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Liquidity in covered bond markets

How liquid is the Norwegian secondary market?

Lars Kristian Oddenes **Chris Fasseland**

Supervisor: Jan Tore Klovland

Financial Economics

NORWEGIAN SCHOOL OF ECONOMICS

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Abstract

In this paper, we study the liquidity in the Norwegian secondary covered bond market, in comparison to other Scandinavian covered and government bond markets. We have gathered data on trades and bonds in the markets from market participants and Financial Supervisory Authorities in the relevant countries, a process that can be characterized as challenging and time consuming. We discuss how new regulations, the reversal of the Government Swap Agreement and the introduction of the Norwegian Covered Bonds Benchmark has affected liquidity. Further, we investigate any differences in liquidity within the Norwegian covered bond market. The research is conducted by implementing different liquidity measures that together allow for thorough research of liquidity in the markets we focus on.

Overall, we find that the liquidity in the Norwegian secondary covered bond market is neither higher nor lower than the liquidity in the comparable markets, even if there are important differences between some markets. Looking at different groups of bonds in the Norwegian covered bond market, we conclude that the larger bonds included in the Covered Bond Benchmark have the highest liquidity. Over the last years, the liquidity in the Norwegian covered bond market has improved considerably along with the growth of the market. From an unstable period with few bonds in the market in 2007 and 2008, all measures point at higher liquidity from 2010/2011 in more stable market conditions. We have not been able to prove what part new regulations and the reversal of the swap agreement have played in the development, but we have some evidence for higher liquidity due to the implementation of the Covered Bond Benchmark.

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1. Introduction

1.1 Research Topic

The topic of our paper is liquidity in the secondary covered and government bond markets in the three Scandinavian countries, Norway, Denmark and Sweden. Covered bonds are bonds backed by a pool of mortgages, issued by licensed credit institutions. Bond holders own a claim to a cover pool, and issuers need to ensure that the value of this pool exceed certain predetermined limits. In order to be characterized as covered bonds, and to ensure uniformity, a number of requirements must be fulfilled. We want to analyze the change in liquidity in the markets from 2007 to 2014, where our primary focus is the Norwegian covered bond market. We compare and contrast both the structure and the liquidity development of the markets.

The Norwegian covered bond market has experienced a considerable growth since the introduction in 2007, and has become a very important funding source for banks. In addition to this growth, the reversal of the Government Swap Agreement, new regulations and the introduction of the Covered Bonds Benchmark make this a very interesting topic. The cost banks face when issuing bonds is currently very low, and yields in the secondary market have decreased considerably over the last years. Liquidity plays an important role in the maturation of this market and increases efficiency. A high level of liquidity lowers the funding cost for issuers in that it reduces the interest rate demanded by investors. Considering the current size of Scandinavian covered bond markets, this is crucial for issuers. Further, the ongoing implementation of the new financial regulatory framework based on Basel III increases the importance of liquidity for financial institutions, which enhances the position of covered bonds.

We contribute to the understanding and insight into covered bonds by taking a new approach focusing on liquidity. By analyzing data from 2007 until October 2014, we present an overview of the liquidity across countries at periods characterized by different market conditions and regulatory requirements. Since the Norwegian covered bond market is relatively young, we are able to present new and important data on liquidity in the market. We present the first effects of the reversal of the Government Swap Agreement and the introduction of Covered Bond Benchmark, measures that are likely to increase the market liquidity. We have defined the following research topic:

How liquid is the Norwegian secondary covered bond market, and how has the liquidity level changed from 2007 until 2014? In addition, how does the market compare to the government bond market in Norway and the covered and government bond markets in the other Scandinavian countries?

1.2 How the research is conducted

We base our research on gathered data from Scandinavian marketplaces on trades and issues of bonds. In order to focus on the three domestic markets, we only include bonds listed on domestic marketplaces in the domestic currency. Most covered and government bonds in the different Scandinavian countries are listed on various exchanges. We have excluded bonds not listed in order to better compare the markets, and due to difficulties in gathering data on unlisted bonds. The collected data is used to assess the liquidity by employing several liquidity measures for all markets. The different measures are complementary, which we hope will provide a comprehensive overview of the level of liquidity. We then look further into the Norwegian covered bond market by comparing bonds and issuers with various characteristics, in order to investigate differences within this market. As an example, we examine the liquidity in bonds included in the Covered Bond Benchmark, to see if the introduction of the benchmark has improved the liquidity in these bonds.

We evaluate the different markets' liquidity over time, as well as across markets. Our research into the Norwegian covered bond market is the most comprehensive, since it has the shortest history and is the market where we expect to see the largest change in the relevant period. In order to put the liquidity in this market into context, we compare it to the liquidity in the government bond market in Norway and with both government bond and covered bond markets in Sweden and Denmark. The Danish market for covered bonds is very large, has a long history and is considered to be very mature. This likely results in high liquidity, and serves as an interesting benchmark for the Norwegian covered bond market.

1.3 Summary of results

The results for all liquidity measures confirm that the liquidity of the Norwegian covered bond market has increased from 2007 until 2014. When further comparing the market to the other Scandinavian markets our main results is that the liquidity in Norwegian covered bonds is neither higher nor lower. There are however important differences between some markets. The turnover rate in the Norwegian covered bond market is in general lower than in all the comparable markets. The large and highly developed Danish covered bond market and the

Swedish government bond market stand out with significantly higher turnover rates. The measures we have employed give us contradictory results at times, but in total, we conclude that the liquidity level in the Norwegian covered bond market is *average* compared to the other markets.

Looking at different groups of bonds in the Norwegian covered bond market, we conclude that the bonds included in the Covered Bond Benchmark have the highest liquidity. The results were unambiguous for all measures except Roll's bid-ask measure. We also study the change in liquidity for the bonds included in this benchmark, to consider the possible effect of the introduction of this in June 2014. Also here we found evidence for improved liquidity on all measures except Roll's bid-ask measure, but we are not able to conclude if the improvement in liquidity is due to this benchmark or other aspects. The same applies for the impact of new regulations and the reversal of the Swap Agreement, as we are not able to state what effects these developments have had on the liquidity improvement.

1.4 Structure of the paper

We will begin by presenting earlier research conducted on the subject, to set the frame for our contribution to the topic. In order to give the reader a good starting point for understanding the Scandinavian covered bond markets, we follow up by introducing the theory of bonds, in particular bonds backed by mortgages that have many of the same advantages as covered bonds. We then move on to describing covered bonds and government bonds in more detail before we examine the market for these bonds in the three Scandinavian countries. The last section dedicated to background information of the market is about regulation, which is very important in a highly regulated financial sector. The methodology chapter is dedicated to liquidity, hereby a definition and a discussion about what it is and how to measure it. Lastly, we present and discuss our data and results, criticism and our conclusions.

2. Review of previous literature

Papers combining the activity in the secondary Norwegian covered bond market and liquidity analysis are very few. To our knowledge the only authors that have looked into this before us are Rakkestad, Skjeltorp and Ødegaard (2012) who analyze the liquidity in the Norwegian bond market. However, they do not compare the liquidity of the Norwegian market to other bonds in for example Denmark or Sweden. Furthermore, due to the covered bond market being very young at the time their paper was written, the time span of their data set is very short. Buchholst, Gyntelberg and Sangill (2010) have written a paper with longer data series on the Danish market. Even though they have longer time series of data, these authors also solely look at the domestic market and do not compare it to other international peers.

Other papers written about the Norwegian covered bond markets are three master theses written by Norwegian students. The oldest is written by law student Myhre (2006) who takes a juridical approach to the topic. The other two are written at Norwegian School of Economics (NHH) during spring of 2013. Martinsen (2013) goes into the details of the institutional aspects of the Norwegian covered bond market and about how the security is priced. In the other thesis, Jørum and Hjermann (2013) discuss the effects of the introduction of covered bonds in Norway on Norwegian banks' capital structure.

Consequently, our analysis differs in that we look at the secondary market of Norwegian covered bonds and that we compare the results with other domestic markets.

3. Theoretical framework

3.1 Bonds and bond pricing

According to Bodie, Kane and Marcus (2003) a bond is a security that is issued in connection with a borrowing agreement, where the borrower is obligated to make specified payments to the bondholder on specified dates. The payments are called coupons and can either be floating or fixed. At the end of the period, at maturity, the borrower has to pay back the debt equal to the par value. A bullet loan is always repaid at maturity, while a callable bond might be repaid earlier. All these terms are written in the bond indenture, which is the bond's contract. Subsequently to an issue, many bonds are listed on an exchange, where they later can be traded among investors.

Bodie et. al. (2003) introduce in their book a formula on how to value a coupon bond. The formula is as follows:

$$Bond\ value = \sum_{t=1}^{T} \frac{Coupon_t}{(1+r)^t} + \frac{Par\ value}{(1+r)^T}$$

Equation 1: Bond valuation

The formula is made up by four components; Coupon, time *t*, par value and the interest rate *r*. $Coupon_t$ refers to the coupon paid each period t and the par value is the value that the investor is promised to receive at maturity. In valuation practice, the par value is usually set to 100 and t depends on the maturity and payment structure of the bond. Although these two components are more or less straightforward, the other two – coupon and the interest rate r – are more complex and thus will be discussed in the following parts.

3.1.1 Coupon

Coupon-paying bonds have either a fixed or floating rate coupon, meaning that the coupon paid to bondholders each period is respectively fixed by a contract or settled based on an underlying interest rate plus a fixed premium (Bjerksund and Stensland, 2014). The premium is mainly set by two aspects; the risk profile (rating) of the bond and the market sentiment at the time the bond is issued. Consequently, the premium of bonds with different ratings and issue dates might vary considerably.

In valuation, the future cash flows paid to bondholders are forecasted. In the fixed rate case, there is no uncertainty about the coupon payments, and the cash flows can easily be forecasted. In the floating rate case, however, the forecasting of the cash flows is more

complex. According to Bjerksund and Stensland (2014), there are different models to forecast the interest rate depending on which assumptions one takes on the distribution of the future interest rate. In the most primitive models, the interest rate is assumed to be normally distributed without drift[1], while the more advanced models like the Black-Karasinski model "allows for volatility, mean reversion, and the central tendency of the short rate to depend on time" (Tuckman and Serrat, 2012)[2].

The main understanding from this part is that forecasting the coupon of a fixed rate bond is simple, but the process is much more difficult for the floating rate case. For our analysis, we only value fixed rate coupon bonds so it is not necessary to go into more detail about floating rate coupon bonds.

3.1.2 Interest rate

The r in the model is important when valuing bonds and is normally called the *yield to maturity (*YTM). Hence, r provides information about what return investors require until maturity for a given bond (Bondie et al., 2003). In the following part we will present two methods of calculating YTM. The methods are relevant because in a later chapter it will be applied when valuing some of the covered bonds in our data set.

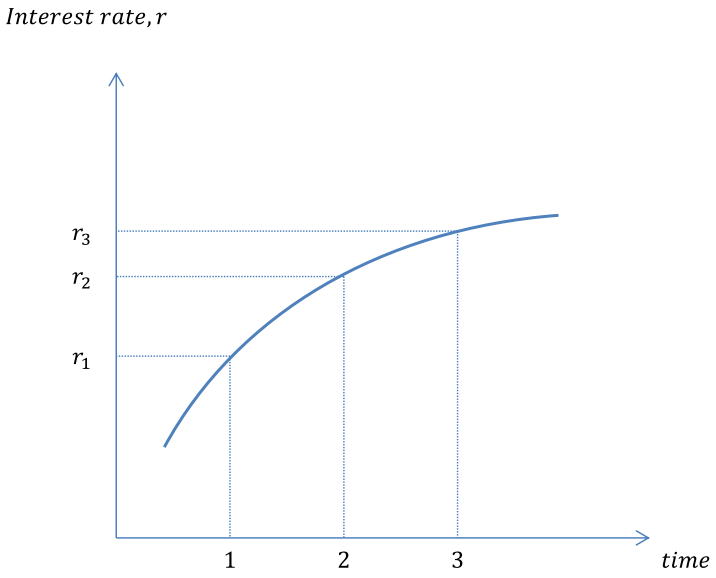


Figure 1: Yield curve

[1] Drift is a phenomenon that is similar to a trend
[2] See chapter 9: The Art of Term Structure Models :Drift (page 251) and chapter 10: The Art of Term Structure Models: Volatility and Distribution (page 275)

In order to explain the first method we use an example where there are three zero-coupon bonds with interest rates r_1, $r_2$and r_3 and maturity at time 1, 2 and 3 respectively (Figure 1). Furthermore, there is an assumption that all bonds in the economy have the same risk profile and all bonds are priced correctly. By using the information we have on these three bonds we can find the YTM of a coupon-paying bond with maturity 1, 2 and 3 by

$$(1 + ytm)^3 = (1 + r_1) * (1 + r_2) * (1 + r_3)$$

$$\boldsymbol{YTM = \sqrt[3]{(1 + r_1) * (1 + r_2) * (1 + r_3)} - 1}$$

Equation 2: Yield-to-maturity (YTM)

The second method is in the case where solely information about the last traded price of the bond ($\bar{P}$) and future coupons paid to bondholders[3] are observable. For a similar bond as the one presented in the first example the pricing formula would look like this:

$$\bar{P} = \frac{C_1}{(1 + r_1)} + \frac{C_2}{(1 + r_2)^2} + \frac{C_3}{(1 + r_3)^3} = \frac{C_1}{(1 + ytm)} + \frac{C_2}{(1 + ytm)^2} + \frac{C_3}{(1 + ytm)^3}$$

Equation 3: Bond price with use of YTM

This cubic function is not easy to solve by hand, but by using Microsoft Excel's Goal Seek function this is no problem.

The two previous examples show that by using the bond pricing formula (Equation 2 and 3) it is possible to obtain key information about the bond that is not available at first hand. For our analysis, we have price data so especially the second method will be used later in this paper.

3.2 Securitization

In order to understand the covered bond market it is helpful to start with an explanation of securitization. Although covered bonds are not included in the definition of bonds issued through securitization, there are many similarities between the two types of securities that explain the motivation behind issuing covered bonds. According to Jobst (2008), securitization is the process of transforming non-tradable assets into tradable securities. Financial institutions securitize assets by picking a selection of assets to place in a cover pool. This pool is transferred to special entities where interest-bearing securities are issued to finance the pooled assets. Bond investors receive fixed or floating rate payments generated by

[3] In real life this would only be the case for a fixed rate bond as discussed earlier

the underlying cover pool of assets. For a pool of assets to be suitable for securitization, it should be sufficiently large and homogenous, allowing for statistical analysis used for rating and risk assessment. The assets need to be sufficiently secure to receive a high credit rating without the backing of the original lender (Giddy, 2001). There should also be a good record of rates, defaults and prepayments, for it to be as attractive as possible for investors.

There are several advantages with securitization. Firstly, it improves the liquidity of assets held by financial institutions because of limited secondary markets for most assets that are not securitized. It also enables small investors to purchase small proportions of the bonds issued, and hence give them the possibility to buy into assets in which they would otherwise not have enough capital to invest. The improved liquidity also makes it easier for investors to sell their bonds in the secondary market, which contributes to reducing the required rate of return for a bond (Saunders and Cornett, 2014).

Further, financial institutions are often able to raise funds more cheaply through securitization. If a bank has high quality assets on their balance sheet, but a higher overall risk level, they can transfer the high quality assets to a separate entity. By also backing the asset base with a high level of equity, the entity will get a higher credit rating than the bank, and will be able to issue bonds at lower costs. Entities established for this purpose also have a much less complicated structure than most banks, which further reduces the risk associated with the bonds issued and improves the credit rating of the issuer. This high rating makes the bonds accessible for more investors. Pension funds and other mutual funds often have restrictions on the riskiness of their investments. The risk of their portfolio is reduced by including low risk bonds in their portfolio (Saunders and Cornett, 2014). High quality investments are also needed to comply with liquidity and solidity requirements relevant for financial institutions. Securitization also leads to advantages in management of credit and liquidity risk management, in that it can be traded quickly.

3.3 Asset backed securities

Asset backed security (ABS) is a product of securitization, and shares many of the characteristics with other types of bonds. In large, there are two types of ABSs; those issued by a Special Purpose Vehicle (SPV) and those issued by a Structured Investment Vehicle (SIV).

SPVs are special entities set up by financial institutions who select a pool of assets (most often residential mortgages) which are sold to the SPV. Securities are created, which are

backed by cash flows from the underlying assets. The ABSs are sold to investors, who then own the right to the cash flows from these underlying assets. The SPV earns fees from the creation and servicing of the ABSs, while the money received from the borrower of the underlying assets is passed through the SPV to the investors. The life of the SPV is limited to the maturity of the underlying assets (Saunders and Cornett, 2014).

In contrast to an SPV, SIVs issue bonds in order to raise cash to purchase a pool of loans from the mother bank, and hold these on the balance sheet until maturity. The bonds issued are backed by the pool of assets. An SIV shares many characteristics with a bank in that it issues bonds to fund mortgages. It cannot however issue deposits, and is hence not technically a bank. Unlike SPV, the investors do not have a direct claim to the cash flows produced by the underlying mortgages, but receive payments according to the terms agreed to when the bonds were issued. The issuer keeps the spread between the amount paid to the bondholders and the amount received from the borrowers. SIVs often have lines of credit from the mother bank, which is therefore still exposed to risk of the assets (Saunders and Cornett, 2014).

