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Interbank and Stock Market Liquidity

An Empirical Analysis of the Market Connection in Norway

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Abstract

This thesis is a study of the connection between demand for liquidity in the interbank market and liquidity in the stock market in Norway for the period from 2003 to 2017. The thesis examines whether increased price of liquidity in the interbank market leads banks to explore alternative sources of obtaining liquidity, such as selling financial assets they keep on the balance sheet. This process is termed "liquidity pull-back". To test the liquidity pull-back hypothesis, stocks on the Oslo Stock Exchange are sorted into ten portfolios based on their liquidity. The market share of daily trading volume of each liquidity portfolio is then regressed on the price of liquidity in the interbank market, measured by IBOR-OIS and TED spreads for the currencies USD, NOK and Euro. The expectation of the hypothesis is that the market share of volume of the most liquid portfolio increases relative to less liquid portfolios when the price of liquidity in the interbank market increases.

The alternative hypothesis is portfolio rebalancing as a result of increased uncertainty. This is controlled for with the inclusion of the VIX.

The empirical analysis is supplemented with qualitative analysis which includes interviews with market participants.

The findings of the analysis lend support to the liquidity pull-back hypothesis for the pre-financial crisis period of 2003 to 2007. However, there is no evidence in favour of the hypothesis in the years after the crisis. Reasons for this appear to be low activity in the Norwegian interbank market and regulations making it expensive for banks to keep stocks on the balance sheet. There is stronger evidence to support the portfolio rebalancing hypothesis, as investors reduce equity exposures in times of increasing uncertainty in financial markets.

Preface

This thesis was written as part of my Master of Science in Economics and Business Administration at the Norwegian School of Economics (NHH). The topic of the thesis reflects my interest in the financial markets and the connections that exist between them. Analyzing this research question has been a learning and rewarding experience.

I owe my thanks to several individuals for helping me in the preparation of my thesis.

First and foremost, I wish to express my gratitude to my supervisor, Tommy Stamland, for his counseling on selection of topic, as well as his valuable inputs and criticism throughout the writing process. His knowledge and insight on the subject have significantly improved the final result. Further, I am grateful to Thomas Eitzen at SEB and Vidar Knudsen at DNB for sharing their knowledge of the Norwegian interbank market with me.

Lastly, I would like to thank my family, who always support me and continue to serve as a constant source of motivation.

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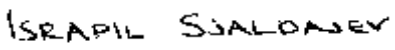

Israpil Sjaldajev

Contents

List of figures

List of tables

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1 Introduction

In the aftermath of the 2008 financial crisis, liquidity became a key topic of discussion, especially in the banking sector and the interbank market. The discussion has since evolved to viewing the importance of liquidity in the broader financial markets. The beginning of the financial crisis has by many been connected to the tripling of the Libor-OIS spread during August 2007. The sharp increase in the spread caused a liquidity shortage and a fall in volume in the interbank market, meaning banks were unwilling to lend out money.

The fall in volume in the interbank market was followed by shocks to other financial markets. Stock prices fell dramatically as major stock markets around the world decreased by 50 %. Therefore, a connection between liquidity in the interbank market and financial markets during shocks and financial crises seems to exist. Research by Hameed, Kang & Viswanathan (2010), among others, seems to confirm this. They find that as financial institutions withdraw from providing liquidity and market participants engage in panic selling, market declines can cause asset illiquidity. Whether the same connection exists in times of normalcy and day-to-day activities is less clear.

Nyborg and Östberg (2013) studied the day-to-day connection between liquidity in the interbank market and financial markets in their paper "Money and Liquidity in Financial Markets". Firstly, the paper introduced the "liquidity pull-back" hypothesis, which studies how demand for liquidity by banks affects activity in financial markets, more specifically the stock market. The liquidity pull-back hypothesis assumes that when lending in the interbank market is expensive, one of the bank's alternatives to obtain liquidity is by selling their financial assets, such as securities. The paper grouped stocks by using Amihud's ILLIQ-measure and studied effects of the pull-back by examining volume on the stock market. Secondly, they controlled for market wide uncertainty and studied its relations on stock liquidity and activity. The authors describe the paper as an *"attempt to bridge two different concepts of liquidity; liquidity as the property of an asset and the central banking concept of liquidity as reserves"*. Nyborg and Östberg performed their analysis on stocks listed on the NYSE, NASDAG and AMEX and the interbank market with its basis on USD Libor-OIS spreads. Their research concludes that there is empirical evidence in favour of the liquidity pull-back hypothesis.

Following previous empirical studies, the main research question in this thesis is whether the liquidity pull-back hypothesis applies to the Norwegian interbank market and stock market. More specifically, the central hypothesis tested in this thesis is:

"Is an increase in the cost of borrowing liquidity in the Norwegian interbank market associated with an increase in the traded volume of liquid stocks on the Oslo Stock Exchange?".

Several analyses are performed in this thesis to investigate this question. Firstly, stock market volume is tested by separating stocks on the Oslo Stock Exchange into 10 portfolios, based on the illiquidity measure proposed by Amihud called "ILLIQ" (Amihud, 2002). Then, each portfolio's market share of volume and relative volume are regressed on Libor-OIS and TED spreads and control variables for the period January 2003 to December 2017, using OLS regression models. Secondly, in order to control for market uncertainty and test the alternative portfolio rebalancing hypothesis, the VIX is introduced to the model. Thirdly, each liquidity portfolio's within month difference in volume is regressed on their average monthly ILLIQ, using a Fama-Macbeth regression procedure. Finally, to supplement the empirical analysis, participants in the interbank market are asked for their comments and input on the presented results.

Thus, the thesis contributes to previous research by applying the methodology to study liquidity in the Norwegian markets. Further, while liquidity in the Norwegian interbank market and liquidity on the OSE have been researched separately, to the author's knowledge, there are few studies that study the connection between the two. Consequently, this thesis gives an insight into the connection between liquidity in Norwegian interbank market and liquidity on the Oslo Stock Exchange.

This thesis is organized as follows: Section 2 presents relevant studies and background on liquidity in the interbank market and stock market respectively. Section 3 presents the data used in the thesis. Section 4 presents the liquidity measures used for the stock market and the interbank market. Section 5 outlines the methodology used in the analysis. Section 6 exhibits the results of the empirical analysis. Section 7 consists of interviews and comments on the findings of the analysis. Section 8 concludes the thesis.

2 Background

In this section, relevant studies on liquidity in the interbank market, liquidity in the stock market, and the connection between the two are reviewed. As the purpose of the thesis is to study the connection between liquidity in the markets, the focus is on literature related to this subject. However, studies on portfolio rebalancing are also reviewed, as this is an alternative hypothesis to the liquidity pull-back hypothesis and therefore of relevance.

2.1 Monetary phenomena and financial markets

A wide set of previous research provide evidence in favour of monetary phenomena, among other factors, affecting stock market returns. Most notably Cutler, Poterba & Summers (1989), examined the fifty largest one-day price changes in the S&P Composite Stock Index from 1926 to 1985. The analysis showed that an increase in the yield of three-month US Treasury bills reduces share values on the stock market. Similarly, Schwert (1981) and Fair (2002) studied the effects of monetary shocks on stock market returns, both showing that monetary shocks have statistically significant effects on returns.

For studies on stock market volume, one can look at the work of Diamond & Verrecchia (1981) and Grundy & McNichols (1989), which studied the effects of private and public information on trading volume. Both conclude that if the released information affects the broader financial markets, such as changes in interest rates and money supply, then trading volume on the stock market is also affected.

As both stock market returns and stock market trading volume are seemingly affected by monetary phenomena, it is then likely that liquidity in the stock market is also affected. As seen in the analysis of US equities by Chordia, Sarkar & Subrahmanyam (2002), which shows that market liquidity plummets in down markets and that an increase in Treasury bond yields can cause investors to reallocate wealth between equity and debt instruments. The paper defines liquidity as the *"ability to buy or sell large quantities of an asset quickly and at low cost"*. The bid-ask spread and relative bid-ask spread were used as measures of liquidity, both of which were shown to increase following an increase in treasury yields. The authors extended their analysis in 2005, in which they provide evidence in favour of causation in the opposite direction. Meaning that liquidity can affect stock prices and trading volume as well.

However, there does not seem to be any analysis or research that attempts to link the interbank market and the stock market, until Nyborg & Östberg (2013), which will be discussed in the next sub-section.

2.2 Interbank market and stock market

The interbank market refers to the informal market where banks can lend or borrow funds, also referred to as liquidity, to and from each other (BIS, 1983). The central bank determines the sum of liquidity available to the market based on its monetary policy and the banks reallocate it amongst themselves. Banks require liquidity for daily transactions such as deposit withdrawals and for capital and liquidity requirements proposed by the Basel Committee (Calomiris, Heider and Hoerova, 2015). Banks normally obtain liquidity through deposits, from the central bank, issuing bonds/certificates, and loans in the interbank market (Hoff, 2011).

Most central banks want to incentivise banks to borrow from each other, rather than from the central bank's discount window. It is therefore more expensive to borrow from the central bank than from other banks or from other sources of liquidity. Similarly, the interest rate on deposits made to the central bank is normally also lower than the interest rate that can be obtained in the interbank market, meaning banks would rather lend funds to other banks. Further, one of the bank's key roles is maturity transformation, whereby short-term customer deposits are transformed into long-term loans (Norges Bank, 2017). Long-term financing requirements are then usually obtained in the bond market, with maturities varying from 3 to 10 years. To manage short-term swings in liquidity, banks have therefore historically used the interbank market to obtain financing through secured or unsecured loans (Norges Bank, 2018).

Unsecured loans make up the largest share of loans in the interbank market (Norges Bank, 2018). The price of an unsecured loan is expressed by a reference rate, which depends on the currency and country in which the bank operates. The reference rates reflect the price of loans with set maturities, ranging from 24-hours ("overnight" or "tomorrow-next"), one week, one month, and up to 12 months. If actual lending activity does not exist, the rates are based on banks' estimates of the rates in such transactions. One such reference rate is Libor. Libor is calculated for ten currencies, based on panel banks' daily responses, in which the panel banks report the rate at which they estimate they could lend or borrow at. The banks' estimates are

dependent on the central bank key rate expectations and a risk premium, where key rate expectations are the most important factor when there is no turbulence in the markets. As an example, for a three-month interbank rate, the most important factor is the average of the key interest rate in the coming three months. This is because the key rate determines the level of the overnight rate in the interbank market. A three-month loan can be replicated by rolling over the overnight rate for three months. The two are then alternatives for a bank when choosing a loan structure, as long as borrowing costs are similar and there are no arbitrage opportunities. Hence, the overnight rate is a link between the key policy rate and the interbank rates.

However, as markets often face turbulence, risk premiums are usually not zero. Risk premiums are varying in nature, depending on the credit risk and availability of liquidity in the market. As risk premiums increase, reference rates increase as well, like they did leading up to the financial crisis in 2008 (Kwan, 2009). As an example, the USD Libor-OIS spread more than tripled in August 2007, increasing from 14 basis points (bps) to 49 in a matter of days. Many have identified this as the beginning of the financial crisis (Hou and Skeie, 2014). The spread reached its highest point a year later, in the aftermath of Lehman Brothers collapse, at 364 bps. During the same time period, stock markets across the world collapsed and indexes such as S&P 500, DAX, Nikkei and OBX declined by more than 40 %.

Furthermore, the interbank market has been shown to have allocational inefficiencies even in times of normalcy (Bindseil, Nyborg & Strebulaev, 2009). Alternative sources of attaining liquidity can then become more attractive. Banks can pull back liquidity from financial markets by selling financial assets they have on the books. Another implication of higher price of liquidity in the interbank market, is that banks may attempt to pass on the increased costs to their customers in the form of higher funding costs and margins. They may also be less willing to lend out money.

This is what Nyborg & Östberg (2013) base the liquidity pull-back hypothesis on. The hypothesis argues that when there is a shortage of liquidity in the interbank market, one should expect an increase in the level of liquidity pull-back by banks, that proceed to sell financial assets such as stocks. Likewise, if banks withdraw money from the markets and are less willing to lend out liquidity, then other market participants may also attempt to replace the lost liquidity provision by selling financial assets. The effects of the pull-back should impact stocks

differently, depending on the liquidity of the stock, and has implications for trade volume and returns. The liquidity of an asset is the cause of the time and the transaction costs required to buy or sell an asset, so that transactions in liquid assets would require less time and less costs compared to transactions in illiquid assets. When a market participant's, such as a bank's, demand for immediate funds suddenly increases, it is therefore most convenient and least expensive to sell the most liquid assets first to obtain the necessary funds in the stock market. The effects of the liquidity pull-back should therefore be reflected with an increase in the trading volume of liquid stocks relative to illiquid stocks. The hypothesis and its expected effects on volume are presented in closer detail in section 5.

2.3 Stock market and uncertainty

Trade volume and returns in the stock market are subject to many different factors, which can cause investors to rebalance their portfolios. Branson (1985) presented the theory of portfolio rebalancing as a result of changes in foreign exchange rates. The theory argues that an increase in foreign exchange rates should be followed by increased demand for domestic assets by investors. Hau and Rey (2005) follow up on the theory in their analysis of equity flows between USA and France, Germany, Switzerland, U.K., and Japan as a result of changes in exchange rates. The analysis shows that equity is reallocated away from the appreciating market.

Portfolio rebalancing can also occur as a result of increased market uncertainty and volatility, as a result of which active investors decrease the weights invested in risky assets, reducing their equity exposures (Zandieh and Mohadessi, 2009). This is shown to be the case by Ang, Gorovvy & Inwegen (2011), whose analysis shows that hedge fund leverage is decreasing with higher volatility, measured with the VIX. This is the basis for the portfolio rebalancing hypothesis (Nyborg and Östberg, 2013). Similar to the liquidity pull-back hypothesis, the hypothesis argues that as investors shift investments from risky assets, such as stocks, they would prefer to do so by minimizing the total price impact. This means that they would sell liquid stocks first, which should be reflected through a relatively higher increase in the volume of liquid stocks compared to less liquid stocks. The portfolio rebalancing hypothesis is also expanded upon further in section 5.

3 Data

Section 3.1 presents data used to analyse stock market trade volume, as well as the variables used to measure liquidity of stocks and sort them into portfolios as outlined in section 4.1. Section 3.2 is the data used for the money market spreads to obtain price of liquidity, and Section 3.3 are daily observations of the VIX as a measure of market volatility.

3.1 Oslo Stock Exchange

The Oslo Stock Exchange (OSE) is the main regulated market for securities in Norway. OSE is a relatively small exchange, with a total market value of NOK 2460 million as of December 2017. There were 202 companies listed in 2017, concentrated mainly in energy, shipping and seafood. In terms of market capitalisation, the three biggest firms constituted 44 % of the market in December 2017.

The stock market data used in this thesis is extracted from Børsprosjektet NHH's database "Amadeus", which provides stock and company information of companies listed on the Oslo Stock Exchange. Funds and derivatives are not included, only listed stocks. Further, only ordinary shares are included, which excludes B shares and Primary Capital Certificates.

The selected time-period is 2003-2018, with daily observations, yielding a total of 795 040 observations across eight variables, with an average of 204 stocks per day. The stock price data is available going back further than 2003, but the frequency of missing daily observations is higher. Further, due to lack of availability of daily observations from the money market data prior to the year 2003, the cut-off point was chosen here. The extracted variables from Amadeus are date, company name, opening price, closing price, bid price, offer price, daily traded volume (in NOK) and share turnover.

The selected variables are then filtered and cleansed. Observations with missing values are excluded. Further, observations with absolute rate of return equal to zero are excluded, as this is an indication of stale prices and low/spurious volume (Nyborg and Östberg, 2013).

This reduces the number of observations by 28 %, to a total of 568 705 observations.

3.2 Money market

The money market data used is the three-month Libor-OIS spread and TED spread for the currencies USD, Euro, and NOK. All obtained from Thomson Reuters Datastream.

The USD Libor-OIS spread refers to the difference between the three-month USD Libor and the three-month USD overnight index swap (OIS) rate. The USD Libor-data has 4173 daily observations, for the time-period 2002-2017. While the OIS has daily observations from 2003, yielding 3680 observations. Thus, the Libor-OIS spread has 3680 observations.

The US TED spread is the difference between the three-month USD Libor and the three-month T-Bill rate. T-Bill rate data with daily observations is available for the same time-period as Libor, hence there are 4173 observations for the TED-spread.

The Nibor-OIS spread is the difference between the three-month Nibor and the Norwegian Central Bank's expected key interest rate. The OIS- rate is the fixed rate in an interest swap, in which a floating interest rate is swapped with a fixed rate, for a certain period. The OIS-rate is not available for Norway until. The Norwegian Weighted Overnight Average (NOWA) was introduced in 2011. As part of Norwegian central bank's liquidity policy, the overnight rate and the key interest rate are closely tied together, which is reflected with the NOWA on average being equal to the central bank's key interest rate since its introduction. Since NOWA is only available from 2011, the expected key interest rate is used as a proxy for the OIS-rate for the entire sample period. The Norwegian TED spread is the difference between the three-month Nibor and the three-month T-bill rate in Norway. Both spreads are based on daily observations for the period 2003-2017, yielding total observations of 3908.

The Euribor-OIS spread refers to the difference between the three-month Euribor and three-month EONIA, while the Euro TED spread is the difference between three-month Euribor and three-month German T-bill rate. Both are daily observations from 2002-2017, yielding 4091 observations.

3.3 Market wide uncertainty

As a measure of uncertainty for financial markets, a volatility index is used. The CBOE Volatility Index, also known by its ticker symbol VIX, is downloaded from Thomson Reuters Datastream for the time-period 2003-2017, there are a total of 4028 daily observations.

4 Liquidity and uncertainty

4.1 Measuring liquidity in the stock market

A stock is said to be liquid if it can be sold or bought quickly at low transaction cost with a small price impact. There are many measures of illiquidity, the one employed in this paper is Amihud's "ILLIQ", which is the daily ratio of absolute stock return to its volume. Since it is a low-frequency measure, the ILLIQ is computable for a large range of stocks over a long time-period (Amihud, 2002).

ILLIQ is defined as:

$$ILLIQ_{it} = \left(\frac{|r_{it}|}{Volume_{it}}\right) * 10^6$$

Where *i* is stock and *t* is day. Based on this, $|r_{it}|$ is the absolute value of each individual stock's daily rate of return based on the opening and closing price, and $Volume_{it}$ is the NOK volume. A large ILLIQ indicates that a stock is illiquid, as the price impact per unit of volume is large. The ILLIQ is multiplied with 10^6 to measure in millions and make numbers more presentable.

ILLIQ is then measured on a monthly basis for each stock:

$$ILLIQ_{ij} = \underset{t \in month_j}{\text{Average}} \left(\frac{|r_{it}|}{Volume_{it}}\right) * 10^6$$

And can also be expressed as:

$$ILLIQ_{ij} = \underset{t \in month_j}{\text{Average}}\, ILLIQ_{it}$$

The average is taken across observations for stock *i* in month *j* when recorded volume is positive.

The average ILLIQ of each stock is used to sort stocks into ten portfolios (deciles) based on the previous month. Portfolio 1 consists of 10 % most liquid stocks in the sample, while Portfolio 10 consists of the 10 % least liquid stocks in the sample.

Descriptive statistics for all 10 portfolios in the sample period are presented in Table 1. Portfolio 1 has a significantly lower ILLIQ-measure than Portfolio 10, with a mean and median of 0.001 and 0.000 for Portfolio 1 and 14.582 and 4.093 for Portfolio 10, respectively. The mean and median for the pooled sample is 1.636 and 0.071. As the ILLIQ is multiplied by 10^6, volume is measured in millions. This means that a daily volume of 1 million NOK implies a price change of 7 % for the median company in the sample. Overall, there is a lot of variation across portfolios.

Table 1: Descriptive statistics of ILLIQ

	Portfolio										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**All**
Mean	0.001	0.004	0.013	0.032	0.063	0.116	0.210	0.401	0.938	14.582	1.636
SE	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.004	0.011	0.685	0.066
SD	0.003	0.008	0.014	0.026	0.047	0.078	0.139	0.272	0.725	44.098	13.901
Med	0.000	0.002	0.008	0.023	0.047	0.095	0.181	0.362	0.760	4.093	0.071
Min	0.000	0.000	0.002	0.005	0.008	0.016	0.027	0.046	0.100	0.376	0.000
Max	0.026	0.055	0.097	0.141	0.211	0.341	0.649	1.360	3.687	441.452	441.452
N	4638	4349	4431	4434	4330	4452	4425	4350	4429	4140	43978

The purpose of separating stocks into portfolios is to study variations in volume across liquidity portfolios using two volume measures: market share of volume and relative volume.

Market share of volume is calculated for each liquidity portfolio, *P*, as a percentage of total volume on day *t*:

$$Market\ share\ of\ volume\ portfolio\ P_t = \frac{Volume\ of\ portfolio\ P_t}{Total\ aggregate\ volume_t}$$

where volume is measured in NOK.

Relative volume, for each pair of liquidity portfolios, *P* and *H*, where P > H, is calculated on day t as:

$$Relative\ volume\ of\ portfolio\ P\ to\ H = \frac{Volume\ portfolio\ P_t}{Volume\ portfolio\ H_t}$$

Summary statistics of market share of volume of each liquidity portfolio are presented in Table 2.

Table 2: Market share of volume (in %)

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mean	83 %	9 %	3 %	2 %	1 %	1 %	0 %	0 %	0 %	0 %
SE	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
SD	15 %	5 %	3 %	2 %	2 %	2 %	2 %	2 %	2 %	1 %
Med	86 %	8 %	3 %	1 %	1 %	0 %	0 %	0 %	0 %	0 %
Min	55 %	1 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
Max	98 %	46 %	46 %	43 %	47 %	39 %	47 %	33 %	37 %	41 %
N	3897	3897	3897	3897	3897	3897	3897	3897	3897	3897

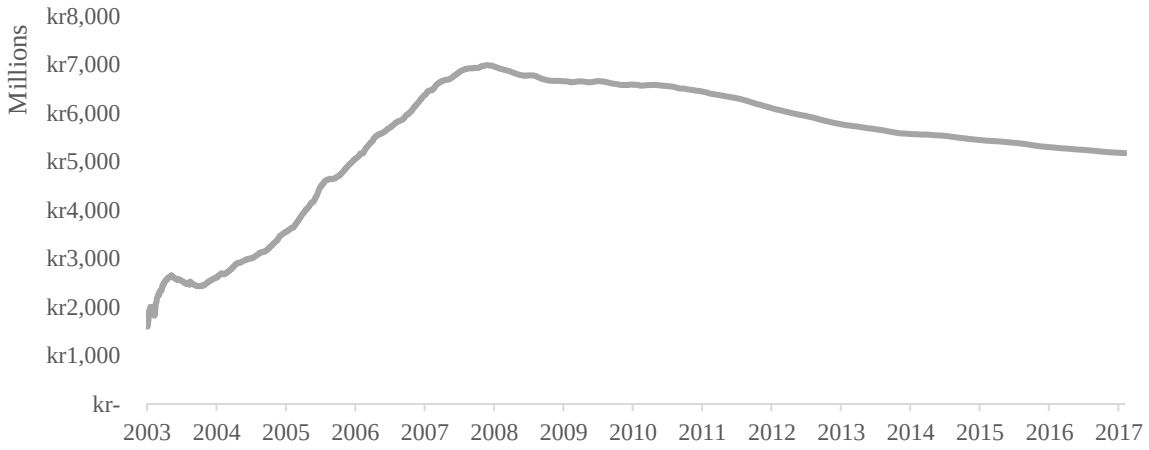
The average market share of volume of Portfolio 1 is 83 % and the five most liquid portfolios account for more than 95 % of volume on a given day. Portfolio 1 to 5 are therefore substantially larger than 6 to 10 in terms of volume. However, there is variation of volume share day to day, and Portfolio 1 has a standard deviation of 15 %.

For comparison, Nyborg and Östberg's analysis of US stocks yielded an average market share of volume of 75 % for the most liquid portfolio, with a standard deviation of 4 %. There appears to be higher concentration of volume in the most liquid portfolio for stocks on the OSE in comparison.

The Oslo Stock Exchange grew significantly over the sample period, both in terms of value and activity. The average daily trade volume on the exchange increased from 1.8 billion NOK in 2003 to 3.7 billion NOK in 2017. The development is shown in Figure 1.

Figure 1: Daily average volume on the Oslo Stock Exchange (2003-2017)

Data obtained from Børsprosjektet NHH «Amadeus»



4.2 Liquidity in the interbank market

One of the banks' important roles in the financial systems across the world is creating liquidity (Berger and Bouwman, 2009). Interbank markets allow liquidity to be transferred from one bank to another based on the demand and supply, i.e. from banks with surplus liquidity to banks with a deficit.

In the interbank market, liquidity is referring to a bank's availability of reserves. The demand for liquidity comes from banks' need to pay or service its commitments such as large deposit withdrawals or loan repayments, as well as liquidity requirements implemented by government regulations. As previously mentioned, banks obtain new liquidity by borrowing in the market or from the central bank, or by selling assets such as securities. Demand for liquidity in the interbank market is impacted by how difficult or how expensive it is to obtain funds. If the price of liquidity of is high, banks may choose other options. How expensive liquidity is, is usually measured by comparing money market rates.

One measure of "tightness" in interbank lending is the difference between an interbank rate and a treasury rate for the same time horizon, known as the TED spread. Usually it is the difference between the 3-month Libor and the 3-month Treasury bill rate. The TED spread is indicative of the investors measure of risk, as the treasury bills are meant to be riskless.

