The Liquidity of the Secondary Market for Debt Securities in Norway

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Abstract

The main purpose of this project is to give an overview of the liquidity and activity in the secondary market for Norwegian debt securities. The second objective is to determine whether the activity and data availability is sufficient to be able construct indicators that can be used to monitor the state of Norwegian bond market on a regular basis. To this end we examine a detailed data set provided to us by Oslo Børs Informasjon (OBI) containing the complete record of daily trading activity in all exchange listed fixed income securities in Norway over the period 1999-2011. Due to the low trading activity in corporate securities and the fact that a large part of trading in corporate debt securities is conducted off market (OTC), makes it challenging to produce reliable liquidity indicators. In particular, order-based liquidity measures (such as the bid ask spread), that typically are superior measures of liquidity supply, are in most cases not possible to construct due to the lack of two sided quote observations. On the other hand, due to the reporting rules of all OTC trades to the Oslo Stock Exchange, trade-based measures of liquidity (such as the Amihud ILR) are more informative.

*The views expressed are those of the authors and should not be interpreted as reflecting those of Norges Bank.

1 Introduction

In this report we examine the liquidity in the Norwegian market for debt securities, tradable fixed income securities issued by Norwegian Corporations and Government. Norwegian corporations issue debt securities either locally, in the Norwegian market, in which case the securities are listed and traded at the Oslo Stock Exchange, or internationally. Internationally issued securities will typically be issued in USD or Euro. Government and other agency issues will typically be targeted at the domestic market. In this report we concentrate on the domestic market, and investigate the activity and liquidity in the secondary market for debt securities.[1]

The liquidity of the domestic debt securities market is of interest to Norges Bank for various reasons. Surveillance of liquidity risk of Norwegian banks is part of Norges Banks work on promoting Financial Stability. The liquidity of the Norwegian debt securities market influences both the asset and liability side of Norwegian banks. Over the recent years, wholesale funding has become an important funding source for Norwegian banks, and especially for medium sized and smaller savings banks, the domestic market is an important long- and medium term funding market. On the asset side, the liquidity of Norwegian bonds is important when assessing the quality of their portfolio of liquid assets. Moreover, from 2015 the Basel III quantitative liquidity requirements are to be put in place for Norwegian banks through CRD IV. Inclusion of NOK denominated bonds in the Liquidity Coverage Ratio (LCR) is to some extent dependent on the secondary market liquidity of such bonds. Lastly, the liquidity of Norwegian government bonds is important when judging the sufficiency of yields of such bonds as benchmarks for long term interest rates.

1.1 Issuance of Debt Securities in Norway

The domestic bond issuance is small compared to the debt securities markets in the large European countries like Germany, France and UK, see Figure 1. By the end of Q3 2011 the total outstanding amount in the Norwegian market was the equivalent of 241 billion USD.[2] In other Nordic countries like Sweden and Denmark the corresponding amounts are 425 and 572 billion USD.

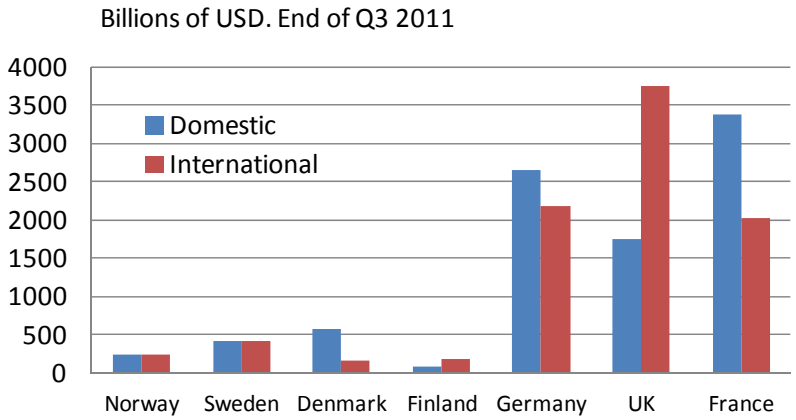
Norwegian corporate firms and financial institutions also issue debt in international markets. By end of Q3 2011 the outstanding amount of Norwegian debt securities in international markets was the equivalent of 241 billion USD, of which financial institutions constituted to approximately 85 per cent. Also for Swedish issuers the outstanding amount in the international market equals the outstanding amount in the domestic market, while domestic issuance dominates in Denmark (Figure 1). In the UK the outstanding amount of internationally issued debt securities is more than twice as large as the outstanding domestic amount.

Norwegian Government bonds and treasury bills amounted to 83,8 billion USD or approximately 35 per cent of the total outstanding amount of domestic debt securities in Q3 2011.

[1] By the domestic debt securities market we will understand issues by residents in domestic currency targeted at resident investors, is defined in BIS (2012).

[2] Domestic see BIS (2012): Quarterly Review.

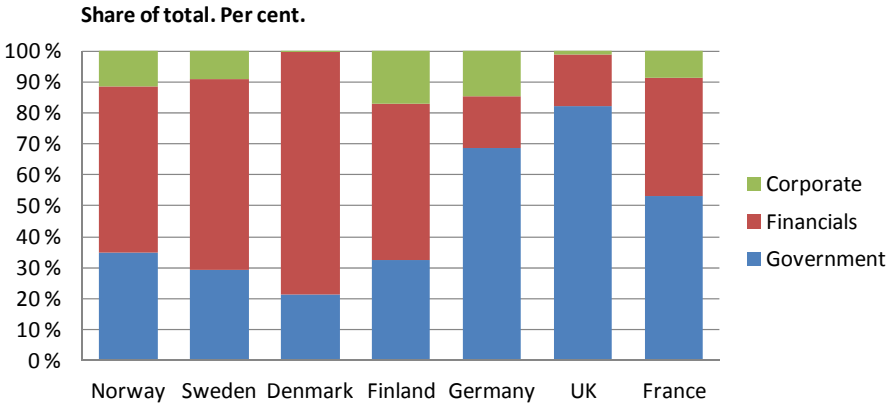
Figure 1
Outstanding debt securities



Norway has no Government debt issued in international markets, i.e. no Government debt issued in other currencies than NOK. According to BIS (2012) all the other European countries issue Government debt in international markets, but the outstanding domestic amount is larger. The share of Government debt in the domestic market in Norway is larger than in Sweden and Denmark, but less than in France, Germany and UK, see Figure 2. The large share of Government securities in the Norwegian market is influenced by elevated issuance of Norwegian treasury bills in 2008 and 2009, when the Norwegian Government introduced a swap arrangement allowing banks to exchange treasury bills for covered bonds as a measure to support bank funding.

Financial institutions constitute a large proportion of the outstanding private sector debt securities in the Norway as well as in the other Nordic countries. In the Norwegian market the outstanding amount issued by banks and other financial institutions were almost 130 billion USD by the end of Q3 2011. Approximately 40 per cent of this was covered bonds.

Figure 2
Domestic debt securities per sector



The first issuance of Norwegian covered bonds took place when the Norwegian legislation entered into force in June 2007. According to Norwegian legislation covered bonds cannot be issued by banks, but must be issued by a separate institution (mortgage company) and secured on loans owned directly by that company. The loans are transferred from a bank or issued by the company directly. Since 2007 the Norwegian covered bond market has grown rapidly, with significant issuance both in the domestic and in international markets. The swap arrangement with the government greatly increased the issuance of covered bonds in the domestic Norwegian market. Covered bonds worth more than NOK 230 billion or 40 billion USD were used in the swap arrangement. By year end 2011 approximately 58 per cent of the outstanding covered bonds from Norwegian Mortgage companies were domestic issues.

Issuance by Norwegian corporate companies is of limited scale compared to financial institutions both in the domestic and international debt securities markets. By the end of Q3 2011 it amounts to just above 11 per cent of the outstanding domestic debt.

1.2 The Bond Market on Oslo Stock Exchange

The Norwegian domestic debt securities market corresponds to the bonds, notes and other debt instruments listed on Oslo Stock Exchange (OSE) and Alternative Bond Market (ABM). Debt securities have been traded at the OSE since 1881. ABM was established by Oslo Stock exchange in 2005, and is an unauthorized market place according to MIFID and not regulated under the Stock Exchange Act. The listing process and reporting requirements are simplified in comparison with the traditional market at Oslo Stock Exchange. The trading rules and system are however similar. Since the start-up of ABM the market place has been dominated by issues from banks and other financial institutions.

At the end of 2011 the outstanding amount of debt securities listed on Oslo Stock Exchange was approximately three times as large as the outstanding amount listed on ABM. However, both the number of issues and issuers were larger on ABM, reflecting smaller volumes per issue and small companies making use of the simplified listing and reporting requirements.

1.2.1 Development in market structure

In 1988 Oslo Stock Exchange introduced an electronic trading system for stocks and derivatives, and from October 1989 this system was also launched for bond trading. The electronic trading system opened up for decentralized trading, in the sense that brokers could trade from office terminals linked to the system.

Ten years later, in September 1999, a new decentralized trading platform (ASTS) was introduced, making it possible with direct routing of orders via brokers to the trading system. For trading in government bonds, launching of the system entailed a change from indicative prices to automatic matching of orders. Automatching amounted to about 20-30 per cent of the trades in government bonds in the first years after the system was introduced, but this share has fallen to approximately 10-15 per cent.

Automatching was not introduced for trading in non-government bonds, which continued being phone-based. However, all trades in non-government bonds were to be reported to the stock exchange within 5 minutes after the trade had taken place, but with a possible application for delayed publication until the end of the day.