3.4 Covered bonds

Covered bonds (COVB) differ from bonds created through securitization in a few aspects. According to ECBC[4] (2008) there is no clear consensus about the definition of a covered bond in the European context, but there are some common features that all agree on:

1. Only licensed credit institutions are allowed to issue covered bonds. They are thoroughly monitored by a national regulator and are the legal unit to which the bondholder has a direct claim in an event of default.
2. The bondholders have a claim on both the issuer and the cover pool, which is referred to as *dual recourse*. Covered bondholders have priority over unsecured debt holders of the credit institution in an event of default.
3. The credit institution needs to maintain a sufficient amount of assets in the cover pool and the value has to exceed the claim of the current bond holders at all time. The practice is often referred to as the *balance principle*.

[4] European Covered Bond Council (ECBC) was established in 2004. Its purpose is to represent and promote the interest of the European covered bond market participants at the international level and its main objective is to operate as the point of reference for matters regarding the industry. For more info see http://ecbc.hypo.org/.

4. The credit institution is on a running basis obliged to have its cover pool monitored by a public or other independent body.

Before moving on and presenting a brief history of the covered bond practice, and later presenting the three Scandinavian covered bond markets in detail, there are some terms and aspects related to the list just presented that are necessary to explain in more detail.

3.4.1 Direct claim to the credit institution

As mentioned in point 2 in the list above, a direct claim is also called a *full recourse right* or *dual recourse.* This means that the bondholders' claims are not only covered by the cover pool (see next point) but also by the credit institution directly (ECBC, 2008). It is hence the credit institution that is exposed to the underlying risk of the mortgaged assets, and hence makes the bond more secure for an investor. This point differentiates covered bonds from ABS that are sold and removed from the balance sheet, where the bondholders' claim is not to the institution that issued the security but solely towards the underlying assets (Rakkestad, Bakke and Dahl, 2010). Consequently, investors in covered bonds are not directly exposed to the risk related to changes in the underlying assets' values, since the issuer is required to follow the balance principle.

The fact that investors in covered bonds are less exposed to the changing value of the underlying assets is important both for the attractiveness from investors with low risk appetite and for the general financial stability. According to the BIS[5] Annual Report (2009) one of the main reasons for the outbreak of the financial crisis starting in 2007 was the moral hazard that occurred with the possibility of issuing debt and later being able to remove the related claim and assets from the balance sheet.

3.4.2 Cover pool

Point 3 in the list above introduces the term *cover pool*. Each covered bond has an attached cover pool of assets that according to the balance principle has to exceed the value of the debt at all times. The purpose of the cover pool is to limit the downside of the investment by assuring the bondholders that they will be repaid by the proceeds from selling the assets in the cover pool in a case of default. Since the cover pool of mortgages must exceed the value of the bonds by a margin, new mortgages are included if some are repaid or default. Asset backed securities are on the other hand backed by a fixed set of mortgages, and if a mortgage

[5] Bank for International Settlement (BIS) represents 60 member central banks all around the world. The mission of BIS is to serve its members in their pursuit of monetary and financial stability. For more info: www.bis.org.

is repaid early or defaults, it will not be replaced. Since the pool of mortgages in ABS is fixed, they are often divided into different tranches according to the riskiness of the bonds. Such division is not possible for covered bonds, since the pool of mortgages constantly change in order to exceed the value of the issued covered bond at all times.

The regulations encompassing what kind of assets that can be included in the cover pool of covered assets are strict, so the credit institution cannot include arbitrary assets in the cover pool. Although most countries' regulations are similar in terms of their general strictness, there are distinctive features in every national regulation[6] depending on its market's structure and size (Rakkestad et al., 2010). Furthermore, in order assure that the value of the cover pool is correctly estimated, there needs to be done continuous mark-to-market valuations by a third party. In practice, this means that an external company evaluates the loans in the cover pool. Some countries also do stress tests of the underlying asset values to further assure the investors of the securities' quality (Bruun-Kallum and Holberg, 2012).

Residential and commercial mortgages are examples of cover assets that can be included in a cover pool. As emphasized earlier, national regulations usually vary. That also goes for what kinds of assets that are eligible for covered bond pools in different countries. ECBC (2014) presents an aggregated display of all issued European covered bonds by underlying assets denominated in Euros (EUR).

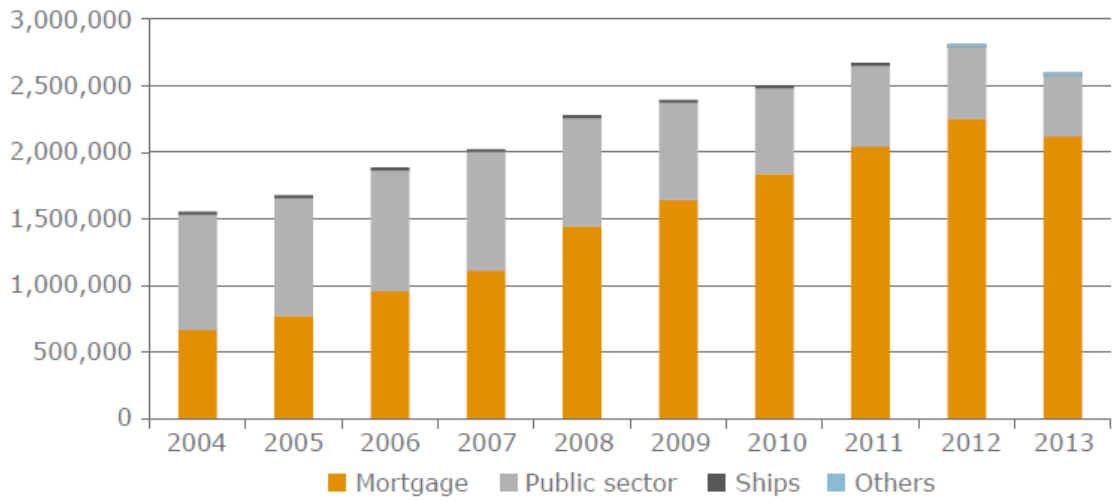


Figure 2: Outstanding volume of European covered bonds by underlying asset in EUR (ECBC, p.109, 2014)

In the period 2004-2006 most underlying assets were public sector debt (Figure 2). In the following period public sector loans continued to represent an important part, but in 2007,

[6] For more detailed discussion see the presentation of the Scandinavian markets

mortgages took over as the biggest asset class used as underlying assets and has dominated since. *Other* assets as referred to in the figure are for example covered bonds issued by some Turkish banks that are backed by loans of small and midsize enterprises (Fuchs and Paciotti, 2013). Even though the range of eligible cover assets are defined by each country's regulation, covered bonds backed by mortgage loans are accepted in all countries with a covered bond system, and are the most common type of cover asset (ECBC, 2014).

4. Covered and government bond markets

4.1 History of covered bonds

The concept covered bonds has its origin in Europe, where the ancient Greeks were the first to take use of a similar structured debt security (ECBC, 2014). The decisive milestones for the development of what we today call covered bonds were laid in the old Prussia[7] in the late 18th century. Mortgage institutions in this epoch were the first to issue types of bonds where the investors had direct coverage in a cover pool (Rakkestad, et. al., 2010). In more recent years, most European countries have followed suit and developed their own covered bonds system.

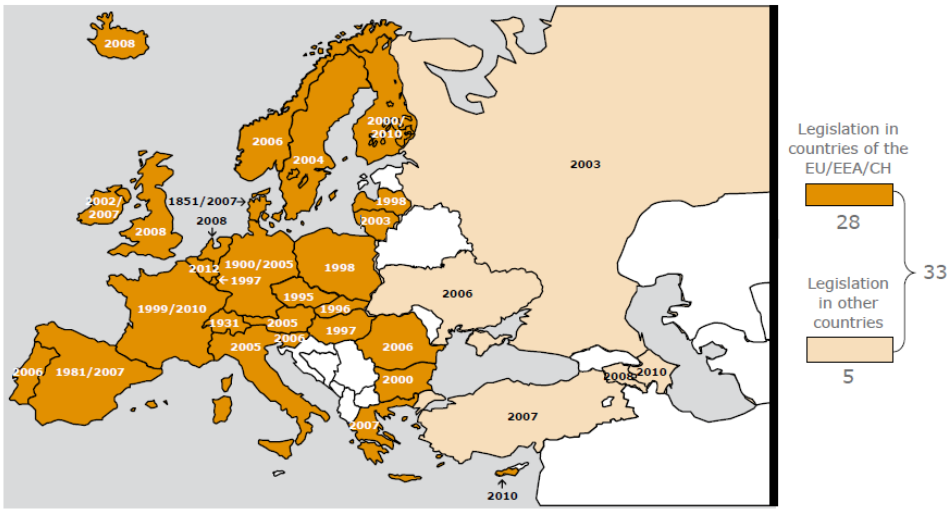


Figure 3: The origin of national regulations for European countries by 2014 (ECBC, p.105, 2014)

Figure 3 provides an overview of all the European countries that today have a covered bond legislation and the year of when latest practice took effect. In addition to already mentioned Germany, countries like Denmark, Switzerland and Spain have long-lasting traditions with use of covered bonds. For the rest of the European countries the legislation that is effective per October 2014 is fairly young, and no more than 10 to 15 years old.

[7] The geographic area that today is known as Germany

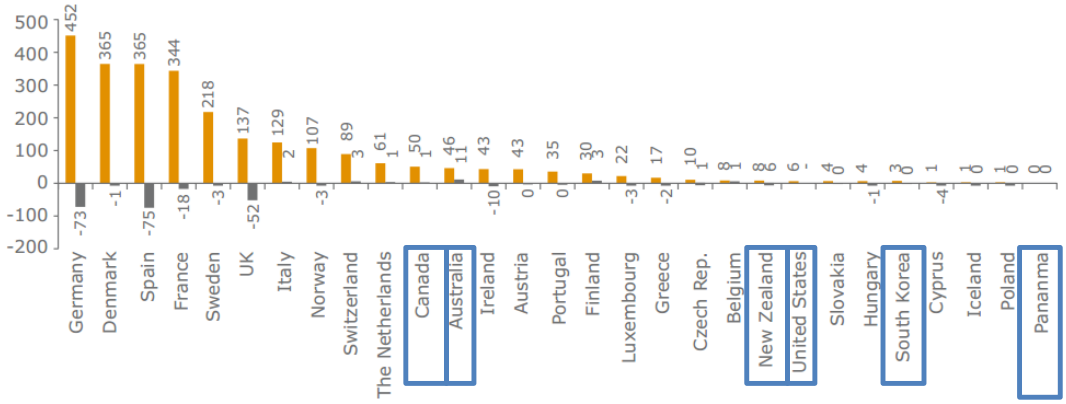


Figure 4: Outstanding covered bonds per 31 December 2012 by country (ECBC, p.515, 2014)

Figure 4 supports the statement that covered bonds are mainly a European phenomenon. Although there are several countries outside Europe that have established covered bond markets, the combined outstanding volume is small in comparison with the aggregated European volume. Another point worth noticing is that the countries with the longest covered bond history such as Germany, Denmark and Spain also have the largest markets in terms of outstanding volume.

Covered bonds are perceived as very safe, which often leads to a strong credit rating[8]. In Germany, there has not been a defaulted covered bond since 1769, and in Denmark, Spain and France there are no registered defaults since the establishment of their covered bonds systems (Rakkestad et al., 2010). Extremely low default rates are likely to be one of the reasons why covered bonds recently were classified as High Quality Liquid Assets Level 1 by the European Commission as part of the Liquidity Coverage Requirement (European Commission, 2014)[9]. Level 1 is the highest liquidity rating an asset can obtain within the European liquidity regulation and this outcome shows the important position covered bonds have in the European financial markets in 2014.

[8] AAA is the highest credit rating possible assigned by the rating agencies Standard & Poors and Fitch. The third major rating agency Moody's and their notification is Aaa. A high rating basically means that the probability of repayment is high.

[9] See the chapter concerning regulation for more discussion

4.2 Government Bonds

4.2.1 What are government bonds?

In order to do a thorough assessment of the liquidity in secondary covered bond markets, we compare these to government bonds. Government bonds are interest-bearing securities issued by a national government. Government debt can be issued as bills or bonds, depending on the maturity of the security. Bonds are papers with maturity of more than one year (Norges Bank, 2003), which we will focus most on due to the closest resemblance to Scandinavian covered bonds. The coupon rate of a government bond normally reflects the market rate at the time it is issued. National governments are in most cases regarded to have high credit worthiness, and such bonds therefore tend to receive a high rating from credit rating agencies. Government bonds are usually only backed by the faith and credit worthiness of the issuing country and not by any assets (The World Bank, 2001). The European debt crisis, where several European countries struggled with high levels of debt and difficulties fulfilling their obligations, served as a reminder that there is also risk associated with government debt. Due to uncertainty in alternative investments, demand for government bonds rise in unstable times.

4.2.2 Functions of government bonds

The most obvious function of government bonds is to finance a country's budget deficit. Further, it might help in implementing wanted monetary policies, and reach monetary goals as well as smoothing consumption and adverse shocks to the economy. The interest rate is commonly used as a measure of the return on a risk free placement, as it is often the best approximation of such an investment (The World Bank, 2001). Government bonds have an increasingly important function in managing credit and liquidity risk in financial institutions. Since government bonds are considered very safe investments, they are important for reducing overall risk on such institution's balance sheet. Recent capital and liquidity regulation developments emphasize the importance of such secure investments. That will be discussed further in the section on regulation.

In some countries where there is no need to finance a budget deficit, government bonds are usually still issued. This is the case in Norway where the non-oil budget deficit of the national budget is financed by transfers from The Government Pension Fund Global[10]. Bonds

[10] A sovereign wealth fund owned by the Norwegian Ministry of Finance on behalf of the Norwegian people, where surplus wealth from the petroleum sector is deposited

are still issued to balance the money market, the government's access to cash and due to value gained from issuing bonds (Ministry of Finance, 2014). Issuing government bonds on a regular basis also supply investors with an approximation of the interest rate on risk free investments with various maturities.

As for bonds in general, liquidity in government bonds is important to minimize the price the issuing country has to pay for funding. Low liquidity will lead to investors demanding a higher compensation when investing in such bonds. A small market, low liquidity, and investors with relatively inelastic demand might also lead to a scarcity premium[11] for government bonds. In that case, the yield is not a good proxy for a risk free yield curve (Hein, 2003).

[11] Scarcity premium refers to the increased price on a security due to demand being much larger than supply

5. Scandinavian bond markets

5.1 Scandinavian government bond markets

In the primary market in Scandinavia, government bonds are sold through auctions. Bonds are assigned at the highest price that on an aggregate allocates the whole value of the bonds. There are primary dealers who are required to quote bid and ask prices through the day in all secondary government bond markets (Danmarks Nationalbank, 2013; Norström, 2011; Norges Bank, 2014). This is likely to increase liquidity by allowing buyers to monitor price changes and trade at known prices. Secondary trades in Scandinavian government bonds are conducted through the domestic stock exchange, different electronic trading platforms or over-the-counter (OTC). Yield series on government bonds in all Scandinavian countries are presented later in the paper.

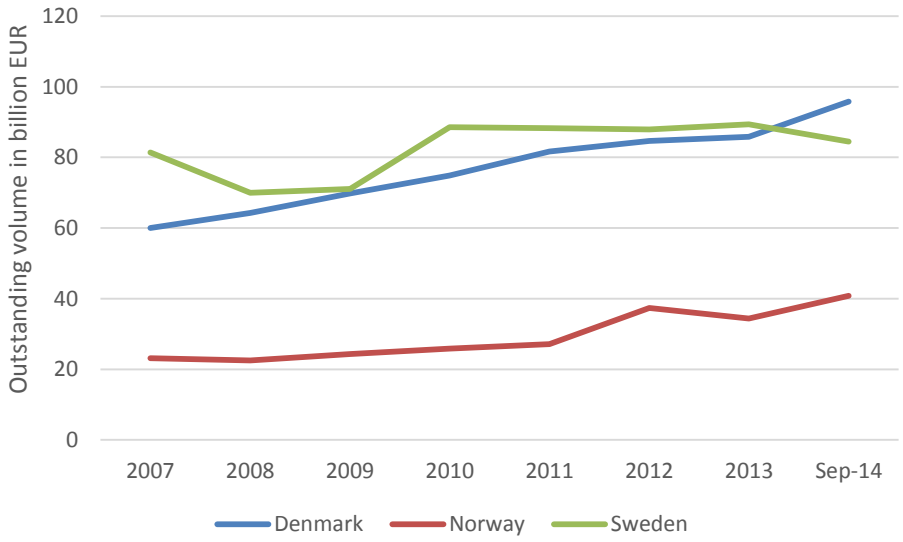


Figure 5: Outstanding volumes in government bonds in Scandinavian countries from 2007 to 2014

As can be seen in Figure 5, the size of the Danish and Swedish government bond markets is quite similar, currently between EUR 80 and 100 billion. The Norwegian government bond market is smaller at EUR 40 billion. The government bond markets are smaller than the respective covered bond markets in all the Scandinavian countries. Since 2007, all markets have increased in size, but the largest relative increases have been in the Danish and Norwegian market.

5.2 Scandinavian covered bond markets

In the following parts, we will present the three Scandinavian covered bond markets in more detail. When we later present the findings on liquidity for the different markets, it is useful to have in mind the markets' characteristics such as size, history and institutional aspects. From

what has already been presented, it is clear that the covered bond market in Denmark is both bigger and has a longer history than the Swedish and Norwegian market, and such characteristics might have an influence on the liquidity of the market.