Another measure for funding liquidity is the Libor-OIS (overnight index swap) spread. Libor (London Interbank Offered Rate) is a reference rate, based on the estimates of a panel of banks. The estimates depend on two key factors, expectations for the central banks key interest rate and risk. In times of normalcy and low uncertainty, it is the expected key interest rate that is the determining factor. A bank that wishes to borrow a fixed quantity of liquidity for a fixed amount of time may borrow from another bank, where the interest is Libor. If the time horizon is three months, then the average expected key interest for the next three months is of relevance, as the alternative is to borrow the funds overnight from the central banks facilities and roll it over every day for three months. Arbitrage theory indicates that the cost of borrowing for the two alternatives should be equal to zero, given that risk premiums are equal to zero. This creates a link between the interbank rates and the expected overnight rate, which in turn is closely linked to the key interest rate. But, in reality risk premiums are not equal to zero, as lending money to other banks entails risk and markets often face turbulence, so that the cost of borrowing from another bank is higher. However, borrowing overnight entails a quantity risk, as a bank cannot be sure that it will be able to obtain the desired quantity of liquidity every day for three months. The Libor-OIS spread is therefore a useful measure for the price of liquidity. Nyborg and Östberg (2013) argue that this spread is a more precise measure of tightness in the interbank market, as it is the difference between two interbank rates, unlike the TED spread.

Libor is calculated for ten currencies based on panel banks' daily responses to the British Bankers Associations, in which the panel banks report the rate at which they estimate they could lend or borrow at. Nibor is not reported to the BBA. Instead, six panel banks in Norway report their estimate of lending or borrowing rate based on the USD Libor and an added currency swap rate (Norges Bank, 2011). The currencies used in this analysis are USD, NOK and Euro, which yields the USD Libor-OIS, Nibor-OIS, and Euribor-OIS spreads. The TED spread for all three currencies is also used. USD, NOK and Euro are used because Norwegian banks' short-term and long-term debt consists almost entirely of these three currencies (Norges Bank, 2017). Changes in the money market spreads for these rates are therefore most likely to affect Norwegian banks' ability to obtain liquidity in the interbank market.

Descriptive statistics of the TED spread and Libor-OIS spread for USD, NOK, and Euro are presented in Table 3. The mean for both spreads is the highest in Norway, with 44.36 for the

TED spread and 43.65 for Nibor-OIS spread. The lowest is in the Eurozone 30.10 for TED spread and 21.00 for Euribor-OIS spread. This is for all days in the sample period.

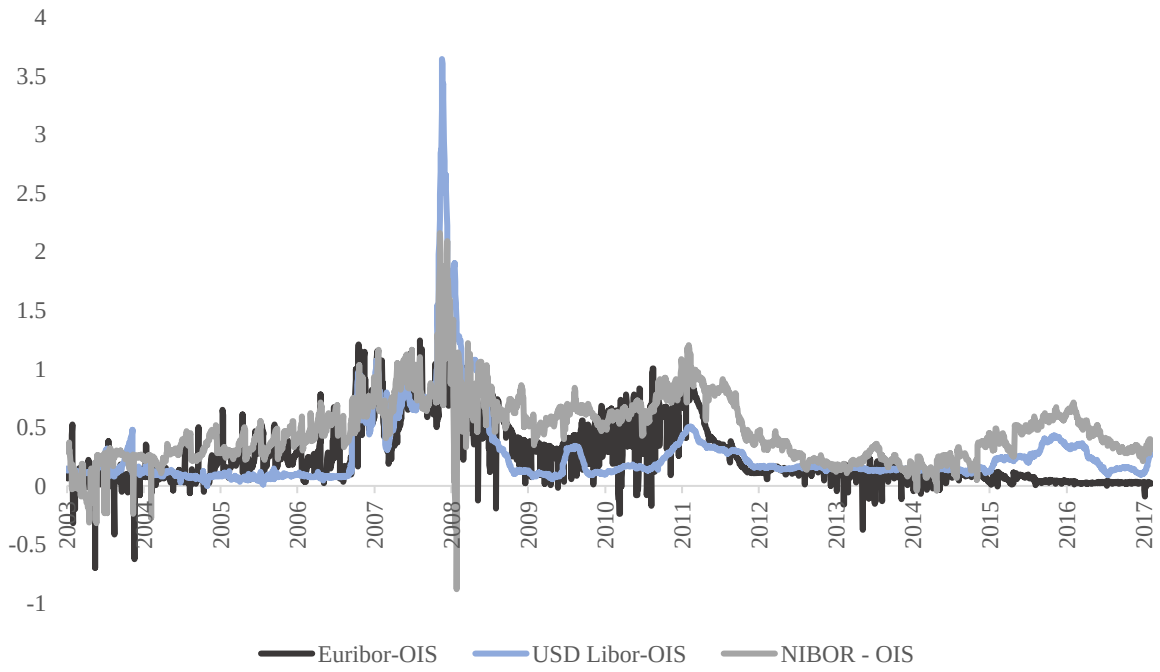
Table 3: Descriptive statistics of money market spreads

	Units	Mean	SE	SD	Median	Min	Max	N
EURO TED	bps	30.10	0.54	35.00	22.00	0.00	291.00	4091
EURIBOR - OIS	bps	21,00	0.33	28.00	12.00	-116.0	170.00	4091
USA TED	bps	39.49	0.62	41.62	26.41	8.00	457.88	4173
USD LIBOR - OIS	bps	27.87	0.53	33.38	15.60	0.00	364.38	3680
NORWAY TED	bps	44.36	0.53	34.03	39.00	0.00	391.00	3908
NIBOR - OIS	bps	43.65	0.49	31.73	43.00	-128.00	216.00	3908

Figure 2 displays the development in the Libor-OIS spreads for the three currencies from 2003 until 2017, which are shown to be highly correlated. In 2007, the sharp increase in the price of liquidity that occurred leading up to the financial crisis can be observed. In 2008, the spreads increase by several orders of magnitude following the default of the Lehman Brothers.

Figure 2: Money market spreads from 2003 to 2017

Data obtained from Thomson Reuters Datastream



4.3 Uncertainty in financial markets

As a proxy for uncertainty in financial markets, the CBOE Volatility Index ("VIX") is used. The VIX was initially introduced in 1993 as an index for futures and option contracts and is a measure of the 30-day volatility in the stock market based on the S&P 500 index options. In later years, the volatility index has become a benchmark for uncertainty in the broader financial markets and has been applied to other financial securities, industries and countries (Whaley, 2008).

The VIX is forward looking and a measure of the risk an investor can expect in the short-term. It is expressed in percentage points, so that VIX equal 10 represents an expected change of maximum 10 % in the next 30 days. This variable is used to test the portfolio-rebalancing hypothesis introduced in section 2.3. The expectation is that as a result of increased volatility, investors seeking to reduce their equity exposures, will wish to do so with the most cost and time-efficient method. This would imply that investors would seek to sell the most liquid stocks first and increased trading activity in the stock market should therefore have a relatively stronger impact on the volume of liquid stocks compared to less liquid stocks.

Table 4: Descriptive statistics for the VIX

This table summarizes the observations from the CBOE Volatility Index for the period 01.01.2003 – 31.12.2017

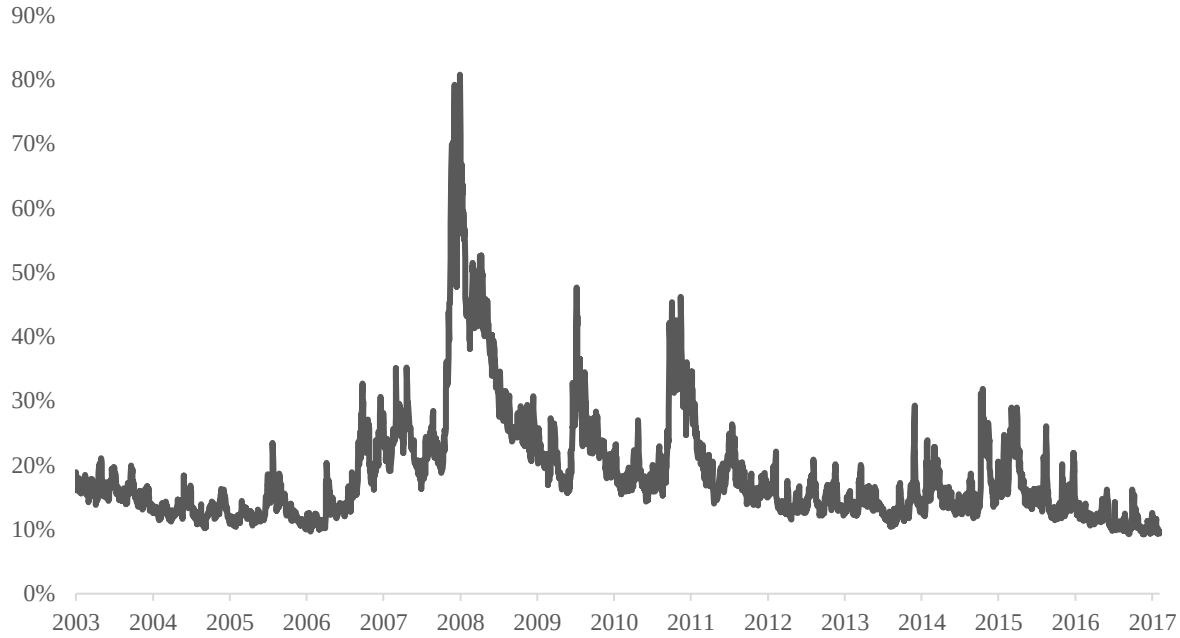
Variable	Mean	Std. Error	Std. Dev	Min	Max	N
VIX	18.87	0.15	9.01	9.23	80.74	3776

Figure 3 displays the development in the volatility index from 2003 until 2017. The index tends to increase during times of political or financial uncertainty. Most notable is the sharp increase of the VIX during the financial crisis in 2008, reaching an all-time high of 80.

The volatility index and the money market spreads are highly correlated, both historically and in the sample period. The VIX and the USD Libor-OIS have a correlation coefficient of 0.76 for the period 2003-2017. Nibor-OIS and Euribor-OIS have a lower correlation with the VIX, with 0.57 and 0.31 respectively for the period 2003-2017.

Figure 3: Development of the VIX from 2003 until 2017

Data obtained from Thomson Reuters Datastream



5 Methodology

In this section, the methodology used to test the liquidity pull-back hypothesis in Section 2 is presented. There are four stages to the methodology. First, a simple OLS-regression to test for a link between the price of liquidity in the interbank market and the market share of volume in the stock market. Second, expand the model by introducing control variables and implementing multiple linear regressions. Further, attempt to distinguish between the liquidity pull-back hypothesis and the portfolio rebalancing hypothesis. Third, re-run the regressions using relative volume instead of market share of volume. Fourth, apply Fama-Macbeth regression using within month variations in volume.

5.1 Simple linear regression

Simple linear regression is used to explain one variable in terms of another. The model has weaknesses as it does not control for many factors, which can cause omitted variable bias. However, it can serve as a basis point, which further analysis can be expanded upon.

5.1.1 Market share of volume on the spreads

To test for a relationship between liquidity in the interbank market and the stock market, one can run regressions of each liquidity portfolio's market share of volume as the dependent variable and Libor-OIS or TED spread as the independent variable.

For each liquidity portfolio, the following time-series regression, using daily observations from the sample period, is applied:

$$Y_t = \alpha + \beta_1 Spread_t + \varepsilon_t \qquad (1)$$

Where:

$$Y_t = \frac{Market\ share\ of\ volume\ portfolio\ P_t}{mean(Market\ share\ of\ volume\ portfolio\ P)}$$

The market share of volume of each portfolio is mean-adjusted by its time-series average to allow for comparisons across groups.

By running this regression for all 10 liquidity portfolios, one can observe how changes in the spread impact the market share of volume of each portfolio. The expectation is that the coefficient on the spread will be positive for the most liquid portfolio and negative for the least liquid portfolio. Meaning an in increase in the spread is reflected by an increase in the market share of volume of liquidity Portfolio 1 and a decrease in the market share of liquidity Portfolio 10. Further, coefficient is expected to be decreasing as one goes from Portfolio 1 to Portfolio 10.

Lagged dependent variables are included when the effects of past results are assumed to persist and are reflected by the autoregressive effect of lagged Y_t (Keele and Kelly, 2005). In the specified model above, the market share of volume of liquidity Portfolio P on day t might be influenced by the market share of volume on day t-1. Therefore, the model is expanded by including the lagged dependent variable as an independent variable:

$$Y_t = \alpha + \beta_1 Spread_t + \beta_2 Y_{t-1} + \varepsilon_t \quad (2)$$

Where:

$$Y_{t-1} = \frac{Market\ share\ of\ volume\ portfolio\ P_{t-1}}{mean(Market\ share\ of\ volume\ portfolio\ P)}$$

The inclusion of a lagged dependent variable means this is a finite distributed lag (FDL) model, more precisely an FDL model of order one (Wooldridge, 2016). Since this is time series data, there is reason to worry that there is autocorrelation, meaning the residual at one point of observation is correlated with another residual. This is a violation of an OLS assumption and leads to incorrect estimates of the standard errors of the estimated coefficients. One solution to correcting for autocorrelation is the inclusion of a lagged dependent variable (Keele and Kelly, 2005).

5.1.2 Market share of volume on market uncertainty

While the model presented in the previous subsection can be used to test the implications of the liquidity pull-back hypothesis, it is hard to distinguish whether the results are driven by

the factors mentioned in the hypothesis or by exogenous factors that the model does not account for.

A key concern with the simple linear regressions in the previous subsection is whether the estimated outputs are a result of liquidity pull-back by banks and other financial institutions, or whether they are the result of investors rebalancing their portfolio as a result of market-wide uncertainty. This is the portfolio rebalancing hypothesis. The idea behind the hypothesis is that higher uncertainty in the broader financial markets could increase the credit spread, as banks are now taking on more risk. Similarly, due to higher uncertainty, investors in the stock market might seek to reduce their exposure to the uncertainty by liquidating their equity holdings. If they were to sell financial securities, they would prefer to do so with liquid securities to minimize price impact, same as the banks. One would expect that this is reflected in relatively higher trading volume for the liquid stocks compared to the less liquid stocks. Similarly, a fall in uncertainty in the markets should be followed with investors increasing their equity exposure and purchasing stocks.

To test the implications of the portfolio-rebalancing hypothesis, the following model is used:

$$Y_t = \alpha + \beta_1 Marketuncertainty + \beta_2 Y_{t-1} + \varepsilon_t \qquad (3)$$

Where Y_t and Y_{t-1} are still the mean-adjusted market share of volume and its lagged value, while $Marketuncertainty$ is the VIX.

If portfolio rebalancing is present in the data, the coefficient of the VIX is expected to behave similarly to the coefficient of the Libor-OIS and TED spreads in the previous model. The coefficient should be positive for the most liquid stocks (Portfolio 1) and negative for the least liquid stocks (Portfolio 10). Meaning that if market uncertainty changes, there is relatively higher activity in the most liquid stocks compared to the less liquid stocks. Further, the coefficient should be decreasing as one moves from Portfolio 1 to Portfolio 10.

5.2 Multiple linear regression

The main drawback of using simple regression analysis is that it makes it difficult to draw ceteris paribus conclusions about the link one is testing for. Multiple regression analysis allows for control of other factors that affect the dependent variable and can therefore help in the search for causality. Further, adding more factors that are useful for explaining the dependent variable, can help explain more of the variation as well.

5.2.1 Distinguishing between the spreads and uncertainty

In order to attempt to distinguish between the hypotheses presented in the previous subsection, one can obtain the part of the spread that is uncorrelated to the market uncertainty and vice versa.

This can be done by initially applying the following regression:

$$Z_t = \alpha + \gamma X_t + \varepsilon_t \tag{4}$$

Where Z_t is the Libor-OIS and X_t is the VIX, or vice versa. The residuals from this regression are uncorrelated with the independent variable, based on the assumption of zero conditional mean being true. The residuals, $Res_{Z|X}$, are then included as an independent variable in the multiple linear regression model:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \varepsilon_t \tag{5}$$

Where X_t is either the Libor-OIS spread or the VIX, depending on which was used as the dependent variable in the previous equation. If the effects of portfolio rebalancing and liquidity pull-back are both present in the data, the expectation is that the coefficients on X_t and $Res_{Z|X,t}$ will be positive for portfolio 1 and negative for the less liquid portfolios. The coefficients should also be decreasing from Portfolio 1 to Portfolio 10.

5.2.2 Introducing control variables

To further test whether the implications of the liquidity pull-back hypothesis and the results of the model in the previous section, control variables are introduced. Initially five control variables are introduced, which yields the following model for each portfolio:

$$Y_t = \alpha + \beta_0 Spread + \beta_1 Y_{t-1} + \beta_2 Res_{Z|X} + \beta_3 Return_t + \beta_4 BidAskRelative_t + \beta_5 Marketvolume_t + \beta_6 Oilprice_t + Turnover_t + v_t \quad (6)$$

The first control variable, $Return_t$, is the equally weighted daily market return on the Oslo Stock. Previous research, such as by Gallant, Rossi & Tauchen (1992), suggests that returns can affect the aggregate volume on the market.

The second control variable, $BidAskRelative_t$, is the relative bid-ask spread of the stocks in each portfolio. This was found by first finding the daily relative bid-ask spread of each stock as a fraction of the stock's closing price. Then, the monthly average relative bid-ask spread of each stock was found and averaged for stocks in each liquidity portfolio, as sorted in 2.1.1. The bid-ask spread is a popular and frequently used measure for the liquidity of a stock and may pick up differences in the liquidity of stocks not captured by the ILLIQ.

The third control variable, $Marketvolume_t$, is the daily NOK volume of the market. The variable is normalised by dividing it with average market volume of the past 5 days. This variable is used to control for any deviations from the short-term average.

The variable $Oilprice_t$ is the price of a barrel of brent oil and is included because the Oslo Stock Exchange has several large companies operating in the oil industry and stock market volume could therefore vary depending on the price of oil.

$Turnover_t$ is the market share of share turnover of each liquidity portfolio as a percentage of total share turnover for the market each day. This variable is also a liquidity measure and is also used to control for differences in liquidity that may have not been captured by the ILLIQ. Descriptive statistics for all control variables are in Appendix A.

5.2.3 Decomposing into periods

In order to be examine how the results of the analysis are affected by the financial crisis, the sample period is further divided into three sub-periods: pre-financial crisis, financial crisis, and post-financial crisis.

The financial crisis is by most believed to have begun in July 2007, with the burst of the housing bubble (Hausman & Johnson, 2014). This was accompanied by a sharp increase in Libor-OIS and TED spreads, both of which more than tripled from the previous month in August 2007. The pre financial crisis period is therefore set as November 2003 until June 2007.

There is far less agreement on when the financial crisis ended, as there are different indicators such as the stock market, unemployment rate and GDP growth. The developments in the stock market are more relevant to this thesis and the cut-off point is therefore selected based on the stock market. Based on the volatility of stock market returns, the financial crisis ended at the end of 2009 (Baur, 2009).

The post-financial crisis period is then from January 2010 until the end of the sample period, which is December 2017.

5.2.4 Relative volume

The dependent variable market share of volume is now replaced with relative volume to see whether results are driven by the most liquid stocks' or if they reflect the overall market. Repeating the steps in the previous sections with relative volume as the dependent variable is also a method to re-examine the results of the previous section and provides a robustness check.

The relative volume measure was presented in section 2.1.1. The measure is now mean adjusted with its time series average, so that the dependent variable is:

$$Y_t = \frac{Relative\ volume\ portfolio\ P_t\ to\ H_t}{mean(Relative\ volume\ portfolio\ P\ to\ H)}$$

And the model is:

$$Y_t = \alpha + \beta_0 Spread_t + \beta_1 Y_{t-1} + \beta_2 Res_{Z|X} + \beta_3 Return_t + \beta_4 BidAskRelative_t + \beta_5 Marketvolume + \beta_6 Oil\ price_t + \beta_7 Turnover_t + v_t \quad (6)$$

Where the independent variables are the same as previously defined.

The expectation is that the liquidity pull-back hypothesis applies to all liquidity groups. This should be reflected with the coefficient on the spread being negative for all portfolio combinations, as relative volume is measured in terms of the volume of the less liquid group divided by the volume of the more liquid group.

5.2.5 Volume on high and low spread days

This subsection presents the model using Fama-Macbeth method for regressions of liquidity portfolios' within month differences in volume on days with high and low Libor-OIS/TED spread. The within month differences for volume are found by: (i) Selecting the two days with the highest and the two days with the lowest spread for each month, (ii) for the selected days, average the values of each liquidity portfolio's normalised share volume on day *t*, where normalised share volume is:

$$Normalised\ share\ volume\ portfolio\ P_t = \frac{Volume\ portfolio\ P_t}{\frac{\Sigma_{i=1}^{5} Volume\ portfolio\ P_{t-i}}{5}}$$

Where share volume is the number of shares that were traded for each stock on day *t*, which are averaged for each portfolio. As share volume is not dependent on the volume of other portfolios, like the market share of volume and relative volume used above, they can be high or low simultaneously across portfolios.

This creates two time series variables, one with volume for stocks on high spread days and one with volume for stocks on low spread days. The difference between these two variables is then used as the independent variables in a Fama-Macbeth procedure for cross-sectional regressions:

$$HSVolume_{P,j} - LSVolume_{P,j} = \alpha_j + \beta_j ILLIQ_{P,j-1} + \varepsilon_{P,j} \quad (7)$$

Where, $HSVolume_{P,j}$ is the normalised share volume of Portfolio P in month j on days with the highest spread and $LSVolume_{P,j}$ is the same for days with the lowest spread. $ILLIQ_{P,j-1}$ is the mean ILLIQ from the previous month for stocks in each portfolio.

6 Empirical results

In this section, the results of the analyses', based on the methodology in the previous section, are presented. First, the results of the simple linear regression model are expanded upon. Second, the analysis is extended to multiple linear regressions with control variables. Third, results of the analysis using relative volume as the dependent variable are presented. Fourth, Fama-Macbeth regressions using share volume are considered. Lastly, results are compared with previous research.

6.1 SLR Results

6.1.1 Market share of volume on spread

The results from regressing the USD Libor-OIS (Panel A) and TED spread (Panel B) on the market share of volume for the ten liquidity portfolios are presented in Table 5. The findings in Table 5 support the liquidity pull-back hypothesis and are in line with the outlined expectations.

The beta coefficient on *Libor-OIS* is positive for the most liquid portfolio (portfolio 1), this suggests that the market share of volume of portfolio 1 increases when *Libor-OIS* increases. The coefficient is negative for portfolios 2 to 10 and decreasing the less liquid the stocks in the portfolio are, indicating a decrease in the market share of volume when *Libor-OIS* increases. The negative coefficients are significant at 1 % or 5 % level, while the positive coefficient on portfolio 1 is significant at 5 % level. The adjusted R^2 is 0.913 for the regression for of liquidity portfolio 1, meaning that 91.3 % of the variation in the market share of volume of portfolio 1 is explained by the included variables. However, this is mostly due to the inclusion of the lagged dependent variable and when this is excluded, the adjusted R^2 drops significantly for all portfolios.

The regressions with the TED spread as the independent variable yield similar results to the regressions with Libor-OIS spread. The coefficient on *TED* is positive for portfolio 1 and negative for the other portfolios. The coefficient is decreasing from portfolio 1 through 10, with the exception of portfolio 9. All negative coefficients are significant at 1 % or 5 % level,

while the positive coefficient on portfolio 1 is significant at 5 % level. The size of the coefficients on the *TED* are similar to the *Libor-OIS* spread and so too is the adjusted R^2.

Table 5: Regressions of market share of volume on USD Libor-OIS and TED spread

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Y_{t-1} + \varepsilon_t$$

Each column represents a separate regression, one for each liquidity portfolio (as sorted in section 4.1). Where Y_t is mean adjusted market share of volume of each portfolio and X_t is the USD Libor-OIS spread (Panel A) and the US TED spread (Panel B). Y_{t-1} is market share of volume of each portfolio for the previous day. Sample period is 11.2003-12.2017 for Libor-OIS and 01.2002 – 12.2017 for the TED spread.

Panel A: Libor-OIS spread

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Constant	0.045***	0.437***	0.398***	0.443***	0.480***	0.476***	0.556***	0.479***	0.472***	0.465***
	(8.90)	(25.73)	(19.05)	(13.62)	(10.01)	(7.58)	(7.29)	(6.17)	(6.15)	(5.13)
Libor-OIS	0.005**	-0.171***	-0.198***	-0.251***	-0.308***	-0.329**	-0.329**	-0.357**	-0.322**	-0.358*
	(1.90)	(-8.85)	(-5.77)	(-3.84)	(-3.00)	(-2.39)	(-2.40)	(-2.08)	(-2.03)	(-1.77)
Y_{t-1}	0.954***	0.610***	0.656***	0.626***	0.604***	0.613***	0.555***	0.619***	0.613***	0.633***
	(188.48)	(45.76)	(51.71)	(45.75)	(45.130)	(46.20)	(39.67)	(46.85)	(46.80)	(48.60)
N	3680	3680	3680	3680	3680	3680	3680	3680	3680	3680
Adj. R^2	0.913	0.429	0.456	0.402	0.371	0.380	0.311	0.385	0.384	0.402
Panel B: TED spread										
Constant	0.044***	0.413***	0.398***	0.456***	0.499***	0.506***	0.594***	0.519***	0.518***	0.510***
	(8.81)	(24.30)	(18.18)	(13.05)	(9.62)	(7.42)	(7.18)	(6.15)	(6.13)	(5.17)
TED	0.004**	-0.092***	-0.133***	-0.190***	-0.240***	-0.278***	-0.344***	-0.317**	-0.319**	-0.330**
	(1.77)	(-6.30)	(-5.07)	(-3.78)	(-3.03)	(-2.61)	(-2.65)	(-2.39)	(-2.38)	(-2.11)
Y_{t-1}	0.954***	0.627***	0.660***	0.626***	0.604***	0.613***	0.554***	0.618***	0.613***	0.631***
	(189.42)	(47.91)	(52.25)	(47.77)	(45.12)	(46.13)	(39.61)	(46.78)	(46.80)	(48.52)
N	4173	4173	4173	4173	4173	4173	4173	4173	4173	4173
Adj. R^2	0.914	0.422	0.455	0.403	0.371	0.380	0.312	0.386	0.386	0.401

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The same regressions are also performed for five liquidity portfolios, presented in Table 6. The average ILLIQ of each stock is used to sort stocks into five portfolios based on the previous month. Portfolio 1 consists of 20 % most liquid stocks in the sample, while Portfolio 5 consists of the 20 % least liquid stocks in the sample.

