.010)	10.1108** (4.798)	0.2747*** (0.015)	8.0865* (4.791)	0.2560*** (0.015)
Recession Dummy* Bank Credit Changes (%)	-9.501** (4.169)	-0.0874*** (0.009)			-9.4986*** (1.249)	-0.0875*** (0.004)		
Industry Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Year Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Firm Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
No of Observation	513,715	513,715	513,715	513,715	512,970	512,970	512,970	512,970
Adjusted R Square	0.0152	0.3851	0.0151	0.3845	0.0074	0.1810	0.0073	0.1801

### Panel B: Financial Firms & Non-Financial Firms

Variable	Financial Firms				Non-Financial Firms			
	I-Amihud (OLS)	II-Spread (OLS)	III-Amihud (OLS)	IV -Spread (OLS)	V-Amihud (OLS)	VI -Spread (OLS)	VII-Amihud (OLS)	VIII-Spread (OLS)
Excess Return	-9.2025*** (0.194)	-0.1787*** (0.001)	-9.1225*** (0.1881)	-0.1772*** (0.0010)	-7.8993*** (0.288)	-0.1355*** (0.001)	-7.718*** (0.2724)	-0.1345*** (0.0013)
Short Interest (BN)	1.4096*** (0.055)	0.0111*** (0.000)	1.4073*** (0.0546)	0.0111*** (0.0002)	1.4922*** (0.060)	0.0114*** (0.000)	1.484*** (0.0604)	0.0114*** (0.0002)
Log(Stock Market Cap)	-2.2627*** (0.125)	0.0070*** (0.001)	-2.2833*** (0.1309)	0.0066*** (0.0005)	-2.3197*** (0.171)	0.0013 (0.002)	-2.362*** (0.1635)	0.0010 (0.0019)
Fed Stress Indicator	18.6567*** (0.918)	0.4643*** (0.005)	17.8110*** (1.3102)	0.4491*** (0.0046)	19.1147*** (2.675)	0.3042*** (0.010)	17.1294*** (2.0694)	0.2931*** (0.0102)
Return Variance	0.1843*** (0.085)	0.0069*** (0.001)	0.1670** (0.0845)	0.0066*** (0.0006)	0.4188*** (0.132)	0.0110*** (0.003)	0.4052*** (0.1303)	0.0109*** (0.0028)
QE1 Dummy* Bank Credit Changes (%)	-9.6686*** (3.083)	-0.8167** (0.017)	-12.434** (3.0618)	-0.8664*** (0.0179)	-15.7648*** (6.166)	-0.5720*** (0.016)	-21.746*** (7.9441)	-0.6056*** (0.0166)
QE2 Dummy* Bank Credit Changes (%)	1.3861*** (4.711)	0.0886 (0.018)	1.4557 (4.7158)	0.0898*** (0.0182)	7.1622 (5.302)	0.0826*** (0.021)	7.4162 (5.2889)	0.0840*** (0.0210)
QE3 Dummy* Bank Credit Changes (%)	11.4648*** (3.920)	0.3703*** (0.013)	10.2857** (4.2424)	0.3491*** (0.0125)	9.4744* (5.033)	0.2008*** (0.016)	6.7277* (4.0155)	0.1854*** (0.0159)
Recession Dummy* Bank Credit Changes (%)	-5.7445*** (6.102)	-0.1032 (0.012)			-12.6637** (5.747)	-0.0710*** (0.012)		
No of Observation	221,773	221,773	221,773	221,773	291,942	291,942	291,942	291,942
Adjusted R Square	0.0230	0.4480	0.0229	0.4471	0.3402	0.0122	0.121	0.3398

