STAFF MEMO

Liquidity in the Norwegian government bond market

NO. 1 | 2017

SNORRE EVJEN,
MARTE GRØNVOLD
AND KARIANNE
GUNDERSEN

NORGES BANK

Staff Memos present reports and documentation written by staff members and affiliates of Norges Bank, the central bank of Norway. Views and conclusions expressed in Staff Memos should not be taken to represent the views of Norges Bank.

ISSN 1504-2596 (online only)
ISBN 978-82-7553-967-8 (online only)

Liquidity in the Norwegian government bond market

Snorre Evjen, Marte Grønvold and Karianne Gundersen[1]

The aim of government debt management in Norway is to borrow at the lowest possible cost. Ample liquidity in the government bond market will help to lower the government's borrowing costs. In this analysis, we examine a number of indicators that, from various angles, can shed light on developments in liquidity in the Norwegian government bond market. The indicators show that liquidity has improved somewhat in the years after 2012. But similar to developments internationally, liquidity still appears to be weaker than prior to the financial crisis. At the same time, new banking regulation has made banks more solvent and liquid than they were pre-crisis and has likely improved their capacity to provide liquidity in periods of turbulence.

Key words: Government bond market, liquidity, indicators.

1. Introduction

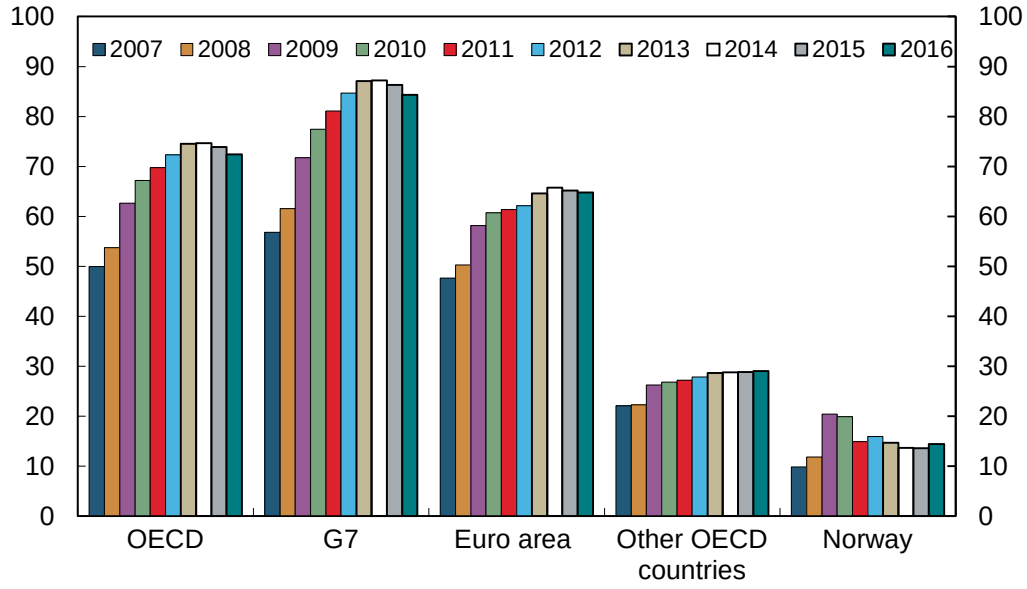
Liquidity in the Norwegian government bond market is often regarded as weak compared with many other western countries, reflecting the small volume of Norway's bond debt outstanding, both in nominal terms and relative to GDP (Chart 1). This reflects the fact that the Norwegian government's financial situation is completely different from that of most other sovereigns.

Most sovereigns borrow to finance their fiscal deficits. Economic weakness in the wake of the financial crisis has put pressure on government finances in many countries. Borrowing increased post-crisis to cover rising budget deficits. However, the Norwegian government does not have fiscal deficits. Substantial oil and gas revenues and returns have over time been transferred to the Government Pension Fund Global (GPFG). The structural non-oil deficit is financed by transfers from the GPFG. Therefore, the Norwegian government does not need to borrow to finance a budget deficit.

The Norwegian government primarily borrows to fund lending from state credit institutions such as the Norwegian State Housing Bank, the Norwegian State Educational Loan Fund and Export Credit Norway and to maintain a cash reserve that is intended to cover current payments from the Treasury. In our view, this is an orderly way to do this: government lending to various state institutions is funded by government borrowing. Borrowing takes place only in Norwegian kroner.

[1] The authors work in the Section for Government Debt Management in the Unit for Market Operations and Analysis. The views and conclusions in this publication are the authors' own and are not necessarily shared by Norges Bank. They must therefore not be reported as the views of Norges Bank.

Chart 1 Central government marketable debt-to-GDP ratios. 2007–2016



Sources: OECD, Statistics Norway and Norges Bank

Even though, strictly speaking, a Norwegian government bond market is unnecessary from a purely fiscal standpoint, there are other benefits of a government securities market. Issuing government securities at both short and long maturities creates a yield curve virtually free of credit risk. The yield curve can serve as a reference for pricing other financial instruments. A government securities market can thus contribute to a better-functioning capital market and financial stability. During the financial crisis, Treasury bills were used in the "swap arrangement", an extraordinary instrument that helped to ensure Norwegian banks long-term funding when international capital markets dried up.[2] This shows that a well-functioning government securities market may be very useful to the authorities in periods of considerable financial turbulence.

Investors will normally require a liquidity premium to invest in illiquid securities. Thus, for the issuer of a security, weak liquidity will entail higher borrowing costs than if its liquidity were good. The aim of government debt management in Norway is to borrow at the lowest possible cost. It is therefore important to ensure the highest liquidity possible. Moreover, it is Norges Bank's objective to promote efficient markets. Well-functioning financial markets contribute to financial stability. Markets are efficient when they are sufficiently deep and competitive so that market prices reflect fundamentals. And for a market, including a government bond market, to be efficient, liquidity must be sufficiently high.

Government bond yields are the price a sovereign must pay to borrow in the global capital market. This price will be determined by a number of factors. We can divide the yield into expected future short-term risk-free interest rates and various risk premiums. Conceptually, we can distinguish between credit risk

[2] See, for example, Norges Bank (2010), page 89.

premiums, term premiums and liquidity premiums. The liquidity premium is the extra borrowing cost owing to weak liquidity. The credit risk premium reflects the risk of a borrower default. This premium will depend on market perceptions of a country's ability to pay, which means that prospects for that country's economic growth and future debt burden are given importance. Government debt management cannot influence these factors. However, the framework for government debt management can, to a certain extent, affect liquidity premiums. The degree of liquidity can, for example, be affected by the volume of the individual bond or bill issue, choice of maturities, selling arrangements, trading venue, degree of transparency and predictability and efforts by primary dealers in the secondary market. We will briefly return to this in Section 2.

It is customary to discuss various dimensions of liquidity.[3] For an investor it is important that a bond can be bought and sold within a short time frame without incurring too high a cost. This dimension of liquidity is called market breadth. A common expression of market breadth is the difference between the bid and ask prices at a given point in time, normally referred to as the "spread". The spread is thus an expression of the transaction costs of a bond trade.

Market depth is often an indication of the ability to trade large volumes without causing substantial movements in a bond's price. This dimension is understandably important for investors who trade large volumes. Market depth may be of somewhat lesser importance for long-term institutional investors who are able to split transactions into smaller amounts and thus spend more time than, for example, hedge funds, which may be interested in being able to make large portfolio adjustments very quickly. Market resilience is a dimension related to market depth. Market resilience is an expression of how long it takes before market breadth and depth return to normal following a disturbance.

Neither liquidity premiums nor other risk premiums are observable. Nevertheless, various indicators can provide an impression of developments in these premiums. A broad set of liquidity indicators can shed light on the various dimensions of market liquidity. In Section 3, we will take a closer look at some of these indicators.

A number of studies have been done previously of liquidity in the Norwegian government securities market. In Hein (2003), liquidity is assessed to be relatively poor compared with other government bond markets. Ødegaard (2017) calculates several measures of liquidity in various segments of the Norwegian bond market on the basis of data from the period 1990–2016. The relative bid/ask-spread measures market breadth and the Amihud illiquidity measure is an indicator of market depth.[4] The study finds that liquidity in the bond markets in general weakened during the banking crisis in the early 1990s and during the financial crisis in 2008. Furthermore, the study shows

[3] See, for example, Hein (2003) and Valseth (2017).
[4] In Section 3, we also estimate these two indicators. However, one difference is that we exclude repurchase agreements (repos) from our turnover data. Using turnover data excluding repos provides, in our view, a more accurate measure of underlying liquidity in the secondary market.

that turnover has been higher in government bonds than in other bonds. Valseth (2017) studies liquidity in the government bond market by calculating various indicators on the basis of data from the period 1999–2015. The results indicate that liquidity was best at the beginning of the analysis period. Market liquidity improved over the past few years to 2015 after a sharp deterioration in connection with the financial crisis in 2008 and some deterioration around the turn of the year 2011–12.

Several studies point out that liquidity in global government bond markets deteriorated during and after the financial crisis and that it is still weaker than in the pre-crisis period. Several causes are likely, and the picture is complex (see, for example, CGFS (2014 and 2016), Bonthron, Johansson and Mannent (2016) and ESRB (2016)). Structural explanatory factors often mentioned in the literature are new financial market regulations and adjustments to banks' business models following the financial crisis. Banks have reduced their bond holdings, which has resulted in less trading and market making. This may reflect banks' preference for assuming less risk and rather giving priority to income sources that are more stable. Banks' adjustments may also be due to stricter regulations. How much of the change in banks' behaviour is due to regulations is uncertain, however. Since the financial crisis, a number of banking regulations have been introduced, some of which are still in the implementation phase. The various regulations may affect liquidity in different ways and may also have different effects on liquidity in various bond market segments.

Among the regulations highlighted is the leverage ratio requirement (CGFS 2014 and Bonthron et al 2016). This is a requirement for the size of banks' equity ratio that is independent of the risk-weighting of banks' assets. Since the requirement is unweighted, it affects government bonds, which have a zero weighting in the calculation of other capital requirements. Another regulation that may affect liquidity is the liquidity coverage ratio (LCR), the requirement to hold liquid assets sufficient to meet the bank's needs if market funding is temporarily unavailable. Banks hold government bonds as part of this buffer. During the build-up phase, this has probably had a temporary positive effect on turnover and liquidity in the market. But once the LCR requirement is met, these holdings will largely remain fixed in banks' balance sheets. This may have a dampening effect on activity and liquidity in the market.

More extensive banking regulation should be viewed in the context of financial stability in a wider perspective. In the years prior to the financial crisis, markets appeared to be highly liquid, and banks had substantial holdings of securities that had been funded by short-term debt. During the financial crisis, liquidity disappeared in many segments of the market, and liquidity was not available when it was most sorely needed. The purpose of banking regulation is to increase banks' liquidity and solvency, which has probably improved their capacity to provide liquidity in periods of financial market turbulence (CFGS 2016, Norges Bank 2016). Impaired market liquidity may thus be seen as the

price that must be paid for more solvent banks and a more resilient financial system.

CGFS (2016) points to the risk of continued liquidity bifurcation. Liquidity has deteriorated most in market segments that have historically been less deep than others, while liquidity is concentrating in the more liquid segments. For benchmark sovereign bonds, liquidity appears little changed, while developments have been weaker for "off-the-run" sovereign bonds and corporate bonds. They also find that the main margin of adjustment is through quantities, rather than prices. Transactions are split into smaller amounts, reducing somewhat the price impact. Trading large amounts has become more time-consuming, as many dealers are reluctant to warehouse large positions.