The coefficient on *Libor-OIS* and *TED* spread is positive for the portfolio with the most liquid stocks (portfolio 1) and negative for the other portfolios, indicating an increase in market share of volume for the most liquid portfolio and decrease for the less liquid portfolios, when *Libor-OIS* or *TED* increases. The coefficients for both spreads are significant at 1 % level. However,

they are not decreasing. This appears to be due to the fact that the most liquid portfolio soaks up almost all of the market share of volume, as the market share of volume of portfolio 1 is 95 % when there are five portfolios, compared to 83 % when there are ten liquidity portfolios.

Since the analysis with five portfolios seems to be somewhat distorted by the concentration of volume in portfolio 1, as well as space concerns, further analysis will be focused on 10 portfolios.

Table 6: Regression of market share of volume on the spread (five portfolios)

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Y_{t-1} + \varepsilon_t$$

Each column represents a separate regression, one for each liquidity portfolio (as sorted in section 4.1). Where Y_t is mean adjusted market share of volume of each portfolio and X_t is the USD Libor-OIS spread (Panel A) and the TED spread (Panel B). Y_{t-1} is market share of volume of each portfolio for the previous day. Sample period is 11.2003-12.2017 for Libor-OIS and 01.2002 – 12.2017 for the TED spread.

Panel A: Libor-OIS spread

	Portfolio				
	1	**2**	**3**	**4**	**5**
Constant	0.208*** (20.84)	0.010*** (17.95)	0.006*** (24.76)	0.002*** (22.61)	0.001*** (15.55)
Libor-OIS	0.006*** (6.03)	-0.015*** (-6.14)	-0.008*** (-7.15)	-0.007*** (-5.76)	-0.021*** (-2.70)
Y_{t-1}	0.779*** (73.34)	0.768*** (71.04)	0.466*** (31.31)	0.468*** (31.52)	0.138*** (8.27)
N	3680	3680	3680	3680	3680
Adj. R^2	0.637	0.622	0.248	0.240	0.022
Panel B: TED spread					
Constant	0.201*** (20.41)	0.010*** (17.07)	0.005*** (23.03)	0.002*** (20.67)	0.001*** (14.02)
TED	0.003*** (4.56)	-0.013*** (-4.80)	-0.007*** (-5.16)	-0.005*** (-3.44)	-0.025*** (-1.64)
Y_{t-1}	0.787*** (75.44)	0.776*** (72.87)	0.477*** (32.19)	0.478*** (32.32)	0.139*** (8.37)
N	4173	4173	4173	4173	4173
Adj. R^2	0.635	0.620	0.243	0.235	0.020

t statistics in parentheses: * *p < 0.1*, ** *p < 0.05*, *** *p < 0.01*

Further, the results with Nibor-OIS and Norwegian TED spread and Euribor-OIS and Euro TED spread are also similar to the ones yielded by the USD Libor-OIS and TED spread. These

are presented in Table 7 (NOK) and Table 8 (Euro). Further analysis using Nibor-OIS and Euribor-OIS are presented in Appendix B and C.

The coefficients on the *Nibor-OIS* are positive for the most liquid portfolio and negative and decreasing for the other portfolios. The coefficients are significant at 1 % level for all ten portfolios. The coefficients for *TED* are only significant at 1 % for portfolios 2 and 3, at 5 % level for portfolios 2, 4, 5 and 9, and insignificant for the others. The size of the coefficients is also significantly lower for the TED spread compared to Nibor-OIS. Overall, only the findings of regressing the Nibor-OIS spread on the market share of volume of the liquidity portfolios supports the liquidity pull-back hypothesis.

Table 7: Regressions of market share of volume on Nibor-OIS/TED

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Y_{t-1} + \varepsilon_t$$

Each column represents a separate regression, one for each liquidity portfolio (as sorted in section 4.1). Where Y_t is mean adjusted market share of volume of each portfolio and X_t is the Nibor-OIS spread (Panel A) and the Norwegian TED spread (Panel B). Y_{t-1} is market share of volume of each portfolio for the previous day. Sample period is 01.2003-12.2017.

Panel A: Nibor-OIS spread

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Constant	0.045***	0.555***	0.614***	0.718***	0.830***	0.898***	1.076***	0.931***	0.931***	0.942***
	(9.00)	(24.98)	(19.62)	(14.23)	(11.04)	(9.07)	(8.98)	(7.62)	(7.62)	(6.59)
Nibor-OIS	0.012***	-0.292***	-0.490***	-0.680***	-0.885***	-1.054***	-1.308***	-1.441***	-1.643***	-1.798***
	(3.38)	(-11.66)	(-10.83)	(-8.08)	(-6.74)	(-5.99)	(-6.10)	(-5.20)	(-5.26)	(-4.65)
$\mathbf{Y_{t-1}}$	0.949***	0.583***	0.618***	0.603***	0.588***	0.599***	0.541***	0.608***	0.608***	0.624***
	(177.70)	(42.57)	(46.66)	(45.01)	(43.27)	(44.53)	(38.31)	(45.57)	(45.57)	(47.51)
N	3908	3908	3908	3908	3908	3908	3908	3908	3908	3908
$\boldsymbol{R^2}$	0.914	0.438	0.469	0.411	0.378	0.386	0.318	0.390	0.390	0.406
Panel B: Norwegian TED spread										
Constant	0.044***	0.473***	0.408***	0.437***	0.462***	0.440***	0.494***	0.397***	0.397***	0.359***
	(8.63)	(24.61)	(16.53)	(10.87)	(7.60)	(5.48)	(5.05)	(3.98)	(3.98)	(3.07)
TED	0.003**	-0.175***	-0.151***	-0.146**	-0.151**	-0.159	-0.166	-0.036	-0.056**	-0.015
	(2.25)	(-9.14)	(-4.47)	(-2.27)	(-1.97)	(-0.89)	(-0.66)	(-0.22)	(-2.22)	(-0.08)
$\mathbf{Y_{t-1}}$	0.955***	0.607***	0.662***	0.630***	0.607***	0.616***	0.557***	0.621***	0.621***	0.634***
	(190.82)	(45.51)	(52.52)	(48.32)	(45.49)	(46.47)	(39.91)	(47.09)	(47.09)	(48.79)
N	3908	3908	3908	3908	3908	3908	3908	3908	3908	3908
$\boldsymbol{R^2}$	0.913	0.430	0.454	0.401	0.371	0.380	0.311	0.385	0.385	0.402

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The coefficient on *Euribor-OIS* is also positive for the most liquid portfolio and negative and is decreasing for the other portfolios, with the exception of portfolio 7. All negative coefficients are significant at 1 % level, while the positive coefficient on portfolio 1 is significant at 5 % level.

The regressions with the *TED* as the dependent variable (Panel B) yield similar results, with a positive coefficient on portfolio 1 and negative coefficients for the other portfolios. Coefficients are decreasing for the less liquid portfolios, with the exception of portfolio 7. The coefficients for portfolio 1,8,9, and 10 are significant at 5 % level, while the others are significant at 1 % level.

Table 8: Regressions of market share of volume on Euribor-OIS/TED

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Y_{t-1} + \varepsilon_t$$

Each column represents a separate regression, one for each liquidity portfolio (as sorted in section 4.1). Where Y_t is mean adjusted market share of volume of each portfolio and X_t is the Euribor-OIS spread (Panel A) and the Euro TED spread (Panel B). Y_{t-1} is market share of volume of each portfolio for the previous day. Sample period is 04.2002 -

Panel A: Euribor-OIS spread

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Constant	0.045*** (8.91)	0.426*** (24.50)	0.441*** (19.39)	0.501*** (14.04)	0.531*** (10.12)	0.560*** (8.12)	0.647*** (7.74)	0.558*** (6.66)	0.568*** (6.68)	0.562*** (5.64)
Euribor-OIS	0.007** (2.03)	-0.174*** (-7.15)	-0.330*** (-7.45)	-0.455*** (-5.43)	-0.502*** (-3.83)	-0.644*** (-3.66)	-0.753*** (-3.50)	-0.695*** (-3.16)	-0.699*** (-3.10)	-0.729*** (-2.82)
Y_{t-1}	0.953*** (186.73)	0.620*** (46.95)	0.647*** (50.40)	0.619*** (46.92)	0.602*** (44.82)	0.610*** (45.81)	0.552*** (39.40)	0.616*** (46.52)	0.616*** (46.52)	0.630*** (48.31)
N	4090	4090	4090	4090	4090	4090	4090	4090	4090	4090
Adj. R^2	0.913	0.425	0.460	0.405	0.373	0.382	0.313	0.387	0.389	0.403
Panel B: TED spread										
Constant	0.044*** (8.72)	0.436*** (23.86)	0.404*** (16.90)	0.478*** (12.10)	0.532*** (9.00)	0.558*** (7.14)	0.656*** (6.91)	0.557*** (5.96)	0.567*** (5.85)	0.560*** (4.95)
TED	0.004* (1.83)	-0.133*** (-7.12)	-0.151*** (-4.53)	-0.237*** (-3.71)	-0.310*** (-3.09)	-0.389*** (-2.88)	-0.476*** (-2.89)	-0.421** (-2.48)	-0.422** (-2.50)	-0.437** (-2.21)
Y_{t-1}	0.954*** (189.11)	0.622*** (47.29)	0.663*** (52.59)	0.626*** (47.75)	0.604*** (45.12)	0.612*** (46.05)	0.554*** (39.55)	0.618*** (46.77)	0.618*** (46.77)	0.632*** (48.51)
N	4090	4090	4090	4090	4090	4090	4090	4090	4090	4090
Adj. R^2	0.913	0.424	0.455	0.403	0.372	0.381	0.312	0.386	0.380	0.403

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6.1.2 Market share of volume on uncertainty

The results from regressing the market share of volume of each portfolio on the VIX are presented in Table 9.

Table 9: Regressions of market share of volume on the VIX

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Y_{t-1} + \varepsilon_t$$

Each column represents a separate regression, one for each liquidity portfolio (as sorted in section 4.1). Where Y_t is mean adjusted market share of volume of each portfolio and X_t is the VIX. Y_{t-1} is market share of volume of each portfolio for the previous day.

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Constant	0.043*** (8.52)	0.630*** (25.39)	0.610*** (17.77)	0.670*** (11.89)	0.719*** (8.48)	0.699*** (6.23)	0.825*** (6.04)	0.704*** (5.06)	0.700*** (5.09)	0.690*** (4.23)
VIX	0.030*** (2.77)	-1.042*** (-13.43)	-1.287*** (-9.42)	-1.534*** (-6.04)	-1.611*** (-4.31)	-1.666*** (-3.13)	-2.025*** (-3.11)	-2.525*** (-2.60)	-3.629*** (-2.30)	-2.727** (-2.21)
Y_{t-1}	0.951*** (183.58)	0.565*** (40.67)	0.631*** (48.27)	0.617*** (46.61)	0.600*** (44.67)	0.611*** (45.95)	0.553*** (39.50)	0.618*** (46.71)	0.611*** (43.61)	0.632*** (48.52)
N	3776	3776	3776	3776	3776	3776	3776	3776	3776	3776
Adj. R^2	0.914	0.445	0.465	0.406	0.373	0.381	0.312	0.386	0.386	0.403

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The results of the regression with the VIX as the dependent variable yields similar results to the regression with the spreads. The coefficient on the *VIX* is positive for the portfolio with the most liquid stocks and negative for the other portfolios. Further, the coefficient is decreasing from portfolio 1 to 10. This indicates that market share of volume is increasing for portfolio 1 following an increase in *VIX* and decreasing for the other portfolios. The results support the portfolio rebalancing hypothesis. As the effects of the portfolio rebalancing are similar to liquidity pull-back, it is necessary to distinguish between the effects of portfolio-rebalancing and liquidity pull-back.

Further, the correlation coefficient between the VIX and the USD Libor-OIS over the sample period is 0.76. Uncertainty in the markets is reflected by higher spreads in the interbank market, as banks and creditors take into account higher credit risk due to the increase in volatility. As the TED spread yields similar results and the Libor-OIS spread is considered a better measure for cost of liquidity in the interbank market, further analysis will be based on the Libor-OIS spread.

6.2 MLR results

6.2.1 Distinguishing effects of spreads and uncertainty

In order to distinguish between the liquidity pull-back and portfolio rebalancing hypotheses', regressions including the VIX and the USD Libor-OIS spread are performed. As mentioned previously, the regressions obtain the part of USD Libor-OIS spread and VIX that is orthogonal to the other. The results of regressing the VIX on Libor-OIS and vice versa are presented in Table 10.

Table 10: Regression of the VIX and USD Libor-OIS

This table summarizes the coefficients from the regression:

$$Z_t = \alpha + \beta_1 X_t + \varepsilon_t$$

Where Z_t and X_t are either the USD Libor-OIS spread or VIX. The regressions are used to obtain the residuals for both models, which are the orthogonal part of Libor-OIS and the VIX to each other. Sample period 01.03-12.2017.

	(1) **VIX**	**(2)** **Libor-OIS**
Constant	0.133***	-0.272***
	(105.59)	(-30.96)
VIX		2.923***
		(69.02)
Libor-OIS	0.196***	
	(69.02)	
N	3680	3680
***Adj. R*²**	0.574	0.574

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The purpose of this regression is to obtain the residuals. The variable Res_{VIX} are the residuals from Model 1, obtained by regressing the VIX on the Libor-OIS spread, is included as an independent variable in the main regression model, presented in Table 11.

The coefficients for the *Libor-OIS* are positive for the most liquid portfolio and negative for the remaining portfolios. Further, the coefficient is decreasing for the less liquid portfolios. Both are in line with the expectations of the liquidity pull-back hypothesis. The coefficient on *Libor-OIS* is significant at 10 % level or better for all portfolios. While this supports the liquidity pull-back hypothesis, this does not exclude the possibility of these effects being due to portfolio rebalancing and the VIX, as the model is only controlling for the part of the VIX not explained by the Libor-OIS spread in the first regression.

There is also evidence in favour of portfolio rebalancing, as seen by the coefficient on Res_{VIX}, which is positive for portfolio 1 and negative for the others. It is also significant for portfolios 1 to 7.

Table 11: Regressions of market share of volume on USD Libor-OIS, VIX and residuals

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Each column represents a separate regression, one for each liquidity portfolio (as sorted in section 4.1). Where Y_t is mean adjusted market share of volume of each portfolio, X_t is the USD Libor-OIS (Panel A) or the VIX (Panel B). The variable $Res_{Z|X,t}$ are the residuals from regressing the VIX on the USD Libor-OIS spread (Res_{VIX}) and vice versa (Res_{LIBOR}). Y_{t-1} is market share of volume of each portfolio for the previous day. As N and Adj. R^2 are by design the same for both panels, they are only included in Panel A. Sample period is 01.2003-12.2017.

Panel A: X is the Libor-OIS spread

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Constant	0.047***	0.488***	0.430***	0.455***	0.485***	0.479***	0.558***	0.481***	0.481***	0.466***
	(9.13)	(27.89)	(20.32)	(13.98)	(10.12)	(7.62)	(7.32)	(6.19)	(6.19)	(5.14)
Libor-OIS	0.045**	-0.191***	-0.214***	-0.257***	-0.311***	-0.331**	-0.355**	-0.359**	-0.363**	-0.369*
	(2.00)	(-9.97)	(-6.27)	(-3.96)	(-3.04)	(-2.41)	(-2.41)	(-2.09)	(-2.09)	(-1.78)
Res_{VIX}	0.032**	-1.142***	-1.562***	-1.838***	-1.881***	-1.637**	-1.972**	-1.987	-1.587	-1.589
	(2.02)	(-10.07)	(-7.63)	(-4.77)	(-3.11)	(-2.01)	(-1.99)	(-1.56)	(-1.46)	(-1.33)
$Y_{t.1}$	0.951***	0.564***	0.629***	0.616***	0.600***	0.611***	0.553***	0.618***	0.618***	0.632***
	(183.48)	(40.58)	(48.07)	(46.56)	(44.66)	(45.94)	(39.49)	(46.70)	(46.70)	(48.51)
N	3680	3680	3680	3680	3680	3680	3680	3680	3680	3680
Adj. R^2	0.914	0.445	0.465	0.407	0.373	0.381	0.312	0.386	0.386	0.403
Panel B: X is the VIX										
Constant	0.043***	0.631***	0.612***	0.670***	0.719***	0.699***	0.825***	0.703***	0.704***	0.690***
	(8.52)	(25.41)	(17.83)	(11.90)	(8.48)	(6.23)	(6.04)	(5.11)	(5.06)	(4.23)
VIX	0.030***	-1.044***	-1.293***	-1.536***	-1.711***	-1.666***	-2.025***	-1.724***	-1.725***	-1.727**
	(2.77)	(-13.45)	(-9.46)	(-6.05)	(-4.31)	(-3.13)	(-3.11)	(-2.71)	(-2.60)	(-2.21)
Res_{LIBOR}	0.004	0.034	-0.092*	-0.103***	-0.151**	-0.132	-0.223	-0.321	-0.332	-0.354
	(0.91)	(1.20)	(-1.80)	(-6.95)	(-2.03)	(-1.02)	(-1.41)	(-1.01)	(-1.02)	(-1.10)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

A stronger test for the liquidity pull-back hypothesis is obtained by regressing the Libor-OIS spread on the VIX, which is Model 2 in Table 10, and using the residuals as an independent variable. The results of this regression are presented in Panel B in Table 11.

The findings lend only weak support in favour of the liquidity pull-back hypothesis. While the coefficients on Res_{LIBOR} are positive for portfolio 1 and 2, they are statistically insignificant. The coefficients are negative and decreasing for the other portfolios, but only statistically significant for portfolio 3,4, and 5. The implication of this is that the part of Libor-OIS not explained by the VIX is insignificant and is not consistent with a presence of liquidity pull-back effects in the data.

The coefficient on the *VIX* is also positive for portfolio 1 and negative and decreasing for the other portfolios. The coefficients are significant at 1 % for portfolios 1 to 9 and 5 % level for portfolio 10. The coefficients on the VIX are also significantly larger than on the Libor-OIS spread. These findings indicate that the effects of portfolio rebalancing are stronger than the effects of a liquidity pull-back, in terms of both higher coefficients and t-values for the variables *VIX* and Res_{VIX}.

6.2.2 Control variables

The results of the analysis with multiple linear regression models with the inclusion of control variables are presented in Table 12 below. Panel A includes residuals obtained from regressing the VIX on the Libor-OIS (Res_{VIX}), while Panel B includes the residuals from regressing the USD Libor-OIS spread on the VIX (Res_{LIBOR}).

The findings in Panel A support the liquidity pull-back hypothesis. The coefficients on *Libor-OIS* follow a similar pattern to previous analysis, with a positive coefficient for portfolio 1 and negative and decreasing for the other portfolios. The coefficient is significant at 1 % level for portfolio 2 and 3, and 5 % for the other portfolios. As mentioned in the previous subsection, this test does not exclude the possibility of the effects being due to portfolio rebalancing. The findings are consistent with the portfolio rebalancing hypothesis also, as the coefficient on Res_{VIX} is positive for the portfolio 1 and negative for the other portfolios. It is significant at 10 % level or above for portfolios 1 to 5, but insignificant for the other portfolios. The model in Panel A serves as a stronger test for portfolio the rebalancing hypothesis, as it includes Res_{VIX}, which is the part of the VIX that is orthogonal to the Libor-OIS spread.

The model in Panel B serves as a stronger test for the liquidity pull-back hypothesis, as the variable Res_{LIBOR} is the part of the Libor-OIS spread that is orthogonal to the VIX. The results

Table 12: Regressions of market share of volume on Libor-OIS and control variables

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Each column represents a separate regression, one for each liquidity portfolio (as sorted in section 4.1). Where Y_t is mean adjusted market share of volume of each portfolio, X_t is the USD Libor-OIS (Panel A) or the VIX (Panel B). The variable $Res_{Z|X,t}$ are the residuals from regressing the VIX on the USD Libor-OIS spread and vice versa. Y_{t-1} is market share of volume of each portfolio for the previous day. W is a vector of the control variables: *Volume* is the aggregate normalised volume of all portfolios. *Market Return* is the equal weighted daily return on the OSE. *Oil Price* is the daily brent spot price. *Bid-ask* is the average relative bid-ask spread of each portfolio. *Turnover* is the daily average market share of turnover for each portfolio. As the control variables, N, and Adj. R^2 are by design the same for both panels, they are only included in Panel A.

Panel A: X is Libor-OIS

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Constant	0.005	1.015***	1.001***	0.764***	0.851***	0.850***	0.867***	0.526*	0.542*	-0.336
	(0.75)	(22.74)	(14.53)	(6.31)	(4.39)	(3.39)	(2.80)	(1.69)	(1.76)	(-0.96)
Libor-OIS	0.044**	-0.186***	-0.198***	-0.215***	-0.242**	-0.294**	-0.364**	-0.368**	-0.350**	-0.402**
	(1.97)	(-9.87)	(-5.82)	(-3.25)	(-2.27)	(-2.05)	(-2.10)	(-2.10)	(-2.01)	(-1.98)
Res_{VIX}	0.034**	-1.219***	-1.320***	-1.355***	-1.296*	-1.290	-1.259	-1.096	-0.964	-1.374
	(2.11)	(-10.47)	(-6.20)	(-3.30)	(-1.95)	(-1.49)	(-1.18)	(-1.01)	(-0.90)	(-1.14)
Y_{t-1}	0.951***	0.515***	0.615***	0.609***	0.597***	0.610***	0.550***	0.614***	0.614***	0.629***
	(184.93)	(36.08)	(46.42)	(45.72)	(44.17)	(45.81)	(39.15)	(46.18)	(46.34)	(48.17)
Volume	0.037***	-0.169***	-0.289***	-0.180**	-0.293**	-0.235	-0.333	-0.210	-0.201	0.384
	(11.14)	(-7.43)	(-6.81)	(-2.16)	(-2.23)	(-1.33)	(-1.54)	(-0.95)	(-0.91)	(1.47)
Market Return	-0.482***	0.899***	1.124***	-1.069***	1.480**	0.927	1.342	-0.802	-1.074	-0.757
	(-4.45)	(3.92)	(2.81)	(-3.03)	(2.38)	(1.03)	(0.19)	(-0.53)	(-0.57)	(-1.16)
Oil Price	0.000	-0.002***	-0.002***	0.000	0.001	0.001	0.004*	0.005**	0.005**	0.006**
	(0.11)	(-3.53)	(-3.94)	(-0.09)	(0.72)	(0.66)	(1.94)	(2.21)	(2.37)	(2.43)
Bid-ask	1.011	-1.408***	-1.473***	-1.170***	-1.160**	-1.302*	-1.730**	-2.209	-2.721*	0.673
	(1.12)	(-4.17)	(-4.61)	(-3.13)	(-2.20)	(-1.92)	(-1.97)	(-1.29)	(-1.94)	(-0.89)
Turnover	0.005	-0.165***	-0.212***	0.524**	0.512	-1.768**	-0.917	-1.485	0.647	-0.034
	(0.75)	(-3.30)	(-3.10)	(1.99)	(1.21)	(-2.00)	(-0.42)	(-0.97)	(0.40)	(-0.02)
N	3680	3680	3680	3680	3680	3680	3680	3680	3680	3680
Adj. R^2	0.917	0.474	0.478	0.410	0.376	0.383	0.314	0.388	0.388	0.405
Panel B: X is the VIX										
Constant	0.001	1.163***	1.160***	0.930***	1.020***	1.032***	1.066***	0.713**	0.713**	-0.118
	(0.21)	(24.37)	(16.03)	(7.33)	(5.09)	(3.92)	(3.33)	(2.21)	(2.21)	(-0.31)
VIX	0.027**	-1.064***	-1.143***	-1.208***	-1.262***	-1.408**	-1.601**	-1.544**	-1.435**	-1.762**
	(2.40)	(-13.44)	(-8.15)	(-4.46)	(-2.84)	(-2.42)	(-2.26)	(-2.18)	(-2.07)	(-2.24)
Res_{LIBOR}	0.003	0.053	-0.067**	-0.054**	-0.117**	-0.153	-0.161	-0.159	-0.163	-0.133
	(1.44)	(1.42)	(-1.97)	(-2.04)	(-2.22)	(-0.20)	(-0.45)	(-0.57)	(-0.60)	(-0.43)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

in Panel B do not lend support to the liquidity pull-back hypothesis, as the coefficients on Res_{LIBOR} are positive for portfolio 1 *and* 2 and are not statistically significant. Further, while the coefficients are negative for the other portfolios, they are only decreasing from portfolio 2 to 6 and only statistically significant for portfolios 3 to 5.

Meanwhile, the test does provide evidence in favour portfolio rebalancing, as the coefficient on the *VIX* is positive for portfolio 1 and negative for the other portfolios. The coefficients on the *VIX* are significant at 1 % or 5 % level for all 10 portfolios. The coefficient is also decreasing from portfolio 1 to 7.

The control variables in Panel A yield varying results. The independent variables *Volume* and *Market Return* perform well for portfolio 1 to 5, the coefficients are significant at 1 % and 5 % level for these portfolios, which is where close to 100 % of the volume is. However, they are insignificant for the other portfolios.

The statistical significance of the coefficients on the variables *Oil price*, *Bid-ask*, and *Turnover* is sporadic. That the relative bid-ask spread does not perform well as a control variable is likely due to how low it is, especially for the liquid portfolios, which is reflected through the high coefficient. The reason for the relative bid-ask spread being so low is the Oslo Stock Exchange's automated order matching system, which has proven to have a positive effect on market liquidity. This has led to the reduction of transactional costs and quoted spreads, which in turn reduces the relative bid-ask spread. The spread is therefore not a good measure of liquidity as a result (Næs, Skjeltorp and Ødegaard, 2008). The variable *Turnover*, which is the market share of traded shares on the stock exchange each day for each liquidity portfolio, does not seem to pick any differences in stock liquidity that weren't already captured with the ILLIQ either.

6.2.3 Decomposing into sub-periods

Table 13 presents the coefficients of the Libor-OIS spread and the residuals from regressing the VIX on the Libor-OIS spread, divided into the pre-crisis period (11.2003 - 06.2007), the crisis period (07.2007-12.2009), and the post-crisis period (01.2010-12.2017).