Since September 1999 the Oslo Stock Exchange has changed its trading system twice, but the main characteristics, including decentralized trading and automatching of bonds, are the same. In the spring of 2002 when Oslo Stock Exchange joined the strategic Nordic alliance NOREX, a common trading platform for the Nordic exchanges Københavns Fondsbørs, Stocholmsbørsen and Islands Fondsbørs was introduced. This made it easier for international brokers to trade directly in the Norwegian market.

The Norex alliance ended in 2009 when Oslo Børs entered into a strategic partnership with London Stock Exchange. The partnership also included the bond market, and caused a transfer from SAXESS to TradElect in April 2010, a common trading system with London Stock Exchange. The Oslo Stock Exchange is currently in the process to migrate to a new trading platform. The transition is expected to be completed by the fourth quarter 2012 when the Oslo Stock Exchange will be moving its equity and fixed income trading onto the London Stock Exchange Group Millennium Exchange trading platform. Millennium Exchange is an ultra low latency, highly scalable trading platform.

There is currently also an ongoing transition to a new trading system which is expected to be finalized in the fourth quarter 2012. This migration is when the Oslo Stock Exchange will migrate to the Millennium platform

2 Literature and liquidity measures

In this section we will provide an explanation of how one typically defines market liquidity in the literature, and give a brief overview of some recent papers that examine the role of liquidity in fixed-income markets. We also address some challenges with respect to sampling frequency and precision of liquidity measures and how that affect this analysis.

2.1 Defining market liquidity

Liquidity is a broad concept that is difficult to define precisely. At a very general level, a liquid market is characterized by the ability to transact a given volume quickly at a low cost and with a small, and short lived (i.e. temporary[3]) price impact. In addition, a liquid market is characterized by a quick replenishment of liquidity and convergence to the equilibrium price after a trade. However, we need to be more precise when attempting to measure liquidity.

Initially, one would want a measure of liquidity that says something about the expected

[3]Price movements associated with trades can generally be decomposed into a temporary and permanent movements. The permanent price movements reflect price discovery as new information enters the price through trades. The temporary price movements are due to liquidity trades that temporary dislocate the price from equilibrium. In a liquid market, this dislocation is quickly reverted as liquidity suppliers replenish the order book, while in an illiquid market, the temporary price dislocation lasts longer before prices revert to equilibrium.

cost of trading for the random investor's point of view. However, as will be discussed further below, the cost of taking (demanding) liquidity is a function of the characteristics and needs of the trader. For example, an impatient trader with a need to sell quickly is likely to incur a much higher cost of trading compared to a patient trader with the same selling need. Typically, the patient trader will submit limit orders (supplying liquidity), while the impatient trader will submit market orders (taking liquidity). A *limit order* to e.g. buy is a resting order to buy a specified volume for a specific maximum price ("limit"). A *market order* is an order to buy a specified volume of an issue without a limit price, which means that the order will execute at increasingly worse prices ("walk the book") until fully filled. An alternative to pure market orders are so-called *marketable limit orders*. Marketable limit orders are simply aggressively priced limit orders (e.g. to buy) that match (and hence immediately execute) against the best priced limit order (e.g. to sell) of the opposite side. If the marketable limit order is partially filled, the remaining part of the order will typically automatically be converted to a regular limit order at the limit price.[4] Hence, regular limit order to buy or sell constitute liquidity supply, while market orders and marketable limit orders constitute liquidity demand.

As a useful starting point, Harris (1990) argues that liquidity can be defined along four dimensions; *width, depth, immediacy and resiliency*. These dimensions are interrelated, and most liquidity measures used in the literature typically capture several dimensions at once. On the other hand, no single measure is able to accurately capture all sides of liquidity, so typically one have to look at several measures, or extract common factors from a set of measures, to get a good picture (see e.g. Chollete, Næs, and Skjeltorp (2008) for an analysis of common factors in a set of stock market liquidity proxies). Before we go into the specific measures that we will look at in this study, it is useful to describe the liquidity dimensions proposed by Harris (1990) in more detail. For this purpose, it is useful to have a reference point. Figure 3 provides such a reference point by showing a general example of a limit order book (i.e. liquidity supply) at one point in time for one security.

It is important to note that while both of the Oslo Stock Exchange (OSE) trading platforms (Saxess until April 2010 and TradElect for the rest of the sample period) has been organized as an continuous electronic limit order market[5] as depicted by the figure, a public limit order book is not a complete description of the Norwegian bond market due to the large fraction of trading that occurs outside the exchange system (*over the counter*). For government securities, there are designated primary dealers that are required to post bid and ask quotes in government securities, such that the bid and ask spread will typically be available through the trading day. For corporate securities on the other hand, there are no such designated market makers that are

[4]There are typically three types of order instruction sets; execution based, time based and period based instructions. Two standard *execution based* order instructions are; "execute and eliminate" (ENE) where the unexecuted part of the order will be canceled, and the "fill or kill" (FOK) instruction in which the order will be immediately canceled unless fully filled. The two standard *time based instructions* are; "Good till canceled" and "Good till time" orders which are similar to the ENE, but with an additional time limit for which the remaining part of the order will reside in the order book. The *period based* instructions include, "At the close", "At the open", "Good for auction" and "Good for day" instructions.

[5]A detailed technical specification of the Fixed Income market model is found at `http://www.oslobors.no/Oslo-Boers/Handel/Handelssystemer/TradElect/Markedsmodell`

required to quote continuous bid and ask prices. All off market transactions are required to be reported to the OSE immediately or by the end of the trading day. Despite the fact that a large fraction of trading occurs off market, for the purpose of conceptualizing liquidity supply and explain the implicit costs components associated with demanding liquidity, the picture figure 3 is useful. While it mainly illustrates how the liquidity supply in an automatic limit order market works, it can more broadly be thought of as reflecting the aggregate liquidity supply both off- and on-exchange at various price levels. On the horizontal axis we have the prices at which investors are willing to provide liquidity, i.e. are willing to buy (bid) and sell (ask). The y-axis reflect the accumulated volume at the respective price levels in the limit order book.

The fixed income market at OSE is structured in several layers where a set of segments defines the trading model for the tradeable instruments. Appendix B contains a more detailed overview of the market structure implemented in TradElect. For the automated continuous auction system, the regular limit orders submitted to the TradElect system is stored and displayed in the order book with full volume. Note that the OB Automatch (OBAU) segment is the only part of the OSE fixed income market where there is continuous trading. Only government bonds have automatch trading on OSE. Once a marketable order is entered into the system, TradElect automatically generates a trade and the details are disseminated to market participants through the InfoLect data feed system. The system also allows the submission of *iceberg orders*, which are partially visible limit orders.[6] All trades executed away from the order book (*manual trades*) must be reported via TradElect within five minutes[7].

Width Width reflects the cost of supplying liquidity (i.e. posting limit orders) versus demanding liquidity (posting market orders).[8] For example, in figure 3, a patient buyer could post a limit order at p_b^1 and wait for an impatient to submit a marketable limit order or market order[9]. From the perspective of an impatient buyer, she would demand liquidity by posting a marketable limit order at p_a^1 (or a market order to buy) which would immediately execute. The difference between the price that the patient buyer would pay (p_b^1) and what the impatient buyer would pay (p_a^1) reflects the implicit cost per share for trading immediately. A more liquid security has typically a tighter spread (smaller width). Hence, width measures how much an investor needs to increase (decrease) the price to obtain immediate execution. There is a large theoretical literature that shows the existence of a positive spread in equilibrium. These models suggest that the spread reflect a compensation to the liquidity supplier for e.g. adverse selection

[6]Iceberg orders are order instructions where e.g. 10% of the order is visible in the limit order book. Once the visible part is executed, a new fraction of the order is automatically entered into the market. The new order looses time priority, and is considered as a new submission of a regular limit order.

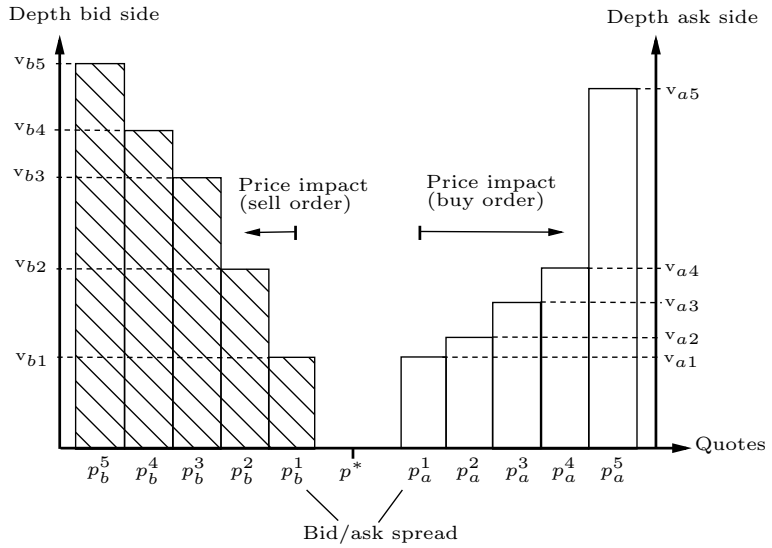
[7]However, by request to the exchange trades can also be allowed to be reported with a longer delay, typically by the end of the trading day.

[8]A limit order is an order with a fixed price and volume, while a market order is an order to buy a specific volume at the best available prices. Hence, a limit order is a passive orders that executed when a market order is submitted.