Furthermore, CGFS notes that trading on electronic platforms with automated execution of transactions has become more widespread. On the one hand, this may have helped reduce trading costs. But these changes may also imply that market prices react more strongly and quickly to new information.

Another factor that according to the literature has affected market liquidity in recent years is the unconventional, expansionary monetary policy conducted in many countries. In recent years, the largest central banks have implemented various programmes for purchasing government bonds, referred to as "quantitative easing". The purpose has been to reduce long-term interest rates to stimulate economic growth and higher inflation. CGFS (2016) notes that unconventional policies have generally supported financial market liquidity, although to different degrees across different market segments. CGFS further argues that unconventional monetary policy has supported bond valuations, reduced volatility and supported bond issuance. The low interest rates have also lowered banks' funding costs related to holding sovereign bonds on their books. Furthermore, portfolio rebalancing owing to very low sovereign yields can raise investor demand for less liquid instruments.

Quantitative easing will probably affect liquidity differently in different stages of the purchasing programmes. For many market participants, quantitative easing may provide a modicum of assurance that they will be able to sell their government bonds without incurring a substantial decline in price. This can lead to higher activity and liquidity in the market in periods when central banks make large purchases. Later, when central banks stop making these purchases, the effect on liquidity may be a different one. In many cases, central banks will hold government bonds on their balance sheets up to maturity. In such cases, a smaller share of the stock outstanding will be available to the other participants for daily trading, resulting in weaker liquidity.

According to Bonthron et al (2016), there are market participants who point out that the Riksbank's purchases of government bonds since February 2015 have had a negative impact on their market liquidity, primarily because the purchased volumes are then not traded in the market.

The main impression from the literature is that it is difficult to state precisely what has driven developments in market liquidity in recent years. Norges Bank conducts semi-annual surveys. Approximately 20 participants are surveyed. To the question of which factors had the greatest effect on liquidity over the past five years, the most frequent response is banking regulation. In the view of most respondents, new banking regulation has impaired banks' capacity to bear risk and act as intermediaries. The survey will be discussed further in Section 2.4.

2. The Norwegian bond market

In this section, a number of features of the Norwegian government bond market will be discussed that are relevant for liquidity in the secondary market, before we examine it in the context of the other segments of the Norwegian bond market.

2.1. The market for Norwegian government bonds

Norwegian government bonds differ from other classes of bonds in Norway in that government bonds are, in practice, without credit risk. Norway's credit rating from all rating agencies is the highest possible. The low credit risk is related in part to the government's ownership of the Government Pension Fund Global (GPFG, also called the "oil fund"). The size of the GPFG corresponds to 15 times the government's marketable debt. Unlike many other countries, the public administration in Norway is a net creditor.

Norges Bank has been given a mandate by the Ministry of Finance to manage government debt. In the mandate there are a number of factors that are of importance for liquidity. The Bank shall seek to maintain a yield curve for government securities with maturities of up to 10 years that can serve as a reference for pricing in the market.[5] This means that priority must be given to issuance in the entire segment up to 10 years. Furthermore, Norges Bank shall meet the government's financing requirement as defined by the Ministry of Finance. The last factor concerns the very limited ability of Government Debt Management to adjust issuance volumes to market liquidity conditions. In isolation, a larger volume outstanding will have a positive effect on liquidity in the secondary market. The higher the volume in circulation, the easier it will be for a market participant to find a counterparty with an opposite interest.

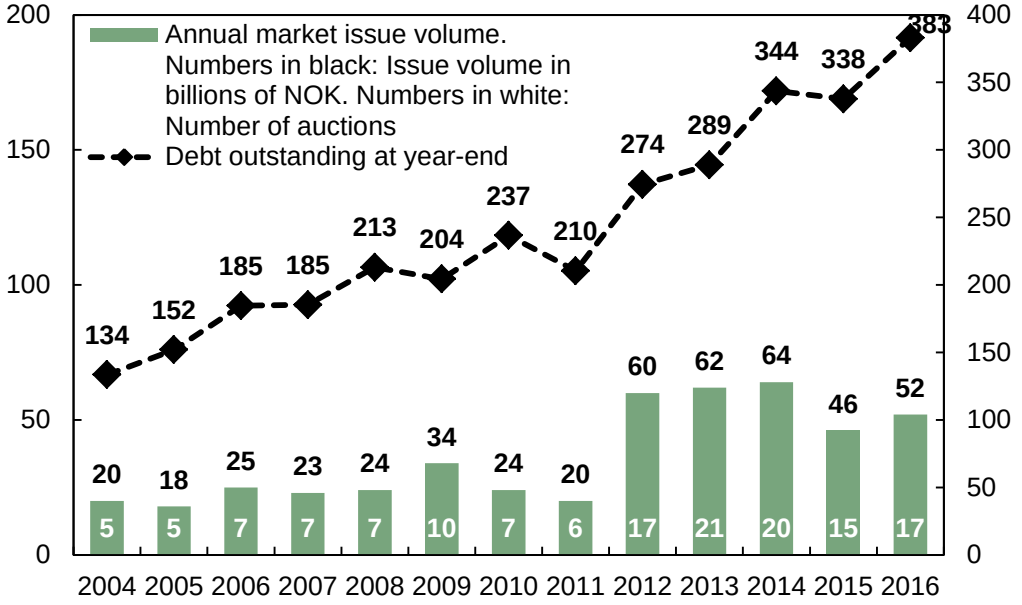
The outstanding volume of government bonds has risen somewhat over the past few years and at year-end 2016 amounted to NOK 383 billion. In the period 2004–2011, just over NOK 20 billion worth of government bonds were issued to the market annually. Between 2011 and 2012, the annual issuance

[5] Two types of government securities are issued in Norway: Treasury bills and government bonds. Treasury bills are zero coupon instruments with a maturity of up to one year. When first issued, government bonds have a maturity over one year and pay an annual coupon. All Norwegian government securities are issued in NOK and quoted on Oslo Børs.

volume tripled (Chart 2.1). The increase is primarily due to the creation of Export Credit Norway and increased lending from the Norwegian Public Service Pension Fund residential mortgage programme. In the period 2012–2014, annual borrowing was around NOK 60 billion, while borrowing over the past two years was approximately NOK 50 billion per year.

Since 2014, a new 10-year bond has been issued each year. Previously, a new 11-year bond was issued every other year. At year-end 2016, there were seven bonds outstanding. The maturity profile is shown in Chart 2.2. In recent years, around half the annual issuance volume was of the new 10-year bond. At year-end 2016, the average weighted maturity of government bonds was 4.9 years.

Chart 2.1 Debt outstanding at year-end (r.h.s.), annual issuance volume (to the market) and number of auctions (l.h.s.). In billions of NOK. 2004–2016



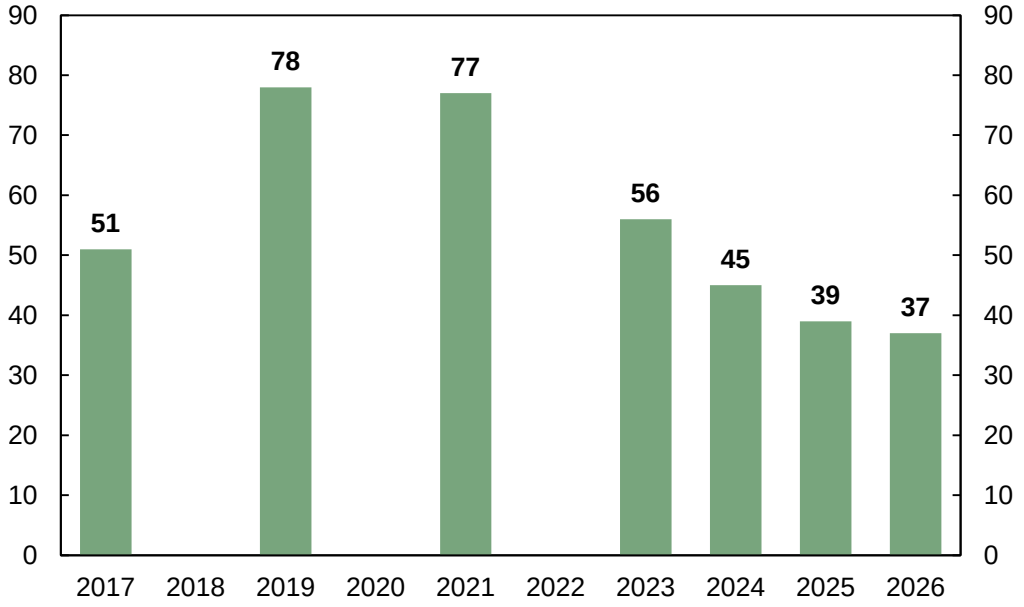
Source: Norges Bank

The maturity profile reflects the mandate, according to which Government Debt Management must maintain a yield curve of up to 10 years. In choosing a maturity profile, an issuer will seek an appropriate balance between liquidity considerations and establishing a yield curve that is as continuous as possible. The practice has long been and continues to be to limit borrowing to a small number of bonds that are gradually built up to a sufficiently large amount. A large outstanding volume of each bond probably makes it simpler for market participants to trade relatively large positions without appreciably affecting prices. In principle, it might be possible to issue even fewer bonds, but in that case with larger volumes per bond. The disadvantage would be the presence of several gaps in the yield curve. Moreover, it is conceivable that the availability of more maturities in the secondary market has some positive effect on liquidity.

To promote the sale of government debt in the primary market and turnover in the secondary market, Norges Bank enters into primary dealer agreements

each year with a number of financial institutions that are members of Oslo Børs.[6] Primary dealers are obliged to quote firm bid and offer prices with appurtenant volumes for Norwegian government securities on Oslo Børs. They have the exclusive right and the obligation to submit bids in ordinary auctions.[7] Other investors must submit bids through one or more of the primary dealers.[8] Primary dealers are able to borrow government securities from the government's own stock under guidelines set forth in the primary dealer agreement.

Chart 2.2 Maturity profile, Norwegian government bonds. In billions of NOK. At year-end 2016



Source: Norges Bank

The repurchase agreement ("repo") programme is important for liquidity in the secondary market. Primary dealers may borrow up to NOK 2 billion of each government security. This borrowing arrangement enables primary dealers to easily and quickly obtain securities when investors seek to purchase Norwegian government securities.

Government Debt Management also conducts bond buybacks. It is regarded as a part of proper market making to enable investors to sell back to the government bonds nearing maturity. This permits a more gradual adjustment of their portfolios. This possibility is assumed to have a positive impact on liquidity in the secondary market.