The evidence in favour of the liquidity pull-back hypothesis is strongest for the pre-crisis period, as the coefficient on *Libor-OIS* is positive for the most liquid portfolio and negative for the other portfolios. Further, the coefficient is decreasing from portfolio 2 to 10. The coefficient is statistically significant at 1 % level for portfolios 1,2, 4 and 6, significant at 5 % level for portfolios 2,8, and 9, and insignificant for the other portfolios.

While for the crisis period, the evidence for the hypothesis is weaker. Although the coefficients on *Libor-OIS* are consistent with the hypothesis, with a positive coefficient on the most liquid portfolio and negative for the other portfolios, they are several magnitudes lower compared to the pre-crisis period. Further, the coefficient is not decreasing for portfolio 2 to 10. The coefficients are significant at 1 % level for portfolios 1 to 4 and 10 % level for portfolios 5 to 10.

The findings do not lend support to hypothesis for the post-crisis period, as the coefficient on *Libor-OIS* is positive for both portfolio 1 and 2 and statistically insignificant for both. However, the coefficient is negative for the other portfolios and trending downwards from portfolio 3 to 10. It is also statistically significant for portfolios 3 to 6 at 5 % level and 1 % level for portfolios 7 to 10. The coefficient is significantly larger for portfolios 3 to 10 in the post-crisis period compared to the pre-crisis and crisis periods, as the Libor-OIS spread is lower in the aftermath of the crisis.

The evidence in favour of the portfolio rebalancing hypothesis, reflected by the coefficient on Res_{VIX}, is consistently present in all three sub-periods. The coefficient in the pre-crisis period is positive for portfolio 1 and negative for portfolios 2 to 10. However, it is only decreasing from portfolio 2 to 6 and only statistically significant for portfolio 1 to 5, which is where close to 100 % of the market share of volume is. The effects appear to be strongest in the crisis period, in terms of the pattern of the coefficients and their statistical significance. The coefficient is positive for the most liquid portfolio and negative for the other portfolios and

decreasing from portfolio 2 to 8. It is statistically significant at 1 % for portfolio 1,2,3, and 6, and varying between 5 % and 10 % for other portfolios. While the coefficients are larger for the post-crisis period, the evidence is weaker. The reason being that the coefficient for portfolio 1 is insignificant, along with the coefficient on portfolios 6 to 10.

Table 13: Regressions of market share of volume on the USD Libor-OIS spread and control variables (divided into sub-periods)

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Each column represents a separate regression, one for each portfolio. Where Y_t is mean adjusted market share of volume of each portfolio, X_t is the USD Libor-OIS The variable $Res_{Z|X,t}$ are the residuals from regressing the VIX on the USD Libor-OIS spread. Y_{t-1} is market share of volume of each portfolio for the previous day. W is a vector of the control variables: volume, market return, oil price, bid-ask spread and share turnover. The control variables are not presented due to space limitations, the regressions with all variables are in Appendix A. Pre-crisis period is 11.2003-06.2007, crisis period is 07.2007-12.2009, post-crisis period is 01.2010-12.2017.

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Pre-crisis period										
Constant	0.373***	0.801***	0.981***	1.307***	1.905***	1.628***	1.312***	0.870***	0.972***	0.626***
	(12.11)	(6.57)	(6.96)	(8.33)	(5.56)	(9.28)	(5.98)	(5.78)	(6.64)	(2.73)
Libor-OIS	0.114***	-0.941***	-0.335	-1.276***	-1.301	-1.315***	-1.384	-0.712**	-0.711**	-0.518
	(3.06)	(-3.58)	(-1.04)	(-3.70)	(-1.48)	(-3.30)	(-0.35)	(-2.09)	(-2.05)	(-0.88)
Res$_{VIX}$	0.037***	-0.337***	-1.520***	-1.821***	-2.248***	-2.605	-1.442	-0.962	-0.739	-1.169
	(3.44)	(-3.56)	(-3.43)	(-3.61)	(-3.31)	(-0.69)	(-1.24)	(-1.21)	(-0.91)	(0.13)
Crisis period										
Constant	0.541***	0.653***	0.733***	0.791***	0.529***	0.656***	0.531***	0.389***	0.357***	0.296***
	(14.17)	(10.18)	(9.36)	(5.90)	(3.27)	(8.54)	(5.47)	(2.90)	(2.66)	(2.86)
Libor-OIS	0.011***	-0.067***	-0.083***	-0.101***	-0.051*	-0.033*	-0.041*	-0.052*	-0.048*	-0.043*
	(5.69)	(-4.85)	(-4.98)	(-3.40)	(-2.02)	(-2.00)	(-1.90)	(-1.68)	(-1.77)	(-1.73)
Res$_{VIX}$	0.053***	-0.093***	-0.561***	-0.584*	-0.877**	-0.738***	-0.229	-0.525*	-0.574*	-0.555**
	(2.83)	(-2.72)	(-3.47)	(-1.95)	(-2.33)	(-4.17)	(-1.00)	(-1.66)	(-1.76)	(-2.15)
Post-crisis period										
Constant	0.001	1.131***	1.168***	0.959***	1.289***	1.636***	1.803***	1.579**	1.621***	-0.039
	(0.08)	(16.62)	(9.39)	(4.18)	(3.55)	(3.25)	(2.97)	(2.55)	(2.64)	(-0.06)
Libor-OIS	0.010	0.104	-0.410**	-0.934**	-1.492**	-2.123**	-3.080***	-3.082***	-2.836**	-3.685***
	(0.74)	(1.14)	(-2.04)	(-2.27)	(-2.27)	(-2.34)	(-2.80)	(-2.74)	(-2.51)	(-2.83)
Res$_{VIX}$	0.036	-1.704***	-1.824***	-2.554***	-2.220**	-2.239	-3.169	-2.739	-2.822	-3.558
	(1.53)	(-10.15)	(-5.24)	(-3.66)	(-2.00)	(-1.45)	(-1.51)	(-1.45)	(-1.50)	(-1.63)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

However, the pattern is consistent with the portfolio rebalancing hypothesis, with a positive coefficient on the most liquid portfolio and negative and decreasing for the other portfolios.

As previously mentioned, a stronger test for the liquidity pull-back hypothesis is obtained by including the residuals from regressing Libor-OIS spread on the VIX, which is the part of the spread not explained by the VIX. The results are presented in Table 14, divided into pre-crisis, crisis, and post-crisis periods.

The results in Table 14 lend weak support for the liquidity pull-back hypothesis. While the effect of the pull-back appear to be present in all three periods, they are varying in terms of both consistency and significance.

For the pre-crisis period, the coefficient on Res_{LIBOR} is positive for the most liquid portfolio and negative for the other portfolios. While the coefficient is not decreasing from portfolio 1 to 10, the coefficient is trending downwards for portfolio 2 to 6. The coefficients are significant at 1 % level for portfolios 1,2,4, and 6, 5 % level for portfolio 8 and 9, and insignificant for the remaining portfolios.

For the crisis period, the coefficient on Res_{LIBOR} is positive for portfolio 1 and negative and decreasing for portfolios 2 to 10. It is significant at 1 % level for portfolios 1,3,5, and 6, 5 % level for portfolios 2 and 3, and insignificant for portfolios 7 to 10. The coefficients are significantly lower during the crisis period compared to the pre-crisis period. In the post-crisis period, the coefficient on Res_{LIBOR} is positive for both portfolio 1 and 2 and decreasing and negative for the other portfolios. The coefficient is however insignificant for portfolio 1,3 and 4, but significant at 5 % and 10 % for the other portfolios. Further, the coefficients for the least liquid portfolios are several orders of magnitude higher than for the pre-crisis and crisis periods.

The results in Table 14 also support the portfolio rebalancing hypothesis for all three periods, as the coefficient on the *VIX* is positive for the most liquid portfolio and negative and decreasing for the other portfolios. In the crisis and post-crisis period, all coefficients on the *VIX* are statistically significant at 10 % level or better. While for the pre-crisis period, four coefficients are insignificant, including the coefficient on portfolio 1. The evidence in favour of portfolio rebalancing is stronger than for the liquidity pull-back hypothesis, especially in

the crisis and post-crisis periods, as the coefficients on the *VIX* and Res_{VIX} are both larger and have higher t-statistics than the coefficients on *Libor-OIS* and Res_{LIBOR}.

Table 14: Regressions of market share of volume on the VIX and control variables divided (into sub-periods)

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Where Y_t is mean adjusted market share of volume of each portfolio, X_t is the VIX. The variable $Res_{Z|X,t}$ are the residuals from regressing the USD Libor-OIS spread on the VIX. Y_{t-1} is market share of volume of each portfolio for the previous day. W is a vector of the control variables: volume, market return, oil price, bid-ask spread and share turnover. The control variables and market share from the previous day are not presented due to space limitations (the regressions with all variables are in the Appendix). Pre-crisis period is 11.2003-06.2007, crisis period is 07.2007-12.2009, post-crisis period is 01.2010-12.2017.

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Pre-crisis period										
Constant	0.368***	0.847***	1.295***	1.661***	2.188***	1.708***	1.491***	0.992***	1.066***	0.608**
	(10.95)	(5.50)	(7.14)	(8.21)	(5.27)	(7.68)	(5.34)	(5.35)	(5.89)	(2.08)
VIX	0.123**	-1.043*	-2.516***	-3.526***	-2.876*	-1.577*	-1.434	-1.421*	-1.221	-0.258
	(2.47)	(-1.74)	(-3.47)	(-4.50)	(-1.71)	(-1.81)	(-1.24)	(-1.80)	(-1.52)	(-0.20)
Res$_{LIBOR}$	0.109***	-0.896***	-0.906	-0.894***	-0.797	-1.234***	-0.011	-0.581*	-0.611*	-0.541
	(2.90)	(-3.36)	(-1.02)	(-2.58)	(-1.04)	(-3.05)	(-0.02)	(-1.65)	(-1.74)	(-0.91)
Crisis period										
Constant	0.530***	0.687***	0.836***	0.903***	0.664***	0.767***	0.575***	0.477***	0.451***	0.386***
	(14.02)	(9.05)	(8.91)	(5.60)	(3.39)	(8.12)	(4.93)	(2.91)	(2.76)	(2.98)
VIX	0.063***	-0.278***	-0.544***	-0.616***	-0.569**	-0.446***	-0.247*	-0.418**	-0.426**	-0.400***
	(5.27)	(-3.39)	(-5.44)	(-3.43)	(-2.53)	(-4.17)	(-1.83)	(-2.18)	(-2.22)	(-2.59)
Res$_{LIBOR}$	0.023	-0.052**	-0.047	-0.309***	-0.387***	-0.382***	-0.005	-0.530	-0.442	-0.544
	(0.85)	(-2.34)	(-1.17)	(-3.17)	(3.35)	(2.78)	(-0.13)	(-0.54)	(-0.74)	(-0.99)
Post-crisis period										
Constant	0.004	1.416***	1.407***	1.248***	1.453***	1.723***	1.916***	1.624***	1.711***	0.060
	(0.40)	(19.37)	(10.96)	(5.27)	(3.96)	(3.40)	(3.14)	(2.60)	(2.75)	(0.08)
VIX	0.034*	-1.538***	-1.868***	-2.771***	-2.699**	-2.987**	-4.259**	-3.861**	-3.833**	-4.879**
	(1.65)	(-9.58)	(-5.50)	(-4.09)	(-2.46)	(-1.98)	(-2.36)	(-2.10)	(-2.10)	(-2.31)
Res$_{LIBOR}$	0.004	0.390***	-0.104	-0.506	-1.120*	-1.748*	-2.549**	-2.623**	-2.764**	-3.089**
	(0.28)	(4.08)	(-0.51)	(-1.19)	(-1.68)	(-1.89)	(-2.26)	(-2.27)	(-2.04)	(-2.29)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6.2.4 Relative volume

Table 15 presents the results of the analysis with relative volume of each liquidity group as the dependent variable. The regressions are performed for the both the Libor-OIS spread and the VIX, in order to test both the liquidity pull-back hypothesis and the portfolio rebalancing hypothesis, this yields 90 regressions in total. Due to space limitations, only the coefficients on the Libor-OIS spread and the VIX are included in the table.

Panel A presents the coefficients of the *Libor-OIS*. The findings in the table seem to indicate that the results of the previous sub-section were mostly driven by the most liquid portfolios. Since the relative volume of each pair of portfolios is always measured in terms of the volume of the less liquid portfolio as a fraction of the more liquid portfolio, the coefficients should be negative for all portfolio combinations in the presence of liquidity pull-back across liquidity portfolios. The coefficients are only negative when Portfolio H (which is the more liquid portfolio) is equal to 1 or 2, which are the two most liquid groups and are all significant at 1 % level. However, for the other portfolio combinations, the coefficient is mostly positive, with only six exceptions. Further, when Portfolio H $\geq$ 3, only 13 coefficients are statistically significant (varying between 1 %, 5 % and 10 % level).

Panel B presents the coefficients of the *VIX*, used to test the portfolio rebalancing hypothesis. The results are similar to Panel A, as the coefficients are negative and statistically significant at 1 % level when Portfolio H is equal to 1 or 2. Furthermore, the coefficient is mostly positive (14 of which are statistically significant at 1 % level, two at 5 %, and one at 1 % level) when Portfolio H $\geq$ 3. Similar to Panel A, this indicates that the results are driven by the two most liquid portfolios.

However, Portfolio 1 and 2 is also where on average 92 % of daily volume resides in the sample period, therefore there may not be enough volume in the remaining 8 portfolios to yield significant results.

The analysis has also been divided into the pre-crisis, crisis, and post-crisis periods. These are included in Appendix A.

Table 15: Regressions of relative volume on Libor-OIS/VIX for the sample period

The dependent variable is now relative volume instead of market share of volume. Each cell represents a separate regression and reports the estimate of the coefficient on the USD Libor-OIS (Panel A) or the VIX (Panel B) from the following regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Where Y_t is the mean adjusted relative volume of Portfolio P to H_t. $Res_{Z|X,t}$ are the residuals from regressing Libor-OIS on the VIX and vice versa. W is a vector of the control variables: market return, market volume, oil price, relative bid-ask spread and share turnover. Sample period is 11.2003 – 12.2017.

Panel A: X is Libor-OIS

Portfolio H	**Portfolio P**								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	-0.154*** (-8.14)	-0.176*** (-7.34)	-0.211*** (-7.01)	-0.445*** (-7.47)	-0.23*** (-5.47)	-0.342*** (-5.36)	-0.347*** (-5.26)	-0.247*** (-2.69)	-0.579*** (-3.43)
2		-0.095*** (-4.19)	-0.102*** (-3.40)	-0.173*** (-3.06)	-0.074*** (-2.96)	-0.100*** (-2.87)	-0.133*** (-3.18)	-0.179*** (-2.91)	-0.270*** (-2.79)
3			0.035 (1.06)	0.016 (0.20)	0.100** (2.42)	0.079 (1.39)	0.194** (2.44)	0.446*** (4.32)	-0.031 (-0.11)
4				0.070 (0.10)	0.079* (1.75)	0.083 (1.60)	0.182** (2.20)	0.370*** (3.82)	-0.065 (-0.19)
5					0.077* (1.88)	0.108* (1.89)	0.279** (2.38)	0.509*** (4.57)	-0.03 (-0.15)
6						0.089 (1.64)	0.216*** (2.67)	0.372*** (3.57)	-0.075 (-0.44)
7							0.130 (1.56)	0.387*** (3.62)	-0.088 (-0.31)
8								0.301*** (3.29)	-0.009 (-0.04)
9									-0.123 (-0.83)
Panel B: X is the VIX									
1	-0.881*** (-11.49)	-1.203*** (-12.09)	-1.469*** (-11.96)	-2.908*** (-12.38)	-1.474*** (-8.88)	-2.114*** (-8.48)	-2.164*** (-8.40)	-1.615*** (-4.54)	-3.904*** (-2.70)
2		-0.738*** (-8.23)	-0.871*** (-7.41)	-1.461*** (-6.66)	-0.634*** (-4.33)	-0.757*** (-3.79)	-0.452 (-2.68)	-0.474*** (-3.32)	-1.825*** (-3.38)
3			0.122 (0.95)	-0.162 (-0.55)	0.534*** (3.37)	0.588*** (2.68)	1.098*** (3.56)	2.37*** (5.94)	0.084 (0.08)
4				-0.159 (-0.62)	0.529*** (3.05)	0.702*** (3.51)	1.218*** (3.82)	1.907*** (5.10)	-0.265 (-0.20)
5					0.594*** (3.76)	0.827*** (3.75)	1.381*** (3.05)	2.45*** (5.69)	0.565 (0.77)
6						0.381* (1.84)	0.673** (2.16)	1.554*** (3.87)	-0.029 (-0.04)
7							0.391 (1.23)	1.187*** (2.89)	-0.544 (-0.50)
8								0.868** (2.46)	-0.327 (-0.42)
9									-0.833 (-1.47)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6.2.5 Volume on high and low spread days

Table 16 exhibits the results of the Fama-Macbeth procedure which regresses the difference in normalised volume between high and low spread days in each month on the ILLIQ for each portfolio. The presented coefficients are the average of the 10 liquidity portfolios (as sorted in section 4.1.), in line with the Fama-Macbeth procedure (Petersen, 2005). The regressions are performed for the full sample period, as well the pre-crisis, crisis and post-crisis periods for both the Libor-OIS and TED spreads.

Table 16: Differences in normalized share volume on high versus low spread days

This table summarizes the results of the following regression, ran for each month j:

$$HSVolume_{P,j} - LSVolume_{P,j} = \alpha_j + \beta_j ILLIQ_{P,j-1} + \varepsilon_{P,j}$$

and reports the average of all the cross-sectional coefficient estimates $(\widehat{\alpha_j}, \widehat{\beta_j})$ with corresponding t-statistics. $HSVolume_{P,j} - LSVolume_{P,j}$ is the difference in month j between normalised share volume on high versus low spread days for liquidity portfolio P.

	Constant	**ILLIQ$_P$**	**N**	**Adj. R^2**
Full sample period	0.269 (0.73)	-0.118 (0.97)	170	0.069
Pre-crisis period	0.237 (1.05)	-0.015 (1.27)	44	0.026
Crisis period	0.207 (0.97)	-0.164 (0.83)	42	0.041
Post-crisis period	0.251 (0.74)	-0.124 (0.91)	84	0.075
Panel B: TED				
Full sample period	0.194 (0.95)	-0.091 (0.85)	170	0.058
Pre-crisis period	0.155 (0.84)	-0.024 (1.13)	44	0.024
Crisis period	0.243 (0.91)	-0.155 (0.94)	42	0.039
Post-crisis period	0.201 (1.02)	-0.088 (0.78)	84	0.068

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The coefficient on ILLIQ$_P$ is negative, regardless of period and spread, which is consistent with the liquidity pull-back hypothesis. However, they are not statistically significant at 10 % level in any period. While the coefficients being negative is consistent with the liquidity pull-

back hypothesis, their insignificance means this particular analysis does not lend support to there being a connection between the Norwegian interbank market for liquidity and the Oslo Stock Exchange for the sample period at 10 % significance.

6.3 Comparison with previous analysis

The findings in the analyses' performed for the Norwegian interbank market and stock market differ from the financial markets in the USA in several ways in regard to the liquidity pull-back hypothesis and its effects.

The initial results of regressing the market share of volume of each liquidity portfolio yield similar results for both stock markets and support the liquidity pull-back hypothesis. An increase in "tightness" of liquidity in the interbank market, measured by the Libor-OIS and TED spread, is associated with an increase in the volume of the most liquid stocks relative to the less liquid stocks. Similarly, regressing market share of volume of each portfolio on the VIX lends support to the portfolio rebalancing hypothesis in both markets.

The results of the analyses using multiple linear regression models with the inclusion of control variables yield differing results. While the findings by Nyborg and Östberg for US stocks are generally consistent with liquidity pull-back hypothesis, the results for Norwegian markets lend only weak support the hypothesis. However, similar to the US stock markets, there is evidence in favour of portfolio rebalancing hypothesis for stocks listed on the OSE.

A key reason for the different findings relating to the liquidity pull-back hypothesis appears to be the relative size of the interbank market in the respective countries. The interbank market in the US is far more active than in Norway. Further, banks in the USA have historically held substantial quantities of stocks on their balance sheet (Kashyap and Stein, 2000), while Norwegian banks do not. The reasons for why Norwegian banks do not keep stocks and other financial assets on their balance are expanded upon in section 7.

Another reason is the period for which the analysis is performed. Nyborg and Östberg's analysis using the Libor-OIS spread was performed for the period 2001 until 2008, which is prior to the financial crisis of 2008. The analysis for Norwegian markets presents strong evidence in favour of the liquidity pull-back hypothesis for the pre-crisis period. That the

evidence is weaker in the post-crisis period could be due to central bank's around the world engaging in quantitative easing in order to add more liquidity to financial markets. The US Federal Reserve and the European Central Bank, in cooperation with several other banks, introduced term auction facilities (TAF) in order to "address elevated pressures in short-term funding markets" and increase liquidity in around the world (Federal Reserve, 2008).

Further, after the events that led to the financial crisis, lack of clear regulation was identified as a key reason for why financial institutions needed to be bailed out by the US Government in 2008 (Amadeo, 2018). Regulators responded to the crisis by reforming the global regulatory framework and enhancing supervision. This has led to banks withdrawing from capital markets and engaging less in non-operational activities (BIS, 2018).

Another factor to consider is that in 2013 it was revealed that Libor had been manipulated by a number of banks for personal profit. As a result, the reference rate has lost some of the credibility it held as a benchmark for interest rates on loans worldwide (McBride, 2016).

7 Qualitative analysis

This section presents qualitative analysis of the Norwegian financial markets, paired with interviews conducted with participants in the Norwegian interbank market. The main purpose of the interviews is to receive inputs on the liquidity pull-back and portfolio rebalancing hypotheses' and the results the analysis has yielded, to supplement the empirical analysis performed. Further, the aim is to gather descriptions about the Norwegian interbank market and connection to the stock market.

For these reasons, the interviews are semi-structured, which entails having specific questions related to the theories and literature, while still allowing for flexibility in the conversation (Harrell and Bradley, 2009). The interviews were conducted by phone. Before the interview took place, interviewees received a short explanation of the liquidity pull-back and portfolio rebalancing hypotheses and the findings of the performed analyses by email. As the interviews are supplementary to the empirical analysis, two interviews with market participants were deemed fit. The respondents were manager at DNB, Vidar Knudsen, and Chief Analyst of Fixed Income at SEB, Thomas Eitzen[1]. The responses are therefore from the perspective of commercial banking.

The interview questions were divided into two categories: the liquidity pull-back and portfolio rebalancing hypothesis and the banking sector and interbank market in Norway.

7.1 Liquidity pull-back and portfolio rebalancing

Section 2 presented the different processes in which a liquidity pull-back by banks could affect the broader financial markets and more specifically the stock market. The first is that in order to pull back liquidity from the market, banks proceed to sell stocks held in their balance sheet.

> *"Norwegian banks generally don't own stocks, as it is very expensive to keep on the balance sheet due to banking regulations. The magnitude of stocks banks' keep on their balance are so small in size that it would not be nearly enough to offset any shortage in liquidity a bank may face in their operations.*

[1] The interviews were conducted in Norwegian and are translated by the author.
Both respondents gave the author verbal permission to quote them in the thesis.

Therefore, it is hard to imagine volume on OSE being affected and that there would be a relative increase in the most liquid stocks compared to less liquid stocks due to a liquidity pull-back by banks in which they sell stocks on OSE."

- Vidar Knudsen, DNB

The second process is that as a result of increased Libor-rates and liquidity pull-back, banks may be less willing to lend out money. As a response, participants in the financial markets with demand for liquidity may attempt to replace the lost liquidity provision in the market by selling stocks.

Increased price of liquidity, measured by IBOR-rates, is not a problem, in and of itself, as banks will respond to increased IBOR-rates by increasing the interest rates on outgoing loans. However, if the increase in IBOR-rates is due to higher risk premiums following increased uncertainty in the broader financial markets, you would expect investors to reduce their equity exposures. The investors with significant gearing are especially more likely to do so. But this would be due to the increased volatility, not increased cost of borrowing. Furthermore, large clients, such as investment funds, that borrow money from a bank establish fixed contracts, where the margins are pre-determined based on their credit ratings.

- Thomas Eitzen, SEB

The measure used for market volatility in this thesis is the VIX, which is a forward-looking measure. The index has become a "barometer" of fear (Whaley, 2008). Investors use the index to insure the value of their stock portfolios. If expected market volatility increases, investors demand higher rates of return on stocks, meaning stock valuation decreases. Similarly, a decrease in volatility is followed by an increase in stock valuation.

The link between the interbank market and the stock market is indirect, where the connecting link is uncertainty or volatility. An increase in the VIX will increase the discount factor, which in turn decreases asset prices.

> *You would then expect that as investors sell stocks, they would sell the most liquid stocks first. In a risk-off period, liquidity (as money), tends to concentrate in the liquid assets. Not necessarily because of the need for money, but because you want to avoid the exposure to risk and be able to sell quickly and in a cost-efficient manner if necessary.*
>
> - Thomas Eitzen, SEB

The respondents deem it more likely that the relative increase in volume of liquid stocks and decrease in less liquid stocks on the OSE is more likely to occur due to portfolio-rebalancing than liquidity-pull back by banks.

7.2 Norwegian banking sector

There are several reasons in the Norwegian banking sector that could result to the liquidity-pull back effects not appearing in the financial markets in Norway.

Firstly, the Norwegian banking sector is relatively small compared to other countries. The aggregate assets in the banking sector in Norway are about twice as big as the country's GDP, while Sweden's banking sector is about four times the size of the country's GDP (Norges Bank, 2013). Furthermore, the interbank market in Norway, as most European interbank markets, is inactive for maturities of 3 to 6 months. Unsecured lending is heavily concentrated in the shortest maturities, like overnight (Norges Bank, 2019).