	Norway	Sweden	Denmark
Type of covered bond	Obligasjoner med fortrinnsrett	Säkerställda obligationer	• Særligt Dækkede Obligationer • Særligt Dækkede Realkreditobligationer • Realkreditobligationer
Updated legislation	1 June 2007	1 July 2004	1 July 2007
Number of issuers	26	10	14
Requirement for "Specialized Mortgage credit institutions"	Yes	No	No
Eligible cover assets	• Residential and commercial mortgages • Public Loans • Derivatives • Substitute assets	• Residential, farm and commercial mortgages • Public loans • Derivatives • Substitute assets	• Loan secured by real property • Public authority loan • Credit institution loan*** • Ship collateral*** • Substitute assets
Substitute asset proportion of total cover pool	20%	20%	15%
Required overcollateralization	No	No	8%****
Financial Supervisory Authority	Finanstilsynet (NO)	Finansinspektionen	Finanstilsynet (DK)
LTV-values	• 75 % residential mortgage • 60% commercial mortgage	• 75% residential mortgage • 70% farm mortgage • 60% commercial mortgage	• 80% residential* • 60% commercial mortgage*
Marketplace	• Oslo Børs • ABM	• Nasdaq OMX Sweden • First North Sweden	• Nasdaq OMX Denmark • First North Denmark
Market makers	No**	Yes	Yes

Table 1: Main features of the three Scandinavian covered bonds markets

* It depends on the type of covered bonds but these are most common percentages

** For the Norwegian Covered Bond Benchmark there are quoted prices 85% of the day

*** Only the case for Særligt Dækkede Obligationer

**** Mandatory only for mortgage banks

5.3 Covered bonds – Norway

5.3.1 History

The Norwegian covered bond market is a young market where the current legislation took effect 1 June 2007[12] (Bruun-Kallum and Holberg, 2012). Since then the market has experienced a tremendous growth and per 31 December 2013 it was the eighth biggest covered bond market in the world in terms of outstanding volume (see Figure 4).

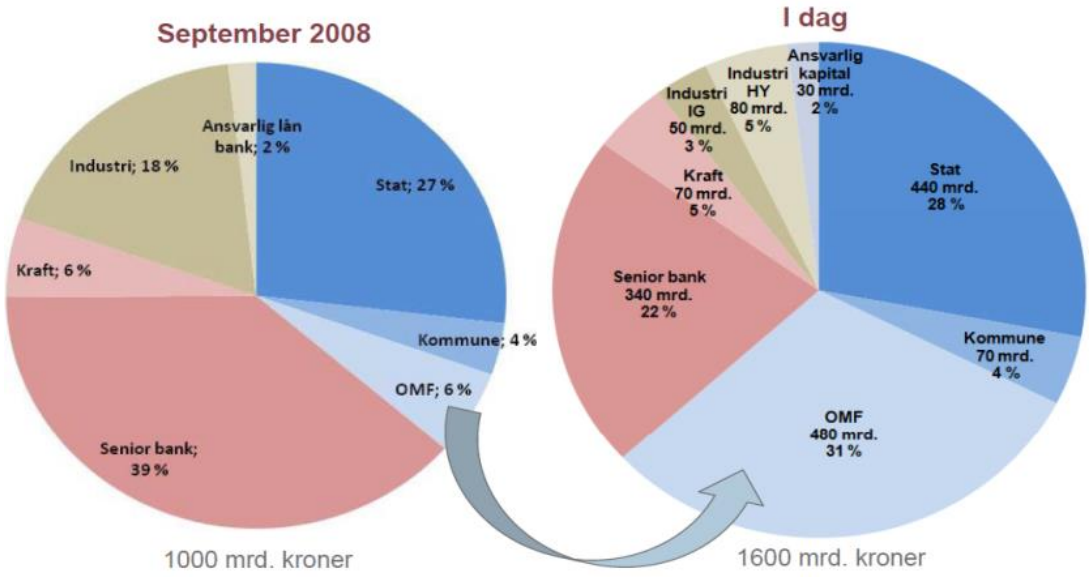


Figure 6: Development of the Norwegian bond market from 2008 until 2014 (Tveit, 2014)

As a result of the strong growth, covered bonds have also obtained the position as one of the most important bond types in the Norwegian bond market (Figure 6). The Norwegian type of covered bond is called "Obligasjon med fortrinnsrett" (OMF) and from representing only 6% in 2008 it stands for 31% of the total Norwegian bond market in 2014. From the figure we can firmly state that senior bank bonds have experienced the largest decreased share. The reason for this is that banks have changed their capital structure towards more covered bond funding (Jørum and Hjermann, 2013).

5.3.2 Requirements

In order to issue covered bonds in Norway a bank needs to fully or partly own a specialized mortgage credit institution approved by the Norwegian Financial Supervisory Authority (FSA)[13] (Norwegian FSA, 2014). Loans are moved from the balance sheet of the bank to the

[12] This new legislation was an evolution of the 2004 legislation for "Obligasjonslån med pantesikkerhet i utlånsportefølje". The reason for the new legislation was partly to improve the funding conditions for Norwegian financial institutions and to reduce the maturity gap on funding and lending activities.
[13] Finanstilsynet

credit institution's balance sheet, before the credit institution issues covered bonds with the transferred loans as cover assets. The raised funds are then used to repay the bank for the transferred loans that the credit institution now formally owns. Since the credit institution is fully of partly owned by the bank, they are the same unit on a consolidated level, and have strong incentives to uphold the solidity of the institution in case of financial distress. This structure provides transparency and it is easier for the FSA to monitor, which is one of the main drivers for why establishing a specialized mortgage credit institution is required (Finance Norway, 2014).

For the Norwegian OMF, the following assets are eligible to take part of the cover pool (ECBC, p. 355, 2014):

- Residential and commercial mortgages (respectively LTV[14] < 75% and 60%)
- Public sector loans
- Loans secured on other registered assets
- Assets in form of derivative agreements
- Substitute assets (maximum 20% of the cover pool's value)

Residential and commercial mortgages are related to residential and commercial real estate respectively. Bonds backed by public sector-loans constitute a very small part of the outstanding volume of bonds, and the only issuer is KLP Kommunekreditt that issues bonds covered with municipality debt (Finance Norway, 2014). No Norwegian covered bonds are backed with loans secured by other registered assets, so this will not be explained further. According to Martinsen (2013), derivatives used to hedge against interest rate and currency risks are usually included in the Norwegian credit institutions' cover pools. The last point on the list of assets that are eligible for the cover pool is substitute assets. According to Norwegian FSA (2014) examples of such assets are highly marketable assets with low risk like bank deposits or other especially liquid and safe securities. This type of assets cannot make up more than 20% of the cover pool's value[15].

As other covered bonds, Norwegian OMF is closely monitored and regulated. In order for the residential mortgages to count as a cover asset, the total loan value of the mortgage needs to be 75% or less of the *market value* of the underlying asset. In other words, if a credit

[14] Loan-to-value (LTV) is a percentage that says how much of the market value of the asset that is leveraged
[15] With special permission by the FSA the percentage can be increased to 30% (Norwegian FSA, 2014)

institution wants to increase the cover pool, the value of an added residential mortgage will only be eligible if the loan value is 75% or less of the market value of the related estate. For commercial mortgages, the LTV has to be equal to or less than 60%. To determine the market value of an estate, credit institutions use an independent third party called Eiendomsverdi (Finance Norway, 2014). There are several ways to value a house, but only the value provided by Eiendomsverdi is valid in regard to the regulation.

5.3.3 Issuers

Although Norwegian issuers have the possibility to denominate bonds in both domestic and foreign currency, the general practice is that only the biggest issuers make use of the international capital markets (Bruun-Kallum and Holberg, 2012). Furthermore, issuers can choose to issue covered bonds with a floating or fixed interest rate. In Norway, there is a strong tradition of financing houses with a floating rate mortgage. Since the majority of Norwegian covered bonds have residential mortgages as cover assets, credit institutions also prefer floating rate funding[16]. However, important investor groups like pension and insurance funds prefer fixed rate bonds. Norwegian credit institutions have solved this by entering interest rate swap agreements when issuing fixed rate bonds (Rakkestad et al., 2010).

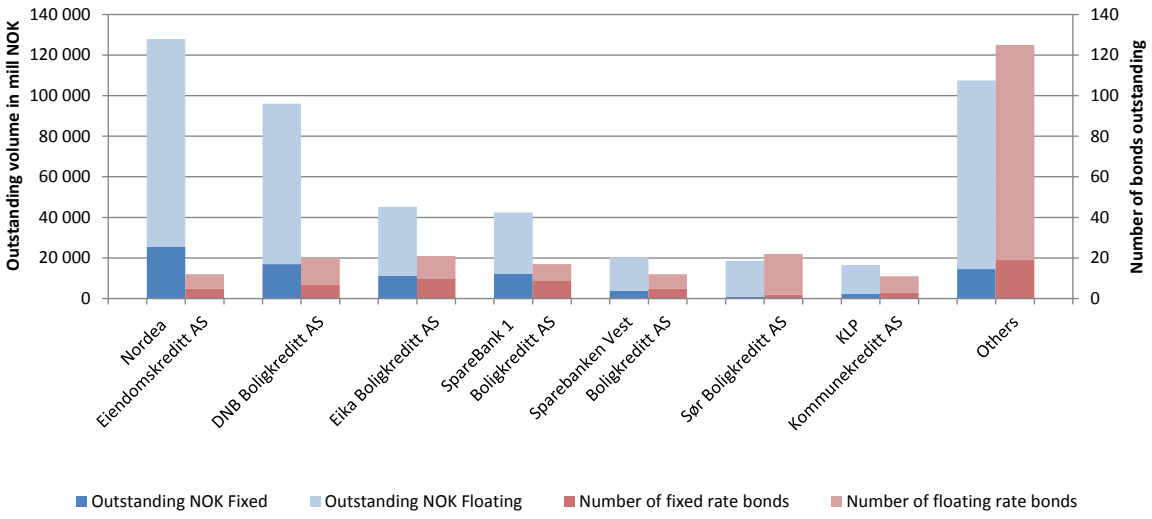


Figure 7: Outstanding volume of the Norwegian NOK market by issuer 30 September 2014 (Stamdata database[17])

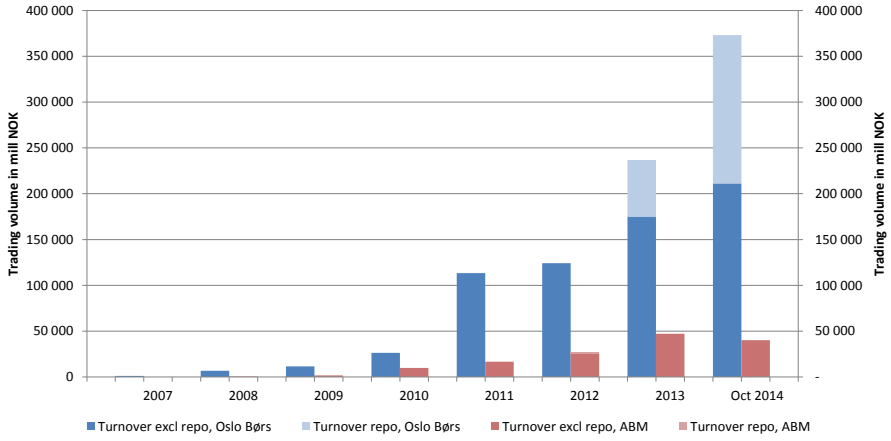
Figure 7 presents the issuers in the Norwegian market, by outstanding volume (left y-axis) and numbers (right y-axis) of fixed and floating rate bonds. "Others" represent the smallest

[16] In order not to be exposed for interest rate risk the cost (funding) and the income (lending) should vary equally, and this is why Norwegian issuers do not want to have floating income but fixed costs

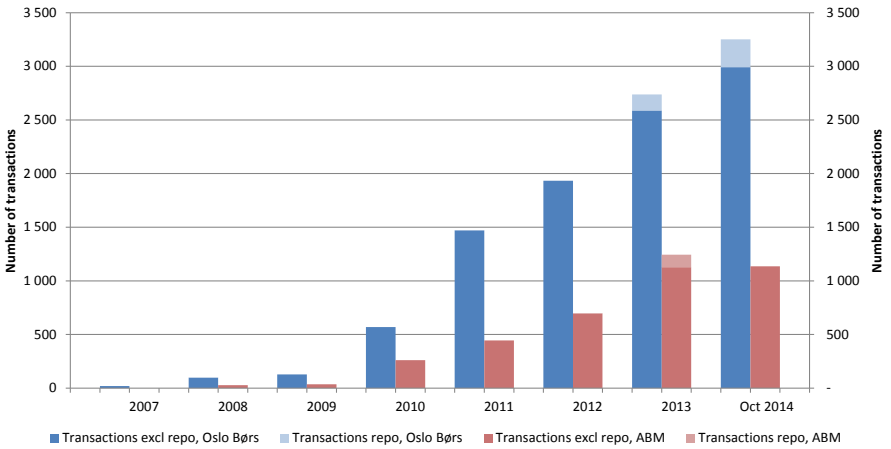
[17] For more information see http://www.stamdata.no

issuers in the market. The market is fragmented and the list counts 26 Norwegian[18] issuers in total, where Nordea Eiendomskreditt AS is the biggest in term of NOK issued covered bonds. The four largest issuers stand for about 56% of the total market, while the smaller issuers together make up a large share of the outstanding value, and especially the number of bonds issued. As a natural consequence, which can be seen from Figure 7, the bonds issued by the largest issuers are larger on average. The size of such a bond is normally increased by the use of tap issues[19].

5.3.4 Development in turnover



a) Development of turnover for Norwegian covered bonds by type of trade and by market place (Oslo Børs' monthly statistics)



b) Development of transactions for Norwegian covered bonds by type of trade and by market place (Oslo Børs' monthly statistics)

Figure 8: Trading activity in Norwegian covered bond marketplaces[20]

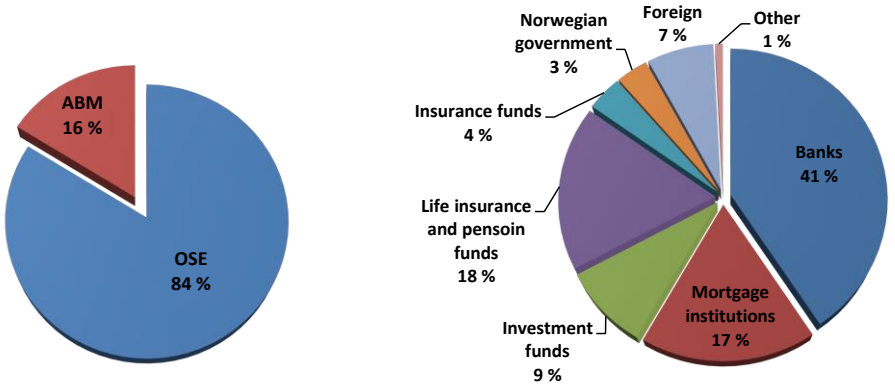
[18] There are covered bonds from 23 credit institutions listed in Norway, but Stadshypotek AB, Skandiabanken AB and Swedbank Hypotek AB are Swedish and thus not included in the Norwegian list

[19] This is the opposite of a pre-issuance issue where the whole loan frame is filled before the issue date. A tap-issue bond makes it possible for the issuer to increase its loan to the market on an ongoing basis.

[20] For more information see http://www.oslobors.no/ob_eng/Oslo-Boers/Statistics/Monthly-statistics

As the market has grown in terms of outstanding volume, the secondary market activity has followed. Part a) of Figure 8 shows that the turnover has increased a lot over the last years, where Oslo Børs is playing the major role. Part b) shows more or less the same development – the number of trades has increased significantly since 2007 and a repo[21] market has been established, which indicates that the market is getting more mature. In terms of number of transactions, Alternative Bond Market (ABM) stands for one third of the activity level of the main marketplace Oslo Børs, and in terms of trading volume, Oslo Børs is even bigger and more important.

5.3.5 Investors



a) Outstanding Norwegian covered bonds by market place per 30.9.2014 (Stamdata)

b) Outstanding Norwegian covered bonds by type of investor per 30.9.2014 (Statistics Norway)

Figure 9: Norwegian marketplace and division of investors[22]

There are two main marketplaces for covered bonds; Oslo Børs (OSE) and ABM, where ABM has fewer listing requirements. As can be seen from part a) of Figure 9, most bonds are listed on OSE. Most Norwegian covered bonds are listed[23] (Bruun-Kallum and Holberg, 2012), but the majority of trades are done off the exchange and then reported to the exchange afterwards[24] (Finance Norway, 2014). The Norwegian market consists of a broad composition of market participants. Among these are banks, pension and insurance funds as well as other types of funds. Norwegian banks are the largest investor with 41%, but mortgage institutions and various funds also own large shares of the Norwegian covered bonds market (Figure 9, part b).

[21] Repurchase agreement is an agreement between two parties where one party sells his asset to another party with an agreement to buy it back after a short period

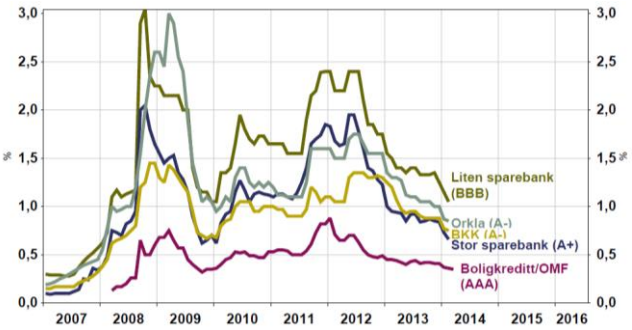
[22] For mor information see https://www.ssb.no/statistikkbanken/selecttable/hovedtabellHjem.asp?KortNavnWeb=vpstat&CMSSubjectArea=bank-og-finansmarked&checked=true

[23] According to our data set around 20 covered bonds denominated in NOK are not listed

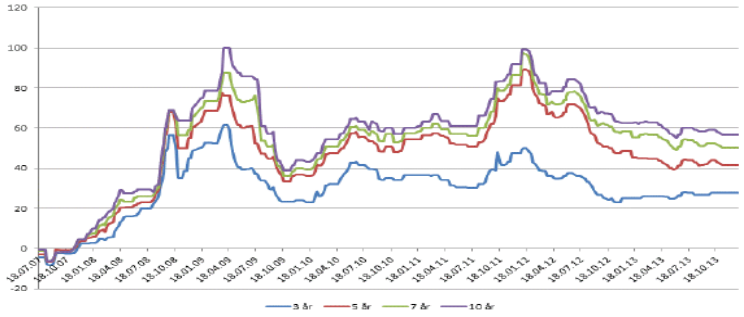
[24] Trades that take place off the exchange needs to be reported to the Oslo Børs within five minutes after the trade has taken place. In markets with market makers this time limit can sometimes be postponed until the end of the trading day so that the broker can unload some of his/her exposure in the market (Hein, 2003).