Norwegian government securities are freely tradable in the secondary market. On Oslo Børs, there is a market for automated trading where all fixed income

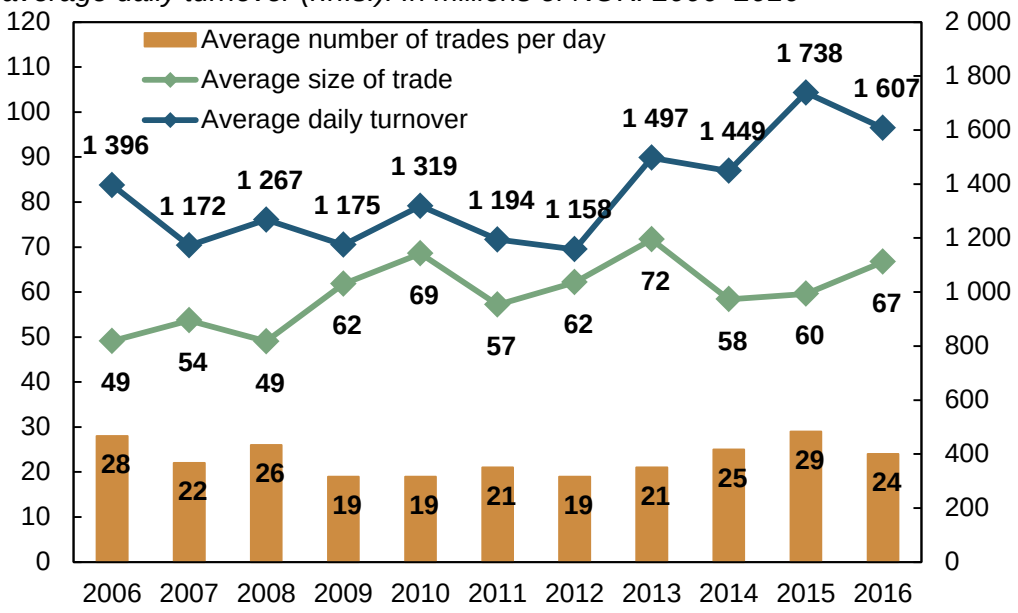
[6] In recent years, there have been four primary dealers of Norwegian government bonds: Danske Bank, DNB, Nordea and SEB.
[7] Norwegian government securities are issued to the market through auctions held on Oslo Børs' electronic trading system. In the auctions, all tenderers receiving an allotment pay the same price ("Dutch" auction or uniform price auction). The method is the same when new bonds are issued and existing bonds are reopened.
[8] However, all fixed income members of Oslo Børs may participate in buyback auctions.

members of the exchange may trade directly using the firm prices quoted by primary dealers. In the government bond market, automated trades have accounted for 7–14 percent of the total recorded trading volume (excluding repo trades). The remaining trades are executed over the telephone or electronic trading platforms.

Turnover has risen in recent years, from NOK 291 billion in 2012 to NOK 407 billion in 2016.[9] The average daily turnover in 2016 was NOK 1.6 billion. In recent years, the tendency has been for somewhat higher turnover in years when a government bond matures (2013 and 2015).

Between 2012 and 2015, annual turnover increased somewhat (Chart 2.3). However, the size of an average trade appears to have remained fairly stable in this period. In 2016, an average of 24 trades of Norwegian government bonds was recorded per trading day. There was turnover in government bonds on each trading over the past four years. In 2016, trading was recorded in all government bonds outstanding on half of trading days. The government bond market therefore appears to be an active market in a Norwegian context, but the relatively low average size of individual trades may reflect limited market depth.

Chart 2.3 Average number of trades per day, average size of trade (l.h.s.) and average daily turnover (r.h.s.). In millions of NOK. 2006–2016



Source: Oslo Børs

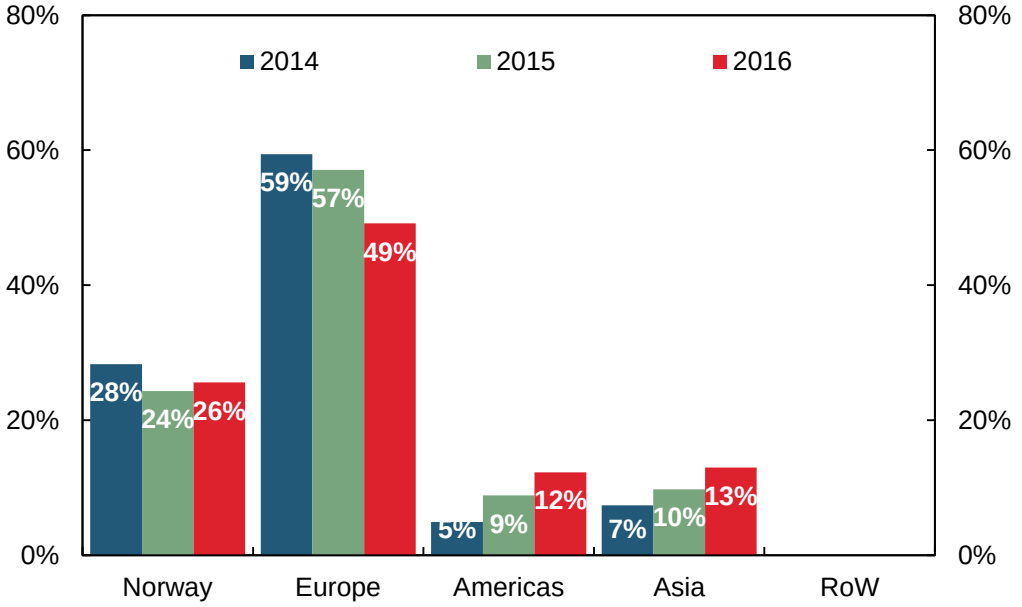
In recent years, Government Debt Management has increased its marketing activities abroad. The purpose has been to inform investors about Norwegian government debt and receive feedback on the unit's own government debt policy. The aim is to increase investor interest in Norwegian government

[9] Turnover by market value, including primary market. The same definition as turnover published on the Oslo Børs website (monthly and annual statistics for bonds).

securities. Over time, this may increase the diversity of the investor base and, it is hoped, demand for Norwegian government securities in the primary and secondary markets.

Primary dealers report turnover in the secondary market for government bonds to Norges Bank on a monthly basis. In 2016, 26 percent of primary dealers' gross turnover was with Norwegian counterparties. European counterparties accounted for around 49 percent of the total (Chart 2.4). In recent years, a rising share of primary dealers' trades has been with counterparties in the Americas and Asia.

Chart 2.4 Government bonds. Gross turnover by region. Reported by primary dealers. Percent. 2014–2016

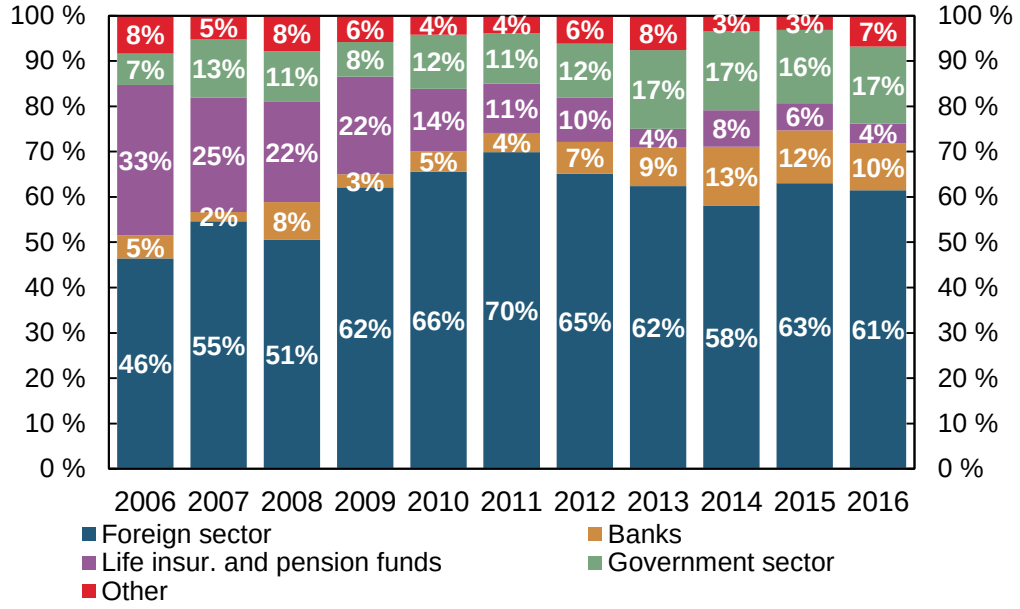


Source: Norges Bank

Foreign investors have traditionally been, and continue to be, the largest holders of Norwegian government bonds. In recent years, foreign investors have held just over 60 percent of the volume outstanding (Chart 2.5). Large Norwegian bondholders are banks. The government itself holds a stock of government securities. Since 2013, this has comprised NOK 8 billion of each bond outstanding. The government's own stock is included in the share held by the government sector (central government and social security funds), which explains why this sector's share is relatively high.

Both ownership and turnover statistics reported by primary dealers indicate that much of the trade in Norwegian government bonds takes place internationally. A broad investor base is favourable for the demand for Norwegian government bonds.

Chart 2.5 Ownership composition, government bonds. Percent. 2006–2016



Source: VPS (Norwegian Central Securities Depository)

2.2. The Norwegian Bond Market

Nordic ABM is an alternative trading venue for the listing and trading of bonds and short-term paper. Nordic ABM is organised and administered by Oslo Børs, but has a less extensive listing process than Oslo Børs. Not all bonds issued in NOK are listed on one of these trading venues, but it is assumed that there is only limited trading in unlisted bonds.

At year-end 2016, bonds were listed on Oslo Børs and Nordic ABM with a total nominal value of NOK 1 619 billion. In addition, bills and certificates were listed with a value or around NOK 92 billion, of which NOK 76 billion is Treasury bills. The largest bond category is covered bonds, followed by government bonds, bonds issued by banks and insurance companies and bonds issued by manufacturing enterprises (Table 2.1 and Chart 2.6).

All fixed income members of Oslo Børs are obliged to report their own trades in listed bonds to Oslo Børs/Nordic ABM.[10] Government bonds were the bond category with the highest turnover in 2016, with NOK 407 billion, followed by covered bonds, with NOK 345 billion. The average size of a government bond trade was somewhat smaller than for covered bonds (Table 2.2).

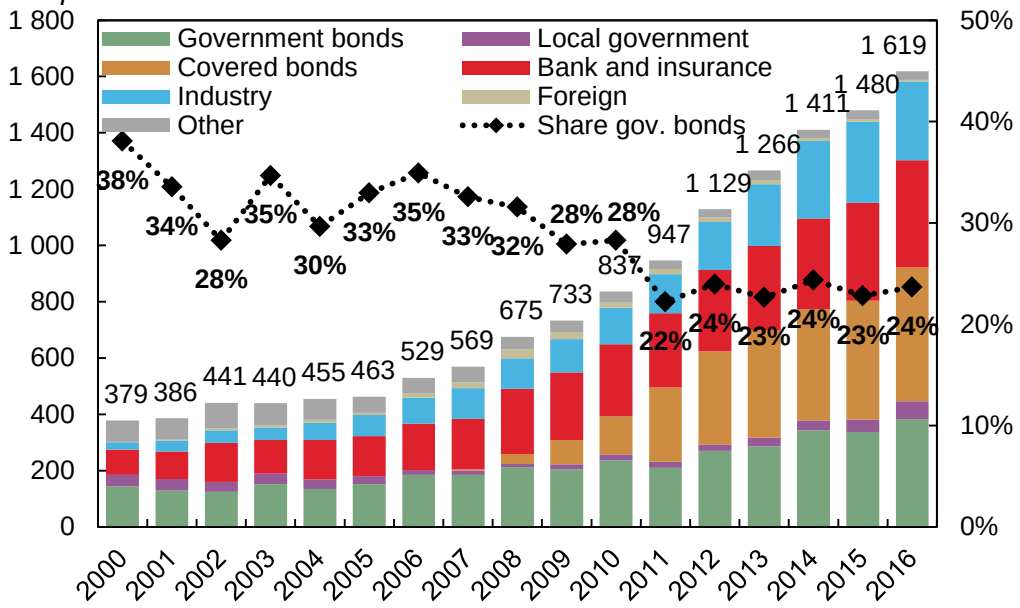
[10] Turnover figures include all trades when one or both parties is a fixed income member of Oslo Børs (double reporting is corrected for). Trades between two participants that are not fixed income members of Oslo Børs are not included in these turnover figures. The exchange's turnover figures also include the primary market and are stated at market value. Reported turnover is therefore higher than the turnover normally reported by Government Debt Management (without the primary market and at nominal value). The turnover figures exclude repo trades.

Table 2.1 Bonds listed on Oslo Børs and Nordic ABM. Year-end 2016.