> *For most countries, there is very little activity in the interbank market. Banks are risk-aware. Further, there are increased liquidity and reserve requirements due to new regulations. Activity is concentrated in the shortest money market rates and the overnight market. The largest interbank market in the world is in the USA, due to large money market funds, which invest in short-term debt securities.*
>
> - Vidar Knudsen, DNB

Even in the US, interbank funding has nearly disappeared, where interbank funding as percentage of assets is below 0.5 % in 2018 (Federal Reserve, 2018). Interbank funding has been replaced by the increase in deposits as percentage of assets. This is the general problem with IBOR's. They are reference rates on transactions that do not take place (Norges Bank, 2019). However, there are markets that resemble the interbank market, as banks obtain short-term financing in the certificate markets. The certificate market for NOK is small, Norwegian banks therefore issue certificates in USD and acquire NOK through a currency swap (Hoff, 2011).

> *Banks obtain short-term financing in USD in the short certificate marked, the interest on which creates a reference. The obtained USD financing is transferred to NOK in a currency swap with a future settlement. This transaction closely resembles an IBOR-transaction. Since a large part of Norwegian banks market financing is obtained in USD, the uncertainty from US markets is also imported. This is also part of the reason why Nibor is based on USD Libor.*
>
> \- Thomas Eitzen, SEB

Secondly, as mentioned by Vidar Knudsen, keeping assets such as stocks on the balance sheet is very expensive for banks. It is expensive due to capital requirements and resolution fees.

Norwegian banks are subject to regulation in accordance with the EU's directives "CRD IV" and "CRR", aimed to ensure compliance between risk exposure and capitalisation in the entity (Finanstilsynet, 2017). Capital requirements are assigned in relation to the risk-weighted assets of the bank, meaning that banks must have a fixed percentage of equity for every NOK they lend out, depending on market and operational risks of the bank. This means that banks do not have any incentives to accumulate large balance sheets when the capital requirements are calculated by the financial supervisory authorities, as this has negative implications for the return on equity investors in the bank can achieve. Norwegian banks therefore attempt to keep their balances slim and do not purchase non-operational assets such as financial securities.

Resolution fees go towards the bank insurance fund, it is a tax paid by banks to the government in case they go bankrupt and the state has to bail them out. Resolution fees are not incurred on

Norwegian banks. They are only incurred on Swedish banks as part of the Swedish Resolution Act. The fees are calculated proportional to the risk they pose to the financial system (Riksgalden, 2019). However, as four of the panel banks that determine the Nibor are Swedish (Swedbank, Handelsbanken, SEB, and Nordea), as well as being active and large banks that operate in Norway, this has implications for both how the Nibor mark-up is set and for activity in the Norwegian financial markets.

8 Conclusion

The purpose of this thesis was to analyze whether there exists a connection between demand for liquidity in the interbank market and the stock market in Norway for the sample period from 2003 to 2017. The main question of this thesis was whether increased price of liquidity in the interbank market is followed by banks engaging in "liquidity pull-back", which involves banks, financial institutions, or levered investors selling financial assets such as stocks to obtain liquidity. The hypothesis argues that such activity should be reflected in the stock market through increased volume in the most liquid stocks relative to less liquid stocks.

The analysis in this thesis finds evidence in line with previous research, by Nyborg and Östberg (2013), in that increased price of liquidity in the interbank market, measured by Libor-OIS and TED spreads, is associated with an increase in the market share of trading volume of the most liquid stocks on the Oslo Stock Exchange for the pre-financial crisis period, 2003 to 2007. Further, increase in spreads is associated with a relative decrease in trading for the portfolios with less liquid stocks. The results are strongest for the most liquid portfolios (portfolios 1 to 4), which on average represent 95 % of the daily trade volume on the exchange. The results are weaker for the less liquid portfolio (portfolios 6 to 10). The stocks in these portfolios may be too small to yield any significant results. However, the findings do not lend support to the hypothesis during and after the financial crisis, as the results either differ from the hypothesis or are not statistically significant.

There is stronger evidence in favour of the alternative portfolio rebalancing hypothesis, which is controlled for with the inclusion of the VIX. An increase in the VIX is reflected in the increase of market share of volume of the most liquid portfolio and decrease of the less liquid portfolios. The effects of portfolio rebalancing are present for the entirety of the sample period, but strongest for the crisis and post-crisis periods. Similar to the liquidity pull-back hypothesis, the effects are strongest for the most liquid portfolios.

The analysis with relative volume of all portfolio combinations allowed for control of whether the effects of liquidity pull-back are present for all portfolios or whether they are driven by Portfolio 1. This also served as a robustness check. The coefficients on IBOR-OIS spreads for the portfolio combinations were mostly positive, which was not consistent with the liquidity

pull-back hypothesis. The results therefore indicate that the findings of the previous analysis were driven by the most liquid portfolio.

The Fama-Macbeth regressions with the portfolios' within-month differences in volume on high versus low spread days as the dependent variable and each portfolios' average ILLIQ as the independent variable did not yield any statistically significant results.

Lastly, the qualitive analysis, which included interviews with Norwegian interbank market participants, presented a discussion of potential reasons for why the empirical analysis did not lend support to the liquidity pull-back hypothesis for the full sample-period. The relatively low activity of unsecured interbank lending in Norway, coupled with new banking regulations which make it expensive for banks to own financial assets, were identified as key factors.

Appendix

A Regressions on USD Libor-OIS and the VIX

Table A1: Descriptive statistics for market return, market volume and oil price

	Market Return (%)	Normalized Market Volume (%)	Oil price ($)
Mean	0.057	101.397	78.680
Std.Error	0.022	0.429	0.441
Std.Dev	1.384	26.778	27.853
Median	0.117	98.255	72.902
Min	-9.252	29.155	26.108
Max	9.622	577.308	152.504
N	3897	3897	3897

Table A2: Descriptive statistics for relative bid-ask spread and market share of turnover of each portfolio

Panel A: Relative bid-ask spread (%)

	Portfolio									
	1	2	3	4	5	6	7	8	9	10
Mean	0.003	0.006	0.010	0.015	0.019	0.023	0.028	0.036	0.047	0.079
Std.Error	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Std.Dev	0.001	0.002	0.004	0.007	0.009	0.012	0.012	0.016	0.022	0.090
Median	0.002	0.005	0.008	0.012	0.016	0.019	0.024	0.030	0.041	0.066
Min	0.001	0.002	0.002	0.004	0.005	0.005	0.007	0.009	0.010	0.006
Max	0.008	0.053	0.040	0.071	0.163	0.418	0.100	0.210	0.178	4.722
N	3897	3897	3897	3897	3897	3897	3897	3897	3897	3897
Panel B: Market share of turnover (%)										
Mean	0.463	0.208	0.120	0.083	0.053	0.030	0.014	0.012	0.010	0.008
Std.Error	0.003	0.002	0.002	0.002	0.001	0.001	0.000	0.001	0.001	0.001
Std.Dev	0.182	0.126	0.102	0.095	0.088	0.055	0.027	0.038	0.036	0.032
Median	0.480	0.179	0.086	0.050	0.022	0.012	0.006	0.004	0.003	0.001
Min	0.022	0.010	0.005	0.001	0.001	0.000	0.000	0.000	0.000	0.000
Max	0.880	0.815	0.822	0.733	0.912	0.619	0.418	0.832	0.715	0.732
N	3897	3897	3897	3897	3897	3897	3897	3897	3897	3897

Table A3: Regressions of market share of volume on Libor-OIS/VIX (pre-crisis)

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Each column represents a separate regression, one for each liquidity portfolio (as sorted in section 4.1). Where Y_t is mean adjusted market share of volume of each portfolio, X_t is the USD Libor-OIS (Panel A) or the VIX (Panel B). The variable $Res_{Z|X,t}$ are the residuals from regressing the VIX on the USD Libor-OIS spread and vice versa. Y_{t-1} is market share of volume of each portfolio for the previous day. W is a vector of the control variables: *Volume* is the aggregate normalised volume of all portfolios. *Market Return* is the equal weighted daily return on the OSE. *Oil Price* is the daily brent spot price. *Bid-ask* is the average relative bid-ask spread of each portfolio. *Turnover* is the daily average share turnover for each portfolio. As the control variables, N, and Adj. R^2 are by design the same for both panels, they are only included in Panel A. Pre-crisis period is 11.2003-06.2007.

Panel A: X is Libor-OIS

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Constant	0.373***	0.801***	0.981***	1.307***	1.905***	1.628***	1.312***	0.870***	0.972***	0.626***
	(12.11)	(6.57)	(6.96)	(8.33)	(5.56)	(9.28)	(5.98)	(5.78)	(6.64)	(2.73)
Libor-OIS	0.114***	-0.941***	-0.335**	-1.276***	-1.301	-1.315***	-1.384	-0.712**	-0.711**	-0.518
	(3.06)	(-3.58)	(-1.04)	(-3.70)	(-1.48)	(-3.30)	(-0.35)	(-2.09)	(-2.05)	(-0.88)
Res_{VIX}	0.037***	-0.337***	-1.520***	-1.821***	-2.248***	-2.605	-1.442	-0.962	-0.739	-1.169
	(3.44)	(-3.56)	(-3.43)	(-3.61)	(-3.31)	(-0.69)	(-1.24)	(-1.21)	(-0.91)	(0.13)
Y_{t-1}	0.575***	0.566***	0.503***	0.418***	0.093***	0.403***	0.282***	0.210***	0.210***	0.172***
	(22.35)	(21.28)	(17.81)	(14.19)	(2.83)	(13.53)	(8.98)	(6.55)	(6.54)	(5.28)
Volume	0.052***	-0.245***	-0.331***	-0.294***	-0.234**	-0.297***	-0.322***	-0.148***	-0.151***	-0.022
	(9.60)	(-6.49)	(-7.00)	(-5.84)	(-2.13)	(-5.17)	(-4.21)	(-2.86)	(-2.91)	(-0.26)
Market return	-0.154***	1.198***	1.218***	1.086***	1.251**	1.900***	1.689	2.917	2.841	1.653
	(-4.77)	(3.07)	(3.23)	(3.14)	(2.28)	(2.68)	(1.08)	(1.26)	(1.23)	(0.43)
Oil price	-0.000	0.002*	-0.002	-0.007***	-0.008**	-0.012***	-0.008***	-0.005***	-0.006***	-0.004*
	(-0.84)	(1.77)	(-1.49)	(-4.40)	(-2.29)	(-6.57)	(-3.44)	(-3.06)	(-3.62)	(-1.66)
Bid-ask	-1.096***	1.057	1.208	1.395	-1.476*	-1.070	1.135	1.165	0.100	-0.284
	(-3.40)	(1.12)	(0.52)	(1.44)	(-1.88)	(-0.31)	(0.37)	(0.75)	(0.10)	(-0.34)
Turnover	0.047***	-0.282***	0.295**	0.206	0.819**	0.157	0.697	0.237	-0,381	0.519
	(4.11)	(-2.97)	(2.26)	(0.99)	(2.13)	(0.47)	(0.80)	(0.74)	(-1.02)	(1.01)
N	940	940	940	940	940	940	940	940	940	940
Adj. R^2	0.480	0.424	0.329	0.296	0.038	0.297	0.134	0.081	0.081	0.038
Panel B: X is the VIX										
Constant	0.368***	0.847***	1.295***	1.661***	2.188***	1.708***	1.491***	0.992***	1.066***	0.608**
	(10.95)	(5.50)	(7.14)	(8.21)	(5.27)	(7.68)	(5.34)	(5.35)	(5.89)	(2.08)
VIX	0.123**	-1.043*	-2.516***	-3.526***	-2.876*	-1.577*	-1.434	-1.421*	-1.221	-0.258
	(2.47)	(-1.74)	(-3.47)	(-4.50)	(-1.71)	(-1.81)	(-1.24)	(-1.80)	(-1.52)	(-0.20)
Res_{LIBOR}	0.109***	-0.896***	-0.906	-0.894***	-0.797	-1.234***	-0.011	-0.581*	-0.611*	-0.541
	(2.90)	(-3.36)	(-1.02)	(-2.58)	(-1.04)	(-3.05)	(-0.02)	(-1.65)	(-1.74)	(-0.91)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A4: Regressions of market share of volume on Libor-OIS/VIX (crisis period)

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Each column represents a separate regression, one for each liquidity portfolio (as sorted in section 4.1). Where Y_t is mean adjusted market share of volume of each portfolio, X_t is the USD Libor-OIS (Panel A) or the VIX (Panel B). The variable $Res_{Z|X,t}$ are the residuals from regressing the VIX on the USD Libor-OIS spread and vice versa. Y_{t-1} is market share of volume of each portfolio for the previous day. W is a vector of the control variables: *Volume* is the aggregate normalised volume of all portfolios. *Market Return* is the equal weighted daily return on the OSE. *Oil Price* is the daily brent spot price. *Bid-ask* is the average relative bid-ask spread of each portfolio. *Turnover* is the daily average share turnover for each portfolio. As the control variables, N, and Adj. R^2 are by design the same for both panels, they are only included in Panel A. Crisis period is 07.2007 – 12.2009.

Panel A: X is Libor-OIS

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Constant	0.541***	0.653***	0.733***	0.791***	0.529***	0.656***	0.531***	0.389***	0.357***	0.296***
	(14.17)	(10.18)	(9.36)	(5.90)	(3.27)	(8.54)	(5.47)	(2.90)	(2.66)	(2.86)
Libor-OIS	0.011***	-0.067***	-0.083***	-0.101***	-0.051*	-0.033*	-0.041*	-0.052*	-0.048*	-0.043*
	(5.69)	(-4.85)	(-4.98)	(-3.40)	(-2.02)	(-2.00)	(-1.90)	(-1.68)	(-1.77)	(-1.73)
Res_{VIX}	0.053***	-0.093***	-0.561***	-0.584*	-0.877**	-0.738***	-0.229	-0.525*	-0.574*	-0.555**
	(2.83)	(-2.72)	(-3.47)	(-1.95)	(-2.33)	(-4.17)	(-1.00)	(-1.66)	(-1.76)	(-2.15)
Y_{t-1}	0.464***	0.394***	0.293***	0.343***	0.031***	0.283***	0.129***	0.191***	0.190***	0.049
	(13.06)	(11.00)	(7.67)	(8.23)	(8.76)	(7.41)	(3.19)	(4.76)	(4.75)	(1.19)
Volume	0.023***	-0.173***	-0.184***	-0.179***	-0.014	-0.159***	-0.162***	-0.142*	-0.143*	0.087
	(6.95)	(-5.82)	(-5.04)	(-2.61)	(-0.17)	(-3.95)	(-3.13)	(-1.92)	(-1.94)	(1.47)
Market return	-0.338***	2.293***	1.227*	0.436	2.181	1.382*	1.898*	1.990	2.077	1.260
	(-4.11)	(3.99)	(1.74)	(0.33)	(1.32)	(1.78)	(1.91)	(1.40)	(1.47)	(1.10)
Oil price	0.000	0.001*	-0.001	-0.002**	-0.002	-0.003***	-0.001	-0.001	-0.001	-0.002***
	(0.04)	(1.75)	(-1.53)	(-2.38)	(-1.34)	(-5.70)	(-1.56)	(-0.71)	(-0.64)	(-2.63)
Bid-ask	1.626***	-1.647***	-1.694***	-1.327*	-1.262	-0.608	-1.361	0.509	0.806	-0.217
	(3.16)	(-3.48)	(-4.56)	(-1.78)	(-0.76)	(-1.31)	(-1.56)	(0.59)	(1.12)	(-1.06)
Turnover	-0.003	-0.230**	-0.058	-0.333	0.471	1.018	-1.481	0.230	0.651	-0.336
	(-0.32)	(-2.52)	(-0.52)	(-0.98)	(1.54)	(0.92)	(-1.43)	(0.18)	(0.50)	(-0.14)
N	654	654	654	654	654	654	654	654	654	654
Adj. R^2	0.461	0.406	0.266	0.163	0.025	0.194	0.056	0.061	0.063	0.027
Panel B: X is the VIX										
Constant	0.530***	0.687***	0.836***	0.903***	0.664***	0.767***	0.575***	0.477***	0.451***	0.386***
	(14.02)	(9.05)	(8.91)	(5.60)	(3.39)	(8.12)	(4.93)	(2.91)	(2.76)	(2.98)
VIX	0.063***	-0.278***	-0.544***	-0.616***	-0.569**	-0.446***	-0.247*	-0.418**	-0.426**	-0.400***
	(5.27)	(-3.39)	(-5.44)	(-3.43)	(-2.53)	(-4.17)	(-1.83)	(-2.18)	(-2.22)	(-2.59)
Res_{LIBOR}	0.023***	-0.052**	-0.035**	-0.309***	-0.387***	-0.382***	-0.405	-0.530	-0.442	-0.544
	(2.85)	(-2.34)	(-2.17)	(-3.17)	(3.35)	(2.78)	(-0.13)	(-0.54)	(-0.74)	(-0.99)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A5: Regressing market share of volume on Libor-OIS/VIX (post-crisis)

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Each column represents a separate regression, one for each liquidity portfolio (as sorted in section 4.1). Where Y_t is mean adjusted market share of volume of each portfolio, X_t is the USD Libor-OIS (Panel A) or the VIX (Panel B). The variable $Res_{Z|X,t}$ are the residuals from regressing the VIX on the USD Libor-OIS spread and vice versa. Y_{t-1} is market share of volume of each portfolio for the previous day. W is a vector of the control variables: *Volume* is the aggregate normalised volume of all portfolios. *Market Return* is the equal weighted daily return on the OSE. *Oil Price* is the daily brent spot price. *Bid-ask* is the average relative bid-ask spread of each portfolio. *Turnover* is the daily average share turnover for each portfolio. As the control variables, N, and Adj. R^2 are by design the same for both panels, they are only included in Panel A. Post-crisis period is 01.2010 – 12.2017.

Panel A: X is Libor-OIS

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Constant	0.001 (0.08)	1.131*** (16.62)	1.168*** (9.39)	0.959*** (4.18)	1.289*** (3.55)	1.636*** (3.25)	1.803*** (2.97)	1.579** (2.55)	1.621*** (2.64)	-0.039 (-0.06)
Libor-OIS	0.010 (0.74)	0.104 (1.14)	-0.410** (-2.04)	-0.934** (-2.27)	-1.492** (-2.27)	-2.123** (-2.34)	-3.080*** (-2.80)	-3.082*** (-2.74)	-2.836** (-2.51)	-3.685*** (-2.83)
Res_{VIX}	0.036 (1.53)	-1.704*** (-10.15)	-1.824*** (-5.24)	-2.554*** (-3.66)	-2.220** (-2.00)	-2.239 (-1.45)	-3.169 (-1.51)	-2.739 (-1.45)	-2.822 (-1.50)	-3.558 (-1.63)
Y_{t-1}	0.966*** (17.65)	0.387*** (18.92)	0.607*** (34.20)	0.593*** (32.96)	0.612*** (34.57)	0.597*** (33.30)	0.536*** (28.38)	0.599*** (33.38)	0.601*** (33.77)	0.622*** (35.57)
Volume	0.024*** (4.70)	-0.105*** (-3.00)	-0.281*** (-3.73)	-0.083 (-0.54)	-0.401* (-1.67)	-0.188 (-0.56)	-0.397 (-0.96)	-0.327 (-0.77)	-0.344 (-0.81)	0.789 (1.58)
Market return	-0.346* (-1.96)	2.471** (2.03)	-1.426 (-0.54)	-1.138 (-0.77)	-2.046 (-0.25)	2.353 (0.88)	2.535 (0.04)	-2.471 (-0.78)	-2.457 (-0.80)	-2.215 (-1.25)
Oil price	-0.000 (-0.37)	-0.002*** (-6.11)	-0,001 (-1.10)	0.002* (1.68)	0.003 (1.28)	0.004 (1.24)	0.009** (2.25)	0.008** (2.01)	0.009** (2.21)	0.008* (1.77)
Bid-ask	1.388 (1.45)	-1.454*** (-5.78)	-1.312*** (-4.15)	-1.477*** (-4.21)	-1.204** (-2.09)	-1.410*** (-2.85)	-1.021*** (-2.72)	-1.841** (-2.10)	-1.779*** (-2.93)	-1.051 (-0.97)
Turnover	0.001 (0.11)	-0.252*** (-3.57)	-0.160 (-0.69)	0.620 (1.49)	0.361 (0.46)	-1.723* (-1.91)	-1.152 (-1.10)	-1.091 (-1.39)	1.506 (0.52)	-0.861 (-0.11)
N	2086	2086	2086	2086	2086	2086	2086	2086	2086	2086
R^2	0.443	0.359	0.464	0.411	0.405	0.384	0.317	0.388	0.388	0.405
Panel B: X is the VIX										
Constant	0.004 (0.40)	1.416*** (19.37)	1.407*** (10.96)	1.248*** (5.27)	1.453*** (3.96)	1.723*** (3.40)	1.916*** (3.14)	1.624*** (2.60)	1.711*** (2.75)	0.060 (0.08)
VIX	0.034* (1.65)	-1.538*** (-9.58)	-1.868*** (-5.50)	-2.771*** (-4.09)	-2.699** (-2.46)	-2.987** (-1.98)	-4.259** (-2.36)	-3.861** (-2.10)	-3.833** (-2.10)	-4.879** (-2.31)
Res_{Libor}	0.004 (0.28)	0.390*** (4.08)	-0.104 (-0.51)	-0.506 (-1.19)	-1.120* (-1.68)	-1.748* (-1.89)	-2.549** (-2.26)	-2.623** (-2.27)	-2.764** (-2.04)	-3.089** (-2.29)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A6: Regressions of relative volume on USD Libor-OIS/VIX (pre-crisis)

The dependent variable is now relative volume instead of market share of volume. Each cell represents a separate regression and reports the estimate of the coefficient on the USD Libor-OIS (Panel A) or the VIX (Panel B) from the following regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Where Y_t is the mean adjusted relative volume of Portfolio P to H_t. $Res_{Z|X,t}$ are the residuals from regressing Libor-OIS on the VIX and vice versa. W is a vector of the control variables: market return, market volume, oil price, relative bid-ask spread and share turnover. Pre-crisis period is 11.2003 – 06.2007.

Panel A: X is Libor-OIS

Portfolio H	**Portfolio P**								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	-0.815**	-2.538**	-2.722**	-2.468**	-3.301*	-1.243**	-1.021**	0.728**	-1.037**
	(-2.09)	(-2.64)	(-2.40)	(-1.96)	(-1.69)	(-2.39)	(-2.36)	(-2.15)	(-2.56)
2		-0.721**	-0.726*	-0.415**	-1.325***	-0.608***	-1.563**	-0.759**	-1.167***
		(-2.00)	(-1.84)	(-2.23)	(-3.14)	(-3.27)	(-2.22)	(-2.41)	(-3.51)
3			-0.326	-0.552	-1.161***	-1.047	-1.872**	-1.778*	-2.973
			(-0.35)	(-0.16)	(-4.95)	(-1.05)	(-2.31)	(-1.94)	(-0.19)
4				-1.794	-1.167***	-3.472	-1.704**	-1.315	-1.291
				(-0.63)	(-4.94)	(-1.86)	(-2.30)	(-1.49)	(-0.56)
5					-1.301***	-0.057	-1.121	-2.678	-2.593
					(-3.00)	(0.04)	-0.62	-0.918	(-0.25)
6						-1.575**	-1.804*	-1.157	-1.771
						(-2.60)	(-1.65)	(-0.43)	(-0.74)
7							0.832	1.487	-1.413
							(0.43)	(0.90)	(-0.86)
8								1.329**	-1.803
								(1.93)	(-0.42)
9									-1.091
									(-0.68)
Panel B: X is the VIX									
1	-1.337***	-0.511**	-0.717**	-0.998***	-0.567***	-0.564	-0.815***	-0.809**	-0.546**
	(-4.29)	(-2.34)	(-2.59)	(-2.97)	(-2.70)	(2.44)	(-2.72)	(-2.43)	(2.47)
2		-1.071***	-0.577*	-1.141***	-1.543***	-1.475***	-1.793**	-1.251***	-1.221***
		(-3.64)	(-1.65)	(2.95)	(-3.75)	(3.82)	(-2.12)	(-2.40)	(-3.01)
3			-0.302*	-0.352	-0.503***	1.395*	1.290	1.814	3.021
			(-1.78)	(1.26)	(-3.37)	(1.79)	(1.53)	(1.46)	(1.22)
4				1.323	1.753***	1.406***	1.941*	2.407*	1.981
				(1.17)	(3.75)	(4.54)	(1.67)	(1.69)	(0.61)
5					1.372**	0.641	0.112	0.866	3.052
					(2.39)	(1.00)	(0.16)	(0.73)	(0.74)
6						1.074	-0.486	-0.194	2.092
						(1.53)	(-0.72)	(-0.18)	(0.57)
7							-0.974	0.370	1.419
							(-1.27)	(0.33)	(0.22)
8								2.189*	3.167
								(1.67)	(0.69)
9									0.524
									(0.18)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A7: Regressions of relative volume on USD Libor-OIS/VIX (crisis)

The dependent variable is now relative volume instead of market share of volume. Each cell represents a separate regression and reports the estimate of the coefficient on the USD Libor-OIS (Panel A) or the VIX (Panel B) from the following regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Where Y_t is the mean adjusted relative volume of Portfolio P to H_t. $Res_{Z|X,t}$ are the residuals from regressing USD Libor-OIS on the VIX and vice versa. W is a vector of the control variables: market return, market volume, oil price, relative bid-ask spread and share turnover. Crisis period is 07.2007 – 12.2009.