[9]The difference between a market order and marketable limit order is that a market order instruction only specifies volume and direction without a specific price and will execute at the best available price(s) in the market. Hence, a large market order might execute across several price levels of the order book. A marketable limit order on will execute only up to a specified price point (limit).

Figure 3
Example of a limit order book

The figure illustrates the limit order book (liquidity supply) at a particular point in time for one security. The horizontal axis shows the quoted prices, where the subscript b and a denote bid and ask quotes, respectively, while the superscript denotes the level of the limit order book relative to the side, and p^* is the bid/ask midpoint price, which reflect the instantaneous "true" value of the security. The vertical axes show the accumulated depth on the bid (left axis) and ask (right axis) sides.



risk, and costs associated with holding inventory and order-handling (see e.g. O'Hara (1995) for an overview of these models).

Depth While *width* measure the cost of demanding one unit of liquidity, it does not reflect how much liquidity is available at the various price levels. If an investor needs to buy (sell) a large volume quickly, the depth available at the various ask (bid) levels is important for the volume weighted average execution price that she will obtain. Typically, the prices at the best quotes (p_b^1 and p_a^1) are unlikely to be representative for a large trader, especially if the order book is dispersed. Looking at figure 3, an impatient buyer that needs to buy a volume equal to v_{a4} would have to pay an average price that is higher ("walk the book") than a trader that needs a volume less or equal to v_{a1}. In addition, comparing the depth of the bid and ask sides we see that a seller would need to change his price less (relative to the best bid) to sell a similar volume as our buyer (relative to the best ask) indicated by the horizontal arrows.

Immediacy Another important aspect of liquidity is how quickly one can find opposite side trading interest. This is generally not a problem in a market with an intermediary standing between the buyers and sellers (i.e. a market makers/dealers). However, in a pure limit order market without any intermediaries, the arrival of buyers and sellers might not always be synchronized in time. In a liquid market, the number of buyers and sellers supplying liquidity is typically greater than in an illiquid market, which reduces the time needed for a patient trader

to fill an order at a reasonable cost. For equities, in 2004, the OSE allowed listed firms to contract with so-called Designated Market Makers (DMMs) to improve the secondary market liquidity of their issued shares. DMMs charge a fee to the firm that has issued the equity to provide liquidity in the the firm's stock through limit orders. See Skjeltorp and Ødegaard (2010) for more details and an empirical analysis of the impact of DMMs on the Oslo Stock Exchange.

Resiliency The fourth dimension proposed by Harris(1990) is *resiliency*. This dimension is notoriously difficult to measure, but captures a very important aspect of secondary market liquidity. The resiliency of the market reflect how quickly the liquidity supply is replenished and the price moves back to equilibrium after a large uninformed liquidity demand has been filled. In figure 3, if the aggressive buy order we looked at earlier takes out the depth of the first four levels of the ask side, resiliency reflect how long it takes before competitive liquidity suppliers come in and reduce the to spread and depth to its pre-trade level. This dynamics is modeled theoretically in a recent paper by Foucault, Kadan, and Kandel (2012), where they show that the resiliency is a function of liquidity suppliers ("makers") monitoring intensity, the fee structure at the trading venue and the fraction of liquidity suppliers.

Trade- versus order-based measures For empirical purposes it is also useful to distinguish between trade-based and order-based measures of liquidity. Aitken and Comerton-Forde (2003) define measures that capture liquidity supply directly (depth, bid/ask spread etc) as order based measures, while measures that look at realized transactions (e.g. trading volume, number of trades, trade size etc) are defined as trade based measures. The main distinction between the two comes from the fact that order based measures are closer to ex-ante measures of liquidity provision while trade based measures only reflect the consumed liquidity. While the two are cross-sectionally related, the results in Aitken and Comerton-Forde (2003) show that measures from the two categories have a low time-series correlation. More importantly, they show that trade-based measures have a tendency to signal favorable liquidity conditions also during periods of stress, even though implicit costs of trading is high. Based on this, they argue that order-based measures are superior proxies for liquidity as such measures more accurately reflect the true costs of obtaining liquidity in periods of stress. They advocate a combination of the bid/ask spread, order-book depth and the probability of order execution to measure liquidity. Notably, their measures are closely linked to the three first dimensions proposed by Harris (1990); i.e. width, depth and immediacy.

2.2 Recent studies on bond market liquidity

It is now widely recognized that the liquidity is important for the pricing of securities. With respect to fixed income securities, there is a large number of studies that document a liquidity premium. For example, Chen, Lesmond, and Wei (2007) find that liquidity is priced in corporate yield spreads. Using a set of several liquidity measures they find that more illiquid bonds earn significantly higher yield spreads, and that an improvement in liquidity causes a significant

reduction in yield spreads. These results hold after controlling for common bond-specific, firm-specific characteristics, and macroeconomic variables. Also, in a recent paper, Bao, Pan, and Wang (2011) establish a strong link between bond liquidity and bond prices, both in aggregate and in the cross-section. that the illiquidity in corporate bonds is substantial, significantly greater than what can be explained by bid-ask spreads. More specifically, they establish a strong link between bond illiquidity and bond prices. In aggregate, changes in market-level illiquidity explain a substantial part of the time variation in yield spreads of high-rated (AAA through A) bonds, overshadowing the credit risk component. In the cross-section, the bond-level illiquidity measure explains individual bond yield spreads with large economic significance.

For treasury bonds, Goyenko, Holden, and Trzcinka (2011) examine the liquidity of the US treasury market across different maturities and the bonds on- or off-the-run status.[10] They measure liquidity by the relative quoted spread and find that liquidity worsens in recessions across all maturities, but that this effect is most pronounced for short-term bonds. They argue that this suggest that investors shift into short-term bonds during recessions.[11] They also find that the more illiquid off-the-run bonds are more sensitive to shocks to inflation and monetary policy surprises than their more liquid on-the-run counterparts, and use this to identify a significant liquidity risk premium in the treasury market. Goyenko and Ukhov (2009) also show that there is a strong relationship between stock and bond Treasury bond market liquidity, with a two way causality relation, consistent with flight-to-quality or flight-to-liquidity episodes. A recent paper by Beber, Brandt, and Kavajecz (2009) examine detailed data from the Euro-area government bond market to study to what degree investors value credit quality and liquidity. Their main result is that there is a negative correlation between credit quality and liquidity, and that cross-sectional variation in sovereign yield spreads is mainly explained by differences in credit quality. However, they also show that liquidity plays an important role especially for low credit risk countries and during times of heightened market uncertainty.

The market based liquidity measures we calculate in this study are similar to those examined in the above mentioned studies, although we will not examine the pricing implications of liquidity in the Norwegian bond market.

3 Data and measures

3.1 Description of data

The analysis in this paper is based on daily data for all listed securities at the Oslo Stock Exchange (OSE) for the period 1980-2011. We restrict, however, the sample period to the period after trading in fixed income securities was organized as a fully automated electronic order book system; i.e. from 1999 through 2011. The main reason for this is that market organization/design and trading rules can have significant effects on price formation and liq-

[10] Once issued, the security is considered as on-the-run and the older issues are off-the-run for the same maturity.

[11] This is similar to the findings in Næs, Skjeltorp, and Ødegaard (2011) who shows that stock market liquidity worsens during recessions, but worsens more for small relative to larger stocks. This suggest that investors shift their portfolios into safer (flight-to-quality) and more liquid (flight-to-liquidity) stocks during recessions.

uidity provision. Hence, we choose a sample period that is relatively stable with respect to the underlying market structure through the sample which is also more representative going forward.

The main dataset is obtained from Oslo Børs Informasjon (OBI) on special order (see Appendix D for a list of the variables available in the feed.). To supplement the market data, we also combine the OBI data with the Stamdata database,[12] which contains information on the terms and characteristics of each individual issue, as well as the complete history of repayments of the individual loans. These data will mainly be used to split the OBI data into subgroups, and to handle the outstanding volume when calculating turnover.

The calculation of order-based liquidity measures for the Norwegian fixed income market is complicated by the fact that a large amount of liquidity provision is off-exchange ("over-the-counter"). However, since all trades are required to be reported to the exchange trade-based measures will probably be more representative. As briefly discussed earlier, and detailed in Appendix B, the fixed income market is defined through various segments. The most relevant segments for this study are the Automatch segment (OBAU), the Call segment (OBOC) and the ABM segment (OABM). Only government securities are traded in the continuous automatch segment (OBAU). The OBI data includes all standard and non-standard repurchase agreement trades (REPO), which we are unable to separate from other trades. The trading of corporate issues is in the opening auction and close auction (OBOC) segment. In between the opening and close auctions, this segment is subject to order entering and manual trade reports. In addition, a large number of corporate issues are listed at the Oslo ABM which is defined as the OABM segment. As opposed to the OBOC segment, OABM does not have an opening or closing auction. Similar to the OBOC segment, OABM is subject to order entering and manual trade reports; i.e. no automatch.

All trades that occur within each segment is classified into various types. These are shown in Appendix C. There are two main types of trades; *automatic* trades and *manual* trades. With respect to the automatic trades, when orders are executed by TradElect, trades are automatically created, trade details are disseminated to the involved parties, and public information is published in InfoLect. With respect to the manual trades, these are trades that execute away from the order book and is reported manually into the system. Unfortunately, the OBI data does not separate directly between the different trade types. Hence, our measures will contain a mix of the various trade types.