5.3.6 Historic yields

a) Yield series of floating rate 3-year OMF and Norwegian government notes (Tveit, 2014)



b) Risk premiums above NIBOR 3M for different 5-year floating rate Norwegian bonds (Tveit, 2014)



c) Risk premiums above NIBOR 3M for floating rate OMFs with different times to maturity (Berg, Rakkestad and Skjeltorp, 2014)

Figure 10: Overview of yield series for Norwegian covered bonds

The last part of the presentation of the Norwegian covered bond market is an overview of historical yield series (Figure 10). Part a) shows the yield development of 3-year floating rate OMF compared to the yield of government bills, which is normally considered as the risk free rate. In part b) we show the different risk premiums above NIBOR[25] 3 month for senior bank loans for respectively a BBB rated small savings bank, some corporations rated A-, a bigger savings bank rated A+ and AAA-rated OMF. The last graphs are shown in part c) where we present the difference in risk premiums for floating rate OMFs with different maturities.

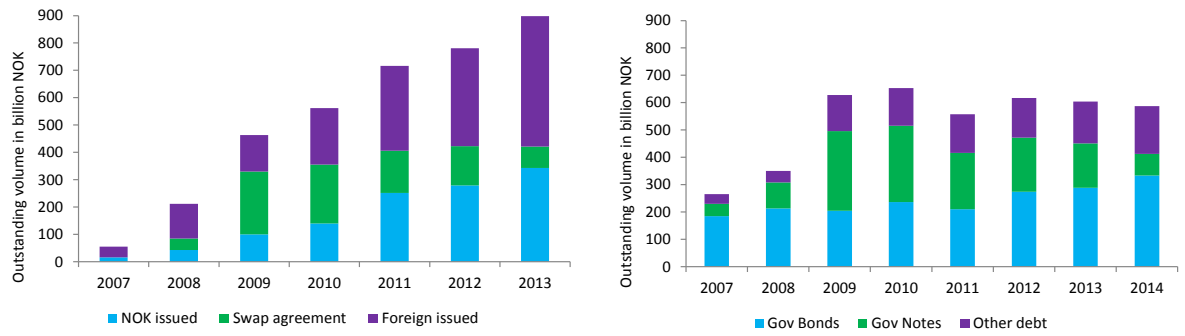
Before starting on the presentation of the Swedish covered bond market we will present a more detailed discussion on two events that we believe have influenced or will influence the activity in the Norwegian covered bond market.

5.3.7 The Government Swap Agreement

The government swap agreement, or "Bytteordningen" was a reaction to the tougher financing situations for Norwegian banks during the financial crisis starting in 2007 (Rakkestad et al., 2010). In practice, the agreement was a facility where the credit institutions could issue and then swap covered bonds for government bills, which had a higher

[25] The Norwegian money market interest rate, which also is the main reference rate in Norway

recognition in financial markets. On mission from the Norwegian Ministry of Finance, the Norwegian Central Bank administrated the agreement, meaning that they were in charge of the swaps and the terms for each agreement. The agreement was passed by the Norwegian parliament on 24 October 2008 and the terms of the last swap agreement was made on 17 December 2009 (Norges Bank, 2013). The maximum length of a swap period was 5 years and the price was decided by the market participants quoting prices for government bills. During the swap period, the covered bonds were in practice taken out of the market and kept on the government's account with the central bank. When reversing the swap agreement the credit institutions got back the covered bonds in exchange for the government securities. Consequently, the covered bonds returned to the secondary market and the outstanding volume of bonds in the market increased. The last reversal of the agreement was 18 June 2014.



a) Outstanding volume of Norwegian covered bonds divided by issue type (Baltzersen, 2013)

b) Break down of Norwegian government debt (Norges Bank, 2013)

Figure 11: Development of issued covered bonds and composition of Norwegian government debt

In order to track the phasing in of the swap agreement we can look at Figure 11 where part a) shows the total amount of outstanding covered bonds by issue type. Part b) displays the development of the Norwegian government debt. The effect of the government swap agreement can be seen by the big increase of the green column in part a) in 2009. This means that even if the outstanding volume of issued OMFs increased a lot, the total volume of outstanding bonds traded in secondary market did not increase as much. The same increase is shown in the green column in part b) for the same year. Combined the two figures tell us that the government issued bills and swapped them for covered bonds. The reversal of the agreement can be seen from the reduction of the two green columns in part a) and b) towards 2014.

5.3.8 The Norwegian Covered Bond Benchmark

The Norwegian Covered Bond Benchmark was established in June 2014 and consists of a selection of the covered bonds listed on Oslo Børs. The benchmark was introduced on

demand from several institutions. Credit institutions for example requested such a list to enhance the availability of covered bonds and thus attract more investors. The benchmark is limited in the way that only covered bonds determined by certain characteristics are included (Borchgrevink, 2014):

- Oslo Børs bonds registered in VPS[26] and denominated in NOK
- Outstanding volume of at least NOK 2.5 billion
- Minimum 10 investors

The main purpose of the benchmark is to increase credit institution's access to capital markets by opening it up to more investors. Up until the second half of 2014, there have not been market makers quoting bid and ask prices for Norwegian covered bonds. As part of the new benchmark there will be quoted two-way prices by market makers 85% of the day and indicative prices will be calculated at all times in an attempt to display the ongoing change in market value of each bond (Borchgrevink, 2014). The anticipated outcome is increased liquidity in the bonds that are included in the benchmark and a more transparent covered bond market.

5.4 Covered bonds – Sweden

5.4.1 History

In resemblance to the Norwegian market, the Swedish covered bond market as we know today is quite young, but it is already one of the biggest covered bonds markets in the world (see Figure 4). The Swedish version of covered bonds is called "Säkerställda obligationer" and the legislation Swedish Covered Bonds Issuance Act was effective from 1 July 2004 (ECBC, p. 439, 2014). Up until 2006 most of the Swedish banks' lending facilities were funded by mortgage bonds[27] (Nilsson, 2013). As Norwegian OMF, Swedish covered bonds also have a cover pool in which the bondholders have a direct claim in case of default and the issuers are subject to balance principle regulation. As a part of the new Swedish legislation, Swedish FSA[28] ordered all banks and mortgage credit institutions to convert their mortgage bonds into covered bonds in order to get an issuance license. Subsequently, all Swedish

[26] Verdipapirsentralen (VPS) is the Norwegian Central Securities Depository. The company provides an efficient infrastructure and services for the settlement of transactions in securities and the registration of ownership rights over securities. For more information see www.vps.no.
[27] Mortgage bonds have been a frequent funding source for Swedish banks since the beginning of the 20th century (Sandström, Forsman, von Rosen and Wettergren, 2013)
[28] Finansinspektionen

mortgage bonds were converted into covered bonds in the period of 2006-2008 (Sandström, Forsman, von Rosen and Wettergren, 2013).

5.4.2 Requirements

In Sweden, the following assets are eligible for inclusion in cover pool (Sandström et al., 2013):

- Residential and farm property mortgages
- Commercial mortgages (maximum 10% of the cover pool's value)
- Public loans
- Substitute assets (maximum 20% of the cover pool's value[29])

These are similar to the Norwegian requirements, also when it comes to the LTV requirements. The maximum LTV for residential, farm property and commercial mortgage is 75%, 70% and 60% respectively. For substitute assets, it is accepted to include other banks' issued covered bonds in addition to other highly liquid assets, such as cash and government securities (Sandström et al., 2013).

5.4.3 Issuers

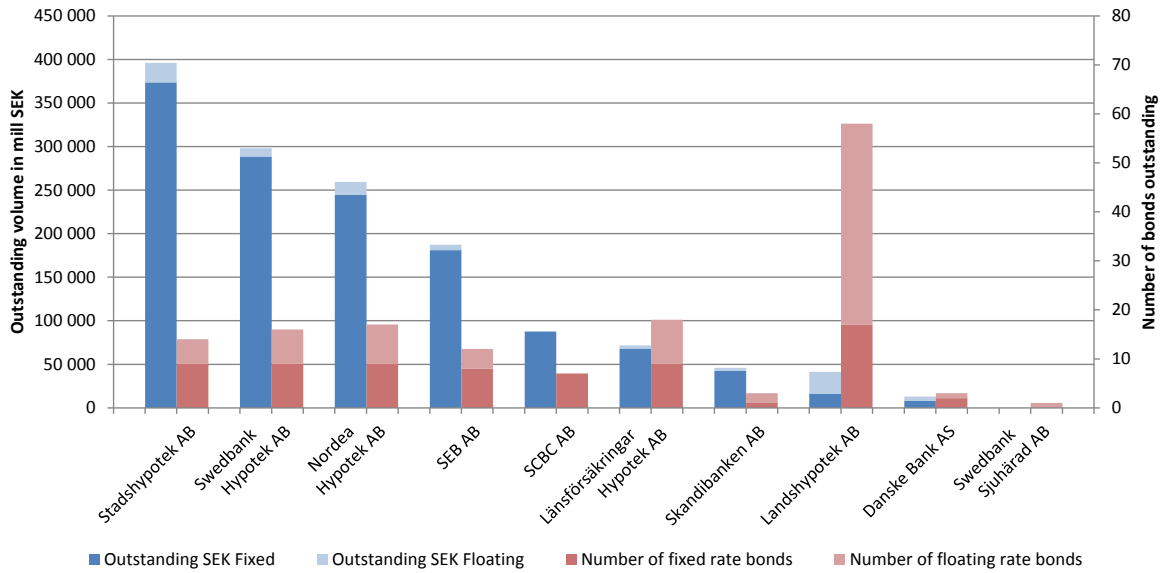


Figure 12: Overview of the outstanding Swedish SEK market by issuer per 30 September 2014 (Stamdata database)

The market for issuing covered bonds in Sweden is relatively concentrated with four big banks dominating the market (Figure 12). There are in total ten issuers which are usually

[29] Can be increased on a temporary basis by the Swedish FSA

funded by the use of tap issues, leading to a market of few but large bond series[30] (Sandström et al., 2013). In the figure, the blue and red show the amount of SEK outstanding (left-hand y-axis) and number of covered bonds issued (right-hand y-axis) respectively and where nuances of blue and red show the proportion of fixed rate and floating rate.

5.4.4 Development in turnover

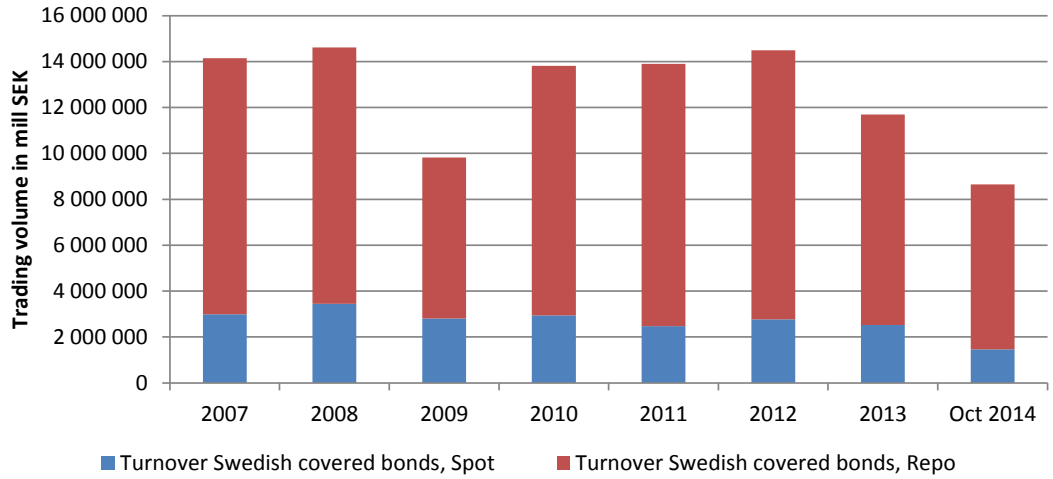


Figure 13: Development of turnover in Swedish covered bonds (Riksbanken database[31])

Despite the fact that most bonds are listed on Nasdaq OMX Sweden[32], the Swedish market is defined as a telephone market, which means that most of the trades are done by phone and thus off the exchange (Söderberg and Lindkvist, 2011). The market makers[33] have an agreement with the authorities to report trades in which they have been involved every month, which is the data presented in Figure 13. The Swedish market has a relatively high turnover and repos play a very important part of the market activity. The Swedish covered bond market sustained a relatively high liquidity even under the recent financial crisis. One of the reasons is that there is a strong domestic investor base that can trade with market makers who quote two-ways prices on an ongoing basis during the whole trading day (Söderberg and Lindkvist, 2011).

[30] These bonds are called "benchmarkobligationer", and tap-issues are normally only done for these types of large bonds. Landshypotek AB for example does not have large enough bonds, so instead of tapping on a benchmark bond they issue smaller bonds on a running basis.
[31] For more information see http://www.riksbank.se/en/Statistics/Money-and-Bond-Markets/
[32] In addition to this there is First North Sweden, but there are no listed covered bonds on this exchange. First North was newly established and is similar to the Norwegian ABM.
[33] Per 1 October 2014 there are eight market makers in the Swedish covered bond market: Swedbank, Handelsbanken, Nordea and SEB, Danske Bank, Nykredit, Barclays and Royal Bank of Scotland

5.4.5 Investors

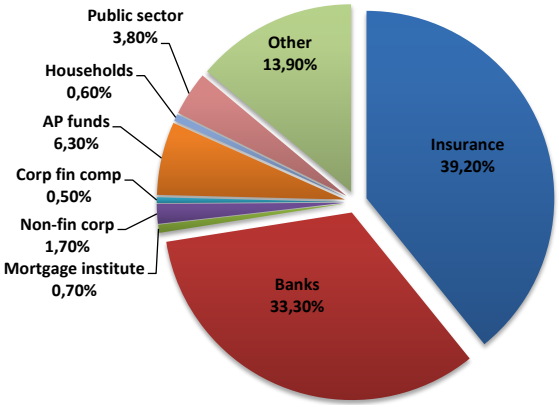


Figure 14: Domestic holders of Swedish covered bonds per 31 December 2013 (Fremberg, 2014)

The most important domestic investors in SEK denominated covered bonds are traditional long term investors, where insurance companies represent the biggest group with 39,2% of the market (Figure 14). Banks are also big investors due to their role as market makers, and in order to fulfill the regulations concerning liquidity buffers (Sandström et al., 2013). However, there are also many short term investors who are important for the liquidity in the second hand market.

5.4.6 Historic yields

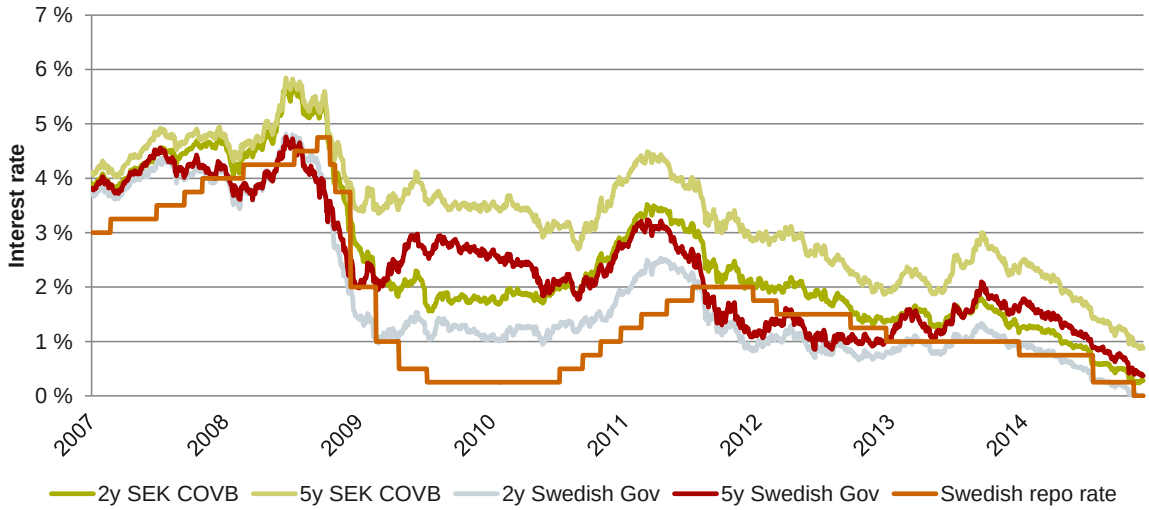


Figure 15: Yield series on floating covered bond, government bonds and the Swedish central bank's repo rate (Nordea Markets Sweden[34])

As for the Norwegian market, we present yield series for covered bonds in Sweden (Figure 15). The first two labels are covered bonds with 2- and 5-year maturity respectively. The next

[34] Data received from Mats Hydén in Nordea Markets Sweden

two labels, represented by the grey and red line, are government bonds also with 2- and 5-year maturity. The orange line is the repo rate offered by the central bank for short term deposits. The spread between covered bonds and government bonds was largest in 2010, but in recent years, it has come down to lower levels.