Panel A: X is Libor-OIS

Portfolio H	**Portfolio P**								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	-0.072*** (-5.42)	-0.057*** (-3.64)	-0.089*** (-2.96)	-0.186** (-1.87)	-0.033 (-1.13)	-0.090* (-1.88)	-0.138 (-1.58)	-0.120 (-1.09)	-0.111** (-2.41)
2		0.056 (0.19)	-0.042 (-0.94)	-0.110 (-0.82)	0.048 (0.90)	-0.071 (-0.08)	-0.058 (-0.40)	0.065 (0.30)	-0.075 (-0.94)
3			-0.024 (-0.40)	-0.086 (-0.59)	0.095 (1.21)	0.008 (0.07)	-0.076 (-0.46)	0.171 (0.64)	-0.025 (-0.22)
4				-0.032 (-0.24)	0.126* (1.66)	0.063 (0.62)	-0.091 (-0.05)	0.160 (0.79)	0.006 (0.04)
5					0.033 (0.48)	-0.048 (-0.37)	-0.099 (-0.41)	0.118 (0.39)	-0.125 (-0.83)
6						-0.028 (-0.27)	-0.029 (-0.15)	-0.034 (-0.13)	-0.125 (-1.22)
7							-0.216 (-1.05)	-0.032 (-0.12)	-0.123 (-0.93)
8								-0.035 (-0.17)	-0.124 (-0.84)
9									-0.094 (-0.80)
Panel B: X is the VIX									
1	-0.405*** (-6.34)	-0.458*** (-5.97)	-0.424*** (-3.00)	-1.285*** (-2.66)	-0.143** (-2.02)	-0.502** (-2.23)	-0.892** (-2.15)	-0.611** (-2.18)	-0.629*** (-2.87)
2		-0.201** (-2.41)	-0.085 (-0.40)	-0.948** (-1.99)	0.508** (2.02)	0.130 (0.35)	-0.423 (-0.62)	0.765* (1.75)	-0.266*** (-2.79)
3			0.492* (1.74)	-0.340 (-0.50)	1.306*** (3.45)	0.986* (1.70)	0.351 (0.44)	2.586** (2.05)	0.505** (1.95)
4				-0.642 (-1.03)	1.175*** (3.24)	0.683 (1.44)	0.406 (0.48)	1.214 (1.27)	-0.120** (-2.16)
5					0.615* (1.90)	-0.221 (-0.36)	-0.909 (-0.80)	0.628 (0.44)	-0.623 (-0.88)
6						-0.741 (-1.53)	-1.336 (-1.50)	-0.884 (-0.70)	-1.072** (-2.20)
7							-1.594* (-1.66)	-1.150 (-0.89)	-1.084* (-1.72)
8								-0.879 (-0.91)	-1.220* (-1.74)
9									-0.842 (-1.51)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A8: Regressions of relative volume on USD Libor-OIS/VIX (post-crisis)

The dependent variable is now relative volume instead of market share of volume. Each cell represents a separate regression and reports the estimate of the coefficient on the USD Libor-OIS (Panel A) or the VIX (Panel B) from the following regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Where Y_t is the mean adjusted relative volume of Portfolio P to H_t. $Res_{Z|X,t}$ are the residuals from regressing USD Libor-OIS on the VIX and vice versa. W is a vector of the control variables: market return, market volume, oil price, relative bid-ask spread and share turnover. Post-crisis period is 01.2010 – 12.2017.

Panel A: X is Libor-OIS

Portfolio H	**Portfolio P**								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	0.166*** (2.22)	0.055*** (2.55)	0.046 (0.37)	-0.041 (-0.33)	0.262*** (2.18)	0.128 (0.80)	0.639*** (2.89)	0.282* (1.73)	0.856* (1.67)
2		-0.307*** (-2.91)	-0.370*** (-2.62)	-0.516*** (-3.79)	-0.079 (-0.71)	-0.223 (-1.55)	0.529 (1.72)	0.017 (0.09)	0.387 (1.08)
3			-0.072 (-0.50)	-0.352*** (-2.69)	0.220*** (2.05)	0.033 (0.22)	1.042*** (3.35)	0.251 (1.37)	0.521* (1.67)
4				-0.211 (-1.54)	0.446*** (3.21)	0.220 (1.39)	0.746*** (3.27)	0.531** (1.99)	0.902** (2.02)
5					0.505*** (3.10)	0.204 (1.09)	1.892*** (3.41)	0.370* (1.78)	0.468 (1.26)
6						-0.173 (-0.86)	0.675** (2.16)	-0.111 (-0.42)	0.273 (0.71)
7							0.802*** (2.92)	0.232 (0.82)	0.484 (0.50)
8								0.112 (0.50)	0.368 (1.32)
9									0.510 (1.24)
Panel B: X is the VIX									
1	-1.189*** (-9.11)	-1.613*** (-8.91)	-2.204*** (-9.63)	-2.265*** (-10.20)	-2.011*** (-9.45)	-1.924*** (-7.20)	-2.463*** (-6.85)	-1.728*** (-6.46)	-1.742** (-2.12)
2		-1.257*** (-7.16)	-1.088*** (-8.76)	-1.119*** (-8.08)	-1.591*** (-8.55)	-1.069*** (-4.58)	-0.885*** (-3.80)	-0.615** (-2.08)	-0.624** (-2.19)
3			-0.601*** (-2.57)	-0.661*** (-3.15)	-0.599*** (-3.36)	-0.488*** (-2.02)	-0.583*** (2.71)	-1.194*** (-4.05)	-0.914* (-1.83)
4				-0.188 (-0.08)	0.734*** (3.30)	1.565*** (6.10)	2.051*** (5.60)	2.209*** (5.13)	1.720*** (2.65)
5					1.003*** (3.85)	1.702*** (5.60)	3.18*** (3.59)	1.991*** (5.90)	2.181*** (3.63)
6						1.100*** (3.39)	1.730*** (3.46)	1.225*** (2.87)	1.577** (2.54)
7							0.549 (1.24)	0.400 (0.88)	0.864* (1.67)
8								0.088 (0.25)	0.507 (1.14)
9									0.013 (0.20)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

B Regressions on Nibor-OIS and Norwegian TED spread

Table B1: Regressions of Nibor-OIS spread and the VIX

This table summarizes the coefficients from the regression:

$$Z_t = \alpha + \beta_1 X_t + \varepsilon_t$$

Where Z_t and X_t are either the Nibor-OIS spread or VIX. The regressions are used to obtain the residuals for both models, which are the orthogonal part of Nibor-OIS and the VIX to each other.

	(1) **VIX**	**(2)** **Nibor-OIS**
Constant	0.098***	0.144***
	(39.76)	(16.59)
Nibor-OIS	0.188***	
	(41.79)	
VIX		1.758***
		(41.79)
N	3776	3776
$\boldsymbol{R^2}$	0.330	0.330

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B2: Regressions of market share of volume of Nibor-OIS/VIX and residuals

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Each column represents a separate regression, one for each liquidity portfolio (as sorted in section 4.1). Where Y_t is mean adjusted market share of volume of each portfolio, X_t is the Nibor-OIS (Panel A) or the VIX (Panel B). The variable $Res_{Z|X,t}$ are the residuals from regressing the VIX on the Nibor-OIS spread (Res_{VIX}) and vice versa (Res_{NIBOR}). Y_{t-1} is market share of volume of each portfolio for the previous day. As Y_{t-1}, N and Adj. R^2 are by design the same for both panels, they are only included in Panel A. Sample period is 01.2003 – 12.2017.

Panel A: X is the Nibor-OIS

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Constant	0.046*** (9.07)	0.601*** (26.61)	0.629*** (20.05)	0.721*** (14.29)	0.831*** (11.05)	0.898*** (9.07)	1.077*** (8.98)	0.931*** (7.62)	0.931*** (7.62)	0.942*** (6.60)
Nibor-OIS	0.012*** (3.42)	-0.316*** (-12.70)	-0.502*** (-11.11)	-0.682*** (-8.11)	-0.885*** (-6.74)	-1.054*** (-5.99)	-1.308*** (-6.10)	-1.141*** (-5.20)	-1.141*** (-5.20)	-1.198*** (-4.65)
Res_{VIX}	0.014 (1.18)	-0.785*** (-8.86)	-0.721*** (-4.56)	-0.586* (-1.93)	-0.307 (-0.64)	0.201 (0.31)	0.330 (0.42)	0.355 (0.44)	0.355 (0.44)	0.512 (0.54)
Y_{t-1}	0.948*** (176.52)	0.548*** (38.94)	0.608*** (45.49)	0.602*** (44.83)	0.588*** (43.25)	0.599*** (44.52)	0.541*** (38.30)	0.608*** (45.55)	0.608*** (45.55)	0.624*** (47.48)
N	3776	3776	3776	3776	3776	3776	3776	3776	3776	3776
R^2	0.914	0.450	0.472	0.412	0.378	0.386	0.318	0.390	0.390	0.406
Panel B: X is the VIX										
Constant	0.046*** (8.82)	0.653*** (26.13)	0.647*** (18.75)	0.695*** (12.36)	0.741*** (8.75)	0.721*** (6.44)	0.846*** (6.22)	0.722*** (5.20)	0.722*** (5.20)	0.705*** (4.33)
VIX	0.032*** (2.95)	-1.081*** (-13.95)	-1.366*** (-10.03)	-1.592*** (-6.29)	-1.762*** (-4.45)	-1.719*** (-3.24)	-2.078*** (-3.21)	-1.769*** (-2.67)	-1.769*** (-2.67)	-1.763** (-2.26)
Res_{Nibor}	0.010** (2.26)	-0.169*** (-5.95)	-0.367*** (-6.98)	-0.572*** (-5.68)	-0.828*** (-5.21)	-1.092*** (-5.11)	-1.370*** (-5.25)	-1.208*** (-4.53)	-1.208*** (-4.53)	-1.294*** (-4.12)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B3: Regressions of market share of volume on Nibor-OIS/VIX and control variables

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Each column represents a separate regression, one for each liquidity portfolio (as sorted in section 4.1). Where Y_t is mean adjusted market share of volume of each portfolio, X_t is the Nibor-OIS (Panel A) or the VIX (Panel B). The variable $Res_{Z|X,t}$ are the residuals from regressing the VIX on the Nibor-OIS spread and vice versa. Y_{t-1} is market share of volume of each portfolio for the previous day. W is a vector of the control variables: *Volume* is the aggregate normalised volume of all portfolios. *Market Return* is the equal weighted daily return on the OSE. *Oil Price* is the daily brent spot price. *Bid-ask* is the average relative bid-ask spread of each portfolio. *Turnover* is the daily average share turnover for each portfolio. As the control variables, N, and Adj. R^2 are by design the same for both panels, they are only included in Panel A. Sample period is 01.2003 – 12.2017.

Panel A: X is Nibor-OIS

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Constant	0.007 (0.93)	1.064*** (23.51)	1.110*** (16.03)	0.882*** (7.30)	1.018*** (5.28)	1.033*** (4.12)	1.128*** (3.67)	0.736** (2.38)	0.776** (2.52)	0.089 (-0.25)
Nibor-OIS	0.013*** (3.25)	-0.252*** (-9.94)	-0.452*** (-9.52)	-0.669*** (-7.30)	-0.913*** (-6.22)	-1.212*** (-6.24)	-1.574*** (-6.70)	-1.452*** (-6.12)	-1.440*** (-6.12)	-1.624*** (-5.91)
Res_{VIX}	0.012 (0.91)	-0.928*** (-10.02)	-0.616*** (-3.77)	-0.210 (-0.66)	0.257 (0.49)	0.784 (1.14)	1.461* (1.73)	1.295 (1.51)	1.497* (1.76)	1.428 (1.47)
Volume	0.037*** (11.16)	-0.169*** (-7.43)	-0.289*** (-6.84)	-0.182** (-2.21)	-0.300** (-2.29)	0.245 (-1.39)	0.343 (-1.59)	0.222 (-1.01)	0.212 (-0.96)	0.376 (1.45)
Return	-0.472*** (-4.36)	0.778*** (3.76)	0.872 (0.64)	-0.502 (-0.19)	1.984 (0.47)	1.272 (0.93)	0.718 (0.10)	-1.243 (-0.60)	-1.427 (-0.62)	-1.993 (-1.19)
Oil Price	0.000 (-0.64)	-0.002*** (-8.93)	0,001 (-1.58)	0.002** (2.06)	0.004*** (2.59)	0.005*** (2.75)	0.010*** (4.22)	0.011*** (4.27)	0.010*** (4.45)	0.012*** (4.33)
Y_{t-1}	0.948*** (178.50)	0.513*** (35.88)	0.599*** (44.58)	0.594*** (43.96)	0.583*** (42.64)	0.595*** (43.98)	0.532*** (37.36)	0.598*** (44.35)	0.599*** (44.47)	0.615*** (46.41)
Bid-ask	0.889 (0.98)	-1.476*** (-4.40)	-1.527*** (-4.89)	-1.083*** (-2.94)	-0.989** (-1.99)	-2.136* (-1.66)	-1.077** (-2.01)	-2.217 (-1.31)	-2.422** (-2.22)	0.814 (-1.08)
Turnover	0.004 (0.60)	-0.140*** (-2.79)	0,042 (-0.35)	0.507* (1.94)	0.270 (0.64)	-1.949** (-2.22)	-2.277 (-1.04)	-1.696 (-1.11)	0.150 (0.09)	0.697 (-0.33)
N	3776	3776	3776	3776	3776	3776	3776	3776	3776	3776
R^2	0.917	0.475	0.483	0.415	0.381	0.389	0.323	0.394	0.394	0.410
Panel B: X is the VIX										
Constant	0.007 (0.95)	1.144*** (23.81)	1.122*** (15.51)	0.811*** (6.34)	0.854*** (4.24)	0.760*** (2.86)	0.719** (2.23)	0.364 (1.12)	0.381 (1.17)	0.502 (-1.32)
VIX	0.030*** (2.65)	-1.064*** (-13.46)	-1.206*** (-8.63)	-1.316*** (-4.88)	-1.433*** (-3.24)	-1.605*** (-2.77)	-1.788** (-2.55)	-1.685** (-2.39)	-1.529** (-2.21)	-1.899** (-2.43)
Res_{Nibor}	0.010** (2.32)	-0.077*** (-2.61)	-0.336*** (-6.04)	-0.629*** (-5.80)	-0.961*** (-5.58)	-1.359*** (-5.88)	-1.848*** (-6.54)	-1.695*** (-5.88)	-1.721*** (-5.95)	-1.892*** (-5.56)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B4: Regressions of market share of volume on Nibor-OIS/VIX and control variables (pre-crisis period)

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Each column represents a separate regression, one for each liquidity portfolio (as sorted in section 4.1). Where Y_t is mean adjusted market share of volume of each portfolio, X_t is the Nibor-OIS (Panel A) or the VIX (Panel B). The variable $Res_{Z|X,t}$ are the residuals from regressing the VIX on the Nibor-OIS spread and vice versa. Y_{t-1} is market share of volume of each portfolio for the previous day. W is a vector of the control variables: *Volume* is the aggregate normalised volume of all portfolios. *Market Return* is the equal weighted daily return on the OSE. *Oil Price* is the daily brent spot price. *Bid-ask* is the average relative bid-ask spread of each portfolio. *Turnover* is the daily average share turnover for each portfolio. As the control variables, N, and Adj. R^2 are by design the same for both panels, they are only included in Panel A. Pre-crisis period is 01.2003 – 06.2007.

Panel A: X is Nibor-OIS

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Constant	0.402***	0.615***	0.910***	1.021***	1.632***	1.421***	1.254***	0.688***	0.803***	0.512**
	(12.90)	(5.71)	(7.36)	(7.89)	(5.56)	(9.20)	(6.58)	(5.47)	(6.49)	(2.60)
Nibor-OIS	0.053***	-0.308***	-0.338**	-0.463***	-0.670**	-0.753***	-0.656***	-0.182	-0.21	-0.182
	(3.38)	(-2.83)	(-2.56)	(-3.33)	(-2.18)	(-4.66)	(-3.13)	(-1.29)	(-1.47)	(-0.78)
Res_{VIX}	0.134*	-0.823**	-2.796***	-3.619***	-2.939*	-1.594*	-1.814	-1.352*	-1.113	-0.136
	(1.80)	(-1.99)	(-3.90)	(-4.68)	(-1.76)	(-1.86)	(-1.59)	(-1.73)	(-1.40)	(-0.11)
Volume	0.052***	-0.248***	-0.330***	-0.298***	-0.240**	-0.302***	-0.326***	-0.150***	-0.153***	0.024
	(9.69)	(-6.54)	(-7.03)	(-5.95)	(-2.18)	(-5.30)	(-4.29)	(-2.90)	(-2.95)	(-0.28)
Return	-1.139***	2.151***	1.771***	2.034***	1.044**	1.879***	1.520	2.847	2.786	1.626
	(-4.72)	(3.04)	(3.23)	(3.14)	(2.24)	(2.70)	(1.03)	(1.23)	(1.20)	(0.43)
Oil price	-0.001***	0.006***	0.001	-0.001	-0.002	-0.006***	-0.004	-0.002	-0.003*	-0.002
	(-3.83)	(4.37)	(0.59)	(-0.78)	(-0.45)	(-2.86)	(-1.38)	(-1.26)	(-1.82)	(-0.78)
Y_{t-1}	0.568***	0.570***	0.486***	0.402***	0.085***	0.379***	0.266***	0.212***	0.212***	0.173***
	(22.00)	(21.62)	(17.04)	(13.55)	(2.59)	(12.58)	(8.43)	(6.60)	(6.59)	(5.31)
Bid-ask	-1.104***	1.319	1.828	2.956	-2.691*	-2.455	0.941	1.395	0.071	-0.312
	(-2.64)	(0.46)	(0.30)	(1.35)	(-1.88)	(-0.92)	(0.31)	(0.90)	(0.07)	(-0.38)
Turnover	0.039***	-0.248**	0.220*	0.187	0.744*	-0.281	0.475	0.219	-0.429	0.426
	(3.35)	(-2.58)	(1.70)	(0.91)	(1.96)	(-0.87)	(0.57)	(0.68)	(-1.15)	(0.86)
N	1113	1113	1113	1113	1113	1113	1113	1113	1113	1113
R^2	0.483	0.424	0.337	0.306	0.044	0.309	0.146	0.081	0.081	0.038
Panel B: X is the VIX										
Constant	0.414***	0.549***	1.082***	1.230***	1.637***	1.207***	1.122***	0.761***	0.830***	0.428
	(11.51)	(3.45)	(5.79)	(6.12)	(3.81)	(5.36)	(3.87)	(3.94)	(4.41)	(1.39)
VIX	0.031**	-0.221**	-2.004***	-2.549***	-1.551	0.153	0.529	0.936	0.665	0.195
	(2.37)	(-2.36)	(-2.75)	(-3.27)	(-0.90)	(-0.18)	(-0.45)	(-1.17)	(-0.81)	(0.15)
Res_{Nibor}	0.058***	-0.341***	-0.449***	-0.606***	-0.786***	-0.816***	-0.728***	-0.236*	-0.254*	0.187
	(3.67)	(-3.17)	(-3.40)	(-4.35)	(-2.58)	(-5.05)	(-3.48)	(-1.68)	(-1.80)	(-0.81)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B5: Regressions of market share of volume on Nibor-OIS/VIX and control variables (crisis period)

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Each column represents a separate regression, one for each liquidity portfolio (as sorted in section 4.1). Where Y_t is mean adjusted market share of volume of each portfolio, X_t is the Nibor-OIS (Panel A) or the VIX (Panel B). The variable $Res_{Z|X,t}$ are the residuals from regressing the VIX on the Nibor-OIS spread and vice versa. Y_{t-1} is market share of volume of each portfolio for the previous day. W is a vector of the control variables: *Volume* is the aggregate normalised volume of all portfolios. *Market Return* is the equal weighted daily return on the OSE. *Oil Price* is the daily brent spot price. *Bid-ask* is the average relative bid-ask spread of each portfolio. *Turnover* is the daily average share turnover for each portfolio. As the control variables, N, and Adj. R^2 are by design the same for both panels, they are only included in Panel A. Crisis period is 07.2007 – 12.2009.

Panel A: X is Nibor-OIS

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Constant	0.540***	0.667***	0.734***	0.783***	0.464***	0.586***	0.517***	0.374***	0.339***	0.262***
	(14.15)	(10.65)	(9.59)	(5.98)	(2.98)	(8.08)	(5.47)	(2.90)	(2.60)	(2.67)
Nibor-OIS	0.009***	-0.031	-0.112***	-0.095*	0.029	0.050	0.007	0.085	0.083	0.052
	(2.60)	(-1.32)	(-3.79)	(-1.77)	(-0.42)	(-1.57)	(0.17)	(-1.45)	(-1.42)	(-1.11)
Res_{VIX}	0.065***	-0.349***	-0.464***	-0.592***	-0.497**	-0.310***	-0.324**	0.312	0.305	-0.325**
	(5.12)	(-3.98)	(-4.43)	(-3.11)	(-2.11)	(-2.75)	(-2.27)	(-1.55)	(-1.51)	(-2.00)
Volume	0.030***	-0.176***	-0.184***	-0.180***	-0.009	-0.152***	-0.162***	-0.139*	-0.139*	0.090
	(7.00)	(-5.90)	(-5.08)	(-2.62)	(-0.10)	(-3.76)	(-3.16)	(-1.89)	(-1.90)	(1.52)
Return	-0.342***	2.384***	1.217*	0.445	2.024	1.243	1.907*	1.956	1.994	1.200
	(-4.17)	(4.14)	(1.73)	(0.34)	(1.23)	(1.59)	(1.93)	(1.38)	(1.41)	(1.05)
Oil price	0.000	0.002	-0.001	-0.002	-0.002	-0.003	-0.001**	0.001	0.000	-0.002**
	(0.41)	(0.47)	(-0.89)	(-2.43)	(-0.87)	(-4.40)	(-2.09)	(-0.19)	(-0.01)	(-2.18)
Y_{t-1}	0.466***	0.403***	0.286***	0.343***	0.033	0.294***	0.126***	0.190***	0.189***	0.051
	(13.12)	(11.24)	(7.44)	(8.25)	(0.81)	(7.68)	(3.12)	(4.73)	(4.73)	(1.24)
Bid-ask	1.413***	-1.314***	-1.950***	-1.254*	-1.765	-0.792*	-1.219	0.339	0.601	-0.262
	(3.04)	(-3.01)	(-4.99)	(-1.85)	(-1.10)	(-1.71)	(-1.45)	(0.41)	(0.88)	(-1.31)
Turnover	0.003	-0.257***	-0.059	-0.327	0.469	0.869	-1.531	0.165	0.628	0.650
	(-0.38)	(-2.82)	(-0.53)	(-0.96)	(1.53)	(0.78)	(-1.48)	(0.13)	(0.48)	(-0.27)
N	654	654	654	654	654	654	654	654	654	654
R^2	0.460	0.401	0.270	0.163	0.022	0.183	0.057	0.061	0.063	0.026
Panel B: X is the VIX										
Constant	0.526***	0.746***	0.801***	0.895***	0.587***	0.645***	0.612***	0.414***	0.377**	0.323***
	(14.01)	(9.85)	(8.71)	(5.62)	(3.11)	(7.17)	(5.36)	(2.61)	(2.38)	(2.62)
VIX	0.065***	-0.341***	-0.504***	-0.609***	-0.475**	-0.319***	-0.291**	-0.345*	-0.337*	-0.334**
	(5.60)	(-4.21)	(-5.19)	(-3.49)	(-2.20)	(-3.10)	(-2.24)	(-1.87)	(-1.83)	(-2.24)
Res_{NIBOR}	0.001	0.012	-0.056*	-0.023	0.032	0.012	0.046	0.047	-0.046	-0.013
	(0.26)	(0.40)	(-1.71)	(-0.38)	(0.41)	(-0.34)	(1.00)	(-0.71)	(-0.69)	(-0.24)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B6: Regressions of market share of volume on Nibor-OIS/VIX and control variables (post-crisis)

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Each column represents a separate regression, one for each liquidity portfolio (as sorted in section 4.1). Where Y_t is mean adjusted market share of volume of each portfolio, X_t is the Nibor-OIS (Panel A) or the VIX (Panel B). The variable $Res_{Z|X,t}$ are the residuals from regressing the VIX on the Nibor-OIS spread and vice versa. Y_{t-1} is market share of volume of each portfolio for the previous day. W is a vector of the control variables: *Volume* is the aggregate normalised volume of all portfolios. *Market Return* is the equal weighted daily return on the OSE. *Oil Price* is the daily brent spot price. *Bid-ask* is the average relative bid-ask spread of each portfolio. *Turnover* is the daily average share turnover for each portfolio. As the control variables, N, and Adj. R^2 are by design the same for both panels, they are only included in Panel A. Post-crisis period is 01.2010 – 12.2017.