	Volume outstanding NOK bn	Share of total Percent	Number of bonds	Average size per issue NOK bn
Government bonds	383	23.7 %	7	54.7
Covered bonds	476	29.4 %	206	2.3
Banks and insurance	381	23.5 %	974	0.4
Industry	279	17.2 %	415	0.7
Local government	63	3.9 %	134	0.5
Other	37	2.3 %	90	0.4
Total	***1 619***		***1 826***	***0.9***

Source: Oslo Børs

Chart 2.6 Stock outstanding of bonds (l.h.s.) and government bonds as a share of bonds (r.h.s.) listed on Oslo Børs or Nordic ABM. In billions of NOK and percent. 2000–2016



Source: Oslo Børs

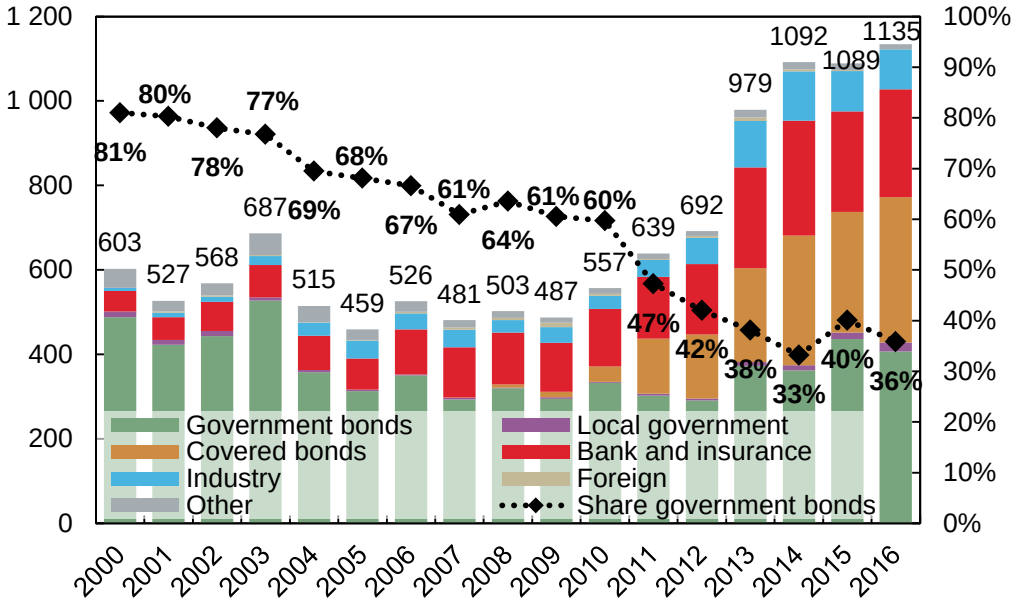
Table 2.2 Turnover of bonds on Oslo Børs and Nordic ABM. Excluding repos. Total for 2016.

	Turnover excl. repos[1] NOK m	Number of trades excl. repos	Average size per trade NOK m	Turnover ratio
Government bonds	407	6 096	67	1.1
Covered bonds	345	4 326	80	0.7
Banks and insurance	255	8 911	29	0.7
Industry	94	9 367	10	0.3
Local government	21	601	35	0.3
Other	12	1 111	11	0.3
Total	***1 135***	***30 412***	***37***	***0.7***

[1] Turnover by market value, including primary market.

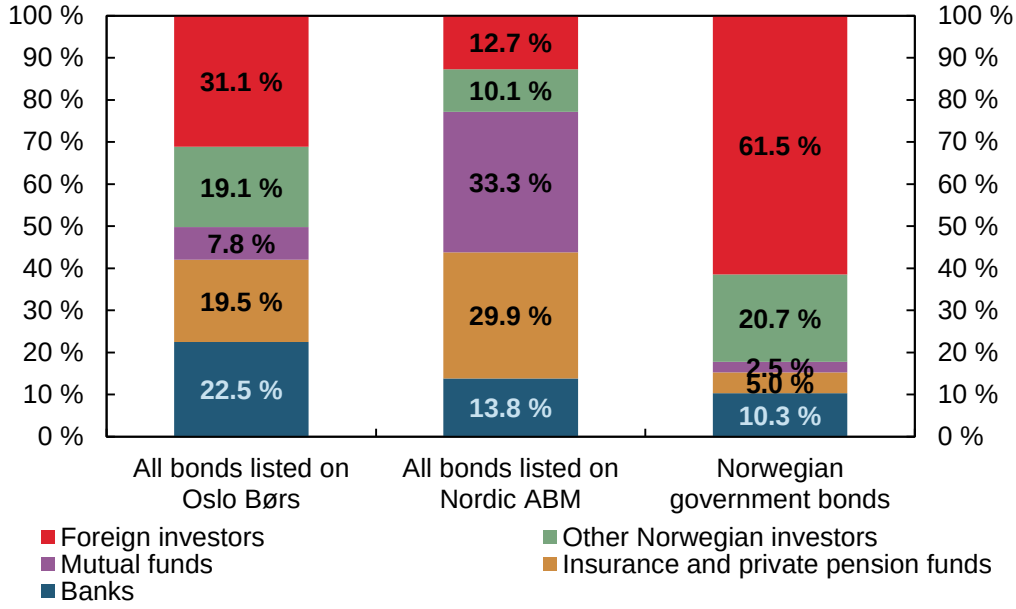
Source: Oslo Børs

Chart 2.7 Turnover in bonds reported on Oslo Børs or Nordic ABM. In billions of NOK. 2000–2016



Source: Oslo Børs

Chart 2.8 Ownership composition of bonds by sector. Percent. Year-end 2016



Source: Oslo Børs

Total turnover on Oslo Børs and Nordic ABM has been rising over the past seven years, primarily driven by higher turnover in covered bonds and bonds issued by banks and insurance companies. Government bonds' share of total turnover has fallen from 81 percent in 2000 to 33 percent at its lowest in 2014. In recent years, government bonds' share appears to have stabilised (Chart 2.7).

Chart 2.8 shows the ownership composition for all bonds listed on Oslo Børs, all bonds listed on Nordic ABM and government bonds. The foreign sector holds a considerably larger share of the government bond market than of the other segments of the Norwegian bond market.

2.3. Covered bonds and government bonds – some observations

Norwegian government bonds and Norwegian covered bonds are both considered to be very safe. It is not obvious which of these is more liquid. Norges Bank's market liquidity survey conducted in January 2017 showed that investors had differing views on this. One reason may be that investors have slightly different ideas about the concept of liquidity. For example, there may be considerable differences between liquidity in normal times and in periods of substantial financial turbulence, which was evident during the financial crisis. Liquidity for Norwegian government bonds is probably higher, relatively speaking, than for the rest of the bond market in a situation of market turbulence (Norges Bank (2016)).

Many different factors may give rise to discrepancies in liquidity between types of bond. Characteristics of the issuer, the currency the bond is issued in and whether the interest rate is fixed or floating may be of importance for the type

of investor that will demand the bond. This may further be of importance for liquidity.

Government bonds constitute the bond category in Norway with the highest turnover and with the largest issues outstanding. A sufficient stock outstanding may make a positive contribution to liquidity. At year-end 2016, the average volume outstanding of individual Norwegian government bonds was approximately NOK 55 billion. By comparison, the average volume outstanding of covered bond issues was NOK 2.3 billion. The volume outstanding of the largest Norwegian "benchmark" covered bond [11] was NOK 13 billion. [12]

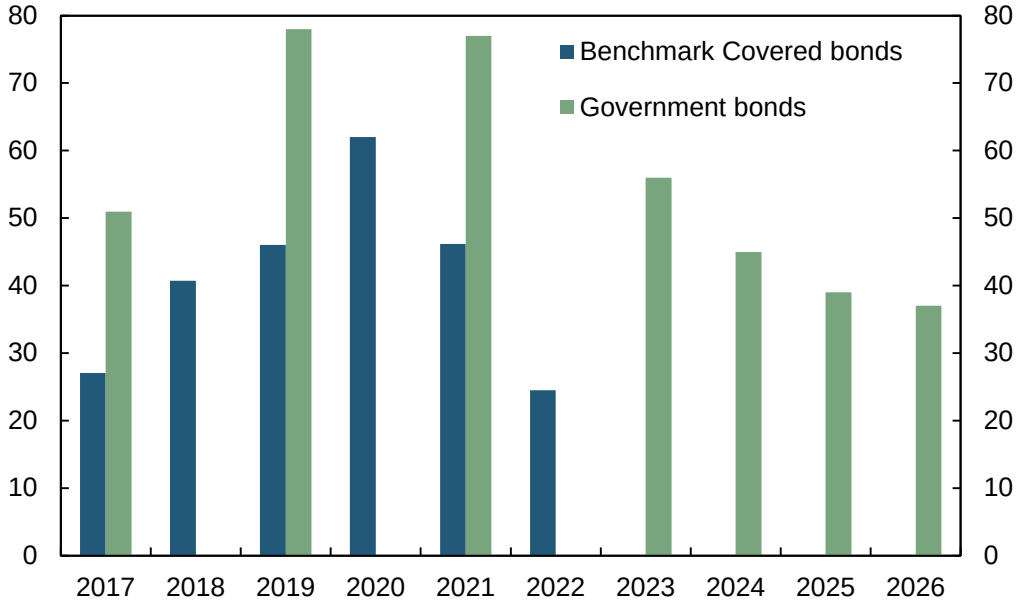
The average volume of a government bond trade is somewhat lower than for covered bonds, but larger than for the other bond categories (Of all bonds and short-term paper listed on Oslo Børs, the instrument with the largest average transaction size is Treasury bills). The average transaction size is relatively low for all bonds, the size of the market taken into consideration. This may be a sign that market participants have limited ability to make large trades, which in turn suggests weak market depth.

A large share of covered bonds is issued with a floating rate, while Norwegian government bonds are issued with a fixed rate. [13] It is possible that this distinction gives rise to differences in liquidity. Investors differ in their preferences and their willingness to hold various fixed income instruments "on their own books". Banks seeking to minimise interest rate risk in their portfolios are probably more willing to hold floating-rate bonds. Long-term investors, such as pension funds, may be more interested in fixed-rate bonds, while more short-term and active participants such as banks prefer floating-rate bonds. This may reduce trading and liquidity in fixed-rate bonds.

Another difference between covered bonds and government bonds is average residual term to maturity. All "benchmark" covered bonds mature before or during 2022, while the maturities of nearly half of the outstanding volume of Norwegian government bonds are longer than this. Liquidity indicators show signs of better liquidity for bonds with shorter maturities (Section 3). It is possible that more short-term investors largely trade in short bonds, while longer bonds are traded by more long-term and less active investors. Low liquidity need not mean low demand for the bond. Even though longer bonds may possibly be less liquid than shorter bonds, ample demand has been noted for long bonds in the primary market.

[11] Covered bonds that are on the Oslo Børs Covered Bonds Benchmark List. In June 2014, Oslo Børs introduced a benchmark list for covered bonds. The covered bonds on this list must meet certain criteria, and are subject to continuous indicative quotation.
[12] Covered bonds are listed on Oslo Børs or Nordic ABM. For covered bonds listed on Oslo Børs, the average was NOK 3.1 billion and for covered bonds defined as "benchmark", the average was NOK 6.7 billion.
[13] Of the "benchmark" covered bonds on Oslo Børs, which accounted for around half of the outstanding stock of Norwegian covered bonds at year-end 2016, 86 percent (volume-weighted) pay a floating rate.