5.5 Covered bonds – Denmark

5.5.1 History

Among the three Scandinavian covered bond markets, the Danish market is a "heavyweight". In terms of outstanding volume, it is the second largest market in the world (Figure 4) and consists of more than 1700[35] covered bonds. Today's system came into force on 1 July 2007 and was motivated by the harmonization of covered bond legislations within the European Union (EU) through Capital Requirements Directive (CRD) 1 (ECBC, p. 249, 2014). One of the main features of the new legislation was the opening for non-specialist banks to issue covered bonds (Sørensen et al., 2013). Danish FSA[36] has the mandate of granting mortgage banks, commercial banks and ship financing institutions licenses to issue covered bonds, and is responsible for monitoring the issuers.

5.5.2 Requirements and market characteristics

Due to the size and significance of the Danish covered bond market, it requires strong regulatory institutions and a sophisticated legislation framework in order to work properly. Today there are in total three types of covered bonds issued in Denmark, differing by issuer characteristics and cover assets (ECBC, p. 249, 2014).

[35] Data per 30 September 2014 from a dataset provided by Nasdaq OMX Denmark
[36] Finanstilsynet

Type of bond	Særligt Dækkede Obligationer (SDO)	Særligt Dækkede Realkreditobligationer (SDRO)	Realkreditobligationer (RO)
Allowed issuers	Commercial or mortgage banks[37]	Mortgage banks	Mortgage banks
Continuous LTV compliance	Yes	Yes	No
Fulfill CRD requirements	Yes	Yes	No
Eligible cover assets	• Loan secured by real property • Public authority loan • Credit institution loan • Ship collateral • Substitute assets (<15%)	• Loan secured by real property • Public authority loan • Substitute assets (15%)	• Loan secured by real property • Public authority loan • Substitute assets (15%)

Table 2: Overview of Danish covered bond types

One of the most important differences between the three types of bonds presented in Table 2 is that SDO and SDRO are "Særlig dækkede", which refers to the continuous LTV compliance requirement[38]. At the time of issuance however, all bonds are required to have an LTV percentage of 80% and 60% for residential and commercial mortgages respectively included in the cover pool (Sørensen et al., 2013).

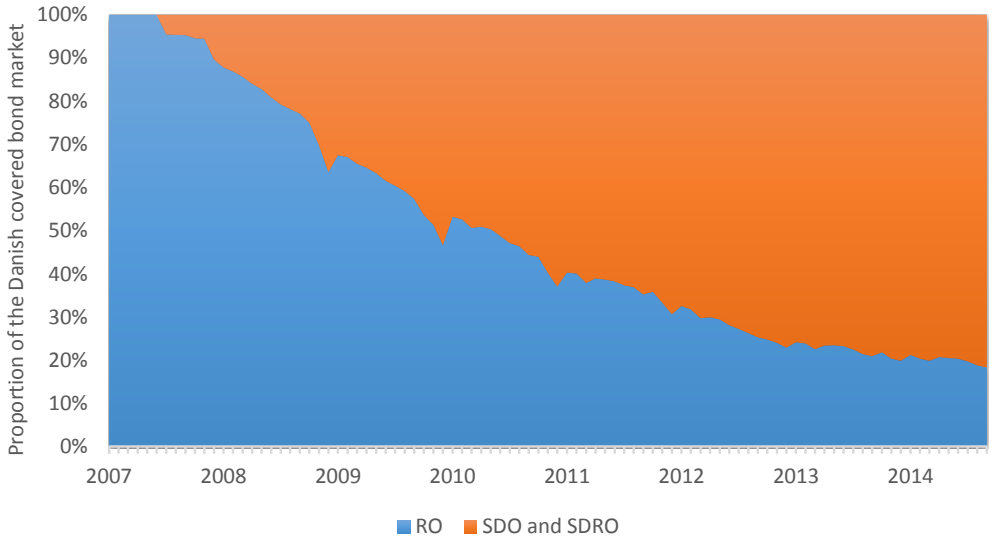


Figure 16: Different types of Danish covered bonds as a percentage of the market (Statbank Denmark database[39])

[37] Danish mortgage banks (Realkreditinstitutter) operate subject to a special banking principle in accordance with Danish legislation, which confines the activities of issuers to the granting of mortgage loans funded by the issuance of covered bonds. Mortgage banks may also carry on other business related to mortgage banking.
[38] According to Nykredit (2010), RO does not fulfill the CRD requirement of continuous LTV compliance. This means that all ROs issued after 1 January 2008 are not considered as covered bonds. However, due to a clause in CRD all ROs issued before 1 January 2008 keep their covered bond status.
[39] A database run by Statistics Denmark with gathered data from the Danish National Bank. For more information see http://www.statbank.dk/2448

As can be seen from Figure 16, the covered bond market in Denmark has gone from consisting only of RO in the beginning of 2007, to SDO and SDRO making up about 80% of the market in 2014.

The LTV ratio is closely monitored by the Danish FSA, and in distressed periods like the financial crisis, when real estate prices in Denmark fell by 20%, the issuers had to supply additional capital to the cover pool in order to satisfy the balance principle (Nykredit, 2010). Danish issuers are also subject to an obligation of overcapitalization[40](OC) that amounts to a minimum of 8% of the risk-weighted capital[41] (Sørensen et al., 2013). This OC requirement results in additional safety for investors on top of the LTV requirement.

According to Nykredit (2010), the Danish covered bond system stands out in several aspects in comparison to the other European markets, and one of the most unique elements is the close link between lending and funding. This is materialized through a pass-through system similar to SPV, where issuers pass through all cash flows from the borrower to the bondholder and vice versa (Nykredit, 2010). If a bank customer is granted a loan, funds from a lender in the market are transferred to the customer. In the following period, all interest and installments are transferred back to the lender. The pass-through system is linked with an extensive use of tap issues, which according to Sørensen et al. (2013) is the most common way to issue covered bonds for Danish banks.

[40] Overcapitalization is when the value of the cover pool is larger than the bond's par value. This requirement is only valid for the issues mortgage banks and not for commercial banks (Martinsen, 2013).
[41] See the Regulation chapter for an explanation of this term

5.5.3 Issuers and bonds in the market

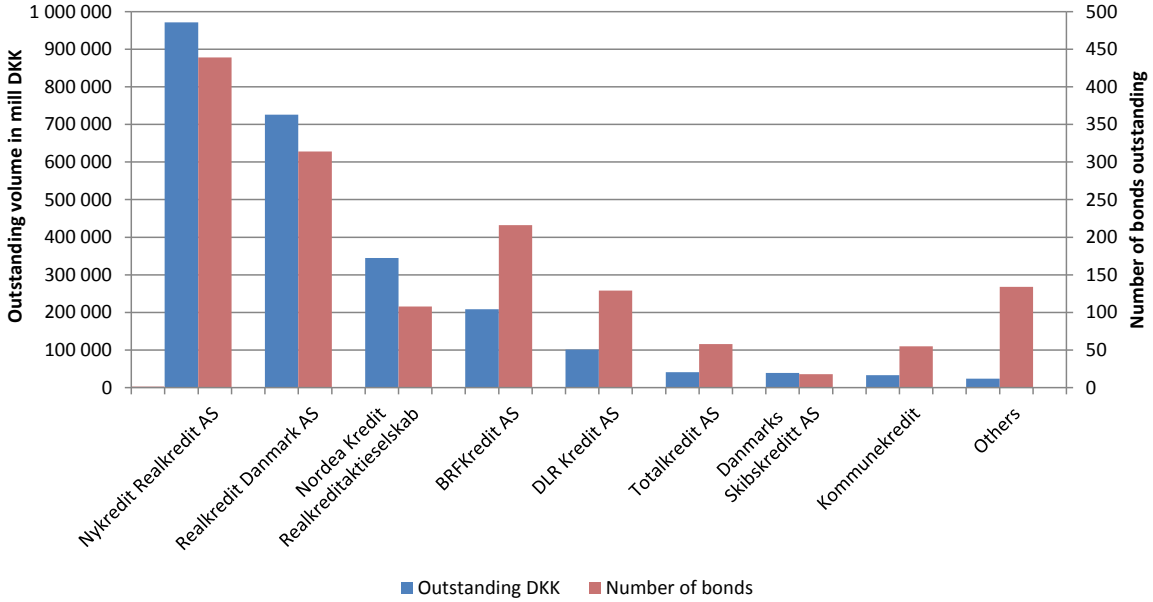


Figure 17: Overview of the outstanding Danish DKK market by issuer per 30 September 2014 (Nasdaq OMX Denmark[42])

As a coherent consequence of its size, the absolute turnover is high in the Danish market, but during the financial crisis in 2008-2009, the secondary market liquidity experienced a minor drop. However, a strong legal and institutional framework supported Danish mortgage banks in issuing tap issues as normal (Sørensen et al., 2013), and according to Nykredit (2010) several countries have considered to implement parts of the Danish system because of this success. The 1700 Danish covered bonds are listed on Nasdaq OMX Denmark, and represent about 80% of all bonds listed on the exchange (Nasdaq OMX Denmark, 2014). Even though there is a vast amount of listed bonds, the marketplace is mainly made up by a group of fewer large bonds series where the 100 largest series comprise 68% of the total market. The concentration in the Danish market is quite high, with 14 issuers, where the two largest[43] stand for about 68% of all bonds issued (Figure 17). The secondary market is supported by seven[44] markets makers that quote bid and ask prices for the listed covered bonds on request (Nykredit, 2010). The Danish market also offer several covered bond indices so investors can follow the developments in the market.

[42] For more info see: http://www.nasdaqomxnordic.com/bonds/denmark
43 Nykredit/Totalkredit and Realkredit Danmark
44 Market makers are typically the largest Danish banks and one or more foreign stockbrokers

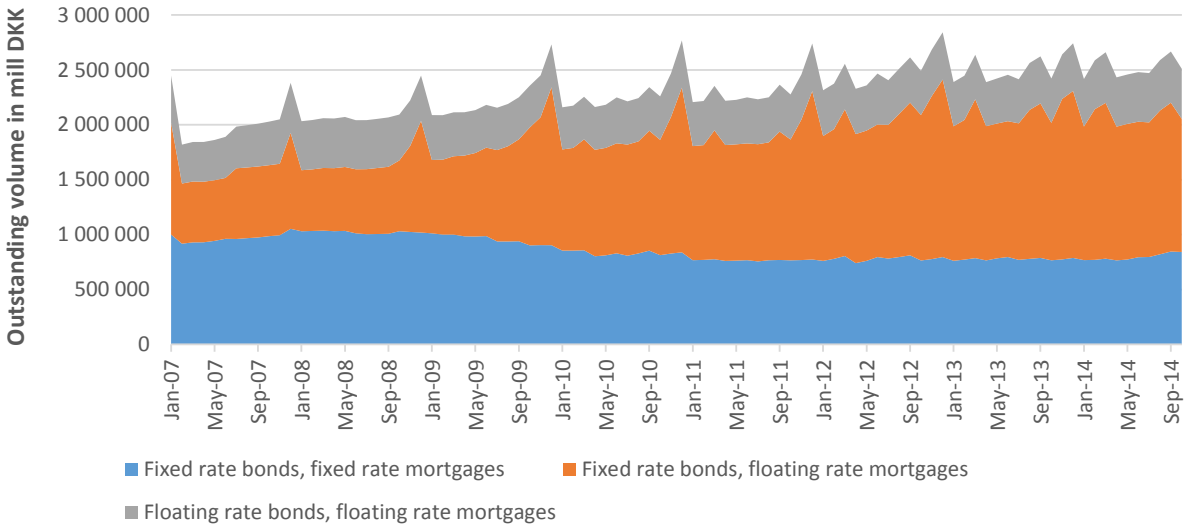


Figure 18: Characteristics of Danish covered bonds and underlying mortgages (Statbank Denmark database)

Figure 18 presents an overview of the different types of Danish covered bonds in the market, as well as characteristics of the underlying mortgages. Danish covered bonds are either fixed or floating, and are backed by mortgages that also have either a fixed or an adjustable interest rate. In the latter case, the interest rate is adjusted at predetermined intervals of time, usually every year, every 3 years or every 5 years. Fixed rate mortgages usually have a maturity of 30 years, but it might be less. As can be seen from Figure 18, floating rate bonds only make up a small proportion of the outstanding volume in the entire period. However, there has been a clear change from underlying mortgages with fixed rates to floating rates. As presented previously, the outstanding volume has increased since 2007, and is in October 2014 at about DKK 2500 billion. Over 80% of outstanding bonds now have a fixed interest rate. More than 50% of these are however backed by floating rate mortgages. Of the underlying mortgages, one third is fixed while the rest is floating. There is still a clear preference of fixed rate bonds by investors.

5.5.4 Development in turnover

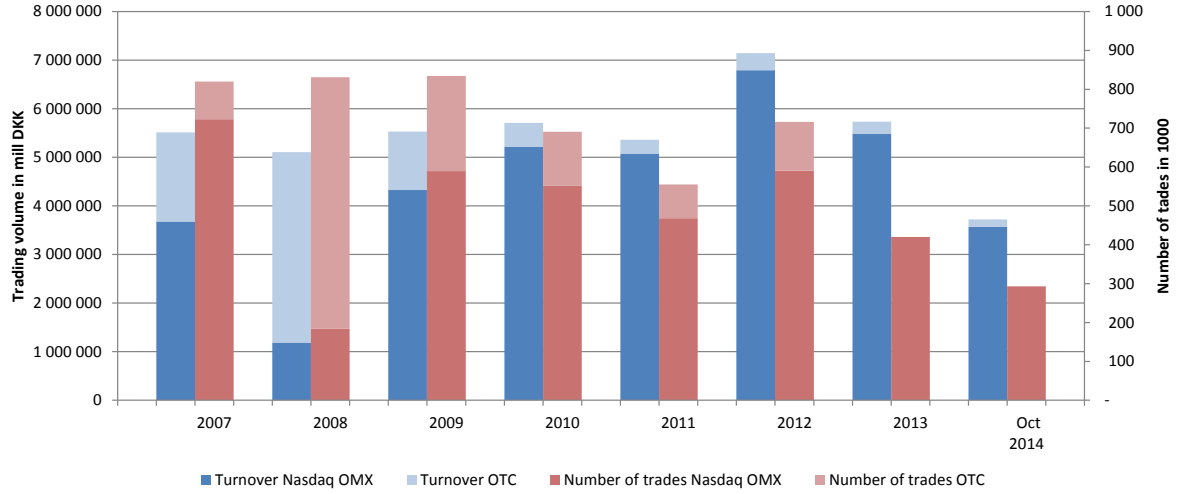


Figure 19: Development of turnover and number of trades in Danish covered bonds (Nasdaq OMX Denmark)

Figure 19 contains information about the trading volume and the number of trades executed from 2007 October 2014. The turnover and number of trades conducted in the period is relatively stable, and reflects the mature state of the Danish covered bond market. Further, the high turnover reflects the large size of the market. The numbers for 2014 are lower than the previous years, but because only data for the first nine months of the year is included, it is likely to end up quite similarly as the previous year.

As can be seen from Figure 19, trades are carried out through on-exchange trading or in the OTC market. For OTC trades, the transaction[45] needs to be reported to the Nasdaq OMX within three minutes after the trade has been conducted. The distribution of trades executed on Nasdaq OMX and OTC has changed a lot in the period. In 2007-2009, and especially in 2008, a substantial part of the trades were made in the OTC market. According to Nasdaq OMX[46], there are two reasons for this development. Firstly, in late 2007 buyers and sellers started to report their trading as OTC trades due to the introduction of new transparency regulations. That resulted in trades appearing as OTC trades in the subsequent years. Secondly, the stock exchange introduced a new pricing strategy in 2009, which incentivized buyers and sellers to report their trades manually to Nasdaq OMX, which thus are presented as on-exchange trades. These are however executed in the telephone market, and are in reality OTC trades. This is the case for most trades conducted, and the Danish market can in large be characterized as an OTC market.

[45] If the trade size exceeds DKK 100 million the reporting trader my request non-disclosure until the close of the trading day (Nykredit, 2010)
[46] E-mail received from Nicolai Jeppesen in Nasdaq OMX Denmark

5.5.5 Investors

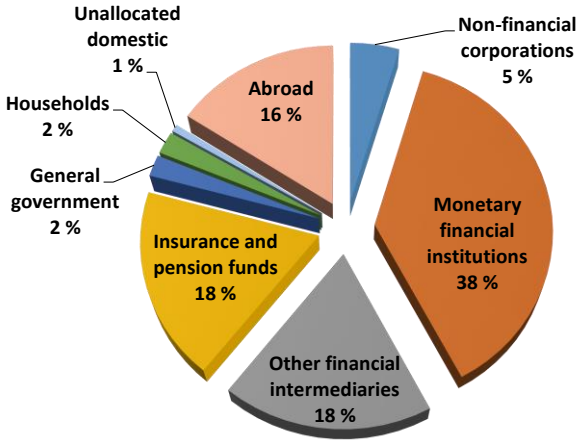


Figure 20: Overview of investors in Danish DKK covered bonds (Statbank Denmark Database)

Figure 20 presents the investor composition in Danish covered bonds, and displays that various financial institutions, including banks hold most bonds, while a non-negligible amount is also held by insurance and pension funds. Foreign investors hold 16% of the outstanding value, while domestic institutions hold 84%. Households and non-financial corporations only hold a very small proportion of the bonds.