3.2 Measures examined in this study

The range of measures we will focus on for the Norwegian fixed income market is limited due to the low activity, the large fraction of trading that occurs off-exchange and the lack of market

[12]Through Stamdata, Norsk Tillitsmann delivers reference data for Norwegian debt securities. The data includes detailed information on i.a. bonds, certificates and structured debt securities issued by governments, municipals, banks and corporate borrowers. The core business of Norsk Tillitsmann ASA is to offer trustee services to bond loan investors. It is mainly owned by Norwegian banks, life assurance companies and securities companies.

indices for corporate issues.[13] We will construct measures of two types and use the distinction proposed by Aitken and Comerton-Forde (2003) between trade-based and order-based measures. However, most of the measures will fall into the trade-based category due to the large part of trading that occurs off-exchange in the Norwegian fixed income market. Due to the rule that all off-market transactions needs to be reported to the exchange on a daily basis, our data contains the complete history of trades. With respect to order based measures, the OBI data also contains bid/ask quotes, although there for most securities are very few two sided quote observations. Hence, with respect to the dimensions proposed by Harris (1990) discussed above, we will only be able to calculate measures that proxy width and depth.

3.2.1 Trade based measures

Activity measures A natural starting point for our analysis is to examine the trading activity in the listed securities. We will measure the average number of days (during a quarter) that the issues are traded, to get an overall measure of trading intensity, the total NOK trading volume, average volume and turnover (transacted volume relative to outstanding volume of the loan at any point in time).[14] Trading activity can be high both in normal periods as well as during turbulent periods (Aitken and Comerton-Forde (2003)), which means that trading activity by itself is not necessarily a good measure of aggregate liquidity variation. However, in the cross section, securities with high trading activity are typically more liquid (i.e. have lower implicit transaction costs).

Price impact measure (depth) As our main trade based liquidity measure we use Amihud (2002)'s ILR measure. ILR is a measure of the elasticity dimension of liquidity and is the most broadly applied measure of illiquidity in the literature due to its modest data requirements. As an elasticity measures of liquidity it measures how much the price moves as a response to trading volume. Kyle (1985) defines price impact as the response of price to order flow, and the Amihud ILR measure is essentially an empirical version of Kyle's lambda. The daily Amihud measure is calculated as,

$$ILR_{i,T} = \left[1/D_T \sum_{t=1}^{T} \frac{|R_{i,t}|}{VOL_{i,t}} \right] \cdot 10^6 \tag{1}$$

where D_T is the number of trading days within a given time window T, $|R_{i,t}|$ is the absolute return over period t for security i, and $VOL_{i,t}$ is the trading volume (in units of currency, which is NOK in our case) over period t. It is standard to scale the estimate up by 10^6 for practical

[13] We have however produced a large electronic document examining a much broader set of measures and also splitting the sample into notes and bonds. This document can be obtained upon request to the authors.

[14] As can be seen in Appendix D the raw data feed also splits trading volume into "official-" and "non-official" volume. During the Saxess period (until April 2010) the official volume field contained a mix of various trade types (repos, reported trades etc.), while this was changed when the TradElect system was introduced from April 2010. During the TradElect period the official volume field was changed to only include automatched trades, uncrossed trades, regular trades that is immediately disseminated and regular trades with delayed reporting. Since we are unable to split the official and non-official volume into finer sub-categories (in particular during the Saxess period), we dismiss these volume variables in the analysis and only look at total volume.

purposes. The Amihud measure is referred to as an illiquidity measure since a high estimate indicates low liquidity (high price impact of trades). Thus, the ILR measure captures how much the price moves for each volume unit of trades. Relative to Figure 3, a low ILR estimate would indicate that there is a large depth in the limit order book that would reduce the average price impact, while a high ILR estimate is an indication that the liquidity supply is low causing prices to move more in response to liquidity demand.

3.2.2 Order based measures

Relative bid/ask spread As for equity market liquidity, different versions of the bid/ask spread is a commonly used measure of width. The relative bid ask spread is calculated as,

$$RS_t = \frac{p_t^a - p_t^b}{p_t^m} \tag{2}$$

where p_t^a and p_t^b are the best ask and bid quotes respectively, and p_t^m is the quote midpoint measured as $p_t^m = (p_t^a + p_t^b)/2$. For direct measurement of the spread, two sided quotes at the same point in time is needed. However, in the Norwegian case a large number of observations only have quotes on one side of the market, and in most cases we do not have any quotes.

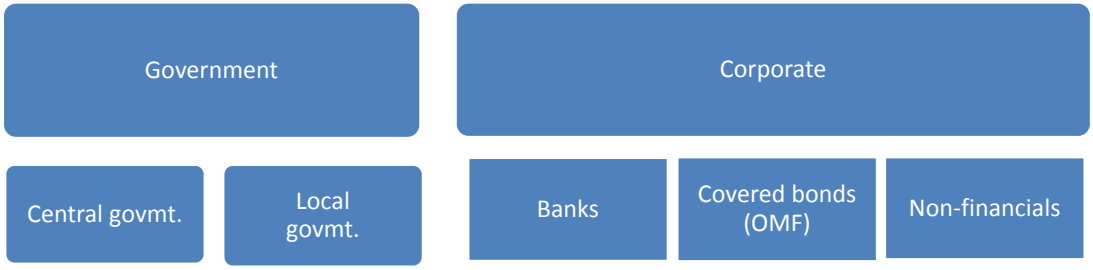
Other spread measures There are also several methods that can be applied to estimate implicit spread measures that does not require quote observations. Two widely used estimators are those proposed by Roll (1984) and Lesmond, Ogden, and Trzcinka (1999) (LOT). Næs, Skjeltorp, and Ødegaard (2008) provides a detailed explanation of these measures with an application on the Norwegian stock market for the period 1980 through 2008. The Roll estimator exploits the serial covariance of successive price movements to identify the bid ask spread. The LOT measure uses the zero return days of individual stocks relative to overall market returns to estimate an implicit trading cost. More specifically, the LOT cost is an estimate of the implicit cost required for the price *not* to move when the market as a whole moves, and Lesmond et al. (1999) shows that their estimator is closely related to both the level and variation in the bid ask spread. However, since the LOT measure requires a broad market index to be estimated, the lack of a long and broad corporate bond market index for Norway, makes the estimation not feasible. We have also tried to estimate the Roll measure for Norwegian issues, however, the low number of transaction prices for individual issues that is not too distant in time makes the Roll measure very noisy, and in many cases negative. Due to these problems, we have left both the LOT and Roll results out of the analysis.

3.3 Groups of issuers and characteristics

We focus on constructing liquidity and activity measures for subgroups of issuers. However, one major problem with the data is that there is a significant amount of missing observations for a large number of issues due to lack of trading activity. This makes the measurement of activity and liquidity challenging when splitting the issues into finer subgroups. While we initially

Figure 4
Groups of issuers

The figure gives an overview of the groups and sub-groups of issuers we are looking at in the analysis.



wanted to split the securities into groups based on e.g. industry, time to maturity, age, size, issue type etc., this was not feasible as we quickly ended up with very few observations within each group.[15]

Figure 4 gives an overview of the main issuer groups we ended up looking at that contains enough observations to construct statistics. All the results in the rest of the analysis will be presented separately for these groups. At the general level, we split the issues into government issues and corporate issues. The government issues is further split into securities issued by central- and local government. The corporate group is split into bank issues, covered bonds (OMF) and securities issued by non-financials. We also attempted to split financials into banks and non-banks, but the non-bank group contained too few observations.

4 Results

4.1 Activity measures

We start by calculating various measures of trading activity to examine the basis for our liquidity measures in the subsequent subsections.

Number of days traded

To get an overall view of the number of securities (unique ISINs) in the dataset, Panel A of Figure 5 shows the quarterly time series of total number of listed issues for the different sub-groups shown in Figure 4. Looking first at the government securities, we see that there has been a significant decline in number of local government securities over the sample period. For issues by central government, there has also been a decline. For corporate issues on the other hand there has been a steady increase in number of issues over the period. In particular the number of bank issues have more than doubled over the period, although there was been a

[15] We have also looked at short term notes with maturity less than one year at issuance and bonds (time to maturity greater or equal to one year at issuance). The activity in the short term notes were so small and variable that we have not looked separately at the short term notes in the analysis. Consequently, we use data for all issues, which include the short term ones. The additional results can be obtained on request to the authors.

decline during 2011. The increase in bank issues from 2005 corresponds to a period of increased credit growth, and increase in wholesale funding for Norwegian banks due to a decrease in the deposit-to-loan ratio. For non-financial issuers there has also been an increasing trend over the sample period. Finally, after the covered bond legislation was adopted in June 2007, we see the growth in number of covered bonds issues by specialized mortgage credit institutions.[16]

In Panel B of Figure 5 we show the fraction of the listed issues for which there is at least one transaction during the quarter. Hence, for each quarter any security that has a positive trading volume on any given day is counted as being traded for that quarter. Looking first at the government securities, we see that there has been an increased trading activity in both for central- and local bond issues. Note however that the fraction for central government issues is inflated by repo transactions as we are unable to separate those out. For corporate issues we see that there is a relatively high fraction of the issues that are traded at least once each quarter. However, these fractions drop dramatically if we increase the frequency to e.g. the monthly or weekly frequency. Furthermore, even at the quarterly frequency, for e.g. bank bonds, at the end of the sample there is about 20% of the issues that are not traded at all on a quarterly basis. For covered bonds we see that there is a significant drop in number of issues that were traded each quarter. One explanation for this sharp drop in trading activity in covered bonds from the end of 2008 through 2009 is the covered bond swap facility set up during the financial crisis.