Chart 2.9 Maturity structure for benchmark covered bonds and government bonds. In billions of NOK. 2017–2026



Source: Oslo Børs

2.4. Survey of Norwegian market participants

Norges Bank has devised a survey of liquidity in the Norwegian bond and short-term paper market that is sent out to Norwegian market participants, to be conducted every six months. To date, the survey has been conducted twice: in September 2016 (regarding liquidity in the first half of 2016) and in January 2017 (regarding liquidity in the latter half of 2016).

Participants were surveyed about the liquidity of six different categories of Norwegian securities:

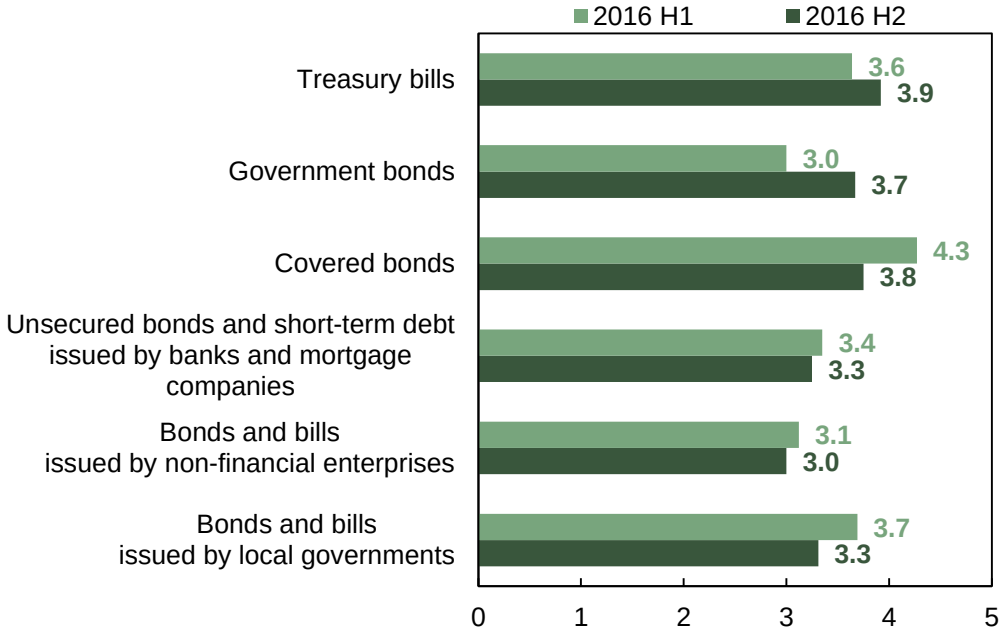
- Treasury bills
- Government bonds
- Covered bonds
- Unsecured bonds and short-term paper issued by banks and mortgage companies
- Bonds and short-term paper issued non-financial enterprises
- Bonds and short-term paper issued by local governments

In both surveys, 17 different market participants responded, both price-setters and investors. They were asked to assess liquidity in the Norwegian market on a scale from 1 to 5, where 1 means poor, 3 means average and 5 means very good. Chart 2.10 shows the responses to the two surveys.

In the survey conducted in September 2016, covered bonds were the bond category assessed with the best liquidity (score 4.3), while government bonds were assessed as the bond category with the lowest liquidity (score 3.0). In the survey conducted in January 2017 Treasury bills were assessed as most

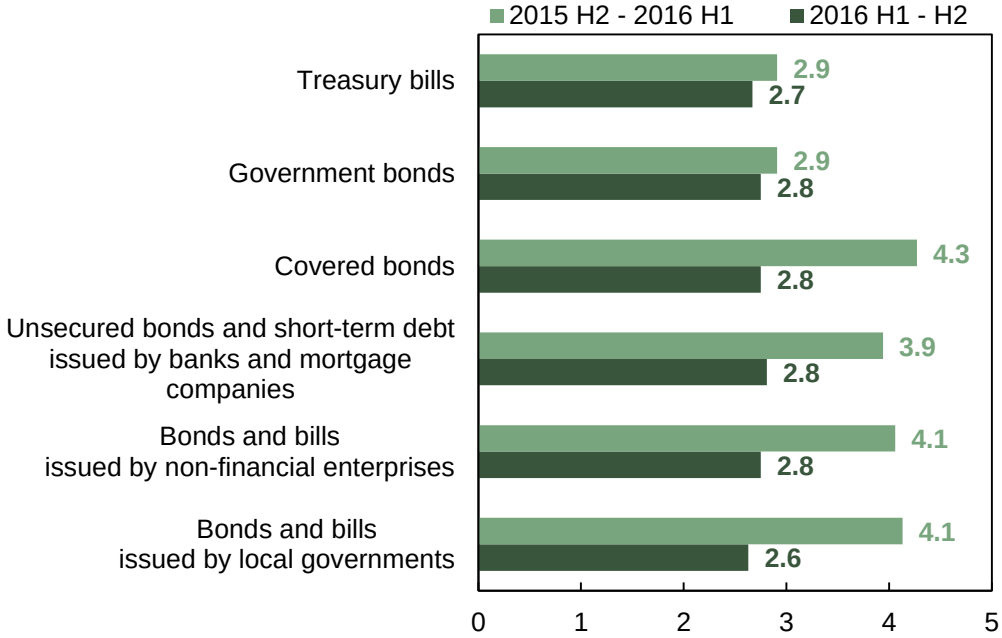
liquid (score 3.9), closely followed by covered bonds (3.8) and government bonds (3.7).

Chart 2.10 Respondents' assessment of market liquidity in 2016 H1 and 2016 H2. Average of responses. Scale: 1 (poor) – 2–3 (average) 4–5 (very good)



Source: Norges Bank

Chart 2.11 Respondents' assessment of changes in market liquidity between 2015 H1 and 2016 H1 and between 2016 H1 and 2016 H2. Average of responses. Scale: 1 (poorer) – 2–3 (unchanged) – 4–5 (much better)



Source: Norges Bank

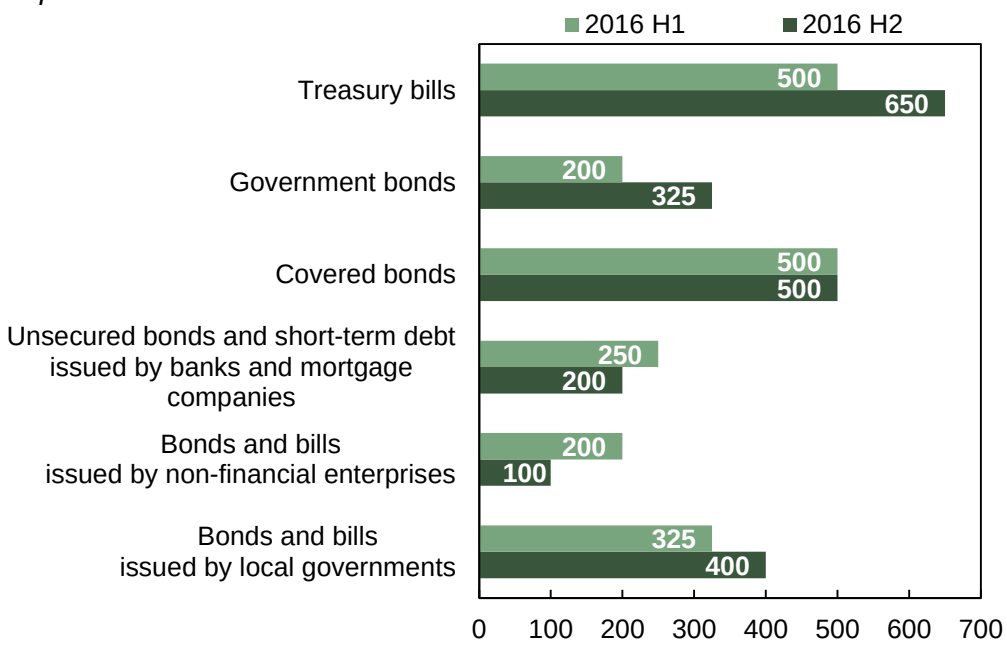
Respondents were asked to assess changes in liquidity since the previous half year on a scale from 1 to 5, where 1 means much poorer, 3 means unchanged and 5 means much better. Chart 2.11 shows the responses in the two surveys.

In the survey conducted in autumn 2016, respondents were of the view that liquidity for Treasury bills and government bonds were broadly unchanged on the previous six months, while they assessed it as better in all the other categories. In the survey conducted in January 2017, respondents were of the opinion that liquidity for all bond categories was marginally poorer, but there was little difference across categories. The responses are somewhat surprising, since the responses to the first question indicate an improvement for Treasury bills and government bonds.

In the survey conducted in September 2016, respondents were also asked "What volume can be traded in the secondary market without causing appreciable price movements?" In the survey conducted in January 2017, this question was revised to "In your assessment, what volume of a single bond can be traded in the course of a day in the secondary market without causing appreciable price movements?". There was considerable divergence in responses to this question and some extreme values seemed improbable. We have therefore chosen to show median values of the responses in Chart 2.12.

Respondents are of the opinion that Treasury bills and covered bonds can be traded in the largest volumes without causing appreciable price movements, which indicates that these categories in the Norwegian market show the best market depth. Considerably smaller volumes of government bonds (and other categories of bonds) can be traded without causing price movements. The volumes that respondents report can be traded are substantially much larger than the actual size of an average trade in all categories.

Chart 2.12 Respondents' assessment of the volume that can be traded in the secondary market without causing appreciable price movements. Median of responses. In millions of NOK



Source: Norges Bank

Respondents were also asked about the factors that in their opinion affect liquidity in the Norwegian bond market. Regulations and lower capacity to bear

risk on banks' own books are mentioned by many respondents. Some respondents reported that liquidity is impaired around the end of quarters or the year. Some respondents also reported that floating-rate bonds are more liquid than fixed-rate bonds.

3. Liquidity indicators

Market liquidity is a multifaceted concept. No single indicator can measure all dimensions of liquidity. It is therefore necessary to use several indicators to shed light on the market situation, and all indicators have their strengths and weaknesses. In this section, we look at three different indicators: turnover ratio, relative bid/ask spread and the Amihud illiquidity measure. We examine developments in the turnover ratio in Norway compared with other government bond markets. We look at the relative bid/ask spread and the Amihud illiquidity measure for all government bonds and for government bonds by maturity segment. This is intended to take into account the different characteristics of government bonds with different residual terms to maturity (Valseth (2017)).

The turnover ratio, the relative bid/ask spread and the Amihud illiquidity measure are well-established indicators of market liquidity and are widely used in research and reports.[14] There are indicators that can provide a more detailed picture of liquidity in the government bond market, but they require greater frequency of data. One of the advantages of the indicators used in this article is that they do not require data with a greater frequency than daily, making it possible to create time series for the indicators that extend further back in time.

3.1. Turnover ratio (market depth)

The turnover ratio is defined as the total volume traded in a year divided by the average volume outstanding in the same period (cf Lavoie (2004)). The turnover ratio can then be interpreted as the share of the volume outstanding traded in the secondary market in the course of a year, or how many times (an amount equal to) the total volume is traded in the course of a year.

Table 3.1 compares measures of market size and the turnover ratio in different countries in 2016. The table shows that the Norwegian market is relatively small compared with the other Nordic countries and New Zealand, in terms of both total turnover and volume outstanding in 2015. Norway's debt level is low compared with many other countries. Small markets are generally assumed to be less liquid than large markets. Expectations that a market is illiquid owing to its size may contribute to low turnover and thus be self-reinforcing. Nevertheless, it is clear that a larger volume outstanding does not necessarily lead to a higher turnover ratio. For example, Sweden's volume outstanding is smaller than Finland's in euro terms but Sweden's turnover ratio is higher.

[14] See, for example, Ødegaard (2017), Valseth (2017) and Finanstilsynet (2016).