**Table 8: Two Stage Least Square Analysis (Instrument Variable Approach)**

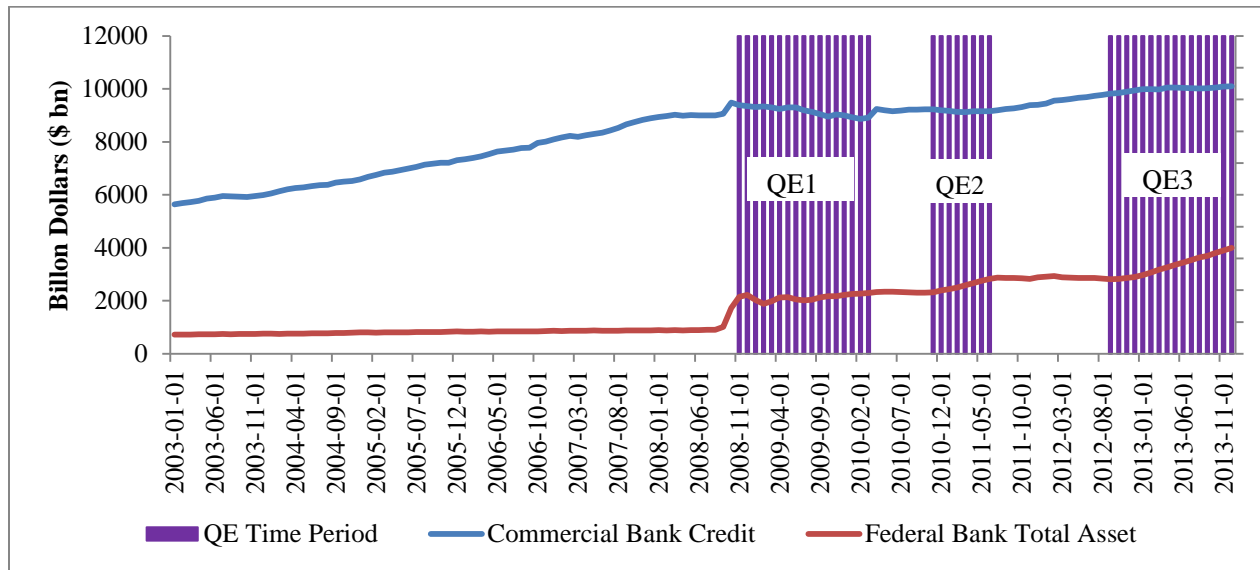
This table reports results of our two stage least square analyses. The first stage dependent variable is bank credit changes and instrument variables are S & P 500 market cap and Changes in Fed Reserve Assets. Second stage dependent variable, in are Amihud Illiquidity and Spread. Second stage main independent variables of interest are the interactions between the predicted values (Fitted value) from first stage regression and different Quantitate Easing Periods (QE-1, QE-2 and QE-3) and recession period. Control variable are excess returns defined as the difference between individual stock return and 3 month T-bill rate, Short Interest is number of stocks held short in billions, Log (Market Cap) is the natural log Market Capitalization of stocks, Fed Stress Indicator measures the level of stress in banking sector and Return Variance captures stock volatility. Heteroscedastic standard errors are in parentheses, and \*\*\*, \*\*, and \* indicate statistical significance at 1% level, 5 % level and 10% levels.

Variable	Stage I	Stage II	
		I- Amihud	II- Spread
Intercept	-0.7270*** (0.010)	339.9244*** (7.603)	5.4994*** (0.012)
Lagged Change Fed Asset (%)	-0.0270*** (0.000)		
S & P 500 Market Cap (MN)	0.1830*** (0.001)		
Excess Returns	-0.0380*** (0.001)	3.1753*** (0.265)	0.0395*** (0.001)
Short Interest (billions)	-0.0250*** (0.000)	0.4330*** (0.040)	-0.0062*** (0.000)
Log (Market Cap)	-0.0010*** (0.001)	-23.7554*** (0.499)	-0.3341*** (0.001)
Fed Stress Indicator	0.3290*** (0.002)	18.0085*** (2.591)	0.4778*** (0.005)
Return Variance	0.0030*** (0.000)	-0.1964*** (0.059)	-0.0002 (0.001)
QE1 Dummy*Fitted Value		-6.3537* (3.398)	-1.6616*** (0.0270)
QE2 Dummy*Fitted Value		72.7509*** (14.608)	0.7981*** (0.039)
QE3 Dummy*Fitted Value		83.6748*** (5.687)	1.5104*** (0.012)
Recession Dummy*Fitted Value		4.6473 (10.935)	-0.2523*** (0.019)
No of Observation	506,724	506,724	506,724
Adjusted R Square	0.219	0.0179	0.4382