Next, we examine how frequently individual issues are traded within each quarter. To measure this, we count the number of non-zero trading volume days for each issue within each quarter, and then take the average across all issues for each quarter. Note that when calculating this average, we include all issues, also those that are listed (i.e. not matured), but not traded, during the quarter. Panel A of figure 6 shows the average number of days traded for government bonds (left figure), and corporate issues (right figure). Looking first at the government securities we see that issues by central government is significantly more frequently traded compared to local government securities. For both groups, there has been an increase in trading frequency through the sample period with central government securities reaching an average of about 45 days on average per security in the fourth quarter of 2011, while for local government issues, the average number of days traded is only about 2.5 days per quarter. Again, the higher trading frequency for central government bonds are affected by the inclusion of repurchase agreements (repos). In the right figure of panel A we show the same statistics for the three groups of corporate issuers. For all groups, we see that the average number of days traded per quarter is on average around 4 days over the period, without any clear trends. Thus, while we in Figure 5 observed a relatively high fraction of securities that is traded each quarter, the statistics on the average number of days traded per security suggest that they, at the individual level, are traded very infrequently.

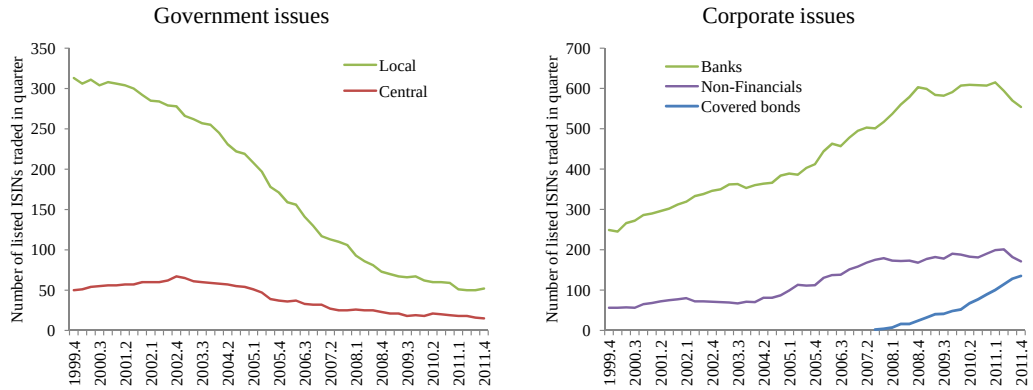
In panel B of Figure 6, we show the total number of listed issues that are traded at least

[16] A commercial bank or a savings bank is not allowed to issue such bonds in its own name, but may establish a mortgage credit institution as a subsidiary. Alternatively, a mortgage credit institution may be established as an independent institution with several shareholders.

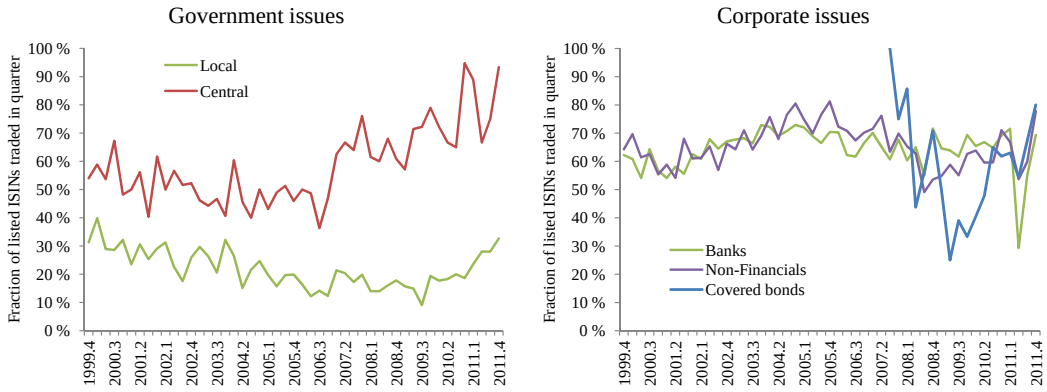
Figure 5
Fraction of ISINs traded

Panel A shows the total number of unique ISINs in the OBI database during each quarter. Panel B shows the fraction of the issues that are traded at least once during each quarter.

Panel A: Total number of listed issues each quarter



Panel B: Fraction of listed issues traded at least once during each quarter



once during each quarter. For the government issues, we see that this number has declined over the sample period, while it has increased for all three groups of corporate bonds. This is closely linked to the number of listed issues within the different groups.[17]

Trading volume

In panel A of Figure 7 we plot the aggregate quarterly trading volume (in mrd. NOK) across all issues within each group. For government issues, we see that the total volume in local government issues has declined steadily over the period, corresponding to the decline in number of listed issues in panel A of Figure 5, although there seems to be an increase in activity the second half of 2011. For central government issues there was an increase in total volume until mid 2007 and then a decline in activity through the fourth quarter of 2011 to a level comparable with 2002. For corporate issues we see that there has been an increasing trend in trading activity for bank bonds and covered bonds. This is in line with the increased number of listed bank bonds over the period. There are two major spikes in trading volume in the second quarter of 2010 and in the first quarter of 2011, in particular for banks. To examine whether this is caused by some extreme outliers, we remove the two largest volume observations. However, this does not remove the spikes. These spikes in activity is also evident for the non-financials, and also for covered bonds in the first quarter of 2011. While it is not clear what causes these spikes in activity, the first spike could be related to the introduction of the new trading system (TradElect) in the second quarter (April) of 2010.

In panel B of Figure 7, we look at the average trading volume across ISINs for each quarter. For government securities, we see that the average trading volume has increased significantly for bonds issued by local government during 2011. This corresponds to the increased aggregate volume for local government bonds in Panel A, which indicate that there are a fewer, but larger issues. For the corporate issues, we see that the average trading volume for covered bonds is much larger than for bank bonds or bonds issued by non-financials. This is most likely due to large issue size of the covered bonds.

Turnover

Since the previous activity measures do not say anything about how much of the outstanding volume is changing hands on average, it is also useful to calculate the average turnover relative to the outstanding volume of the individual bonds at each point in time.[18] Figure 8 (a) shows the average quarterly turnover for government issues, and part (b) shows the turnover for corporate issues. Looking first at the government securities, we see that the central government issues have a significantly higher turnover that local government securities. This is caused by the

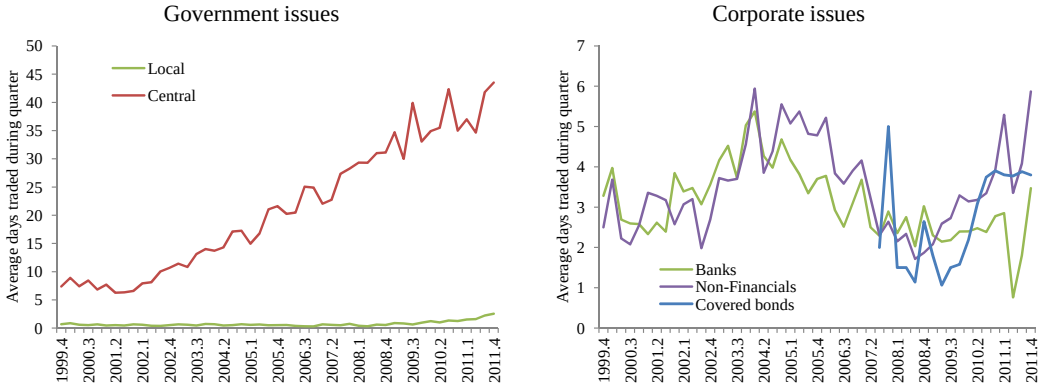
[17]For banks, we observe that there is a sharp drop in number of issues traded in the second quarter of 2011. We have not identified any errors in the data. One explanation could be the drop in listed bank securities in the same quarter that we observed in panel B of figure 5. Hence, if many of the most actively traded bank bonds matured during the same quarter, that could explain the spike.

[18]We calculate turnover velocity as the transaction volume in NOK divided by the quarter divided by the nominal outstanding NOK volume at the beginning of the quarter.

Figure 6
Number of days traded

Panel A shows the average number of days traded for securities issued by central and local government (left), and for corporate issues (right). Panel B shows the total number of listed issues (ISINs) that are traded at least once in each quarter.