Panel A: X is Nibor-OIS

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Constant	0.001 (0.14)	1.235*** (18.20)	1.312*** (10.89)	1.081*** (4.94)	1.389*** (4.02)	1.699*** (3.57)	1.953*** (3.41)	1.716*** (2.92)	1.853*** (3.17)	0.214 (0.32)
Nibor-OIS	0.013** (2.04)	-0.261*** (-6.37)	-0.644*** (-6.96)	-1.057*** (-5.61)	-1.545*** (-5.10)	-2.010*** (-4.88)	-2.852*** (-5.86)	-2.674*** (-5.42)	-2.657*** (-5.44)	-3.159*** (-5.61)
Res_{VIX}	0.022 (0.88)	-1.360*** (-7.60)	-1.133*** (-3.07)	-1.376* (-1.83)	0,497 (-0.42)	0.288 (0.17)	0.735 (0.37)	1.016 (0.49)	1.121 (0.55)	1.095 (0.46)
Volume	0.024*** (4.70)	-0.106*** (-3.01)	-0.279*** (-3.72)	-0.079 (-0.51)	-0.392 (-1.64)	-0.187 (-0.55)	-0.383 (-0.93)	-0.315 (-0.75)	-0.328 (-0.78)	0.818* (1.65)
Return	-0.342* (-1.94)	2.490** (2.04)	-1.684 (-0.65)	-1.373 (-0.82)	-2.609 (-0.32)	2.495 (0.81)	0.455 (-0.03)	-1.230 (-0.84)	-1.250 (-0.86)	-1.860 (-1.27)
Oil price	-0.000 (-0.63)	-0.002*** (-5.93)	0.001 (-0.78)	0.003** (2.13)	0.004* (1.83)	0.006* (1.94)	0.012*** (3.15)	0.011*** (2.92)	0.012*** (3.16)	0.013*** (2.83)
Y_{t-1}	0.964*** (161.71)	0.395*** (19.41)	0.589*** (32.63)	0.580*** (31.87)	0.599*** (33.38)	0.582*** (32.02)	0.518*** (27.09)	0.583*** (31.99)	0.584*** (32.22)	0.605*** (34.02)
Bid-ask	1.689 (1.21)	-1.200*** (-5.26)	-2.495*** (-3.09)	-2.560*** (-3.00)	-1.051 (-0.97)	-2.306* (-1.89)	-2.146* (-1.92)	-1.442* (-1.65)	-1.614*** (-2.69)	-0.981 (-0.91)
Turnover	0.001 (0.15)	-0.221*** (-3.11)	0,229 (-0.99)	0.612 (1.48)	0.264 (0.34)	-2.640* (-1.86)	-2.746 (-1.27)	-2.183 (-1.09)	1.882 (0.65)	0.996 (0.12)
N	2009	2009	2009	2009	2009	2009	2009	2009	2009	2009
R^2	0.943	0.355	0.470	0.416	0.410	0.389	0.325	0.394	0.395	0.411
Panel B: X is the VIX										
Constant	0.000 (-0.01)	1.378*** (18.74)	1.385*** (10.85)	1.140*** (4.80)	1.284*** (3.50)	1.443*** (2.84)	1.548** (2.54)	1.295** (2.08)	1.421** (2.28)	0.270 (-0.38)
VIX	0.042* (1.80)	-1.522*** (-9.44)	-2.116*** (-6.20)	-3.119*** (-4.58)	-3.443*** (-3.11)	-3.790** (-2.50)	-5.138*** (-2.86)	-4.576** (-2.49)	-4.466** (-2.45)	-5.485*** (-2.61)
Res_{Nibor}	0.010 (1.41)	-0.082* (-1.80)	-0.494*** (-4.90)	-0.875*** (-4.17)	-1.479*** (-4.54)	-2.048*** (-4.53)	-2.949*** (-5.43)	-2.808*** (-5.06)	-2.805*** (-5.08)	-3.304*** (-5.13)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B7: Regressions of relative volume on Nibor-OIS/VIX and control variables

The dependent variable is now relative volume instead of market share of volume. Each cell represents a separate regression and reports the estimate of the coefficient on the USD Libor-OIS (Panel A) or the VIX (Panel B) from the following regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Where Y_t is the mean adjusted relative volume of Portfolio P to H_t. $Res_{Z|X,t}$ are the residuals from regressing Libor-OIS on the VIX and vice versa. W is a vector of the control variables: market return, market volume, oil price, relative bid-ask spread and share turnover. Sample period is 01.2003 – 12.2017.

Panel A: X is Nibor-OIS

Portfolio H	**Portfolio P**								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	-2.512***	-0.334***	-0.430***	-0.879***	-0.558***	-0.739***	-0.635***	-0.564***	-1.158**
	(-10.27)	(-10.54)	(-10.92)	(-11.54)	(-10.18)	(-9.08)	(-7.58)	(-4.84)	(-2.27)
2		-0.242***	-0.310***	-0.504***	-0.371***	-0.368***	-0.117	-0.074	-0.580
		(-8.24)	(-8.09)	(-7.03)	(-7.68)	(-5.63)	(-1.25)	(-0.64)	(-1.33)
3			-0.041	-0.114	-0.092*	-0.006	0.285***	0.352***	-0.096
			(-0.98)	(-1.19)	(-1.79)	(-0.08)	(2.83)	(2.71)	(-0.28)
4				-0.035	-0.445	0.073	0.379***	0.415***	0.029
				(-0.41)	(-0.80)	(1.13)	(3.64)	(3.41)	(0.07)
5					0.079	0.269***	0.686***	0.688***	0.265
					(1.54)	(3.72)	(4.63)	(4.90)	(1.11)
6						0.230***	0.513***	0.592***	0.227
						(3.39)	(5.04)	(4.50)	(1.07)
7							0.366***	0.478***	0.077
							(3.51)	(3.56)	(0.22)
8								0.181	-0.043
								(1.57)	(-0.17)
9									-0.091
									(-0.49)
Panel B: X is the VIX									
1	-0.904***	-1.215***	-1.485***	-2.938***	-1.529***	-2.150***	-2.175***	-1.625***	-3.909**
	(-10.27)	(-12.20)	(-12.09)	(-12.54)	(-9.24)	(-8.65)	(-8.45)	(-4.58)	(-2.51)
2		-0.744***	-0.877***	-1.467***	-0.652***	-0.765***	-0.453	0.472	-1.828
		(-8.31)	(-7.47)	(-6.69)	(-4.47)	(-3.84)	(-1.58)	(1.32)	(-1.38)
3			0.122	-0.163	0.541***	0.588***	1.010***	2.373***	0.084
			(0.95)	(-0.56)	(3.42)	(2.69)	(3.56)	(5.94)	(0.08)
4				-0.160	0.531***	0.702***	1.219***	1.907***	-0.265
				(-0.62)	(3.06)	(3.51)	(3.83)	(5.10)	(-0.20)
5					0.593***	0.829***	1.389***	2.453***	0.568
					(3.76)	(3.76)	(3.07)	(5.70)	(0.78)
6						0.383*	0.679**	1.557***	-0.028
						(1.85)	(2.19)	(3.88)	(-0.04)
7							0.393	1.186***	-0.544
							(1.23)	(2.88)	(-0.50)
8								0.864**	-0.328
								(2.45)	(-0.52)
9									0.813
									(-1.47)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B8: Regressions of relative volume on Nibor-OIS/VIX and control variables (pre-crisis)

The dependent variable is now relative volume instead of market share of volume. Each cell represents a separate regression and reports the estimate of the coefficient on the USD Libor-OIS (Panel A) or the VIX (Panel B) from the following regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Where Y_t is the mean adjusted relative volume of Portfolio P to H_t. $Res_{Z|X,t}$ are the residuals from regressing Libor-OIS on the VIX and vice versa. W is a vector of the control variables: market return, market volume, oil price, relative bid-ask spread and share turnover. Post-crisis period is 01.2003 – 06.2007.

Panel A: X is Nibor-OIS

Portfolio H	**Portfolio P**								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	-0.149**	-0.382***	-0.855***	-1.523***	-2.283***	-2.516***	-1.303***	-1.427**	-3.755**
	(-2.35)	(-2.76)	(-5.15)	(-4.06)	(-7.35)	(-5.36)	(-3.20)	(-2.05)	(-2.27)
2		-0.192*	-0.459***	-0.843***	-1.569***	-1.511***	-0.581*	-1.115**	-2.496
		(-1.81)	(-3.62)	(-3.21)	(-6.18)	(-4.56)	(-1.90)	(-2.26)	(-0.85)
3			-0.331**	-0.282**	-1.324***	-1.030***	-0.322	-0.643	-2.091
			(-2.41)	(-2.57)	(-5.51)	(-3.63)	(-1.06)	(1.42)	(-0.90)
4				-0.196	-0.708***	-0.636**	0.315	-0.101	-1.079
				(-0.48)	(-2.65)	(-2.33)	(0.75)	(-0.20)	(-0.37)
5					-0.641***	-0.269	0.124	-0.143	-0.947
					(-3.08)	(-1.15)	(0.58)	(-0.33)	(-0.63)
6						0.375	0.920***	0.249	-0.159
						(1.46)	(3.71)	(0.64)	(-0.12)
7							0.977***	0.585	-0.148
							(3.49)	(1.46)	(-0.06)
8								-0.356	-1.147
								(-0.75)	(-0.17)
9									-0.616
									(-0.57)
Panel B: X is the VIX									
1	-0.775***	-2.693***	-3.080**	-2.630	-3.609***	-1.474	-1.099	0.722	-3.164
	(-1.03)	(-2.82)	(-2.76)	(-1.03)	(-1.83)	(-0.47)	(-0.39)	(0.15)	(-0.56)
2		-0.695***	-0.762**	0.398	1.576***	0.581	2.545	1.769	-2.853
		(-5.31)	(-2.47)	(0.22)	(3.32)	(0.26)	(1.21)	(1.41)	(-0.51)
3			0.317	0.544	1.390***	2.043	1.864**	1.783	-1.021
			(0.34)	(0.16)	(5.13)	(1.05)	(2.31)	(1.54)	(-0.19)
4				1.809	9.123***	3.430*	6.742**	5.322	-1.315
				(0.64)	(4.92)	(1.83)	(2.32)	(1.49)	(-0.56)
5					4.304***	0.051	1.128	2.681	-2.612
					(3.00)	(0.03)	(0.63)	(0.91)	(-0.25)
6						-4.547*	-2.825*	-1.151	-6.774
						(-2.58)	(-1.67)	(-0.43)	(-0.74)
7							0.879	2.536	-4.147
							(0.46)	(0.91)	(-0.86)
8								6.335*	-4.831
								(1.93)	(-0.42)
9									-5.116
									(-0.69)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B9: Regression of relative volume on Nibor-OIS/VIX and control variables (crisis period)

The dependent variable is now relative volume instead of market share of volume. Each cell represents a separate regression and reports the estimate of the coefficient on the USD Libor-OIS (Panel A) or the VIX (Panel B) from the following regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Where Y_t is the mean adjusted relative volume of Portfolio P to H_t. $Res_{Z|X,t}$ are the residuals from regressing Libor-OIS on the VIX and vice versa. W is a vector of the control variables: market return, market volume, oil price, relative bid-ask spread and share turnover. Crisis period is 07.2007 – 12.2009.

Panel A: X is Nibor-OIS

Portfolio H	**Portfolio P**								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	-0.061**	-0.105***	-0.150***	-0.310	-0.135**	-0.095	-0.234	-0.293	-0.155*
	(-2.49)	(-3.45)	(-2.61)	(-1.60)	(-2.37)	(-1.03)	(-1.38)	(-1.38)	(-1.74)
2		-0.135*	-0.138*	-0.301	-0.137	-0.029	-0.217	-0.208	-0.147
		(-2.29)	(-1.69)	(-1.16)	(-1.34)	(-0.19)	(-0.78)	(-0.50)	(-0.95)
3			-0.062**	-0.142	-0.088	0.083	-0.183	-0.021	-0.036
			(-0.54)	(-0.50)	(-0.58)	(0.35)	(-0.56)	(-0.04)	(-0.16)
4				-0.039	-0.095	0.070	0.028	-0.177	0.059
				(-0.15)	(-0.65)	(0.36)	(0.08)	(-0.45)	(0.19)
5					-0.086	0.139	-0.226	0.176	-0.118
					(-0.67)	(0.54)	(-0.49)	(0.30)	(-0.41)
6						0.222	0.109	0.276	0.095
						(1.12)	(0.30)	(0.53)	(0.48)
7							-0.306	-0.213	-0.088
							(-0.77)	(-0.40)	(-0.34)
8								-0.162	-0.056
								(-0.41)	(-0.19)
9									0.103
									(0.45)
Panel B: X is the VIX									
1	-0.404***	-0.460***	-0.426***	-1.261***	-0.145	-0.502**	-0.894**	-0.615	-0.630
	(-6.32)	(-5.99)	(-3.01)	(-2.67)	(-1.04)	(-2.23)	(-2.16)	(-1.18)	(-2.88)
2		-0.203	-0.085	-0.950	0.511**	0.131	-0.424	0.764	-0.266
		(-1.43)	(-0.50)	(-1.49)	(2.03)	(0.35)	(-0.63)	(0.75)	(-0.70)
3			0.483*	-0.339	1.293***	0.985*	0.351	2.560**	0.506
			(1.70)	(-0.50)	(3.41)	(1.69)	(0.44)	(2.05)	(0.95)
4				-0.644	1.178***	0.684	0.408	1.213	-0.120
				(-1.03)	(3.25)	(1.44)	(0.48)	(1.27)	(-0.16)
5					0.614*	-0.219	-0.912	0.628	-0.624
					(1.90)	(-0.35)	(-0.80)	(0.44)	(-0.88)
6						-0.743	-1.336	-0.883	-1.073**
						(-1.54)	(-1.50)	(-0.70)	(-2.21)
7							-1.597	-1.154	-1.084*
							(-1.64)	(-0.89)	(-1.72)
8								-0.882	-1.219*
								(-0.91)	(-1.74)
9									-0.842
									(-1.51)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B10: Regressions of relative volume on Nibor-OIS/VIX and control variables (post-crisis period)

The dependent variable is now relative volume instead of market share of volume. Each cell represents a separate regression and reports the estimate of the coefficient on the Nibor-OIS (Panel A) or the VIX (Panel B) from the following regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Where Y_t is the mean adjusted relative volume of Portfolio P to H_t. $Res_{Z|X,t}$ are the residuals from regressing Libor-OIS on the VIX and vice versa. W is a vector of the control variables: market return, market volume, oil price, relative bid-ask spread and share turnover. Post-crisis period is 01.2010 – 12.2017.

Panel A: X is Nibor-OIS

Portfolio H	**Portfolio P**								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	-0.175*** (-5.47)	-0.240*** (-5.56)	-0.311*** (-5.74)	-0.298*** (-5.60)	-0.174*** (-3.47)	-0.177*** (-2.68)	-0.124** (-2.36)	-0.109** (-2.63)	-0.017** (2.08)
2		-0.276*** (-6.20)	-0.402*** (-6.77)	-0.322*** (-5.68)	-0.145*** (-3.17)	-0.104* (-1.75)	-0.193 (2.52)	-0.068 (-0.50)	0.137 (0.93)
3			-0.088 (-1.48)	-0.090* (-1.68)	0.149*** (3.38)	0.195*** (3.13)	0.691*** (5.39)	0.391*** (5.15)	0.435*** (3.37)
4				-0.007 (-0.12)	0.293 (5.09)	0.365*** (5.56)	0.654*** (6.91)	0.652*** (5.88)	0.624*** (3.73)
5					0.350 (5.19)	0.375*** (4.82)	1.258*** (5.50)	0.500*** (5.76)	0.631*** (4.08)
6						0.167** (2.00)	0.523*** (4.06)	0.247** (2.25)	0.485*** (3.03)
7							0.338*** (2.98)	0.194* (1.65)	0.360*** (2.69)
8								-0.016 (-0.17)	0.174 (1.51)
9									0.111 (0.65)
Panel B: X is the VIX									
1	-1.131*** (-8.65)	-1.566*** (-8.66)	-2.148*** (-9.39)	-2.231*** (-10.04)	-1.912*** (-9.03)	-1.902*** (-7.10)	-2.427*** (-6.72)	-1.708*** (-6.37)	-1.732** (-2.11)
2		-1.274*** (-7.26)	-2.102*** (-8.83)	-1.820*** (-8.09)	1.591*** (-8.55)	-1.069*** (-4.59)	-0.888* (-1.81)	-0.618** (-2.09)	-0.625 (-1.09)
3			-0.601** (-2.57)	-0.659*** (-3.14)	-0.064 (-0.37)	0.491** (2.04)	1.359*** (2.74)	1.206*** (4.10)	0.921* (1.84)
4				-0.018 (-0.08)	0.739*** (3.33)	1.577*** (6.16)	2.081*** (5.69)	2.232*** (5.20)	1.728*** (2.67)
5					1.011*** (3.89)	1.710*** (5.63)	3.200*** (3.62)	2.012*** (5.97)	2.198*** (3.66)
6						1.097*** (3.37)	1.736*** (3.47)	1.225*** (2.87)	1.583** (2.55)
7							0.543 (1.24)	0.401 (0.88)	0.866* (1.67)
8								0.088 (0.25)	0.506 (1.13)
9									-0.131 (-0.20)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

C Regressions on Euribor-OIS and Euro TED spread

Table C1: Regressions of Euribor-OIS and the VIX

This table summarizes the coefficients from the regression:

$$Z_t = \alpha + \beta_1 X_t + \varepsilon_t$$

Where Z_t and X_t are either the Euribor-OIS spread or VIX. The regressions are used to obtain the residuals for both models, which are the orthogonal part of Euribor-OIS and the VIX to each other.

	(1) **VIX**	**(2)** **Euribor-OIS**
Constant	0.168***	0.147***
	(81.69)	(14.29)
Euribor-OIS	0.068***	
	(12.59)	
VIX		0.627***
		(12.59)
N	3776	3776
$\boldsymbol{R^2}$	0.043	0.043

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table C2: Regressions of market share of volume on Euribor-OIS/VIX and residuals

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \varepsilon_t,$$

Each column represents a separate regression, one for each portfolio. Where Y_t is mean adjusted market share of volume of each portfolio, X_t is the Euribor-OIS (Panel A) or the VIX (Panel B). The variable $Res_{Z|X,t}$ are the residuals from regressing the VIX on the Euribor-OIS spread (Res_{VIX}) and vice versa ($Res_{EURIBOR}$). Y_{t-1} is market share of volume of each portfolio for the previous day. As Y_{t-1}, N and Adj. R^2 are by design the same for both panels, they are only included in Panel A. Sample period is 01.2003 – 12.2017.

Panel A: X is Euribor-OIS

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Constant	0.048***	0.507***	0.483***	0.517***	0.539***	0.564***	0.651***	0.571***	0.571***	0.564***
	(9.26)	(27.95)	(20.97)	(14.47)	(10.28)	(8.18)	(7.79)	(6.70)	(6.70)	(5.66)
Euribor-OIS	0.008**	-0.209***	-0.361***	-0.469***	-0.509***	-0.649***	-0.757***	-0.699***	-0.699***	-0.732***
	(2.20)	(-8.72)	(-8.21)	(-5.62)	(-3.89)	(-3.69)	(-3.53)	(-3.18)	(-3.18)	(-2.83)
Res_{VIX}	0.027**	-0.993***	-1.175***	-1.333***	-1.473***	-1.336**	-1.637**	-1.361**	-1.361**	-1.338*
	(2.50)	(-12.78)	(-8.58)	(-5.18)	(-3.64)	(-2.46)	(-2.47)	(-2.01)	(-2.01)	(-1.68)
$Y_{t.1}$	0.950***	0.548***	0.612***	0.608***	0.596***	0.607***	0.549***	0.614***	0.614***	0.629***
	(179.64)	(38.91)	(46.04)	(45.52)	(44.16)	(45.45)	(39.12)	(46.28)	(46.28)	(48.16)
N	3776	3776	3776	3776	3776	3776	3776	3776	3776	3776
Adj. R^2	0.914	0.450	0.471	0.410	0.375	0.383	0.314	0.388	0.388	0.404
Panel B: X is the VIX										
Constant	0.045***	0.653***	0.640***	0.685***	0.727***	0.707***	0.831***	0.711***	0.711***	0.695***
	(8.68)	(26.12)	(18.57)	(12.18)	(8.57)	(6.30)	(6.10)	(5.11)	(5.11)	(4.27)
VIX	0.031***	-1.082***	-1.351***	-1.569***	-1.729***	-1.685***	-2.042***	-1.741***	-1.741***	-1.740**
	(2.87)	(-13.95)	(-9.92)	(-6.19)	(-4.36)	(-3.17)	(-3.14)	(-2.62)	(-2.62)	(-2.23)
$Res_{Euribor}$	0.006*	-0.141***	-0.281***	-0.378***	-0.409***	-0.558***	-0.645***	-0.606***	-0.606***	-0.640**
	(1.65)	(-5.90)	(-6.36)	(-4.46)	(-3.07)	(-3.11)	(-2.95)	(-2.70)	(-2.70)	(-2.43)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table C3: Regressions of market share of volume on Euribor-OIS/VIX and control variables

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Each column represents a separate regression, one for each liquidity portfolio (as sorted in section 4.1). Where Y_t is mean adjusted market share of volume of each portfolio, X_t is the Euribor-OIS (Panel A) or the VIX (Panel B). The variable $Res_{Z|X,t}$ are the residuals from regressing the VIX on the Euribor-OIS spread and vice versa. Y_{t-1} is market share of volume of each portfolio for the previous day. W is a vector of the control variables: *Volume* is the aggregate normalised volume of all portfolios. *Market Return* is the equal weighted daily return on the OSE. *Oil Price* is the daily brent spot price. *Bid-ask* is the average relative bid-ask spread of each portfolio. *Turnover* is the daily average share turnover for each portfolio. As the control variables, N, and Adj. R^2 are by design the same for both panels, they are only included in Panel A. Sample period is 01.2003 – 12.2017.

Panel A: X is Euribor-OIS

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Constant	0.008	0.990***	1.001***	0.788***	0.881***	0.906***	0.929***	0.571*	0.614**	0.313
	(1.09)	(22.44)	(14.73)	(6.54)	(4.55)	(3.61)	(3.00)	(1.84)	(1.99)	(0.90)
Euribor-OIS	0.006	-0.166***	-0.314***	-0.429***	-0.490***	-0.759***	-0.879***	-0.848***	-0.872***	-0.902***
	(1.61)	(-6.92)	(-7.06)	(-4.91)	(-3.61)	(-4.17)	(-3.99)	(-3.77)	(-3.87)	(-3.42)
Res_{VIX}	0.027**	-1.023***	-1.046***	-1.054***	-1.044**	-1.042*	-1.096	-1.040	-0.871	-1.281
	(2.35)	(-12.91)	(-7.45)	(-3.88)	(-2.33)	(-1.77)	(-1.52)	(-1.44)	(-1.22)	(-1.60)
Volume	0.037***	-0.168***	-0.285***	-0.174**	-0.289**	-0.227	-0.322	-0.200	-0.189	0.394
	(11.14)	(-7.38)	(-6.73)	(-2.10)	(-2.20)	(-1.29)	(-1.49)	(-0.90)	(-0.85)	(1.51)
Market return	-0.478***	2.820***	1.080	1.011	1.602	1.293	1.921	-1.205	-1.334	-1.068
	(-4.42)	(3.83)	(0.79)	(-0.01)	(0.61)	(1.10)	(0.28)	(-0.43)	(-0.47)	(-1.08)
Oil price	0.000	-0.002***	-0.001***	0.001	0.002	0.002	0.006**	0.006***	0.007***	0.008***
	(-0.12)	(-9.72)	(-2.98)	(0.67)	(1.15)	(1.24)	(2.56)	(2.82)	(3.02)	(2.93)
Y_{t-1}	0.950***	0.508***	0.602***	0.602***	0.593***	0.605***	0.545***	0.608***	0.609***	0.625***
	(18.07)	(35.41)	(44.90)	(44.83)	(43.71)	(45.21)	(38.61)	(45.54)	(45.70)	(47.65)
Turnover	0.003	-0.138***	0.004	0.305	0.302	-2.268**	-1.737	-1.785	0.434	-0.370
	(0.46)	(-2.77)	(0.03)	(1.14)	(0.70)	(-2.55)	(-0.79)	(-1.17)	(0.27)	(-0.17)
Bid-ask	0.679	-1.334***	-1.423***	-1.176***	-1.027**	-1.557**	-1.198**	-1.201	-1.120**	-0.790
	(0.72)	(-3.96)	(-4.54)	(-3.19)	(-2.27)	(-1.99)	(-2.22)	(-1.55)	(-2.42)	(-1.05)
N	3776	3776	3776	3776	3776	3776	3776	3776	3776	3776
R^2	0.917	0.476	0.482	0.412	0.377	0.386	0.317	0.390	0.390	0.406
Panel B: X is the VIX										
Constant	0.004	1.148***	1.141***	0.913***	0.995***	0.980***	0.995***	0.631*	0.641**	0.217
	(0.58)	(24.08)	(15.81)	(7.21)	(4.97)	(3.72)	(3.11)	(1.96)	(1.99)	(-0.58)
VIX	0.029**	-1.083***	-1.197***	-1.278***	-1.307***	-1.473**	-1.600**	-1.527**	-1.380**	-1.791**
	(2.56)	(-13.68)	(-8.56)	(-4.73)	(-2.95)	(-2.53)	(-2.27)	(-2.16)	(-1.99)	(-2.28)
$Res_{Euribor}$	0.004	-0.096***	-0.242***	-0.357***	-0.419***	-0.688***	-0.804***	-0.776***	-0.812***	-0.814***
	(1.15)	(-4.01)	(-5.45)	(-4.06)	(-3.05)	(-3.73)	(-3.57)	(-3.38)	(-3.50)	(-3.02)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table C4: Regressions of market share of volume on Euribor-OIS/VIX and control variables (pre-crisis period)

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Each column represents a separate regression, one for each liquidity portfolio (as sorted in section 4.1). Where Y_t is mean adjusted market share of volume of each portfolio, X_t is the Euribor-OIS (Panel A) or the VIX (Panel B). The variable $Res_{Z|X,t}$ are the residuals from regressing the VIX on the Euribor-OIS spread and vice versa. Y_{t-1} is market share of volume of each portfolio for the previous day. W is a vector of the control variables: *Volume* is the aggregate normalised volume of all portfolios. *Market Return* is the equal weighted daily return on the OSE. *Oil Price* is the daily brent spot price. *Bid-ask* is the average relative bid-ask spread of each portfolio. *Turnover* is the daily average share turnover for each portfolio. As the control variables, N, and Adj. R^2 are by design the same for both panels, they are only included in Panel A. Pre-crisis period is 01.2003 – 07.2007.