## Figures

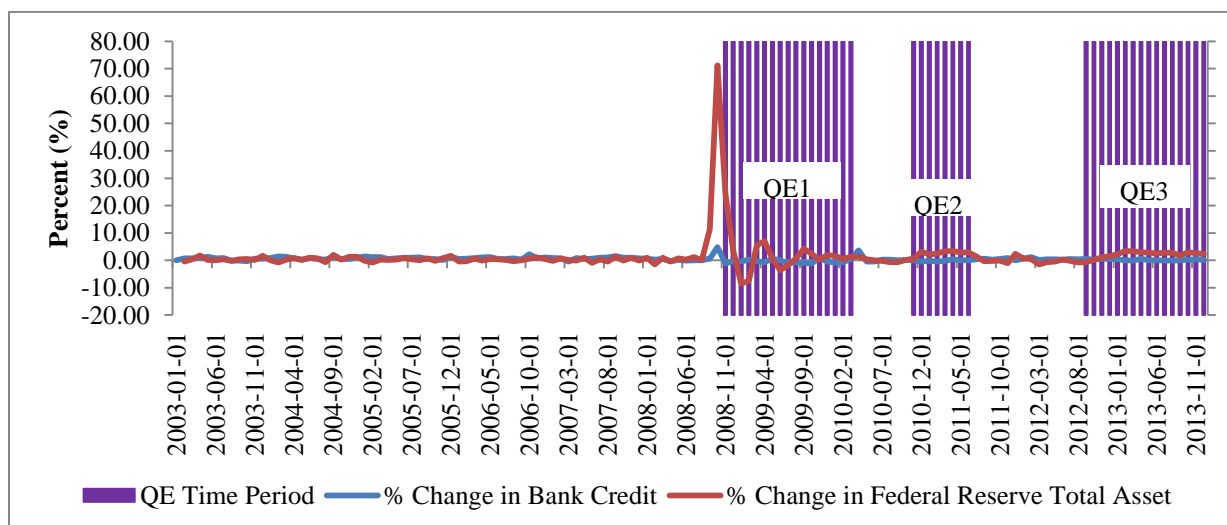
**Figure 1: Federal Reserve Assets and Bank Commercial Credit**

In this figure we plot Federal Reserve banks total asset (blue line) and bank credit of commercial banks (green line). On the horizontal axis is the date and the vertical axis is dollar amount of these series in Millions of dollars. The orange shaded region represents the different quantitative easing (QE) period implemented by United States Federal Reserve Bank.



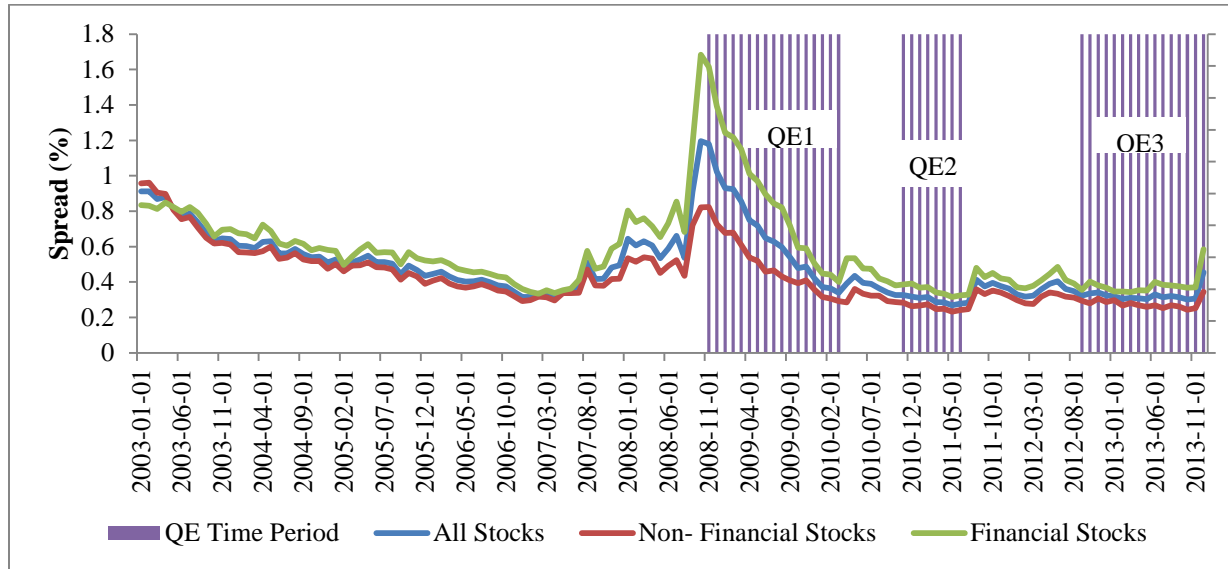
**Figure 2: Monthly changes in Federal Reserve Bank total assets and monthly changes in Commercial Bank total credits.**

In this figure we plot Federal Reserve banks total asset changes (blue line) and bank credit of commercial banks changes in percentage (red line). On the horizontal axis is the date and the vertical axis is the percentage changes. The green shaded region represents the different quantitative easing (QE) period implemented by United States Federal Reserve Bank.