Panel A: Average number of days traded during quarter



Panel B: Number of traded issues during quarter

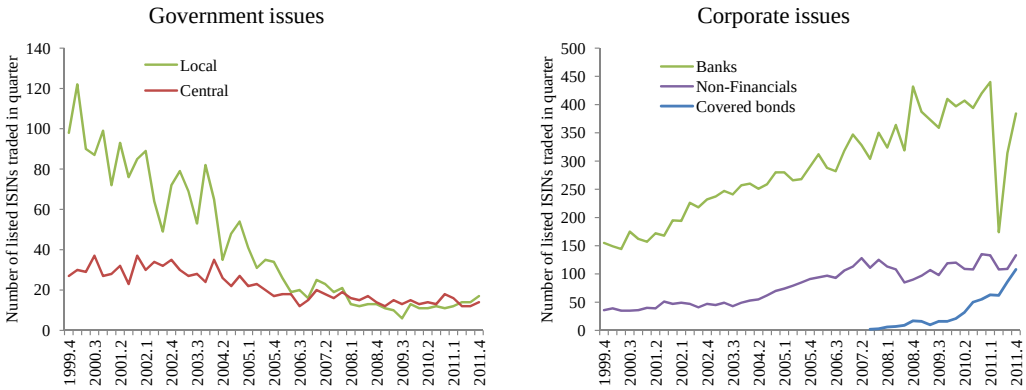
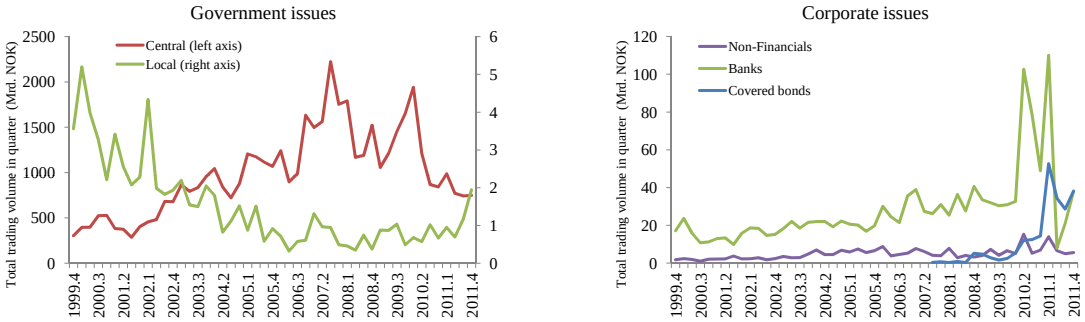


Figure 7
Aggregate quarterly trading volume

Panel A shows the aggregate trading volume in each quarter in mrd. NOK. for government issues (left) and corporate issues (right). Panel B shows the corresponding average quarterly trading volume across the listed ISINs.

Panel A: Aggregate quarterly trading volume (mrd. NOK)



Panel B: Average quarterly trading volume across ISINs

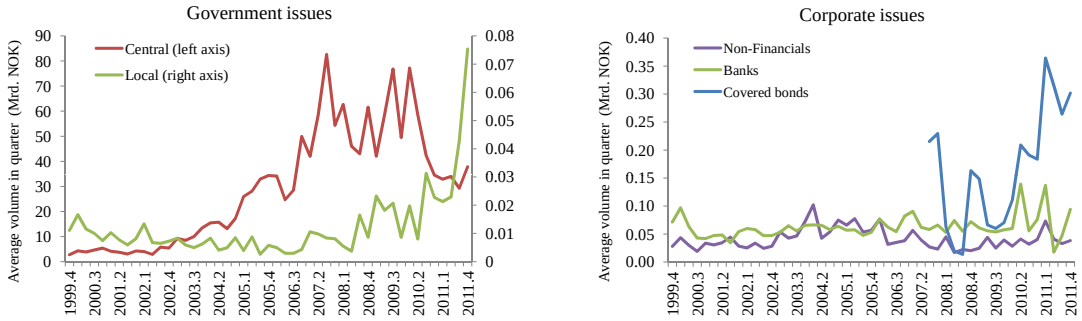
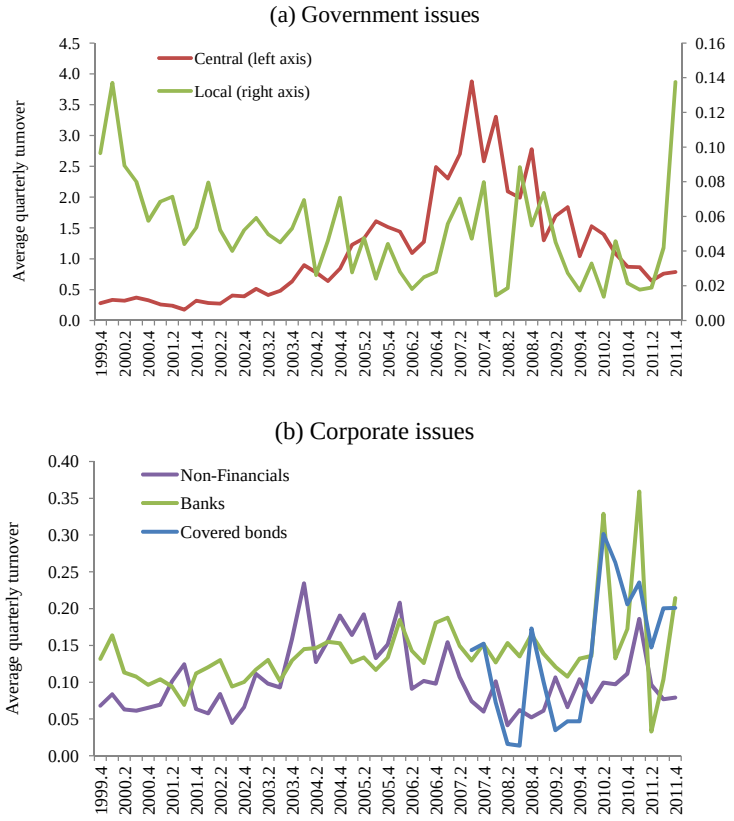


Figure 8
Average quarterly turnover

The figure shows the average quarterly turnover relative to outstanding volume across all ISINs each quarter. Panel (a) shows the statistics for securities issued by central and local government, and panel (b) shows the numbers for corporate issues split into non-financials, banks and covered bonds. Panel (c) and (d) shows the corresponding number of daily observations (ISINs) within a quarter underlying the different series.



large fraction of the activity in the central government securities related to repo activity. At the peak in the fourth quarter of 2007, the average government bond was turned over almost four times. With respect to the local government issues, these have experienced an increased turnover during the last half of 2011, consistent with the earlier results. For the corporate bond issues, there is no particular trend, except that there is a high, and increasing, variation in turnover over the sample period. The turnover numbers are very noisy given the low number of days traded for the individual issues each quarter (as shown in figure 6). In addition, these numbers are affected by the changing composition of bonds and the size of new issues over the period.

4.2 Liquidity measures

As discussed earlier, it is useful to distinguish between liquidity measures that are based on the actual trade executions and prices and measures that are based on order information. We will

next look at two liquidity measures that we are able to calculate using the available data. The first is a trade based measure (the Amihud illiquidity ratio) and the second measure is an order based measure (the bid ask spread).

Amihud (2002) illiquidity ratio (ILR)

The Amihud illiquidity ratio (ILR) is aimed at measuring how much prices move as response to one currency unit of trade. Securities for which the price move more as response to trades are considered less liquid as the average price impact per currency unit is larger. As mentioned earlier, the calculation of ILR is less data intensive compared to what is required to calculate the bid ask spread. Also, the ILR is potentially more informative since it is a trade-based measure that does not rely on posted limit orders/quotes, but only that all actual trades that are reported to the exchange. Hence we do not need to restrict the calculation to only trades that are done in the Oslo Stock Exchange system. We calculate the ILR as defined in equation 1 based on Amihud (2002). Hence, for each issue we calculate the total NOK volume and absolute return over each quarter. Then, for each quarter we take the equally weighted average ILR across all issues to construct the quarterly time series for each group. Panel A of Figure 9 shows the average quarterly Amihud illiquidity ratio (ILR) calculated for government issues (left) and corporate issues (right), with the corresponding underlying number of observations in panel B. Looking first at panel A, we see that the overall ILR level of government securities, the government issues has a significantly lower ILR than for corporate issues, except for covered bonds that are similar in level as for government issues. To illustrate this we include the covered bond ILR series to the figure for government issues (dotted blue line). Note that the range of the vertical axis is different for the two figures in panel A and that the ILR is presented in percentage terms.

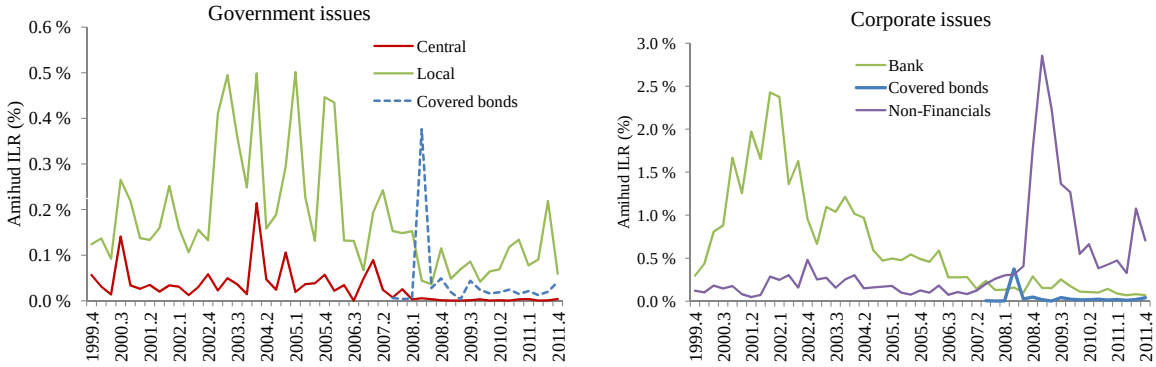
With respect to the time series patterns, it is interesting to note that for securities issued by central government the ILR dropped to a very low level from 2008 and onwards. The main reason for this trend is likely to be partly explained by the large increase in trading volume and turnover (the denominator in the ILR expression) in central government securities shown in figures 8 and 7. A similar pattern is also visible for the local government securities and covered bonds. In the right figure in panel A, we see that for the corporate securities that ILR worsened dramatically for bank issues during the burst of the "DotCom bubble" in 2001/2002. During the sub-prime crisis on the other hand, non-financials experienced a dramatic increase in ILR, while we do not observe a corresponding increase in ILR for bank issues.