Table 3.1: Comparison of market size and turnover ratio in 2016

	Norway	Sweden	Finland	Denmark	New Zealand
Average volume outstanding in local currency	NOK 371bn	SEK 622bn	EUR 84.5bn	DKK 721bn	NZD 62bn
Average volume outstanding in billions of EUR[1]	40.8	64.9	84.5	96.9	41.2
Total turnover in local currency	NOK 314bn	SEK 2 662bn	EUR 131.9bn	DKK 601bn	NZD 172bn
Total turnover in billions of EUR[1]	34.6	236.0	131.9	80.8	113.0
Turnover ratio	0.85	3.64	1.56	0.83	2.77

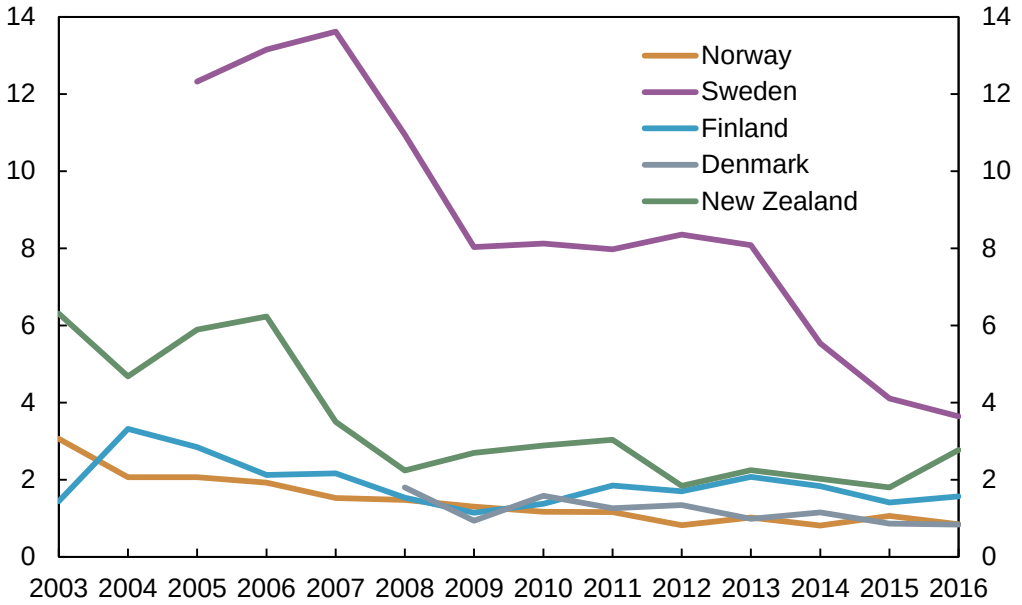
[1]*All debt issued in a currency other than the euro is translated into euros at the exchange rate at year-end 2016.*

Sources: See appendix "Data used in calculating turnover ratios". Foreign exchange rates are from Thomson Reuters.

Many structural factors other than size may be of importance for turnover and the turnover ratio. Investor composition and the size and maturity of the individual bond will likely be significant. Detailed statistics for different countries' investor bases are not readily available. Foreign investors hold approximately 62 percent of the stock of Norwegian government bonds. In summer 2015, the corresponding figures for Finland, Denmark and New Zealand were 85, 47 and 70 percent, respectively (see OECD (2016)). As mentioned above, it is not certain how the degree of foreign ownership affects liquidity in a market. The more holders of Norwegian bonds there are, the easier it will be to find a counterparty for someone wanting to buy or sell. Therefore, a bondholder structure that is as widely dispersed as possible will normally be good for liquidity. On the other hand, it is important that a large share of investors are not typical "hold-to-maturity" investors. The statistics reveal nothing about this. The average maturity of government debt also varies considerably across countries. The maturity of Norway's debt is relatively short compared with other OECD countries, which should perhaps, in isolation, indicate somewhat better liquidity (see Galliani, Petrella and Resti (2014)).

Chart 3.1 shows developments in the turnover ratio in Norway, Sweden, Denmark and Finland in the period 2003–2016, all of which have experienced largely falling turnover ratios in this period. For Sweden, which has shown a considerably higher turnover ratio than the other countries from the beginning, the decline in the turnover ratio is more pronounced. To a certain extent, this supports the view that liquidity in international markets in general has deteriorated since the financial crisis.

Chart 3.1 Turnover ratio in various countries. 2003–2015



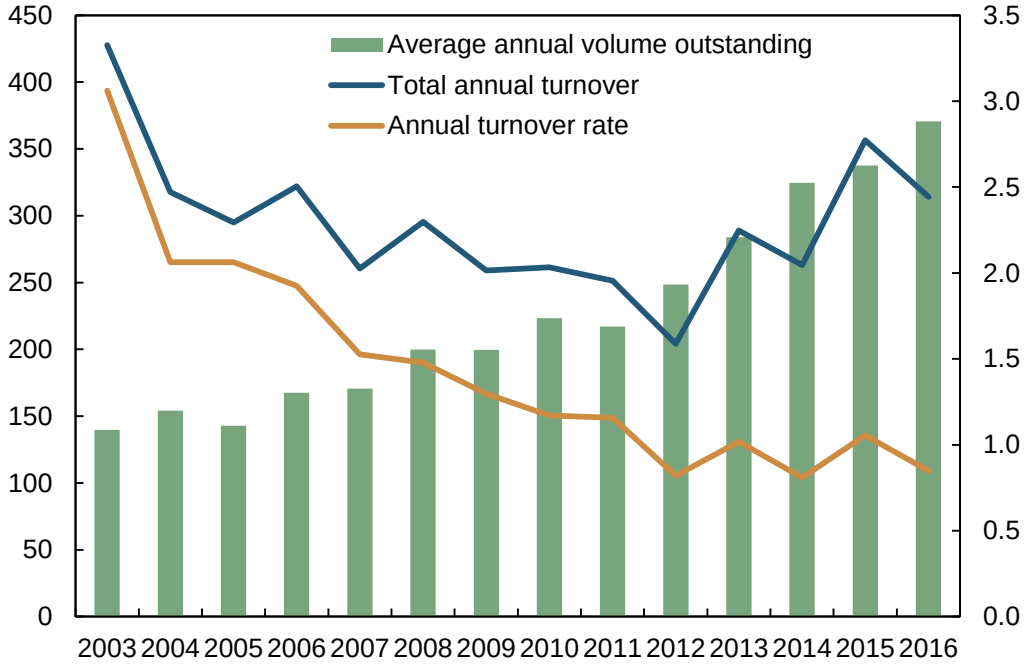
Source: See appendix “Data used in calculating turnover ratios”

In this group of countries, Norway shows the lowest turnover ratio through nearly the entire period. This supports the perception that the Norwegian government bond market is less liquid than many other government bond markets. At the same time, the differences between the turnover ratio in the Norwegian market and other government bond markets have narrowed in many cases. Even though the turnover ratio in Norway has been declining through the period, the fall appears to be less pronounced than in many other markets.

In the Norwegian bond market, the turnover ratio fell from around 3.1 to 1.1 in the period 2003–2015. Between 2003 and 2012, total turnover fell, while the volume outstanding rose moderately (see Chart 3.2). Both of these factors drive down the turnover ratio. Between 2012 and 2015, the turnover ratio was more stable. In the same period, both the volume outstanding and turnover increased considerably. Even though the volume outstanding increased, turnover rose to a sufficient degree to maintain the turnover ratio at approximately the same level since 2012.

The turnover ratio provides an indication of the marketability of Norwegian government bonds relative to other government bonds, but is based on data for what *has* previously *been* traded and may therefore be influenced by some periods of very high turnover. The turnover ratio describes liquidity *ex post* and not *ex ante.* For that reason, it does not necessarily provide a picture of how easily an investor can trade a government bond and what this would cost. For an insight into that dimension of liquidity, we will look at the relative bid/ask spread.

Chart 3.2 Volume of Norwegian government bonds outstanding (left-hand scale, in billions of NOK), turnover (left-hand scale, in billions of NOK) and turnover ratio (right-hand scale). 2003–2015



Sources: Oslo Børs and Norges Bank

3.2. Relative bid/ask spread (market breadth)

3.2.1. The relative bid/ask spread

In a perfect and liquid market, a security can be immediately converted into cash, irrespective of the size of the trade and without any transaction costs. Transaction costs are an important indicator of market liquidity. The higher transaction costs are, the poorer the market breadth. A measure of transaction costs is the relative bid/ask spread, defined as:

$$Spread_t = \frac{p_t^a - p_t^b}{p_t^m} \times 100 \qquad (3.1)$$

where p_t^a and $\mathrm{p}_\mathrm{t}^\mathrm{b}$ are the best ask and bid prices, respectively, at time t, and where the mid-price, $\mathrm{p}_\mathrm{t}^\mathrm{m}$, is the average of p_t^a and $\mathrm{p}_\mathrm{t}^\mathrm{b}$.

In the calculation of the relative spread, we have used daily price data from the period September 1999 to December 2016. The ask and bid prices are the best prices on Oslo Børs at market close. After calculating a daily spread for each government bond, we find a daily average for all government bonds and calculate an average for all government bonds in the quarter. This then results in an unweighted relative bid/ask spread for all government bonds. The relative bid/ask spread can be interpreted as the cost of executing a trade measured as a percentage of the mid-price.

A weakness of the relative bid/ask spread as a liquidity indicator is that it is possible that transaction costs for large volumes are higher than indicated by

the relative bid/ask spread, since prices are quoted only up to a certain volume on Oslo Børs. For large volumes, it is therefore possible that the relative bid/ask spread underestimates transaction costs and consequently gives the impression that liquidity in the market is better than it actually is. On the other hand, it is also possible that primary dealers quote a larger spread on the exchange than they would have done for larger volumes in the telephone market to ensure bargaining space for themselves when an investor requests bid and ask prices. The relative bid/ask spread is thus not an exact measure of transaction costs in the market, but it is not obvious if the measure over- or underestimates actual transaction costs. The relative bid/ask spread is also primarily a measure of developments in market breadth.

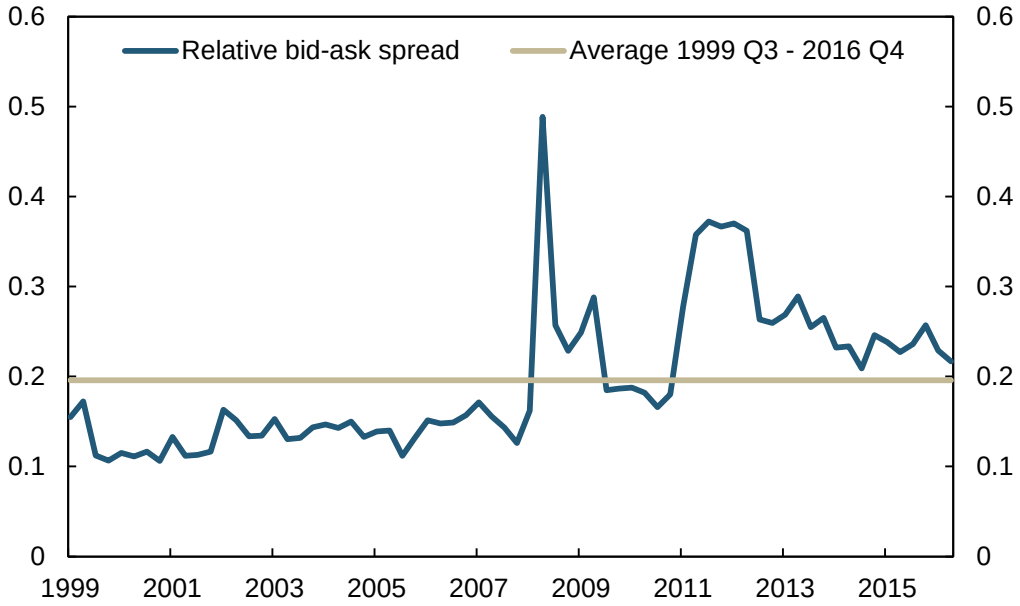
3.2.2. Results

The relative bid/ask spread indicates that liquidity in the government securities market deteriorated markedly during the financial crisis in 2008 and during the euro crisis in 2011-2012 (Chart 3.3). Even though transaction costs have fallen since 2012, they have not returned to their pre-2008 levels. In the period 1999 Q3 – 2008 Q2, transaction costs averaged 0.14 of the mid-price, while in the period 2008 Q3 – 2016 Q4 they averaged 0.26 percent of the mid-price. That is to say, transaction costs have risen by around 0.1 percent of the mid-price since the financial crisis.