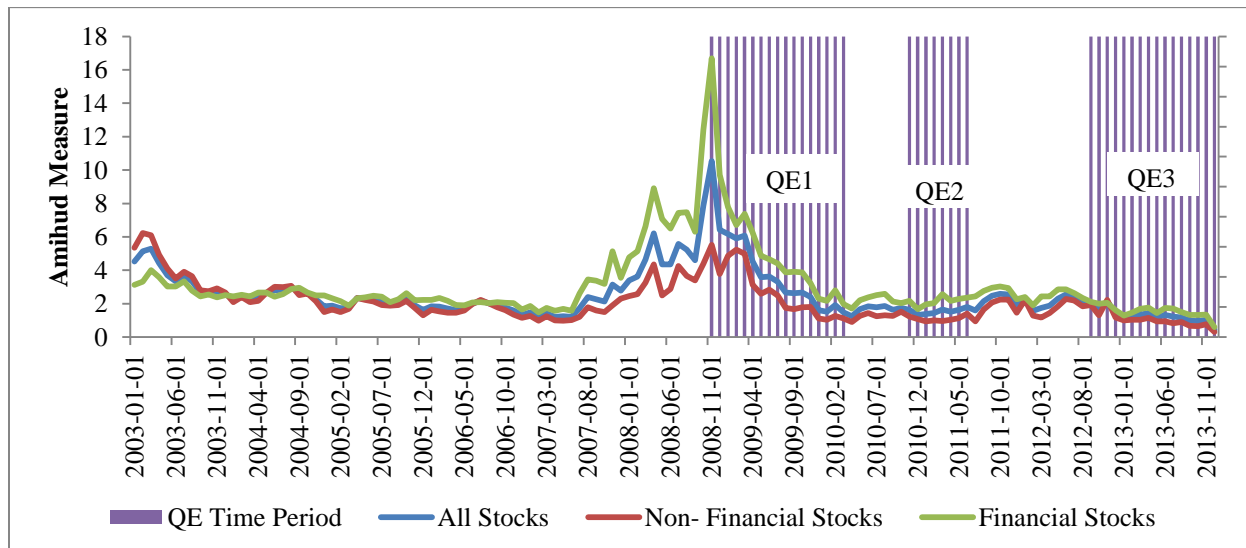
**Figure 3: Amihud Illiquidity**

In this figure we plot the monthly average Amihud measure for all stocks, financial firms and Non-Financial firms. The blue line represents Amihud measure for all stocks, orange line represents Amihud measure for non-financial firms and grey line represents Amihud measure for financial firms. The violet shaded region represents different quantitative easing period in United States.