Panel B in the figure show the number of unique issues underlying the different series in panel A. For government issues we see that there has been a large reduction in the number of listed securities issued by local government, while central government securities have been relatively stable. For corporate issues we see an opposite trend where both the number of traded ISINs have increased for all groups. For bank issues however, as noted earlier, we observe a downward spike in the first quarter of 2011. We have not managed to identify the cause of this large drop in number of traded issues during that particular quarter. It does not, however, seem

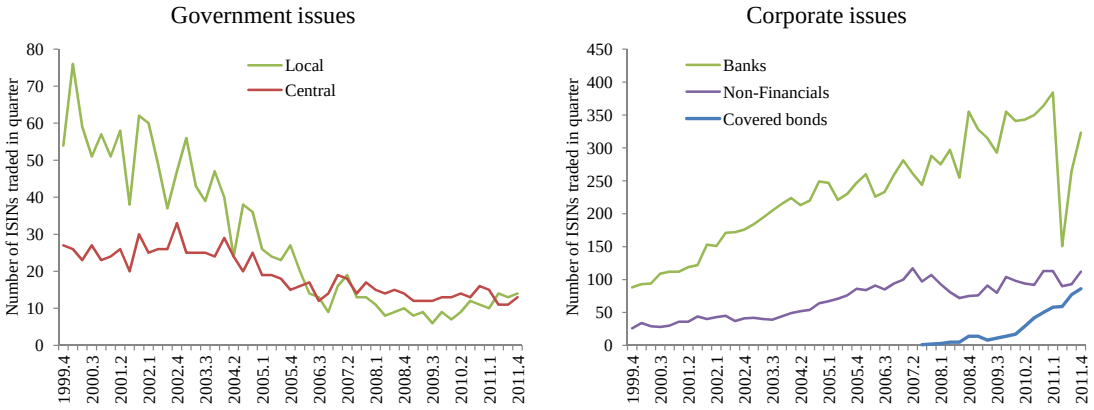
Figure 9
Illiquidity ratio (ILR)

Panel A shows the equally weighted average illiquidity ratio (ILR) for government issues and corporate issues. Panel B shows the corresponding number of observations underlying the different series.

Panel A: Quarterly ILR



Panel B: Number of observations (ISINs) for each quarter



to affect the average ILR as seen from the corresponding series for bank issues in panel A.

Relative bid ask spread

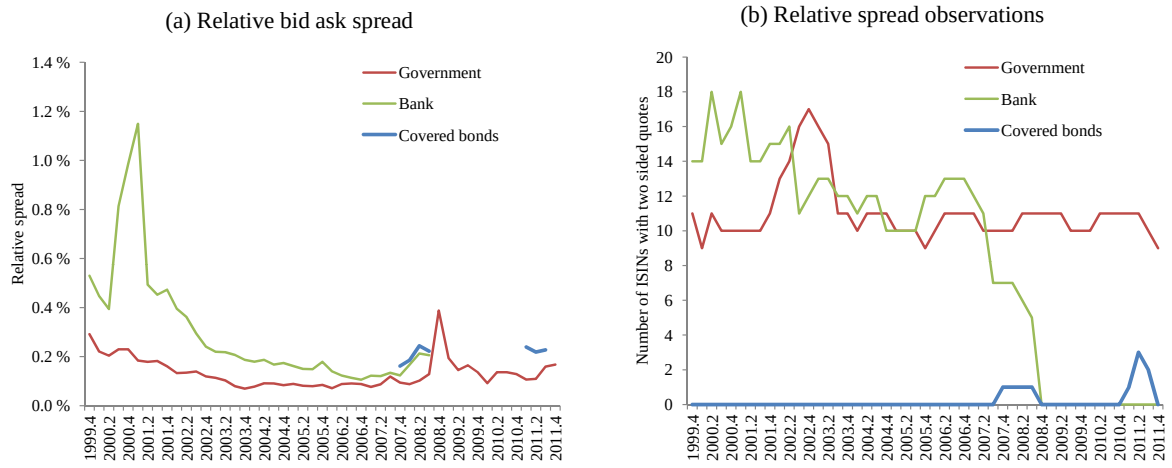
The next liquidity measure we calculate is the relative bid ask spread as defined in equation (2). This is a measure within the class of order based measures, as defined by Aitken and Comerton-Forde (2003). In an active limit order market or in a market with many competing market makers, the spread is a measure of the cost required to supply liquidity. Note that to calculate the spread, we need there to be both a bid and ask quote for the same day for a security. Given the market structure at the fixed income market at the Oslo Stock Exchange, it is essentially only for government securities that there is a continuous market with designated market makers (primary dealers) required to quote bid and ask prices as well as orders from other participants.

For corporate bonds, there is an opening and close auction similar to equities, and order entering and manual trade reports. For the Oslo ABM segment there is order entering and manual trade reporting, but without any opening or closing auction. As opposed to government securities, there are no designated market makers in corporate bonds.

In Figure 10 (a) we show the equally weighted average relative bid ask spread (in % of the midpoint price) for government issues, bank issues and covered bonds. These are the only groups that we were able to calculate spreads for. Part (b) of the figure shows the number of quarterly observations underlying each of the series. Looking first at figure (b) we clearly do not have enough observations to put any weight on these spread estimates. The only series that have a reasonable number of two sided quote observations is the one for government bonds due to the primary dealers responsibility to quote bid and ask prices. For the bank issues, there is until 2008 a few ISINs with two sided quotes, however, after 2008 there are none. For comparison, we also include covered bonds for which there are only a few quarters that there are two sided quotes for a few of the issues.

Figure 10
Relative bid ask spread

Panel (a) shows the equally weighted average relative bid ask spread for government bonds, bank bonds and covered bonds in percent of the midpoint price. Note that the series for banks stops in the third quarter of 2008 due to lack of two sided bid ask quotes in the OBI data. Panel (b) shows the corresponding number of observations underlying the different series.



Looking at figure 10(a), we see that the government bond relative spread is generally below the spread of bank bonds. Also, there are two points when the bid ask spread series widens; for bank issues during the burst of the "DotCom bubble" in 2000/2001, and for government securities in 2008 during the sub-prime crisis. This reflect that the implicit cost of demanding liquidity increases during times of stress. Comparing the spread series for government securities with the ILR series in figure 9 there is no corresponding increase in ILR for government securities in 2008. This illustrates that it is important to look at several measures to get a complete

picture. For bank bonds however, the increased spread for bank bonds during the 2000/2001 period is consistent with what we observed for the ILR in figure 9. Unfortunately, we do not have enough two-sided quotes to calculate any spread series for bank- and covered bonds during the sub-prime crisis in 2007/2008. Note that while there is an significant increase in spreads for government securities during 2008, this may be much lower than what we would have observed for corporate issues (similar to what we observe for the 2000/2001 period).

These patterns largely coincide with what we observe for measures of equity market liquidity, analyzed in Næs et al. (2008). Furthermore, in Næs et al. (2008) they also observe that while all stocks become more illiquid during periods of stress, smaller stocks become relatively more illiquid than larger stocks. However, looking at the number of unique ISINs in part (b) of the figure, suggest that the sample size is too small to interpret these series any further. Interestingly, the few points of covered bond spread estimates suggest that they are close to what we observe for bank issues. Overall, due to the low activity and market structure of fixed income trading in Norway, the bid ask spread is not very informative measure of liquidity due to the lack of two sided quotes being reported. As discussed in the introduction, there are alternative estimators that can be used to estimate an implicit spread based on prices and not actual bid ask quotes such as e.g. the Roll (1984) estimator or the Lesmond et al. (1999) estimator. However, these still require there to be a reasonable level of trading activity for each individual security to be estimated reliably, which is not the case for the Norwegian market.[19]

5 Summary and conclusion

In this analysis we use the complete database of registered transactions in fixed income securities listed on the Oslo Stock Exchange (OSE) for the period 1999 through 2011. The main purpose of the project has been to assess whether there is sufficient activity to construct liquidity indicators that can be used to monitor the state of the Norwegian fixed income market on a regular basis based on the OBI database.

At the aggregate level, the trading activity and volume has increased over the sample period. However, this has to a large degree been driven by an increased trading activity in government securities up to 2008, with a decline in activity in the period after 2008. For corporate bonds, there has also been an increase in overall activity. This increase has been accompanied by doubling of the number of corporate bond issues over the sample period. However, when we split the sample subgroups of government and corporate issues, and look at the intensity that the securities are traded within each quarter, we find these number to be very low. In particular for corporate issues, we find that securities are traded on average 4 days per quarter which means that there is a large number of issues that are not traded on a quarterly basis.

With the low trading activity, any statistical measure that attempt to measure liquidity

[19] We tried to estimate the Roll implicit spread estimator. However, the estimates were very noisy, and the estimates came out negative in many cases, which suggest that there are not enough datapoints. The Lesmond et al. (1999) implicit spread estimator is more data intensive, and also require a market index to be estimated, so we did not attempt to estimate it, given the poor results of the less data demanding Roll estimator.

would be highly unreliable and would in most cases not give an accurate picture of the actual liquidity supply. We attempt to calculate an order based measure (bid ask spread), but find that this is particularly difficult to measure for corporate securities as there are very few two sided quote observations. This is mainly due to the low trading activity in corporate bonds and the fact that most trading is conducted over the counter (OTC). For corporate bonds there is not enough observations to calculate the spread series after 2008. For the government securities on the other hand, there are enough two sided quote observations to produce the spread series throughout the sample period, and we see that the spread series increases during the major stress periods in our sample.