The declining level of interest rates over the past 20 years has, in isolation, contributed to a slightly narrower relative spread through the period. When bond yields fall, prices rise. The denominator in the relative spread has edged up in the period as a whole. Another factor that will affect the relative spread over time, is the price quoting requirements in the primary dealer agreements. The agreements specify requirements maximum spreads between bid and offer prices for a specified minimum volume. The requirements have been adapted to market conditions, and they have varied through the years (Chart 3.4).[15] The chart shows that the requirements for maximum price spread were marginally lower over the past two years than the average for the period 1999-2007. Nevertheless, the relative spread was higher during these years than in in pre-crisis years.

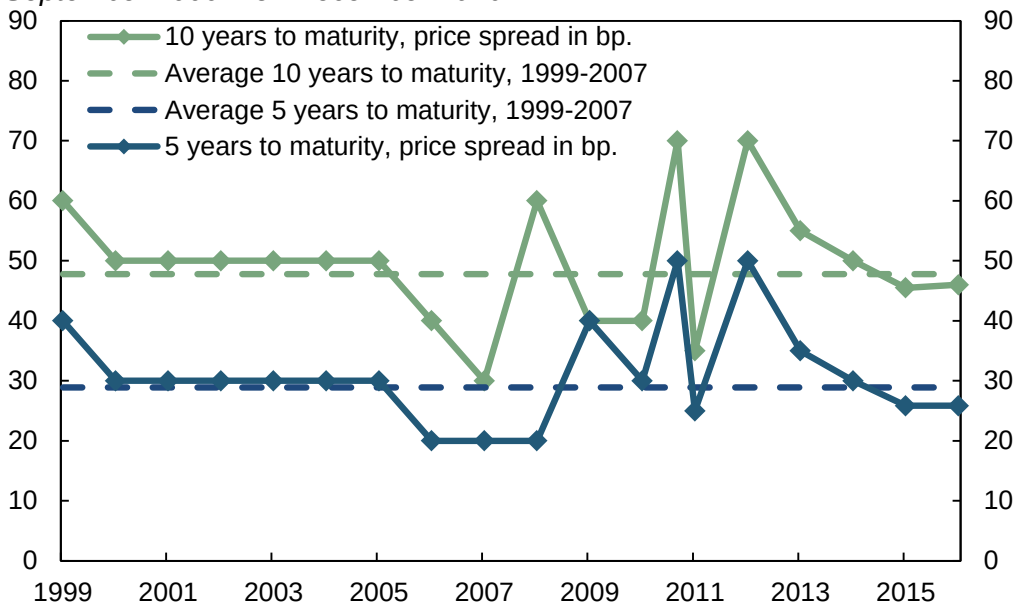
[15] From 2015, the price spread requirements were specified in basis points and not in price points. For 2015 and 2016, basis points have been converted into price points by multiplying the maximum permitted yield spread (5 basis points) by the modified duration for a bond with between approximately five and 10 years to maturity.

Chart 3.3 Relative bid/ask spread. Government bonds. Percent. 1999 Q3 – 2016 Q4



Sources: Oslo Børs, Thomson Reuters and Norges Bank

Chart 3.4 Norges Bank's requirements for primary dealer price quoting on Oslo Børs for bonds with 10 and 5 years to maturity. Price points. 6 September 1999 – 31 December 2016



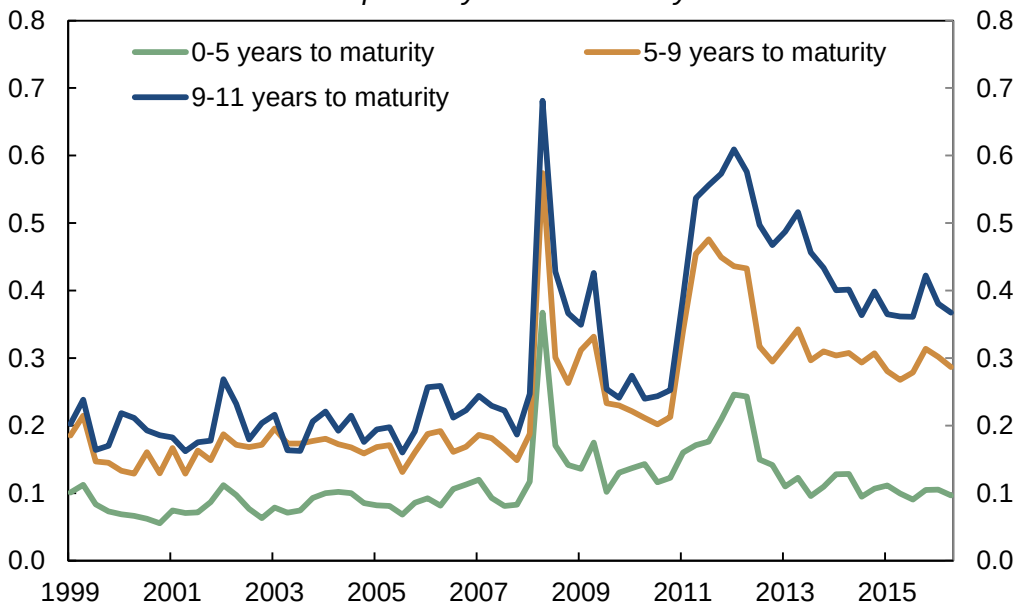
Source: Norges Bank

3.2.3. Relative spread by term to maturity

Chart 3.5 shows developments in the relative bid/ask spread for groups of government bonds by term to maturity. In general, the relative bid/ask spread for bonds with a longer term to maturity is wider than for bonds with a shorter term to maturity through the entire period. Transaction costs for bonds with a longer term to maturity also rise to a greater degree in 2008 and in 2011–

2012. This may reflect less willingness to sell and greater willingness to buy Norwegian government bonds in periods of considerable market turbulence.

Chart 3.5 Relative bid/ask spread by term to maturity. Government bonds.



Sources: Oslo Børs, Thomson Reuters and Norges Bank

A possible contributory factor to lower liquidity in the longer segment may be that the volume outstanding over time has been smaller for bonds with long maturities. This reflects the issuance strategy whereby new bonds have been issued with a long maturity and then built up over several years through reopenings. As the term to maturity of the individual bonds has shortened, the volume outstanding of these bonds has therefore increased substantially. Bonds with lower volumes outstanding are assumed to be less liquid than bonds where volumes outstanding are higher.[16]

The difference in transaction costs for the various government bond segments has also risen. Transaction costs for government bonds with 0–5 years to maturity have returned to the same level as prior to 2008, while transaction costs for government bonds with 5–9 years to maturity and 9–11 years to maturity remain appreciably higher than they were pre-crisis. This implies that the difference in average transaction costs for the two different groups has increased.

One reason for the widening relative spread for the various segments may be the falling interest rate level following the financial crisis in 2008. Norwegian government bonds are issued virtually at par, ie the coupon rate is approximately equal to the market rate and the price is close to 100 percent. When the interest level falls, the market rate or yield on the bond will be lower than the coupon rate and the price will be higher than 100 percent. Bonds with

[16] Since 2014, new government bonds have been issued with 10-year maturity. In the years prior to this, new bonds were most often issued with 11-year maturity. The 10-year bonds, which have been issued annually since 2014, are built up relatively quickly for liquidity reasons.

9–11 years to maturity therefore tend to be those that since the financial crisis are priced closest to par, because they are bonds that were issued most recently.[17] It is therefore possible that the effect of the falling interest rate level is less pronounced on the relative spread for this segment than for bonds with 5–9 years to maturity or 0–5 years to maturity. It is possible that this maturity segment better represents actual developments in liquidity in the Norwegian government bond market.

3.3. Amihud illiquidity measure (market depth)

3.3.1. The Amihud illiquidity measure

To investigate in detail developments in the depth of the government bond market, we have also calculated the Amihud illiquidity measure. This indicator expresses how trading volume impacts prices in the market. To gauge this impact, Amihud (2002) uses an illiquidity measure, ILLIQ, which is defined as:

$$ILLIQ_{iT} = 10^9 \left[\frac{1}{D_{iT}} \sum_{t=1}^{T} \frac{|R_{it}|}{VOL_{it}} \right] \quad (3.2)$$

Where D_{iT} is the number of days with data for security i in a given time period T. R_{it} is the return on security i in the period t and is defined as the difference in the mid-price, P_t^m, from day to day, or $R_{it} = \frac{P_t^m - P_{t-1}^m}{P_{t-1}^m}$. VOL_{it} is the daily trading volume of security i in period t. In the calculation of ILLIQ, daily data have been used to calculate an ILLIQ for each security. We then find the average for all government bonds outstanding in the relevant quarter to obtain a value for the entire market.

In the calculation of ILLIQ, daily data for volume traded per security on Oslo Børs and daily data for closing prices from Oslo Børs have been used. In the calculation we have used the day's last quoted bid and ask prices to then calculate a mid-price. We could have also used the last traded price on Oslo Børs instead of the mid-price.[18]

ILLIQ may be interpreted as the daily price response for each NOK billion traded. The higher ILLIQ is, the greater the price response per NOK billion traded and the lower the liquidity in the market. It is not always useful to interpret the *levels* of ILLIQ directly, and we focus instead on *developments over time* and developments for a maturity segment relative to other maturity segments.

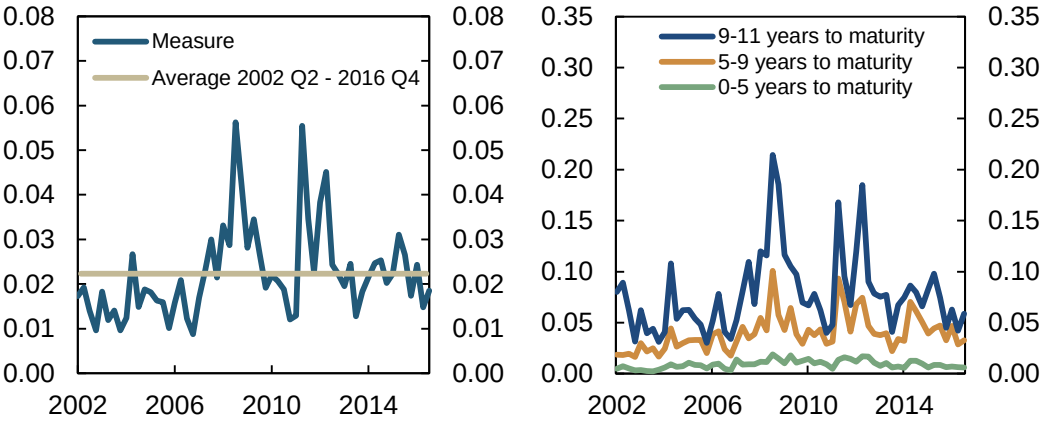
[17] See footnote 16.
[18] Using the last trading price instead of the mid-price might better represent the actual price change from a market trade, but the definition of last trading price has varied over time. To obtain a consistent data series, we have used the mid-price.