Panel A: X is Euribor-OIS

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Constant	0.391***	0.594***	0.876***	1.000***	1.588***	1.339***	1.244***	0.650***	0.758***	0.476**
	(12.64)	(5.48)	(6.99)	(7.60)	(5.30)	(8.45)	(6.39)	(5.12)	(6.05)	(2.40)
Euribor-OIS	0.020**	-0.163***	-0.146**	0.100	0.160	0.129	1.096	-0.161**	-0.165**	0.183
	(2.46)	(-2.87)	(-2.15)	(-1.39)	(-1.02)	(-1.56)	(-0.89)	(-2.22)	(-2.27)	(-1.53)
Res_{VIX}	0.152*	0.973	-1.985***	-1.592***	-3.078*	-1.429	-1.701	-1.654**	-1.440*	0.396
	(1.75)	(-1.64)	(-4.10)	(-4.56)	(-1.82)	(-1.64)	(-1.47)	(-2.09)	(-1.78)	(-0.30)
Volume	0.052***	-0.244***	-0.326***	-0.293***	-0.234**	-0.296***	-0.321***	-0.148***	-0.152***	0.022
	(9.57)	(-6.46)	(-6.94)	(-5.83)	(-2.12)	(-5.15)	(-4.20)	(-2.86)	(-2.93)	(-0.26)
Market return	-1.158***	1.287***	0.914***	1.183***	1.135**	0.997***	1.749	1.931	0.915	0.755
	(-4.79)	(3.12)	(3.29)	(3.18)	(2.30)	(2.71)	(1.10)	(1.27)	(1.26)	(0.46)
Oil price	-0.001***	0.005***	0.002	-0.003**	-0.004	-0.009***	-0.006***	-0.002	-0.003*	0.002
	(-3.08)	(4.27)	(0.15)	(-2.17)	(-1.19)	(-4.53)	(-2.80)	(-1.11)	(-1.68)	(-0.63)
Y_{t-1}	0.576***	0.568***	0.487***	0.417***	0.390***	0.413***	0.280***	0.202***	0.203***	0.172***
	(22.44)	(21.43)	(17.07)	(14.13)	(2.76)	(13.94)	(8.90)	(6.25)	(6.29)	(5.27)
Turnover	0.040***	-0.229**	0.202	0.158	0.833**	-0.163	0.581	0.172	-0.391	0.383
	(3.35)	(-2.36)	(1.55)	(0.75)	(2.20)	(-0.49)	(0.70)	(0.54)	(-1.05)	(0.77)
Bid-ask	-1.323**	1.773	1.452	1.841	-1.355*	-1.587	1.415	1.790	0.377	0.270
	(-2.27)	(0.51)	(0.57)	(1.53)	(-1.72)	(-0.47)	(0.46)	(1.15)	(0.38)	(-0.33)
N	1113	1113	1113	1113	1113	1113	1113	1113	1113	1113
Adj. R^2	0.480	0.424	0.337	0.297	0.039	0.293	0.136	0.086	0.086	0.040
Panel B: X is the VIX										
Constant	0.389***	0.583***	1.131***	1.369***	1.843***	1.413***	1.379***	0.726***	0.804***	0.376
	(11.25)	(3.75)	(6.17)	(6.90)	(4.36)	(6.20)	(4.84)	(3.92)	(4.43)	(1.27)
VIX	0.064	0.287	-1.169***	-1.887***	-1.202	-0.824	-1.191	-0.911	-0.704	0.310
	(0.77)	(-0.47)	(-3.01)	(-3.71)	(-1.30)	(-0.94)	(-1.03)	(-1.16)	(-0.88)	(0.24)
$Res_{Euribor}$	0.024***	-0.189***	-0.224***	-0.194***	0.240	-0.166**	0.140	-0.204***	-0.202***	0.194
	(2.82)	(-3.33)	(-3.24)	(-2.64)	(-1.52)	(-1.99)	(-1.29)	(-2.77)	(-2.75)	(-1.61)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table C5: Regressions of market share of volume on Euribor-OIS/VIX and control variables (crisis period)

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Each column represents a separate regression, one for each liquidity portfolio (as sorted in section 4.1). Where Y_t is mean adjusted market share of volume of each portfolio, X_t is the Euribor-OIS (Panel A) or the VIX (Panel B). The variable $Res_{Z|X,t}$ are the residuals from regressing the VIX on the Euribor-OIS spread and vice versa. Y_{t-1} is market share of volume of each portfolio for the previous day. W is a vector of the control variables: *Volume* is the aggregate normalised volume of all portfolios. *Market Return* is the equal weighted daily return on the OSE. *Oil Price* is the daily brent spot price. *Bid-ask* is the average relative bid-ask spread of each portfolio. *Turnover* is the daily average share turnover for each portfolio. As the control variables, N, and Adj. R^2 are by design the same for both panels, they are only included in Panel A. Crisis period is 08.2007 – 12.2009.

Panel A: X is Euribor-OIS

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Constant	0.594***	0.554***	0.484***	0.669***	0.277*	0.441***	0.488***	0.211*	0.157	0.125
	(14.92)	(9.78)	(7.07)	(5.62)	(1.85)	(6.70)	(5.27)	(1.69)	(1.23)	(1.41)
Euribor-OIS	-0.039***	0.170***	0.353***	0.276**	0.290*	0.256***	0.0274	0.230	0.266*	0.231**
	(-4.82)	(3.01)	(4.96)	(2.18)	(1.75)	(3.32)	(0.27)	(1.58)	(1.83)	(2.07)
Res_{VIX}	0.060***	-0.312***	-0.445***	-0.658***	-0.385*	-0.272***	-0.276**	-0.335*	0.308	-0.302**
	(5.20)	(-3.79)	(-4.38)	(-3.79)	(-1.76)	(-2.63)	(-2.10)	(-1.77)	(-1.64)	(-1.97)
Volume	0.023***	-0.175***	-0.181***	-0.193***	-0.004	-0.152***	-0.158***	-0.139*	-0.139*	0.091
	(7.04)	(-5.86)	(-4.99)	(-2.94)	(-0.05)	(-3.77)	(-3.08)	(-1.88)	(-1.89)	(1.54)
Market return	-0.344***	2.390***	1.245*	0.461	2.070	1.261	1.918*	1.938	2.048	1.274
	(-4.26)	(4.15)	(1.78)	(0.37)	(1.25)	(1.62)	(1.94)	(1.36)	(1.45)	(1.11)
Oil price	0.000	0.002	-0.001**	-0.003***	0.001	-0.003***	0.001	0.001	0.005	-0.002***
	(0.93)	(0.51)	(-1.97)	(-3.10)	(-0.90)	(-5.30)	(-1.60)	(-0.63)	(-0.51)	(-2.62)
Y_{t-1}	0.441***	0.398***	0.280***	0.224***	0.032	0.288***	0.124***	0.190***	0.189***	0.049
	(12.41)	(11.10)	(7.29)	(5.24)	(0.78)	(7.52)	(3.09)	(4.74)	(4.73)	(1.19)
Turnover	0.002	-0.257***	-0.052	-0.366	0.461	1.129	-1.500	0.137	0.639	-1.019
	(-0.29)	(-2.83)	(-0.47)	(-1.12)	(1.50)	(1.01)	(-1.45)	(0.11)	(0.49)	(-0.99)
Bid-ask	1.520**	-1.742***	-0.943***	-0.838**	-1.209	0.501	-1.746*	0.674	0.994	0.167
	(2.15)	(-2.66)	(-3.38)	(-2.01)	(-0.69)	(-1.03)	(-1.90)	(0.71)	(1.27)	(-0.78)
N	654	654	654	654	654	654	654	654	654	654
R^2	0.453	0.398	0.271	0.111	0.023	0.187	0.055	0.061	0.063	0.029
Panel B: X is the VIX										
Constant	0.552***	0.743***	0.833***	1.010***	0.568***	0.683***	0.569***	0.449***	0.415***	0.356***
	(14.70)	(10.12)	(9.25)	(6.83)	(3.10)	(7.85)	(5.18)	(2.92)	(2.70)	(2.98)
VIX	0.071***	-0.343***	-0.566***	-0.665***	-0.479**	-0.374***	-0.217*	-0.401**	-0.407**	-0.379**
	(6.21)	(-4.29)	(-5.91)	(-4.07)	(-2.24)	(-3.68)	(-1.69)	(-2.19)	(-2.23)	(-2.58)
$Res_{Euribor}$	-0.015*	0.044	0.173**	0.010	0.135	0.146*	0.084	0.094	0.141	0.109
	(-1.86)	(0.77)	(2.31)	(0.07)	(0.79)	(1.87)	(-0.81)	(0.62)	(0.93)	(0.93)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table C6: Regressions of market share of volume on Euribor-OIS/VIX and control variables (post-crisis period)

This table summarizes the results from the regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Each column represents a separate regression, one for each liquidity portfolio (as sorted in section 4.1). Where Y_t is mean adjusted market share of volume of each portfolio, X_t is the Euribor-OIS (Panel A) or the VIX (Panel B). The variable $Res_{Z|X,t}$ are the residuals from regressing the VIX on the Euribor-OIS spread and vice versa. Y_{t-1} is market share of volume of each portfolio for the previous day. W is a vector of the control variables: *Volume* is the aggregate normalised volume of all portfolios. *Market Return* is the equal weighted daily return on the OSE. *Oil Price* is the daily brent spot price. *Bid-ask* is the average relative bid-ask spread of each portfolio. *Turnover* is the daily average share turnover for each portfolio. As the control variables, N, and Adj. R^2 are by design the same for both panels, they are only included in Panel A. Crisis period is 01.2010 – 12.2017.

Panel A: X is Euribor-OIS

	Portfolio									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Constant	0.004	1.128***	1.088***	0.795***	1.021***	1.210**	1.182**	0.972*	1.086*	0.791
	(0.38)	(17.07)	(9.17)	(3.66)	(2.94)	(2.53)	(2.07)	(1.66)	(1.88)	(-1.23)
Euribor-OIS	0.009	-0.465***	-0.435***	-0.517**	-0.610*	-0.823*	-1.085**	-1.106**	-1.108**	-1.360**
	(1.28)	(-9.28)	(-4.23)	(-2.49)	(-1.93)	(-1.85)	(-2.03)	(-2.05)	(-2.07)	(-2.17)
Res_{VIX}	0.034	-1.330***	-1.682***	-2.542***	-2.262**	-2.407	-2.483*	-2.997	-2.944	-2.901*
	(1.46)	(-8.25)	(-4.86)	(-3.65)	(-2.02)	(-1.56)	(-1.87)	(-1.57)	(-1.55)	(-1.77)
Volume	0.024***	-0.103***	-0.275***	-0.075	-0.389	-0.169	-0.371	-0.298	-0.316	0.823*
	(4.68)	(-2.95)	(-3.65)	(-0.48)	(-1.62)	(-0.50)	(-0.90)	(-0.70)	(-0.75)	(1.65)
Market return	-0.348**	0.529**	-1.413	-1.038	-1.939	1.051	0.697	-1.113	-1.147	-1.136
	(-1.97)	(2.10)	(-0.54)	(-0.75)	(-0.23)	(0.90)	(0.05)	(-0.77)	(-0.78)	(-1.24)
Oil price	-0.000	-0.002***	0.001	0.003**	0.004*	0.005	0.010***	0.010**	0.011***	0.010**
	(-0.51)	(-5.48)	(-0.71)	(1.96)	(1.66)	(1.62)	(2.66)	(2.45)	(2.67)	(2.19)
Y_{t-1}	0.966***	0.364***	0.602***	0.593***	0.613***	0.598***	0.539***	0.601***	0.603***	0.624***
	(165.54)	(17.60)	(33.75)	(32.96)	(34.68)	(33.45)	(28.58)	(33.57)	(33.92)	(35.80)
Turnover	0.000	-0.255***	0.177	0.525	0.310	-1.798*	-1.699	-1.902	1.436	-1.258
	(-0.05)	(-3.64)	(-0.77)	(1.26)	(0.39)	(-1.96)	(-0.98)	(-1.33)	(0.49)	(-0.16)
Bid-ask	1.247	-1.255***	-1.776***	-1.304***	-1.333**	-1.393***	-1.049***	-1.045**	-1.001***	0.944
	(1.41)	(-3.15)	(-3.38)	(-3.88)	(-2.22)	(-2.80)	(-2.72)	(-2.22)	(-3.16)	(-0.87)
N	2009	2009	2009	2009	2009	2009	2009	2009	2009	2009
R^2	0.943	0.368	0.466	0.411	0.404	0.383	0.316	0.387	0.388	0.404
Panel B: X is the VIX										
Constant	0.002	1.348***	1.361***	1.202***	1.389***	1.607***	1.754***	1.470**	1.575**	0.146
	(-0.20)	(18.56)	(10.52)	(5.02)	(3.75)	(3.14)	(2.83)	(2.33)	(2.50)	(-0.20)
VIX	0.040*	-1.719***	-1.997***	-2.857***	-2.715**	-3.089**	-4.349**	-3.940**	-3.895**	-5.036**
	(1.74)	(-10.58)	(-5.83)	(-4.19)	(-2.46)	(-2.04)	(-2.40)	(-2.14)	(-2.13)	(-2.38)
$Res_{Euribor}$	0.005	-0.338***	-0.274***	-0.275	-0.393	-0.593	-0.752	-0.820	-0.827	-0.988
	(0.79)	(-6.74)	(-2.63)	(-1.29)	(-1.23)	(-1.30)	(-1.37)	(-1.47)	(-1.48)	(-1.51)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table C7: Regressions of relative volume on Euribor-OIS/VIX and control variables

The dependent variable is now relative volume instead of market share of volume. Each cell represents a separate regression and reports the estimate of the coefficient on the Euribor-OIS (Panel A) or the VIX (Panel B) from the following regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Where Y_t is the mean adjusted relative volume of Portfolio P to H_t. X_t is Euribor-OIS/VIX. $Res_{Z|X,t}$ are the residuals from regressing Euribor-OIS on the VIX and vice versa. W is a vector of the control variables: market return, market volume, oil price, relative bid-ask spread and share turnover. Sample period is 01.2003 – 12.2017.

Panel A: X is Euribor-OIS

Portfolio H	**Portfolio P**								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	-0.178***	-0.299***	-0.377***	-0.456***	-0.329***	-0.300***	-0.266***	-0.250**	-1.071*
	(-6.97)	(-8.95)	(-9.03)	(-5.64)	(-5.74)	(-3.48)	(-2.96)	(-2.00)	(-1.94)
2		-0.209***	-0.253***	-0.102	-0.176***	-0.011	0.103	0.190	-0.519
		(-6.68)	(-6.13)	(-1.33)	(-3.40)	(-0.15)	(1.02)	(1.50)	(-1.11)
3			-0.035	0.288***	0.028	0.273***	0.381***	0.499***	-0.033
			(-0.77)	(2.78)	(0.50)	(3.52)	(3.49)	(3.54)	(-0.09)
4				0.327***	0.076	0.332***	0.439***	0.634***	-0.005
				(3.58)	(1.23)	(4.68)	(3.90)	(4.80)	(-0.01)
5					0.051	0.349***	0.487***	0.676***	0.118
					(0.92)	(4.47)	(3.04)	(4.45)	(0.45)
6						0.389***	0.546***	0.701***	0.310
						(5.29)	(4.95)	(4.92)	(1.35)
7							0.420***	0.682***	0.096
							(3.71)	(4.69)	(0.387)
8								0.477***	0.155
								(3.82)	(0.06)
9									-0.010
									(-0.05)
Panel B: X is the VIX									
1	-0.905***	-1.252***	-1.517***	-2.909***	-1.491***	-2.114***	-2.164***	-1.616***	-3.907**
	(-11.80)	(-12.56)	(-12.36)	(-12.39)	(-8.99)	(-8.48)	(-8.40)	(-4.55)	(-2.50)
2		-0.746***	-0.877***	-1.458***	-0.635***	-0.757***	-0.453	0.473	-1.826
		(-8.34)	(-7.47)	(-6.64)	(-4.34)	(-3.79)	(-1.58)	(1.32)	(-1.38)
3			0.122	-0.164	0.534***	0.590***	1.101***	2.377***	0.085
			(0.95)	(-0.56)	(3.37)	(2.70)	(3.57)	(5.96)	(0.08)
4				-0.161	0.530***	0.706***	1.221***	1.916***	-0.265
				(-0.63)	(3.05)	(3.54)	(3.84)	(5.13)	(-0.20)
5					0.594***	0.823***	1.383***	2.457***	0.566
					(3.76)	(3.78)	(3.06)	(5.72)	(0.77)
6						0.384*	0.676**	1.560***	-0.030
						(1.86)	(2.18)	(3.89)	(-0.04)
7							0.391	1.188***	-0.545
							(1.23)	(2.90)	(-0.50)
8								0.867**	-0.328
								(2.46)	(-0.42)
9									-0.833
									(-1.47)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table C8: Regressions of relative volume on Euribor-OIS/VIX and control variables (pre-crisis period)

The dependent variable is now relative volume instead of market share of volume. Each cell represents a separate regression and reports the estimate of the coefficient on the Euibor-OIS (Panel A) or the VIX (Panel B) from the following regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Where Y_t is the mean adjusted relative volume of Portfolio P to H$_t$. X_t is Euribor-OIS/VIX $Res_{Z|X,t}$ are the residuals from regressing Euribor-OIS on the VIX and vice versa. W is a vector of the control variables: market return, market volume, oil price, relative bid-ask spread and share turnover. Pre-crisis period is 01.2003 – 06.2007.

Panel A: X is Euribor-OIS

Portfolio	**Portfolio P**								
H	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	-0.094	-0.177**	-0.321***	-0.641***	-0.787***	-0.716***	-0.713***	-0.998**	-2.873
	(-1.46)	(-2.20)	(-3.35)	(-2.93)	(-4.50)	(-2.64)	(-2.99)	(-2.47)	(-1.45)
2		-0.104*	-0.163**	-0.469***	-0.653***	-0.422**	-0.383**	-0.873***	-2.339
		(-1.69)	(-2.21)	(-3.06)	(-4.50)	(-2.19)	(-2.14)	(-3.04)	(-1.37)
3			-0.150*	-0.222	-0.630***	-0.296*	-0.370**	-0.692**	-1.783
			(-1.87)	(-0.77)	(-4.54)	(-1.79)	(-2.07)	(-2.63)	(-1.32)
4				-0.056	-0.446***	-0.268*	-0.228	-0.432	-1.659
				(-0.23)	(-2.88)	(-1.69)	(-0.93)	(-1.44)	(-0.97)
5					-0.239**	-0.040	-0.070	-0.321	-1.062
					(-1.98)	(-0.30)	(-0.46)	(-1.28)	(-1.22)
6						0.209	0.329**	-0.235	-0.229
						(1.40)	(2.29)	(-1.04)	(-0.30)
7							0.252	0.046	-0.907
							(1.55)	(0.19)	(-0.65)
8								-0.259	-0.893
								(-0.93)	(-0.92)
9									0.290
									(0.46)
Panel B: X is the VIX									
1	-0.775	-2.671***	-2.926***	-2.548	2.419*	-1.292	-1.071	0.762	-1.306
	(-1.03)	(-2.80)	(-2.60)	(-0.99)	(1.70)	(-0.41)	(-0.38)	(0.16)	(-0.56)
2		-0.690	-0.731	0.420	1.370***	0.608	2.566	4.813	-1.061
		(-0.95)	(-0.84)	(0.23)	(3.17)	(0.27)	(1.22)	(1.42)	(-0.51)
3			0.325	0.550	1.229***	2.051	1.883**	1.826	-2.964
			(0.35)	(0.16)	(5.00)	(1.05)	(2.32)	(1.56)	(-0.19)
4				1.799	1.106***	3.431*	1.700**	1.320	-1.129
				(0.64)	(4.91)	(1.82)	(2.30)	(1.49)	(-0.56)
5					4.288***	0.060	1.120	2.684	-2.587
					(2.98)	(0.04)	(0.62)	(0.91)	(-0.25)
6						-4.548**	-2.813*	-1.162	-2.765
						(-2.58)	(-1.66)	(-0.44)	(-0.74)
7							0.833	2.495	-1.414
							(0.43)	(0.90)	(-0.86)
8								6.333*	-2.798
								(1.93)	(-0.42)
9									-2.083
									(-0.68)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table C9: Regressions of relative volume on Euribor-OIS/VIX and control variables (crisis period)

The dependent variable is now relative volume instead of market share of volume. Each cell represents a separate regression and reports the estimate of the coefficient on the Nibor-OIS (Panel A) or the VIX (Panel B) from the following regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Where Y_t is the mean adjusted relative volume of Portfolio P to H_t. X_t is Euribor-OIS/VIX. $Res_{Z|X,t}$ are the residuals from regressing Euribor-OIS on the VIX and vice versa. W is a vector of the control variables: market return, market volume, oil price, relative bid-ask spread and share turnover. Crisis period is 07.2007 – 12.2009.

Panel A: X is Euribor-OIS

Portfolio H	**Portfolio P**								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	0.236***	0.420***	0.337***	0.674*	0.095	0.293*	0.341	0.570	0.439**
	(4.92)	(6.98)	(3.61)	(1.81)	(0.87)	(1.70)	(1.08)	(1.60)	(2.55)
2		0.342***	0.083	0.362	-0.366*	-0.116	-0.122	-0.140	0.153
		(3.08)	(0.53)	(0.72)	(-1.84)	(-0.39)	(-0.23)	(-0.18)	(0.52)
3			-0.522**	-0.703	-1.071***	-0.818*	-1.424**	-1.515	-0.555
			(-2.46)	(-1.30)	(-3.57)	(-1.78)	(-2.34)	(-1.54)	(-1.32)
4				-0.382	-0.952***	-0.660*	-1.478**	-0.536	-0.348
				(-0.78)	(-3.30)	(-1.76)	(-2.22)	(-0.71)	(-0.60)
5					-0.680***	-0.165	-0.143	-0.167	0.201
					(-2.68)	(-0.34)	(-0.16)	(-0.15)	(0.36)
6						0.491	0.340	1.000	0.864**
						(1.29)	(0.48)	(1.01)	(2.25)
7							0.052	0.639	0.472
							(0.07)	(0.64)	(0.95)
8								1.384*	0.843
								(1.83)	(1.52)
9									0.369
									(0.84)
Panel B: X is the VIX									
1	-0.411***	-0.477***	-0.440***	-1.264**	-0.114	-0.461**	-0.774**	-0.370	-0.630***
	(-6.36)	(-6.21)	(-3.65)	(-2.60)	(-0.80)	(-2.06)	(-1.89)	(-0.80)	(-2.82)
2		-0.188	0.094	-0.962	0.547**	0.151	-0.212	1.002	-0.280
		(-1.31)	(0.47)	(-1.47)	(2.12)	(0.39)	(-0.31)	(0.98)	(-0.72)
3			0.690**	-0.363	1.327***	0.965	0.642	2.789**	0.486
			(2.49)	(-0.52)	(3.42)	(1.62)	(0.82)	(2.18)	(0.89)
4				-0.743	1.146***	0.593	0.489	1.205	-0.214
				(-1.16)	(3.09)	(1.22)	(0.56)	(1.23)	(-0.28)
5					0.636*	-0.281	-0.795	0.808	-0.696
					(1.94)	(-0.44)	(-0.69)	(0.56)	(-0.95)
6						-0.826*	-1.337	-0.867	-1.194**
						(-1.66)	(-1.47)	(-0.67)	(-2.39)
7							-1.477	-0.957	-1.155*
							(-1.50)	(-0.74)	(-1.79)
8								-0.889	-1.384*
								(-0.90)	(-1.92)
9									-0.924
									(-1.62)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table C10: Regressions of relative volume on Euribor-OIS/VIX and control variables (post-crisis period)

The dependent variable is now relative volume instead of market share of volume. Each cell represents a separate regression and reports the estimate of the coefficient on the Nibor-OIS (Panel A) or the VIX (Panel B) from the following regression:

$$Y_t = \alpha + \beta_1 X_t + \beta_2 Res_{Z|X,t} + \beta_3 Y_{t-1} + \Pi' W_t + \eta_t,$$

Where Y_t is the mean adjusted relative volume of Portfolio P to H_t. X_t is Euribor-OIS/VIX. $Res_{Z|X,t}$ are the residuals from regressing Euribor-OIS on the VIX and vice versa. W is a vector of the control variables: market return, market volume, oil price, relative bid-ask spread and share turnover. Post-crisis period is 01.2010 – 12.2017.

Panel A: X is Euribor-OIS

Portfolio H	**Portfolio P**								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	-0.391***	-0.406***	-0.507***	-0.422***	-0.410***	-0.386***	-0.527***	-0.274***	-0.381*
	(-10.24)	(-8.03)	(-8.05)	(-8.01)	(-7.02)	(-5.14)	(-5.11)	(-3.60)	(-1.68)
2		-0.212***	-0.351***	-0.112*	-0.188***	-0.053	0.058	0.186**	0.024
		(-4.34)	(-5.32)	(-1.81)	(-3.66)	(-0.79)	(0.41)	(2.17)	(0.15)
3			-0.093	0.135**	0.074	0.232***	0.493***	0.575***	0.334**
			(-1.38)	(2.23)	(1.50)	(3.31)	(3.44)	(6.73)	(2.32)
4				0.240***	0.218***	0.452***	0.609***	0.794***	0.481**
				(3.79)	(3.39)	(6.13)	(5.77)	(6.41)	(2.57)
5					0.097	0.317***	0.640**	0.459***	0.461***
					(1.29)	(3.65)	(2.50)	(4.75)	(2.67)
6						0.315***	0.492***	0.522***	0.505***
						(3.36)	(3.42)	(4.22)	(2.82)
7							0.214*	0.352***	0.258*
							(1.69)	(2.68)	(1.73)
8								0.085	0.037
								(0.82)	(0.28)
9									-0.115
									(-0.60)
Panel B: X is the VIX									
1	-1.280***	-1.703***	-2.286***	-2.289***	-1.969***	-1.925***	-2.433***	-1.704***	-1.729**
	(-9.82)	(-9.38)	(-9.98)	(-10.31)	(-9.31)	(-7.20)	(-6.74)	(-6.35)	(-2.10)
2		-1.264***	-2.104***	-1.815***	-1.585***	-1.070***	-0.883*	-0.620**	-0.622
		(-7.20)	(-8.83)	(-8.06)	(-8.52)	(-4.59)	(-1.79)	(-2.10)	(-1.08)
3			-0.601***	-0.667***	-0.061	0.493**	1.350***	1.226***	0.918*
			(-2.57)	(-3.19)	(-0.36)	(2.04)	(2.71)	(4.19)	(1.84)
4				-0.017	0.732***	1.593***	2.074***	2.249***	1.721***
				(-0.08)	(3.30)	(6.24)	(5.67)	(5.25)	(2.65)
5					1.000***	1.707***	3.175***	2.008***	2.188***
					(3.83)	(5.62)	(3.57)	(5.96)	(3.64)
6						1.103***	1.734***	1.240***	1.586**
						(3.40)	(3.47)	(2.91)	(2.55)
7							0.542	0.402	0.864*
							(1.23)	(0.89)	(1.67)
8								0.088	0.506
								(0.25)	(1.13)
9									-0.131
									(-0.20)

t statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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