Due to the reporting rules at the Oslo Stock Exchange, where all OTC transactions shall be reported to the exchange at least by the end of the trading day, trade-based liquidity measure are more representative measures of liquidity of the Norwegian market. The Amihud Illiquidity ratio (ILR) is such a trade based measure, and is calculated using the total volume transacted both on- and off-market. Due to this, the ILR measure is superior to order-based measures when it comes to measuring liquidity of the Norwegian fixed income market. The low trading activity in individual securities, however, makes it problematic to perform a a more detailed cross-sectional analysis across finer groups of issuers and across various securities characteristics.

A Overview of important events at the Oslo Stock Exchange

1881 First listing of debt securities at the OSE

1988 Oslo Børs Informasjon (OBI) established

1989 Decentralization of the bond market (brokers moved out of the exchange floor)

1993 Electronic registration of quotes and trades

1999 ASTS fully automated trading system launched

2001 Oslo Børs became a limited company, fully owned by Oslo Børs Holding ASA.

2002 Oslo Børs moved onto the SAXESS trading system (NOREX platform)

2007 Oslo Børs Holding ASA merged with VPS Holding ASA to create Oslo Bøers VPS Holding ASA.

2009 Oslo Børs entered into a strategic partnership with London Stock Exchange Group (exited the NOREX alliance)

2010 TradeElect system adapted during the period 2009-2010 for equities and bond trading.

2012 Oslo Børs will adapt the Millennium trading platform which is the platform used by the London Stock Exchange.

B Market structure - TradElect

In general, the market structure in TradElect consists of four levels (shown in figure 11). The *Market* defines the geographical elements of the trading environment; e.g. business calendar and time zone. A market may have many segments connected to it. Oslo Børs' trading will be in the market "OB". A *Segment* is a set of sectors where common features apply to the securities; e.g. tick size and other high level specifications of the trading model. A *Sector* is a set of securities with common behavior; e.g. price monitoring thresholds. A *Security* is the tradable instrument. The segments and sectors details are provided in figure 12.

Figure 11
The Oslo Børs Fixed Income Market structure (Source: Oslo Børs)

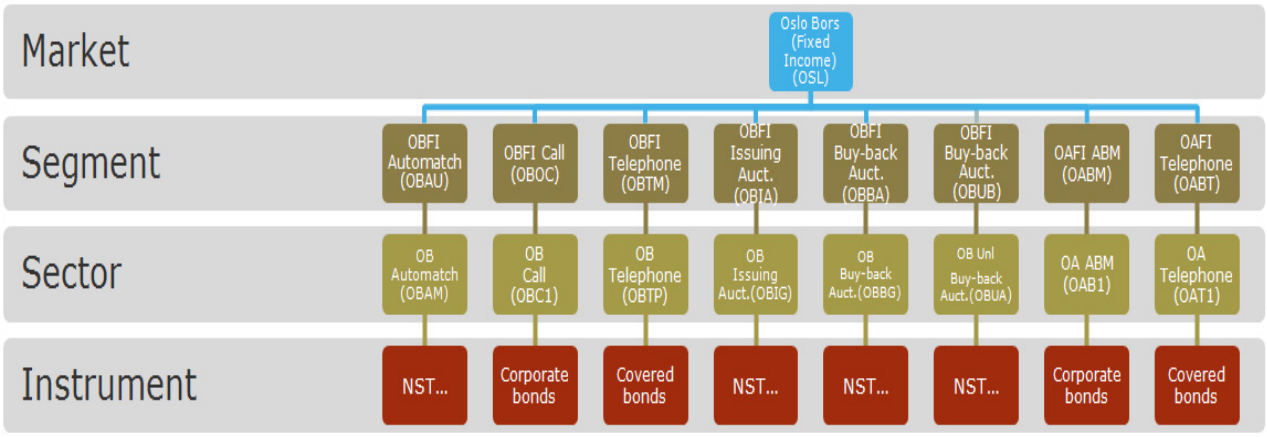


Figure 12
Description of the segments (Source: Oslo Børs)

Segment	Sector (s)	Description / Comment
OBAU	OBAM	**OBFI Automatch (OBAU)** Oslo Børs: The only segment in the fixed income market where there are continuous automatch trading. There is no price monitoring. Static tick size.
		OB Automatch (OBAM) This sector includes bonds that are traded by an opening auction followed by automatch. Historically only government bonds have had automatch trading on Oslo Børs.
OBOC	OBC1	**OBFI Call (OBOC)** Oslo Børs: This segment has an opening auction and a closing auction. In between of the auctions this segment is subject to order entering and manual trade reports.
		OB Call (OBC1) Historically, this segment includes corporate bonds for Oslo Børs.
OBTM	OBTP	**OBFI Telephone (OBTM)** Oslo Børs: This segment is subject to order entering and manual trade reports. Orders are visible to the market with counterparties. No individual trades are visible to the market. When the market closes an average price and traded volume will be published.
		OB Telephone (OBTP) There are currently no bonds issued in this sector. However, this is subject to change overnight.
OBIA	OBIG	**OBFI Issuing Auctions (OBIA)** Oslo Børs: Non-dominant orderbook. This segment is subject to ad hoc issuing auctions. The Dutch Auction Model is used. Only the Central Bank and primary dealers will have access.
		OB Issuing Auctions (OBIG) This sector includes only government bonds. The order book is only active during an issuing auction.
OBBA	OBBG	**OBFI Buyback Auctions (OBBA)** Oslo Børs: Non-dominant orderbook. This segment is subject to ad hoc buy-back auctions. The Dutch Auction Model is used. Only the Central Bank and primary dealers will have access.
		OB Buy-back Auctions (OBBG) This sector includes only government bonds on an ad hoc basis. The order book is only active during a buy back auction.
OBUB	OBUA	**OBFI Unlimited buyback Auctions (OBUB)** Oslo Børs: Non-dominant orderbook. This segment is subject to ad hoc buy-back auctions. The Dutch Auction Model is used. Access for all fixed income members on Oslo Børs.
		OB Unlimited Buy-back Auctions (OBUA) This sector includes only government bonds. The order book is only active during a buy back auction.
OABM	OAB1	**OAFI ABM (OABM)** Oslo ABM: This segment is subject to order entering and manual trade reports. No automatch, opening auction or closing auction.
		OA ABM (OAB1) Historically, this segment includes corporate bonds for Oslo ABM.
OABT	OAT1	**OAFI Telephone (OABT)** Oslo ABM: This segment is subject to order entering and manual trade reports. Orders are visible to the market with counterparties. No individual trades are visible to the market. When the market closes an average price and total traded volume will be published.
		OA Telephone (OAT1) There are currently no bonds issued in this sector. However, this is subject to change overnight.

C Trade types

Figure 13
Trade types (Source: Oslo Børs)

Trade type	Description	Orderbook / Manual	Publishes
AT	Automatic trade	Orderbook	Immediate
UT	Uncrossing Trade	Orderbook	Immediate
O	Ordinary trade	Manual	Immediate
ON	Non-standard settlement	Manual	Immediate
OR	Repo	Manual	Immediate
OU	Outside of opening hours[1]	Manual	Immediate
OE	Exchange granted trade	Manual	Immediate
OH	Other[2]	Manual	Immediate
OL	Odd lot[3]	Manual	Immediate
OK	Ordinary trade delayed publication	Manual	Delayed
DN	Non-standard settlement delayed publication	Manual	Delayed
DR	Repo delayed publication	Manual	Delayed
DU	Outside of opening hours delayed publication[2]	Manual	Delayed
DE	Exchange granted trade delayed publication	Manual	Delayed
DH	Other delayed publication[3]	Manual	Delayed
DL	Odd lot delayed publication	Manual	Delayed

[1] Used for all Ordinary trades that are entered into outside of opening hours (i.e. before 9:00 or after 16:00 on any trading day)
[2] Used for trades where the following trade types are used today: Portfolio trade, derivatives related trade, volume weighted average trade
[3] Used for all odd lot trades, regardless of what the trade represents.

D OBI bond feed variables (Source: Oslo Børs)

MARKET DATA FILE BASED FEED – 15 MIN DELAYED / END OF DAY

DEFINITION OF BOND PRICE RECORDS

Data types
Date : Encoded as YYYYMMDD
Integer : Integer with maximum value 2^{31}
Char(n) : Trimmed string of printable characters (ISO8859-1) with maximum length n.
Decimal(n) : Decimal number with precision n

Field Name	Data Type	Description
Trade Date	Date	Trade Date
Security Id	Integer	Unique number identifying the security
Symbol	char(16)	local code, sometimes referred to as ticker symbol
ISIN	char(12)	ISIN number
ISIN Subcode	char(1)	Field separating non-unique ISIN numbers
Security Name	char(34)	Full name of security
Bid	Decimal(3)	Best bid price at market close
Offer	Decimal(3)	Best offered price at market close
Open	Decimal(3)	First official trade
High	Decimal(3)	Highest official trade price
Low	Decimal(3)	Lowest official trade price
Close	Decimal(3)	Official close
Nom. official volume	Decimal(0)	Official nominal amount traded.
Nom. non-official volume	Decimal(0)	Non-official nominal amount traded. Includes all non-official types of trade

Fields are separated by TABS. Null observations are indicated by an empty field i.e. [TAB][TAB].

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