A weakness of this indicator is that it is not necessarily the case that day-to-day price changes are driven only by trades on the exchange. Price changes may, for example, also be driven by international interest rate movements. On days with very low or no turnover, factors other than trading volume must obviously have given rise to any price movements. We have therefore chosen to omit observations where a government bond's daily trading volume is lower than NOK 5 million. Regardless, the indicator can provide an overall picture of how prices in the market respond to government bond trades.

3.3.2. Results

Chart 3.6a shows that ILLIQ was considerably higher around the time of the financial crisis in 2008 and the euro crisis in 2012. This implies that it is more difficult to buy or sell a volume of a certain size without causing appreciable price movements in periods of market turbulence. In recent years, this indicator has been slightly higher than it was in the early 2000s. It appears to be consistent with developments in the relative bid/ask spread. Developments have also been somewhat more volatile after 2008.

Charts 3.6 a and b Amihud illiquidity measure for all government bonds and by term to maturity. Government bonds. 2002 Q2 – 2016 Q4



Sources: Oslo Børs, Thomson Reuters and Norges Bank

Chart 3.6 b shows the Amihud illiquidity measure for the maturity segments 0–5 years, 5–9 years and 9–11 years. The calculations show that the price impacts are most pronounced the longer the maturity. The chart shows that price movements for bonds with 0–5 years to maturity have been broadly at the same level for the entire period. The measure for bonds with 5–9 years and 9–11 years to maturity has varied considerably. The levels are also somewhat higher than they were prior to the financial crisis.

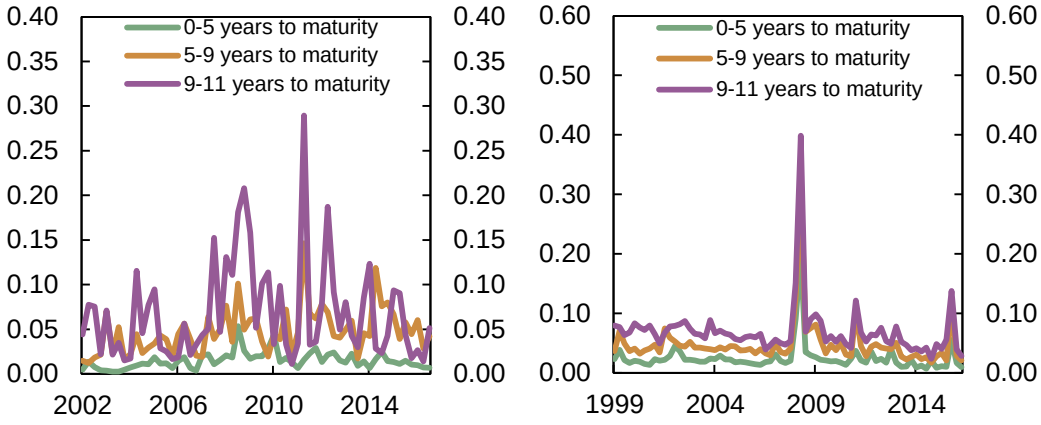
3.4. Liquidity risk

Investors not only make decisions on the basis of the current state of liquidity, but they are forward-looking and also take account of what they believe the future state of market liquidity will be. Liquidity risk may be defined as the risk that liquidity will be reduced in the future, so that investors must trade at a higher cost than they do today. One way to estimate liquidity risk is to

calculate the standard deviation of the Amihud illiquidity measure and the relative spread. This provides a picture of how market depth and breadth have varied previously and in periods of considerable market turbulence (Danmarks Nationalbank (2013)). It may indicate how market liquidity will react in the event of considerable market turbulence in the future.

Charts 3.7 a and b suggest that liquidity risk measured using this method has risen in periods when market liquidity has deteriorated, that is to say during the financial crisis and in the period 2011–2012. In other words, high volatility has correlated with high levels of the liquidity indicators. We also note that transaction costs (measured by the relative spread) appear to be less volatile than market depth. This reflects Norges Bank's requirement for primary dealers to quote prices on Oslo Børs. Limits for price spread (transaction costs) are specified in the primary dealer agreements and therefore cannot vary to the same extent as the Amihud illiquidity measure. For volumes higher than those quoted by primary dealers on Oslo Børs it is therefore possible that the Amihud illiquidity measure provides a more accurate picture of liquidity risk in periods of market turbulence.

Charts 3.7 a and b Standard deviation of the Amihud illiquidity measure (left) and relative bid-ask spread (right). 1999–2016



Sources: Oslo Børs, Thomson Reuters and Norges Bank

4. Summary

Norges Bank Government Debt Management monitors liquidity in the secondary market because it influences the government's borrowing costs. A liquid market for government securities makes it easier to buy and sell Norwegian government securities without incurring high costs. At the same time, a lower liquidity premium contributes to lower borrowing costs for the government. There are many dimensions to liquidity, and it is therefore important to employ more than one indicator. As a whole, the indicators in this article provide useful insight into developments in market liquidity in the secondary market for government bonds.

The analysis of different indicators shows on the whole that liquidity in the secondary market deteriorated during the financial crisis and subsequently in the period of turbulence in government debt markets in some European countries in 2011–2012. These were periods of solid demand in the primary market for Norwegian government securities. Indicators of transaction costs and price movements from trades indicate somewhat improved liquidity in the Norwegian government bond market since 2012. Furthermore, Norges Bank's survey shows that market participants regarded liquidity in the government securities market as average to good in the second half of 2016, and slightly better than in the preceding six-month period. From an international perspective, liquidity in the Norwegian government bond market is often deemed to be weak. This is also implied when we compare turnover ratios in different countries' government bond markets.

According to the indicators, liquidity has, in recent years, continued to be weaker than prior to the financial crisis. This is consistent with developments in international bond markets, which suggests the importance of structural, international driving forces for liquidity in Norwegian markets as well. There may be several reasons why market liquidity is weaker than pre-crisis. To the question of which factors had the greatest effect on liquidity over the past five years, the most frequent response in Norges Bank's survey in autumn 2016 was new banking regulation. In the view of many respondents, new banking regulation has weakened banks' incentives to hold securities on their own balance sheets and act as intermediaries. However, the pre-crisis situation proved to be unsustainable. The experience during the financial crisis was that liquidity may be perceived as good, but in segments of the bond market it can disappear quickly in periods of market turbulence. It is therefore uncertain that the period up to 2007 is an appropriate benchmark period. Moreover, new banking regulation has made banks more solvent and liquid and has likely improved their capacity to provide liquidity in periods of turbulence.

References

Amihud Y. (2002) “Illiquidity and stock returns: cross-section and time-series effects”. *Journal of Financial Markets,* 5 (2002), 31-56.

Aitken M. and Comerton-Forde C. (2001) “How Should Liquidity be measured?”. *Pacific-Basin Finance Journal,* 11 (2003), 45-49.

Bonthron, Fredrik, Tor Johansson and Jenny Mannent (2016) “Market liquidity on the Swedish bond market and its importance for financial stability.” *Economic Commentaries* No 3, May 2016, Sveriges Riksbank.

Buchholst, B. V. (2011) “Liquidity in Danish Covered and Government Bonds”. *Monetary Review*, Part 1 (1st Quarter 2011), 157-163.

CFGS (2014) “Market making and proprietary trading: industry trends, drivers and policy implications”. *CFGS Papers* No 52, November 2014, Committee on the Global Financial System.

CGFS (2016) “Fixed income market liquidity”. *CFGS Papers* No 55, January 2016, Committee on the Global Financial System.

Danmarks Nationalbank (2013) *Danish Government Borrowing and Debt* - Special Chapter: Liquidity in Danish Government Securities.

Ejsing, Jacob W. and Jukka Sihvonen (2009) *Liquidity Premia in German Government Bonds*. European Central Bank.

ESRB (2016): *Market liquidity and market making*. European Systemic Risk Board, European System of Financial Supervision.

Finanstilsynet (2016) *Risk Outlook* 2016. June 2016.

Fleming, M. J. (2002) Are Larger Treasury Issues More Liquid? Evidence from Bill Reopenings. *Journal of Money, Credit and Banking*, 34(3), 707-735.

Galliani, Clara, Giovanni Petrella and Andrea Resti (2014) “The liquidity of corporate and government bonds: drivers and sensitivity to different market conditions.” *JRC Technical Reports*, European Commission.

Hein, Jesper (2003) “Liquidity and scarcity in the Norwegian government bond market”. *Economic Bulletin,* 4/03, Norges Bank, 157-165.

Lavoie, S. A. (2004) “The Evolution of Liquidity in the Market for Government of Canada Bonds”. *Bank of Canada Review*, Summer 2004, 19-31.

Norges Bank (2010) *Annual Report 2009*.

Norges Bank (2016) *Financial Stability Report* 2016, 41-42.

OECD (2016) *Sovereign Borrowing Outlook 2016*.

Valseth, Siri (2017) “Likviditeten i det norske statsobligasjonsmarkedet” [Liquidity in the Norwegian government bond market]. *Samfunnsøkonomen*, 1/2017 (Norwegian only).

Ødegaard, Bernt Arne (2017) “Bond Liquidity at the Oslo Stock Exchange”. Forthcoming Norges Bank *Staff Memo*.

Appendix

Data used in calculating turnover ratios

The statistics for the turnover ratio in various countries are based on publicly available data for turnover and volume outstanding in these countries. It is possible that there are considerable differences in the way different countries compute turnover and what they include in their turnover statistics. For example, some countries control for double-counting in their turnover statistics, while others do not. Some countries include trading platforms other than physical exchanges, while for others this information is not available. In addition, other instruments are included in some countries' turnover statistics, such as real return bonds. These are only some examples of factors explaining why turnover ratios are not directly comparable across countries. Nevertheless, the statistics provide an indication of developments in each country over time and of the extent to which Norwegian developments correspond with developments internationally.

Sources for turnover ratio statistics

Country	Turnover	Volume outstanding
Norway	Norges Bank	Norges Bank
Sweden	Sveriges Riksbank	Swedish National Debt Office
New Zealand	Reserve Bank of New Zealand	Reserve Bank of New Zealand
Finland	Treasury Finland	Treasury Finland
Denmark	Danmarks Nationalbank	Danmarks Nationalbank

Comparison of data for debt outstanding

Country	Is the government's stock included?	Are bonds included with maturity of less than 1 year?	Are Treasury bills included in the statistics?	Are other debt instruments included (eg real return bonds, foreign currency bonds)?	Is debt outstanding measured in nominal volume?
Norway	Yes	Yes	No	No	Yes
Sweden	Not specified	Yes	No	No	Yes
Denmark	Yes	No	No	No	Yes
Finland	Not specified	Yes	No	No	Yes
New Zealand	Not specified	Yes	No	No	Yes

Comparison of turnover data

Country	Which trading platforms are included?	Are bonds included with residual maturity of less than 1 year?	Are repos included?	Is the primary market included?	Are bills included?	Are other debt instruments included?	Is turnover measured in nominal volume?	Is double-counting controlled for?
Norway	Oslo Børs	Yes	No	No	No	No	Yes	Yes.
Sweden	Not specified	Yes	No	No	No	Not specified	Not specified	Yes
Denmark	Nasdaq OMX	Yes	Not specified	Not specified	Yes	Yes, real return bonds	Yes	Not specified
Finland	MTS Finland and MTS Euro	Yes	No	Not specified	No	No	Not specified	Not specified
New Zealand	Not specified	Yes	No	No	Not specified	Yes, real return bonds	Yes	Not specified