5.5.6 Historic yields

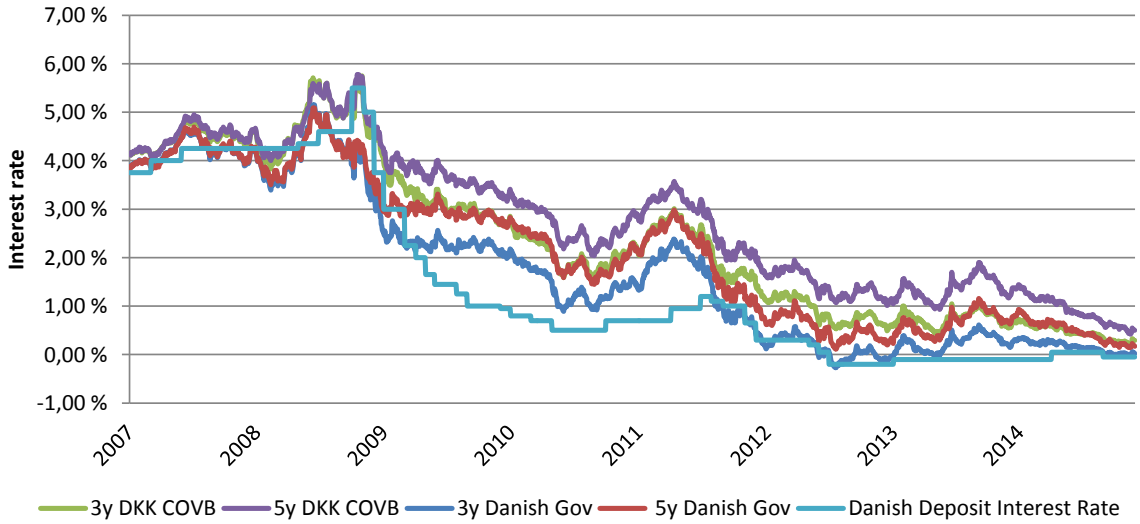


Figure 19: Yield series for Danish covered bond, government bonds and the Danish central bank's deposit rate (Nordea Markets Denmark[47])

As for the two other Scandinavian countries, yield series for Danish securities are presented in Figure 21. Included are covered bonds and government bonds with 3-year and 5-year maturities, in addition to the Danish deposit interest rate. After a peak in 2008-2009, there has

[47] Data received from Maria Holm Rasmussen in Nordea Markets Denmark

been a significant decline in yields for all securities, and a convergence close to a 0% interest rate. The deposit interest rate has experienced the lowest level of interest rates since 2009, with government bonds at slightly higher levels, and covered bonds at somewhat higher rates. The interest rate for 5-year securities has been higher than 3-year securities for both government and covered bonds.

The three Scandinavian markets have now been presented for the reader. The presentations are relatively brief but provide sufficient information in order to do some comparisons, and to understand the size and structure of the different markets. This paper's main focus is the secondary market liquidity for Scandinavian covered bonds, so the discussions represent relevant background information for the later analysis. In large, the Swedish and Norwegian markets have a similar structure, even though the Swedish market has a more concentrated group of issuers, where most of them also act as market makers. The Danish market has the longest history, is the biggest in terms of outstanding volume and turnover, and has the most sophisticated legislation. A common characteristic for the Swedish and Danish market is that they mainly constitute of large bond series and use of tap issues. The liquidity in the Swedish and Danish market suffered less than in the Norwegian market, where the government had to introduce a swap agreement in order to support and secure the funding of Norwegian banks.

6. Regulation

6.1 Basel III – Introduction

The global banking sector has been subject to increased attention and monitoring after the recent financial crisis. There is a clear consensus about the need for a more detailed regulation in order to minimize the probability of similar crisis in the future. Previous regulations[48] did not work as planned, and a new and updated version of the Basel regulation, called Basel III, is being introduced. The point of including this chapter is to introduce the parts of the framework and other relevant regulations that might have or will have an impact on the liquidity in the Scandinavian covered bond markets.

The main features of Basel III[49] are to increase bank liquidity and decrease leverage and short term funding. The new accord will rather build on the earlier accords than replacing them (Basel Committee, 2011). The framework was agreed upon by the members[50] of the Basel committee on Banking Supervision in 2010-2011, and will be phased in during 2013-2019 (Appendix 1). In Europe, the Basel III recommendations will be implemented in the new directive called Capital Requirements Directive (CRD) IV and will be the prevailing directive for the Scandinavian markets. The new regulations are divided in the following parts:

- Risk-weighted assets
- *Leverage ratio*
- Liquidity
    - Liquidity Coverage Ratio
    - Net Stable Funding Ratio

Although they are all important in a regulatory sphere, our focus will be on risk-weighted assets and the liquidity measures since they are most relevant for liquidity in covered bonds. The new regulations are likely to both increase the demand for covered bonds as part of new portfolio compositions, and the supply due to more emphasis on longer term funding sources. That might affect the liquidity in the markets. In addition to the Basel III regulation, this paper will present the new bail-in framework that the European Parliament and the Council of the EU passed earlier this year (Vale, 2014). The framework is likely to affect the attractiveness of covered bonds.

[48] Basel I and Basel II
[49] Also called "Third Basel Accord"
[50] Members representing 28 countries from all around the world

6.2 Risk-Weighted Assets

To assure that banks have a strong funding position, the Basel Committee has decided to further develop the Basel II regulation's view on risk-weighted assets (RWAs). The new regulation requires that banks hold a minimum of 7%[51] of their RWAs in equity capital, an increase from 2.5% in Basel II (BNP Paribas Fortis, 2013). The RWAs are calculated by multiplying the value of a given asset with its risk weight:

$$RWAs = \sum_{i=1}^{n} Value\ of\ asset_i * risk\ weight\ for\ asset_i$$

Equation 4: Risk-weighted asset (RWA)

The risk weight is a predetermined percentage depending on the riskiness of the asset, where a risky asset has a high percentage and a risk-free asset will have a risk weight of 0%. Finally, a bank sums up all the individual RWAs to find the total RWAs.

Type of asset	Risk weight	Characteristics
Covered bonds (EU/EEA)	10%	• Rating ECAI 1 • > EUR 500M • OC > 2%
Covered bonds (Outside EU)	10%	• Rating ECAI 1 • OC > 7%
Covered bonds (EU/EEA)	20%	• Rating ECAI 2 • > EUR 250M • OC > 7%
Unrated Covered bonds	35%	• OC > 10% • > EUR 250M

Table 3: Overview of risk weights for different types of European covered bonds (Johansen and Wiberg, 2014)

All the risk weights presented in Table 3 are low compared to other assets. The lowest weight of 10% is for the highest rated (ECAI[52] 1) and largest (larger than EUR 500M) bonds issued by credit institutions within the EU or the European Economic Area (EEA). Covered bonds with an outstanding volume larger than EUR 250 million and without ECAI rating have the highest risk weight among covered bonds. In order to be included the bonds also need to comply with some sort of OC level. Finally, covered bonds smaller than EUR 250M cannot be included in the liquidity buffer.

[51] This number varies depending on the local or regional regulations. For the Norwegian case this number is 8%, where the minimum requirement for Common Equity Tier 1 is 4,5%, Capital Conservation Buffer is 1,5% and Systemic Risk Buffer is 2% (Jansrud, 2014).

[52] External Credit Assessment Institution (ECAI) is just another word for rating agencies. The European Banking Authority (EBA) has been given the assignment of mapping objectively all ECAI in order to promote a consistent implementation of ratings provided by different ECAIs in CRD IV practice (EBA, 2014).

This reinforced requirement of equity capital will force banks either to allocate more of their capital towards less risky assets with low risk weights such as cash, government or covered bonds, or to increase their equity capital through retained earnings or private offerings. Assuming that banks will do a little of both means that the RWA regulation might increase banks' demand for less risky papers such as covered bonds.

6.3 Liquidity Coverage Ratio

The liquidity coverage ratio (LCR) is a measure of a bank's liquid assets, and the ability to fund operations in a difficult market-funding environment. The measure was introduced in the Basel III regulation, and is seen as one of the most important reactions by regulators following the recent financial crisis (BNP Paribas Fortis, 2013). During the crisis, several big banks had huge liquidity problems due to difficulties of obtaining funding in the market. Market participants were resistant to trade other securities than those of very high liquidity (BIS, 2009). Thus, low liquidity might have substantial consequences for a financial system.

According to Basel Committee (2013) LCR is as follows:

$$\frac{Stock\ of\ high\ quality\ liquid\ assets}{Total\ net\ cash\ outflows\ over\ the\ next\ 30\ calender\ days} \geq 100\%$$

Equation 5: Liquidity coverage ratio (LCR)

The fraction tells us that at a minimum, the high quality liquid assets (HQLAs) have to exceed the amount of net outflow estimated[53] for a 30-days period in a distressed market environment. Under the assumptions that all HQLAs are regarded as safe investments, a bank does not need to raise more funds in the market in order to cover the outflow. They can in theory always fund the net cash outflow by selling HQLAs and will thus not face liquidity problems.

When estimating a bank's HQLAs all approved assets are divided into two groups; HQLA Level 1 and HQLA Level 2, where HQLA Level 1 has the highest liquidity. These securities have the lowest haircut rate when calculating the value of the HQLA stock. In that way, the haircut rate helps to adjust the value of a security when determining how much of an asset's market value that can be included in the stock of HQLAs. Since Norway[54], Sweden and

[53] The net cash outflow is estimated on assumptions about the relationship to the funding source
[54] As part of the EEA

Denmark are all under European legislation the relevant haircut rates are decided in the new CRD IV regulation (see Table 4 below).

There are limits to the size of each asset class' share of the HQLAs, which is also covered by CRD IV. As a starting point, the Basel committee recommended that the value of HQLA Level 1 securities should not exceed 60% of the total HQLA stock, and that covered bonds should not be defined as HQLA Level 1[55] (Johansen and Wiberg, 2014). In this case European regulators did not follow the recommendations from the Basel Committee. On 10 October 2014, the European Commission (2014) informed that certain covered bonds will be included in the HQLA Level 1, and that the applicable cap of the total HQLA stock is 70%. Together with covered bonds, other highly liquid assets such as cash, deposits and government bonds are defined as HQLA Level 1.

HQLA	Level	Cap applicable	Haircut applicable
Covered bonds ECAI 1	1	70%	7%
Covered bonds ECAI 2	2A	40%	15%
Unrated high quality covered bonds	2B	15%	30%

Table 4: Overview of covered bond in CRD IV (European Commission, 2014)

Covered bonds rated as ECAI 1 are eligible for HQLA Level 1 (Table 4). These bonds have the lowest haircut[56] rate, and due to an applicable cap of 70%, they will probably make up an important part of European banks' stock of HQLAs. The unrated covered bonds have the lowest liquidity of the bonds in the table and hence assigned the highest haircut rate.

The LCR will be implemented gradually in 2015-2019 (Appendix 1). The European LCR legislation has given covered bonds a central position, which might increase the demand for covered bonds in Europe. However, it is uncertain when the liquidity effect of the LCR will occur. Although the minimum requirement will be only 60% in 2015, banks might position themselves for a future change of the requirement and thus adapt their portfolio already from 2015.

6.4 Net Stable Funding Ratio

Together with LCR, the Net Stable Funding Ratio (NSFR) informs regulators about the bank's ability to cope with distressed market conditions. The objective of implementing such

[55] The main underlying assets, residential mortgages, have not experienced severe price falls during the last decades so it is difficult to conclude that covered bonds have high quality when they have not been "tested"
[56] Sovereign debt as government bonds and bills are regarded as the least risky security with a correspondingly haircut of 0%

regulations is to promote more medium and long-term funding of a bank's assets and activities. The NSFR was also introduced in Basel III to prevent a similar liquidity crisis that many banks faced under the financial crisis. According to BIS (2009), many banks were capitalized with short-term market funding. When the crisis occurred, the short term debt could no longer be rolled over[57]. That would not occur if banks had HQLA they could sell to repay their debt, which shows that the LCR and NSFR complement each other. According to the Basel Committee (2009) the NSFR is calculated as follows:

$$\frac{Available\ amount\ of\ stable\ funding}{Required\ amount\ of\ stable\ funding} \geq 100\%$$

Equation 6: Net Stable Funding Ratio (NSFR)

The relevant time span is one year. According to KPMG (2012) both the numerator and denominator are calculated by applying risk weights depending on the asset type, similarly to the calculation of RWAs. The numerator is related to the right hand side of the balance sheet, where long-term funding as equity and long-term debt is dedicated a high weight. As for the denominator, assets on the left hand side of the balance sheet are included. Risky and/or long-term assets are dedicated a high risk weight, meaning that a company needs more available stable funding.

This new regulation will probably also influence the portfolio and funding composition of banks. Banks will want to increase the maturity of their funding in order to be less exposed to refinancing risk. The long-term structure of covered bonds, which reduces a bank's duration gap,[58] is one of the reasons for why covered bond markets have grown rapidly in many countries recently (ECBC, p.106, 2014). When calculating the NSFR, covered bonds contribute considerably to the available amount of stable funding. On the other hand, the requirement for stable funding for covered bonds as an asset is low. These two factors will likely lead to increased activity in covered bond markets. Again, it is unclear when such an effect might occur in the marketplace. According to the phase-in schedule of Basel III regulations (Appendix 1), the NSFR will not be fully implemented before 2018, which means that banks have several years to fully adapt to this requirement.

[57] Rolling over debt refers to the type of short-term market funding such as 7-days repurchase agreements that is continuously repeated.
[58] When the assets' duration is different from the liabilities' duration. In the case of a bank the assets usually have the highest duration and thus a bank reduces the gap by increasing the duration of the liabilities.

6.5 Bail In

In addition to the Basel III accord that is being implemented through the CRD IV, the Council of the EU and the European Parliament have agreed upon a recovery plan for banks that will be an important mechanism in order to solve potential future banking crises (KPMG, 2013). According to Vale (2014), the bail in legislation is implemented so that banks that face distressed periods are able to continue with their core business without capital injections from local governments. In practice, bail in means that a troubled bank can be forced to convert some of its liabilities with low priority into equity and write it off if in case of substantial loses.

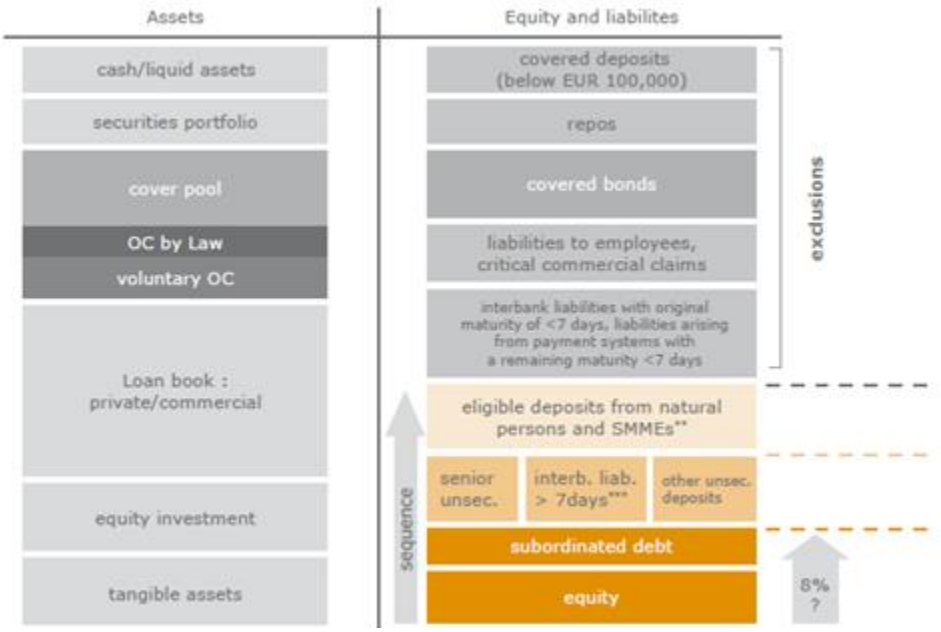


Figure 20: Bail in process (ECBC, p.61, 2014)

Figure 22 gives an example of which assets that are subject to the European bail in legislation. The first thing to notice is the clear sequence of the liabilities' priority and the liabilities that are excluded from the bail in framework. In an event of a banking crisis, the shareholders' equity will be written off first. If the losses exceed shareholders' equity, subordinated debt will be converted into equity and written off[59]. This process will continue and might include deposits from natural persons and small, medium and micro sized enterprises (Figure 22). The reaming liabilities on the balance sheet are exempt from being converted. Thus, if losses are large, banks can still go bankrupt or need to request capital injections from the local government.

[59] If the bail in legislation is exercised, at least 8 % of the liabilities must initially be written off or converted

The new legislation will increase the risk for several debt holders in the bank. Investors in for example subordinated debt and senior unsecured debt have traditionally been protected by a contract that assures them their interest and principal amount. If the bank fails to repay and goes bankrupt, the shareholders will take loses, but debt holders will still get some or all of their claims repaid. However, as the bail in framework give authorities the right to force specific debt holders to convert their claims into equity, their investor rights are weakened and the debt becomes more risky.

A plausible consequence of this new legislation is that funding sources as subordinated debt and other types of debt included in the bail in framework will be more expensive due to the increased risk. Banks might therefore end up funding more of their business by issuing other types of debt that is higher up in the capital structure, as covered bonds. That might lead to increased supply of such securities. As discussed earlier, the effect of increased supply is again uncertain, but a bigger outstanding volume will most likely result in increased absolute turnover.