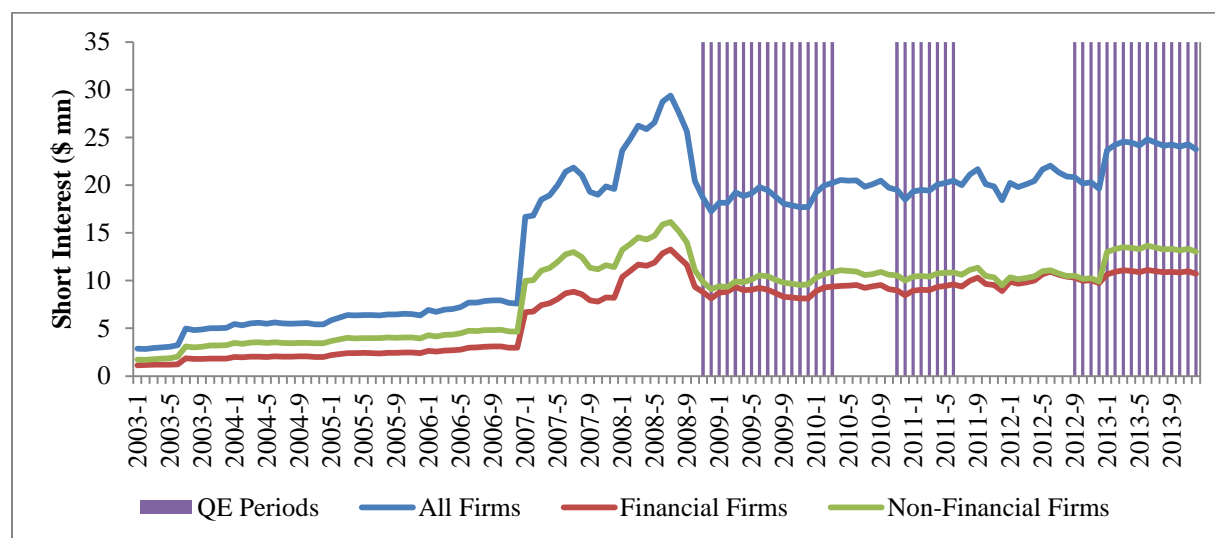
**Figure 4: Spread**

In this figure we plot the average monthly relative quoted spread (Spread) for all stocks, financial firms and Non-Financial firms. The blue line represents Spread for all stocks, orange line represents Spread for non-financial firms and grey line represents Spread for financial firms. The violet shaded region represents different quantitative easing period in United States.



**Figure 5: Short Interest across study Period**

In this figure we plot the monthly average Short Interest for all firms, financial firms and Non-Financial firms. The blue line represents Short Interest for all firms, red line represents Short Interest for financial firms and green line represents Short Interest for non-financial firms. The violet shaded region represents different quantitative easing period in United States.





## Appendix

**Table A1: Variable definition and measurement**

Table describes major variables used in regression analysis.

Variable Name	Short Name	Definition and computation
Spread	Spread	Defined as relative quoted spread. Computed as (Ask Price-Bid price)/ Mid Quote. Mid quote is average value of Ask and Bid Price (Stoll, 2000).
Amihud Measure	Amihud	Ratio of absolute stock return divided by dollar volume. We have used monthly average value of this variable in our analysis. To eliminate scale problem, we multiply this variable by a million (Amihud, 2002).
Short Interest Ratio	SHint	Computed as total stock shorted divided by outstanding shares (Asquith et al., 2005).
Bank Credit of all Commercial Banks	BnkCrd	Total credit available with all the commercial bank. We use monthly average bank credit of all commercial banks. <a href="https://research.stlouisfed.org/fred2/series/TOTBKCR">https://research.stlouisfed.org/fred2/series/TOTBKCR</a>
Total FED Assets	FedAsset	Monthly average of total Assets all Federal Reserve banks. We have used monthly change in total FED Asset. <a href="https://research.stlouisfed.org/fred2/graph/?g=2Rfn">https://research.stlouisfed.org/fred2/graph/?g=2Rfn</a>
Market Capitalization	MCap	Monthly average market capitalization.
Fed Financial Stress Index	FSInd	It measures the degree of financial stress in the markets and is constructed from 18 weekly data series: seven interest rate series, six yield spreads and five other indicators. We have used monthly average value of this variable. <a href="https://research.stlouisfed.org/fred2/series/STLFSI">https://research.stlouisfed.org/fred2/series/STLFSI</a> See the details: <a href="https://research.stlouisfed.org/publications/es/10/ES1002.pdf">https://research.stlouisfed.org/publications/es/10/ES1002.pdf</a>
Excess Return	ExRet	Stock return minus three month treasury bill rate.
Return variance	RetVar	Monthly average of square of stock return.
Recession Dummy	DummyRecess	Variable take value 1 for NBER declared recession periods otherwise 0. <a href="http://www.nber.org/cycles/cyclesmain.html">http://www.nber.org/cycles/cyclesmain.html</a>
QE1 Dummy	DummyQE1	Variable take value 1 for FED's QE-1 period otherwise 0. <a href="https://research.stlouisfed.org/publications">https://research.stlouisfed.org/publications</a>
QE2 Dummy	DummyQE2	Variable take value 1 for FED's QE-2 period otherwise 0. <a href="https://research.stlouisfed.org/publications">https://research.stlouisfed.org/publications</a>
QE3 Dummy	DummyQE3	Variable take value 1 for FED's QE-3 period otherwise 0. <a href="https://research.stlouisfed.org/publications">https://research.stlouisfed.org/publications</a>

**Figure A1: Financial Firms & Non-Financial Firms**

In this figure we plot the financial firms and non- financial firms across our sample period. Green bar indicates non-financial firms and purple bar indicates financial firms.