7. Methodological issues regarding liquidity

7.1 What is liquidity?

In this paper we will compare the liquidity in the secondary Scandinavian bond markets from 2007 until 2014. In order to do this there are several quantitative measures that can be applied. However, before discussing how to measure liquidity it is necessary to clarify what the term liquidity means.

Liquidity is an ambiguous term that is hard to define in only one sentence. This is supported by Mohanty (2002) who claims that "market liquidity has several dimensions and there is not one satisfactory definition that captures all the features of a liquid market". A couple of papers on liquidity were presented in the review of previous literature. This is however only a tiny part of what that has been written about market liquidity, which demonstrates how extensive the research on this field is. Nevertheless, researches do not clearly agree on how to define this term and you can find different definitions in each paper. A definition given by Amihud and Medelson (1991) is commonly agreed upon and states that "an asset is liquid if it can be bought or sold at the current market price quickly and at low cost". This means that liquidity is related to trades in the market and is high if trades can be easily facilitated. Even though this is a fairly brief definition, it does not explain what "quickly" and "low cost" mean. A more deliberate definition is provided by Gabrielsen, Marzo and Zagalia (2011) who claim that "a market is often said to be liquid when the prevailing structure of transactions provides a prompt and secure link between the demand and supply of assets, thus delivering low costs of transaction." Instead of saying "at a low cost", Garbrielsen et al. (2011) give a more describing definition by using microeconomic terms as demand and supply. But again, this is not a non-elusive definition of the term, and an even more deliberate definition is necessary.

7.2 Dimensions of liquidity

Harris (1990) is frequently[60] referred to when defining liquidity in the most complete way. Harris introduces the following four dimensions of liquidity; *width, depth, immediacy* and *resilience,* which are similar to the dimensions Kyle (1985) uses to define liquidity; tightness, depth and resilience. Although the four dimensions that Harris introduces might seem independent, Wuyts (2007) states that they are not and may at times overlap.

[60] Some examples are Mohanty (2002), Chen and Zheng (2008) and Rakkestad, Skjeltorp and Ødegard (2012)

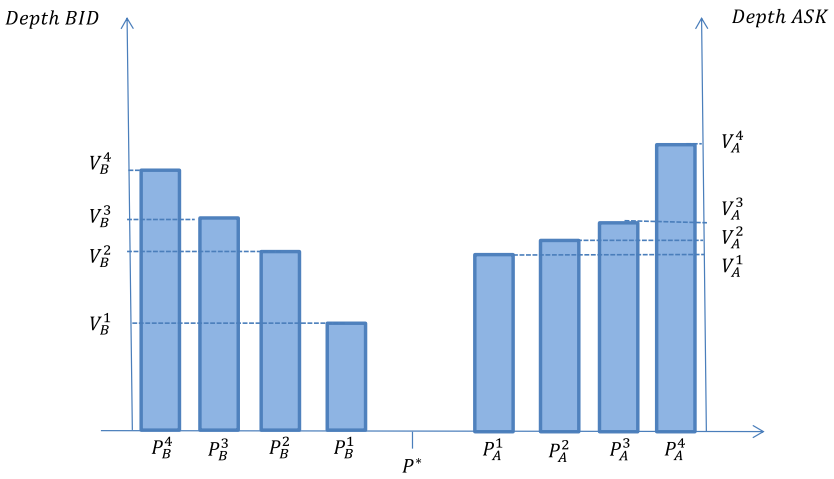


Figure 21: Arbitrary order book

For the following presentation of Harris' (1990) four dimensions of liquidity, it is helpful to use a figure (Figure 23) in order to provide a better understanding for the reader. The figure gives an example of an arbitrary order book of a traded asset (e.g. bond) where there are buyers (bid) and sellers (ask) that quote prices they are willing to trade on. In the middle, there is the market price P^*, which is the price of the last trade registered in the market. The height of the columns illustrates the quantity offered at the different quoted prices.

As we discussed in the part about the Scandinavian markets, most of the bonds we analyze are not traded in an auto-matched trading system. Some are not traded in a trading system at all due to the markets' OTC traditions. Still, the aspects related to liquidity apply independently of how trades are conducted.

7.2.1 Width

The first dimension Harris (1990) mentions is *width*. In Figure 23, width is the difference between the highest bid price P_B^1 and the lowest ask price P_A^1 and is often described as the bid-ask spread. The spread can be regarded as the price one has to pay in order to acquire liquidity at a given moment. A seller who wants to sell assets in order to obtain more funds might initially be unwilling to sell below P_A^1 , which is the price he believes to be fair. If something happens that forces the seller to raise funds quickly, he needs to find a buyer for his quoted assets. In our model, the seller would prefer the buyer with the highest bid price P_B^1. This is however a lower price than what the seller believes to be fair. Hence, the cost of the urgent liquidity need is the spread $P_A^1 - P_B^1$. Depending on the size of the spread, it is

possible to give an estimate on whether the liquidity in the market is high or low, where a tight spread indicates high liquidity.

As the example above illustrates, good liquidity is defined by a tight spread and thus a low transaction cost. This coincides with the definition of Amihud and Mendelson (1991) that relates to "low cost". This is only a part of Harris' definition of liquidity, which shows that their definition is narrower and relatively incomplete.

What neither Harris' (1990) definition of width nor Amihud and Mendelson (1991) talk about is the quantity an investor can buy or sell at prices P_A^1 and P_B^1. This is a highly relevant issue when discussing market liquidity because investors in financial markets may want to trade considerable amounts. That might lead to a bigger transaction cost than first perceived by the initial bid-ask spread.

7.2.2 Depth

Next, Harris (1990) introduces *depth*, which reflects the volume that can be traded in the market without affecting the price (Hein, 2003). This second dimension is of great importance for big investors and must be seen in combination with width when analyzing liquidity. The main reason for this is that investors that have to sell off assets in order to raise funds want to minimize the transaction cost. As mentioned earlier, the transaction cost is the spread between P_A^1 and P_B^1, but this applies only for a finite amount.

In Figure 23, imagine there is a seller that thinks the fair price is P_A^1 and offers an amount equal to V_A^1. If a sudden funding need emerges and the seller needs to liquidate assets as quickly as possible, the act of impatience comes with a cost which is the spread $P_A^1 - P_B^1$. However, since $V_B^1 < V_A^1$ the seller needs to accept an even lower price P_B^2, which will increase the transaction cost to $P_A^1 - P_B^2$ for the volume $V_A^1 - V_B^1$. Since $V_A^1 = V_B^2$ the seller does however not need to accept an even lower price as all extra supply is absorbed in the market at P_B^2. This example shows that in some cases the width dimension is an incomplete definition of market liquidity. It might not reflect the actual transaction cost.

7.2.3 Immediacy

The third dimension is *immediacy* and according to Wuyts (2007) it "refers to how quickly trades of a given size can be done at a given cost". The market liquidity is not considered good if market participants cannot meet in a marketplace and carry out trades. This dimension is harder to observe by looking at market and transaction data. It is more a matter

of the institutional and technological facilities then just quoted bid and ask prices. Although technological obstacles are not common in developed markets today, there are markets where the institutional aspects are not in place. Examples of this are markets without market makers who quote prices, or markets that do not have an established marketplace to carry out trades so that most trades are done OTC. In this case brokers play an important role.

Gabrielsen et al. (2011) emphasize that a liquid market is related to "a prompt and secure link between demand and supply of assets". Their more unraveled definition supports Harris (1990) in his third dimension. If the link between buyers and sellers is not secure, more contractual work needs to be done before the trade can be executed. This dimension is vital for market participants that for example are in a liquidity squeeze, and need to raise funds quickly[61].

7.2.4 Resiliency

The last dimension is according to Rakkestad et al. (2012) "notoriously difficult to measure, but captures a very important aspect of secondary market liquidity". *Resiliency* is about how fast prices will return to normal following an uninformed and unbalanced order flow (Harris, 1990). The word "unbalanced" is in this context related to the depth of the quoted market prices. The reason why prices move in the first place is an increased demand that exceeds the depth of market supply. That leads to the same outcome as in the example discussed earlier, where the market price moves from P^* to P_B^2 (see Figure 23). The market is resilient if market makers quickly react by increasing the supply of assets and thus reducing the difference between the market price before and after an unbalanced order flow. Rakkestad et al. (2012) also refer to a paper by Foucault, Kadan and Kandel (2012) where the researches show that resiliency can be given as a function of three input factors, where one relates to how intensely market makers monitor the market. The rationale behind this is that the more they monitor the market, the faster they can provide liquidity and thus prices will be less variable.

So, from the discussion of these four dimensions, a liquid market is characterized by a small width, large depth, good immediacy and strong resiliency. It is important to look at these measures collectively, as they are interrelated (Wuyts, 2007). For example, it is not to any help for a seller that the width is small and the depth is large if immediacy is poor. On the

[61] Nordic Trustee (before Norsk Tillitsmann) plays a vital role in the contractual part in the Nordic markets. See www.nordictrustee.com for more information.

other hand, an investor can face small depths for bid prices but if the resilience of the market is good then large amounts can still be sold at a low transaction cost.

7.3 How to measure liquidity?

Harris (1990) argues that liquidity is defined along four dimensions and this paper will take this approach as well. Next, we discuss how to *measure* some of the different liquidity dimensions in order to compare bond types and bonds markets. In addition to the complexity of defining liquidity, researchers also have difficulties in finding a set of measures that capture all aspects of liquidity. Dick-Nielsen, Feldhütter and Lando (2009) write that "there is no consensus on how to measure the liquidity of an asset, so we examine *a number of* liquidity-related measures (…)". Amihud and Mendelson (1991) support this statement and say that "liquidity (…) is not observed directly but rather has a number of aspects that *cannot be captured in a single measure*". Since most of the literature states that one should comprise several measures when analyzing liquidity, this paper will follow the same practice.

In the paper by Goyenko, Holden and Trzcinka (2009) several analysis are carried out with a wide range of old and new liquidity measures, in order to identify the most appropriate ones. That paper shows that there exists a vast amount of different liquidity measures than can be applied in our analysis. However, the conclusion of the paper is that some measures are better than others. Consequently, it is better to stick to a set of few good measures than several imprecise ones.

In order to combine the different dimensions of liquidity provided by Harris (1990) with sound and applicable liquidity measures, we will look to Buchholst, Gyntelberg and Sangill (2010) when choosing measures. The measures they employ are as follows:

- Median trade size
- Turnover rate
- Bid-ask spread
- Trade price impact measure (Amihud)

Although these measures are all relevant for our analysis, we need to adjust some of them according to the available data on the Scandinavian bond markets. Due to lack of daily transaction data for some markets,[62] we use average trade size instead of median trade size,

[62] Se chapter about Data for more discussion about the data set

and we simplify the price impact measure. More discussion on these minor changes follows below.

The subsequent part will go into the four proxies and measures of liquidity. The two liquidity *proxies* (average trade size and turnover rate) are quite straightforward and will not need much explanation. However, two liquidity *measures* (Roll's bid-ask spread measure and the simplified price change measure) will include an element of theoretical discussion. From this point, we will refer to these four measures and proxies as measures only.

7.4 Liquidity measures

7.4.1 Average trade size

The *average trade size* is a measure that will give a brief illustration of the activity in the markets, in terms of the size of the trades. A large average trade size means that it is possible to buy and sell big quantities in the market. This measure is related to Harris' (1990) depth dimension.

7.4.2 Turnover rate

The *turnover rate* has strong theoretical appeal and data for this rate is easy to obtain (Datar, Naik and Radcliffe, 1998). The rate discloses how many times the outstanding amount of assets is traded in a given period. The formula is

$$Turnover\ rate = \frac{Total\ traded\ volume}{Total\ amount\ of\ outstanding\ volume}$$

Equation 7: Turnover rate

This rate can be calculated per day, month or year. It can also be calculated for each security or aggregated for the whole market. The intuition is that a high rate indicates high liquidity while a low rate indicates low liquidity. For example, a market with a low turnover rate might have many investors holding on to their securities due to reasons such as a bank's required amount of liquid assets. This means that a buyer needs to increase his price substantially in order to find a seller, which would lead to an increased transaction cost as explained related to Harris (1990) width dimension. On the other hand, a low turnover rate might indicate that there are few buyers quoting prices due to various reasons. Again, the transaction cost would be high because the seller would have to decrease the price substantially in order to find a buyer. Both of these examples illustrate how turnover rate is related to liquidity and transaction costs through the width element.

In addition to the information the rate provides, Dick-Nielsen et al. (2009) defines the inversed rate as the average holding time for an asset. This means that if the inversed turnover rate based on monthly (quarterly) data is 10, the average holding period is 10 months (quarters).

As mentioned, the rate can be calculated both per bond and for the market as a whole. In order to get a measure of the turnover rate for an average bond in the market we should calculate the turnover rate per bond and then take the unweighted average. This requires a very comprehensive data set since we need to know the volume of each trade in addition to the bond's outstanding volume at all times. As we will discuss in the data chapter, our transaction data is not detailed enough to calculate this per bond for all markets. We will therefore calculate the aggregated turnover rate instead. It is not clear which method that is most correct, but since we in this paper compare several markets, we are confident that the aggregated turnover rate serves our purpose.

7.4.3 Bid-ask spread

So far, we have not discussed measures directly related to the dimensions provided by Harris (1990). The *Bid-ask spread* is the spread between the highest bid price and the lowest ask price, respectively P_B^1 and P_A^1 in Figure 23. This spread is frequently used to measure width. According to Chen, Lesmond and Wei (2007) the bid-ask spread is the most utilized liquidity measure among researchers. Rakkestad et al. (2012) introduces a similar measure that is called the *relative bid-ask spread.* The formula of this measure is:

$$RS_t = \frac{P_t^A - P_t^B}{P_t^M}$$

Equation 8: Relative bid-ask spread

P_t^A and P_t^B are the best ask and bid prices quoted during the period, and $P_t^M = (P_t^A + P_t^B)/2$. RS_t is easy to calculate for securities where bid and ask prices are quoted regularly, but in markets such as the Norwegian covered bond market, such prices are not officially quoted. In such cases, measures like *Roll's (1984) bid-ask spread measure* or Lesmond, Ogden and Trzcinka's (1999) *LOT measure* can be applied. Since the LOT measure requires a long and broad index for the underlying security, we will employ the Roll measure (Rakkestad et al., 2012). However, based on empirical research the Roll bid-ask spread measure is not necessarily the optimal choice. Both Lesmond (2005) and Lesmond, Ogden and Trzcinka

(1999) prove that the LOT measure dominates the Roll measure. But again, we do not have a long and broad index for the underlying assets so we will choose the Roll measure.

Roll (1984) suggests that under the assumption that markets are informationally efficient[63], it is possible to estimate the bid-ask spread by using this formula:

$$Spread\ measure = 2\sqrt{-cov(P_{t+1} - P_t, P_t - P_{t-1})}$$

Equation 9: Roll's bid-ask spread measure

Cov is the first-order serial covariance[64] and P_t is the transaction price at time t, where t can for example be a week, a month or a quarter. The denomination of the spread depends on whether the input price changes are in absolute terms or in percentage. In our case, the price change and spread will be in absolute terms. For calculating the measure Buchholst et al. (2010) use data from a rolling window of 21 trading days where there are several trades every day. We have data sets with fewer observations than this paper, thus we will use a longer rolling window of 32 trading days. In order to make sure that the covariance is reliable, we find it necessary to increase the amount of trading days to get sufficient amount of input data.

Roll (1984) claims that the price of a security moves continuously and randomly within a price interval where $P_t^B < P_t < P_t^A$ (see Figure 24). For his research he assumed that each security will trade at the bid and ask price 50 % of the time respectively (Holden, 2009).

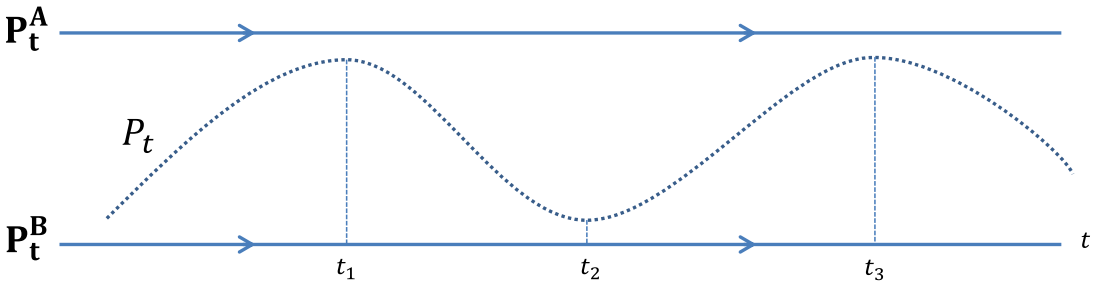


Figure 22: Roll's assumption about price movement of a security

In Figure 24 the price moves back and forth within an interval with ask prices at the top and bid prices at the bottom. This movement indicates a negative covariance between prices for different times *t*. If one calculates the covariance of several price changes occurring between t_1 and t_2, and t_2 and t_3 the $cov < 0$, and this condition has to be satisfied in order for the Roll

[63] A market price of a security reflects all public information
[64] Measure of how much two random variables move together. In order to calculate the covariance you need several observations for each variable because it impossible to calculate the covariance between to constants.

measure to be valid. Spreads are reported as positive numbers, and since the spread will be negative when $cov > 0$, the result is not valid and cannot be used in the later analysis.

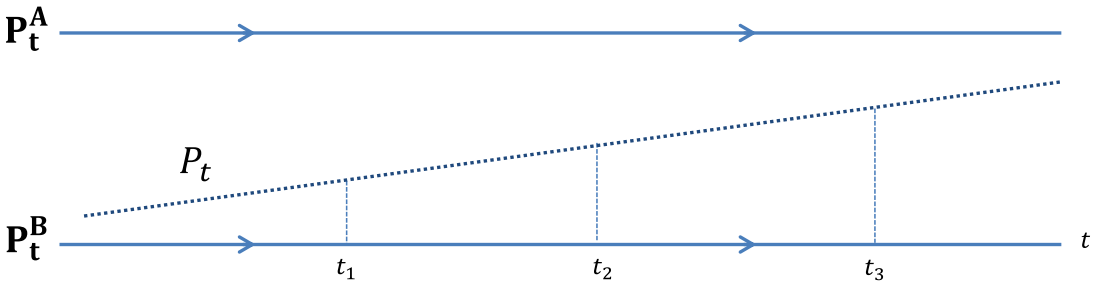


Figure 23: Price movement with increasing upward trend

An example of a price movement that results in a negative spread is shown in Figure 25. In this case, $cov > 0$ for all times t and the results will not provide information about the estimated spread.

As a final remark on the Roll measure, there are some complications related to its use. Since there is an assumption that prices move up and down within an interval determined by bid and ask prices, it is important to have frequent data on trades. Consequently, if trades are not frequent the measure might be imprecise. Furthermore, for some securities there might be price paths that are not random walks but on the contrary with strong downward- or upward-sloping trends. Such characteristics will add noise to the results and make them incorrect or invalid. Finally, the covariance might be a source of error because a too small sample will make the covariance imprecise. This is also related to the issue of not having enough data because a larger sample size for the covariance calculations leads to fewer Roll measure calculations. This enforces the problem related to bonds where there is already a problem with few trades.

The bid-ask spread is one of the most important liquidity measures, and indicates the width dimension of the market liquidity. Usually, the required inputs are historical quotes of bid and ask prices for a period of time. However, in markets were such quotes are not available, a measure like Roll's (1984) bid-ask spread measure must be used.

7.4.4 Price impact

The fourth and last measure is a *price impact* measure that is related to the depth dimension in Harris (1990). The main academic measure for depth is the Amihud (2002) Illiquidity Measure. This is supported by Chen and Zheng (2008) claiming that "a widely used proxy for measure of liquidity in recent empirical studies is an illiquidity measure employed by

Amihud (2002)". Several papers like Mancini, Ranaldo and Wrampelmeyer (2013), Bushman, Le and Vasvari (2010) and Buchholst et al. (2010) apply the Amihud illiquidity measure. According to the latter paper, the formula is as follows:

$$Amihud_i = \frac{\left|\frac{P_i - P_{i-1}}{P_{i-1}}\right|}{Q_i}$$

Equation 10: Amihud's Illiquidity Measure

P_i is the trading price and Q_i is the trading volume, where a big relative price change indicates low liquidity. In that case, the depth of the current bid or ask price is small and the trade has a big impact on the price and again a significant transaction cost. However, if the trade is of a large size, a larger price impact is expected because the trading volume is high. To adjust for this, Amihud proposes to divide by Q_i. The intuition behind this is that a market does not need to be illiquid every time the price moves because an investor that carries out a big trade will automatically move the price. Consequently, in this case an investor must expect a higher transaction cost.

In the subsequent years after Amihud (2002) published his measure, numerous researchers have come up with their own versions[65]. One recently published version was presented by Dick-Nielsen, Gyntelberg and Sangill (2012), who have come up with the following formula:

$$PI_{t,i,k} = \frac{\left|P_{t,i,k} - P_{t,i-1,k}\right|}{P_{t,i-1,k}}$$

Equation 11: Dick-Nielsen et al.'s relative price change measure

The *i* signifies the transaction number on day *t* in bond *k*. The only difference from the original Amihud (2002) formula is that Dick-Nielsen et al. (2012) do not divide the relative price change by the trade volume (Q_i in $Amihud_i$). They argue for this based on empirical observations in their paper that prove there is no significant relationship between price impact and trading volume for the Danish bond market[66].

Preferably, we should apply both price change measures in our paper on covered bond markets for two reasons. Firstly, two measures will probably give a better indication of which market that is more liquid than one measure. Secondly, we could test if Dick-Nielsen et al.'s

[65] Rakkestad et al. (2012), Chen and Zheng (2008) and Dick-Nielsen et al. (2009)
[66] If there is any relationship at all, the relationship is negative

(2012) claim that relative price changes are independent of trade size also goes for the Norwegian market. However, as we already have emphasized, our data sets do not include sufficient information on trading volume, which makes it impossible to calculate the Amihud Illiquidity Measure. This paper will thus use Dick-Nielsen et al.'s (2012) relative price change measure.

Now we have presented the four measures we will use in our analysis:

- **Average trade size**
- **Aggregated turnover rate**
- **Bid-ask spread measure (Roll (1984))**
- **Relative price change measure (Dick-Nielsen et al. (2012))**

8. Data

8.1 Selection of data

We base our analysis on data from Scandinavian marketplaces on trades and issues of bonds from 2007 until October 2014. We focus solely on the domestic market in each country, and therefore only include bonds listed on domestic marketplaces in the domestic currency. Most covered and government bonds in the different Scandinavian countries are listed on various exchanges, and the data has been assembled from a wide range of databases. We have excluded bonds not listed in order to better compare the markets and due to difficulties in gathering data on these bonds. We have also eliminated all identified outliers in order to avoid noisy results. The main focus of the paper is to compare the liquidity of traded bonds in three different countries and thus at least three different markets places are included.

In order to carry out the analysis, we need data on (1) outstanding volumes of the bonds in the market, (2) historical trading prices and (3) trading volumes per bond. The relevant period is 1 January 2007 to 30 September 2014. Even though the three data types might seem simple, the work of obtaining all the data has been more time-consuming than expected. Somewhat special bond markets that lack proper transparency is the main reason for this. This goes in particular for information about trades made in the secondary market. Altstedter (2014) supports the claim that bond markets are less transparent than other markets, such as stock markets.

Type of security	Type of data	Source	Included in sample
Norwegian government bonds	Outstanding volumes	Oslo Børs	All bonds listed in the relevant period
	Prices	Infront[67]	All listed bonds per 30.9.2014
	Trading volume	Oslo Børs	All bonds listed in the relevant period
Norwegian covered bonds	Outstanding volumes	Stamdata	All bonds listed in the relevant period
	Prices	DNB	All bonds listed in the relevant period
	Volumes	DNB	All bonds listed in the relevant period
Swedish government bonds	Outstanding volumes	SCB[68]	All bonds listed in the relevant period
	Prices	Nasdaq OMX Sweden	All bonds listed per 30.9.2014
	Trading volumes	Riksbanken	All bonds listed in the relevant period
Swedish covered bonds	Outstanding volumes	Stamdata	All bonds listed in the relevant period
	Prices	Nasdaq OMX Sweden	All listed fixed rate benchmark bonds per 30.9.2014
	Trading volumes	Riksbanken	All bonds listed in the relevant period
Danish government bonds	Outstanding volumes	Nasdaq OMX Denmark	All bonds listed in the relevant period
	Prices	Nasdaq OMX Denmark and Danish FSA	All bonds listed per 30.9.2014
	Trading volumes	Nasdaq OMX Denmark and Danish FSA	All listed bonds in the relevant period
Danish covered bonds	Outstanding volumes	Nasdaq OMX Denmark	All bonds listed in the relevant period
	Prices	Nasdaq OMX Denmark and Danish FSA	75 largest bonds listed per 30.9.2014
	Trading volumes	Nasdaq OMX Denmark and Danish FSA	All bonds listed in the relevant period
Currencies	SEK/EUR, NOK/EUR and DKK/EUR	Macrobond database	

Table 5: Sources for data on Scandinavian covered bonds and government bonds

Table 5 provides an overview of the different marketplaces and institutions that have been involved when gathering data for the later analysis. In addition to the data provided by the marketplaces in each country, we have used published data from public institutions such as central banks and statistical bureaus. Furthermore, Nordic Trustee's database "Stamdata" has been particularly useful in our work. This database provides reference data for Nordic debt securities and the depth and accuracy available is superior for data on the Scandinavian fixed

[67] Data provider – www.goinfront.com
[68] Finansmarknads- and verdepapperstatistiken from Svenska Statistiska Centralbyrån (SCB)

income markets[69]. Stamdata has been especially helpful for collecting information about individual bonds and outstanding volumes in the Norwegian and Swedish market[70]. Stamdata has also been helpful as an introduction to what specifications a standard bond contract includes, which is relevant information when dealing with bonds. As presented above, both the Swedish and the Danish bond markets are organized by Nasdaq OMX, but they are still set up as two different marketplaces.

In the next three parts we will go into more detail about each of the countries in terms of where to find relevant data and eventual complications we encountered on the way.

8.2 Data - Norway

As shown in Table 5, we have used several sources in order to obtain sufficient data for the Norwegian market. For Norwegian covered bonds, DNB[71] provided us with a complete data set with trades executed in all bonds at Oslo Børs in the relevant period. This gave us a quick introduction to the covered bond market in Norway. Additionally, we received a set of trades for Norwegian covered bonds from 2010 from Nordea. We used these two sets and information from Stamdata and Oslo Børs to put together a list of trades in all the covered bonds we wanted to include in our set. Noticing that the set of bonds from the two banks did not match, we spent a considerable amount of time investigating which bonds that did in fact meet our definition of the market. We ended up with a total of 311 bonds, where 299 of these were backed by residential mortgages[72]. For trades, Oslo Børs publish a monthly report on the secondary market activity for bonds in Norway. However, the statistics they offer for free only go back five years, so Infront's database[73] was necessary in order to complete the set on trading data for government bonds. We obtained outstanding amounts for all government and covered bond on a monthly basis by downloading data on initial issues, tap issues and buybacks from the Stamdata database.

To investigate different parts of the Norwegian covered bond market, we split the set of bonds into smaller groups according to certain characteristics. Wanting to differentiate on the size of bonds, we made one group consisting of bonds with an outstanding volume less than

[69] Bloomberg and Reuters also provide data
[70] Stamdata has relatively few Danish bonds in its database
[71] Norway biggest financial services group
[72] The remaining 12 bonds were backed by commercial mortgages
[73] This database is based on Oslo Børs database

NOK 1 billion. Further, we separated bonds included in the Covered Bond Benchmark and lastly bonds issued by the three largest issuers in the market[74].

One important aspect of our data is that it is uncertain whether tap issues are included in the trading data on covered bonds or not. As they are not part of the secondary market activity, they should be excluded when calculating liquidity measures. According to market participants, tap issues often appear as normal trades in the data sets. However, according to our research, that is not always the case. Even though we have identified tap issues by comparing data from Stamdata and DNB, we have also encountered situations where we are certain that tap issues do not appear as normal trades. Due to this uncertainty, and the fact that we have not been able to get a good explanation on the procedure in such cases, we have chosen not to adjust the data. To get an indication on the possible effect of this, we have compared the amount of tap issues to the total amount of trades for each single year from 2008 (Table 6).

Year	Tap issues	Total turnover	Tap issues / Total turnover
2008	5 500 000 000	7 929 500 00	69 %
2009	10 200 000 000	14 371 330 000	71 %
2010	18 200 000 000	41 975 500 000	43 %
2011	70 415 000 000	138 992 000 000	51 %
2012	43 475 000 000	159 319 900 000	27 %
2013	44 696 666 666	234 734 800 000	19 %
2014*	72 454 000 000	233 900 000 000	31 %
Total	264 940 666 666	831 223 030 000	32 %

* Until October

Table 6: Overview of tap issues and turnover for the Norwegian covered bond market

In Table 6 we have included data on tap issues from Stamdata and turnover figures from the DNB data set. As can be seen, the ratio of tap issues to total turnover was about 70% in 2008 and 2009, but has fallen to 20%-30% in the last three years. These percentages represent the worst case scenario for how much our turnover figures are affected.

8.3 Data - Sweden

The Swedish market is less transparent than the Norwegian covered bond market, which for example can be seen from the amount of data sources that have been used in the process. This transparency issue resulted in us using an incomplete data set. More specifically, we do not have data on all bonds listed in the relevant period, and for the bonds where we do, the data are only on a daily basis. In the process of gathering data, we first approached different

[74] DNB, Nordea and Sparebank1 (SB1)

institutions, but it turned out that no one had a complete data set for the entire market. As we did for the Norwegian market, we also approached Swedish commercial banks, but they only had data sets on trades where they acted as a buyer or seller. We also contacted Riksbanken[75] which only could provide monthly aggregated trading data. We ended up using historical daily yield data provided by Nasdaq OMX Sweden on currently listed benchmark bonds. Per October 2014, both fixed and floating rate bonds are listed on the exchange, but due to the complicated process of valuing floating rate bonds[76], our Swedish set of price data consists only of historical prices on fixed rate bonds[77]. The valuations had however not been possible without the information about maturity dates and coupon rates provided by Stamdata. In order to calculate prices, we made a simple valuation model with input from among others Stamdata. For government bonds we faced exactly the same complications as for covered bonds, and our data set for these securities is also based on prices of fixed rate bonds[78] calculated from daily yield data.

Another shortage in the Swedish data is that we lack data on trading volume on transactional level. For the average trade size measure, this would however not have been a problem if we possessed the number of transactions per day. Yet again, the Swedish market turned out to be opaque and we have not obtained this information. Swedish FSA was the only actor that could supply us with transaction level data. It was very cryptic so we ended up not using it.

Lastly, we needed monthly outstanding volumes for the two types of bonds. As previously mentioned, Stamdata has an extensive database on the Norwegian and Swedish covered bond market, so that part turned out to be less challenging. For the government bonds, we found the data by accessing SCB's website and combining two different statistical reports.

8.4 Data - Denmark

As stated earlier, the Danish covered bond market is the biggest market in terms of most measures, has the longest history and is the most sophisticated in terms of legislation. However, it has been challenging to get our hands on a complete and correct set of data for the Danish markets. A lot of information is available at Nasdaq OMX's webpages, but due to the vast amount of bonds in the market, it was too time-consuming to extract the data

[75] http://www.riksbank.se/en/Statistics/Money-and-Bond-Markets/
[76] See bonds pricing chapter
[77] Fixed rate bonds dominate the market so this is regarded as a good proxy for the whole market. For better explanation see Figure 12 about the Swedish issuers.
[78] All government bonds are fixed rate bonds

manually. We therefore contacted different institutions hoping to get help putting a complete data set together, among others the Association of Danish Mortgage Banks, the Danish Mortgage Banks' Federation, The Danish National Bank, several Danish commercial banks, The Danish FSA and Nasdaq OMX Denmark. After getting in contact with the right people at the two latter institutions, we were able to put together large sets of data.

We received a vast data set with all trades conducted in all covered bonds from Nasdaq OMX. The data period was from 2007 until October 2014, and included prices and volumes of trades. The only information about the bonds except this was the ISIN number, which limited our possibilities of reviewing the bonds and look at selections of bonds according to any characteristics. We later received a set with aggregated data on average prices, trading volumes and outstanding volumes for all bonds on a monthly basis. These were more manageable, and were used to calculate the number of trades and liquidity measures like monthly average trade size per bond and turnover rate. In addition to the data received from Nasdaq OMX, we received daily data from the Danish FSA, which also included data on Danish government bonds.

Unfortunately, due to two reasons, we decided not to use the daily data on prices and volumes from the sets mentioned earlier. Firstly, these data were so large that we had difficulties with calculating liquidity measures without our computers struggling. Secondly, we discovered unusually large differences in prices, both within the same day, and between subsequent trading days. After consulting the Danish FSA on this, we decided to discard the data.

We ended up downloading daily data on a selection of bonds from the Nasdaq OMX website. For government bonds, we downloaded daily prices and trading volumes on all bonds that were listed at the time of extraction. In order to get sufficient data to do sensible calculations on covered bonds, we made a selection based on the following requirements:

1. Outstanding value of more than DKK 5 billion by October 2014
2. Issued before 2012
3. Trade at the time of extraction

Being able to do calculations on all bonds in the markets would be ideal. However, with the difficulties we have encountered, and due to the large size of the market, we believe we are able to make sound conclusions with the restrictions we have made.

A general observation for the markets in all Scandinavian countries is that outstanding volumes are easier to obtain than transaction data such as price and volume per trade. Most of the trading volumes we have are on aggregated levels, not on transactional levels. We have approached the local FSAs in Denmark and Sweden, trying to get information in order to adjust for the lack of transactional data. This was as stated helpful for Danish bonds, but the Swedish data set was too cryptic to use.

9. Results

9.1 Structure of results

These results are based on the data discussed in the preceding chapter. As stated previously, the data sample of bonds for the Danish and Swedish market is not complete. For the analysis this means that for average trade size and turnover rate, we will use data gathered for the whole market. However, when we estimate the other liquidity measures, the input is only based on parts of the markets. The structure of the presentation will be in the same order as for the measures discussed in the methodology chapter. As for each measure, we will first present the development of the Norwegian covered bond market. Then we will do a comparison with the other two Scandinavian covered bond markets, followed by a comparison with government bond markets in the same countries. Finally, we will break the Norwegian market down into several groups in an attempt to explain its development in more detail.

Using data denominated in the local currency would affect the comparison of the average trade size and Roll's bid-ask spread measure. When comparing markets in different countries, we have converted all numbers into EUR.

To show an example of gathered raw data, we have included two tables in the appendix (Appendix 3 and 4). The former presents output data on liquidity measures in the Norwegian covered bond market, while the latter displays raw data for calculating the measures in one Norwegian covered bond.

9.2 Average trade size

9.2.1 Norwegian covered bond market

The first result is of the average trade size for the entire Norwegian covered bond market (Norwegian COVB).

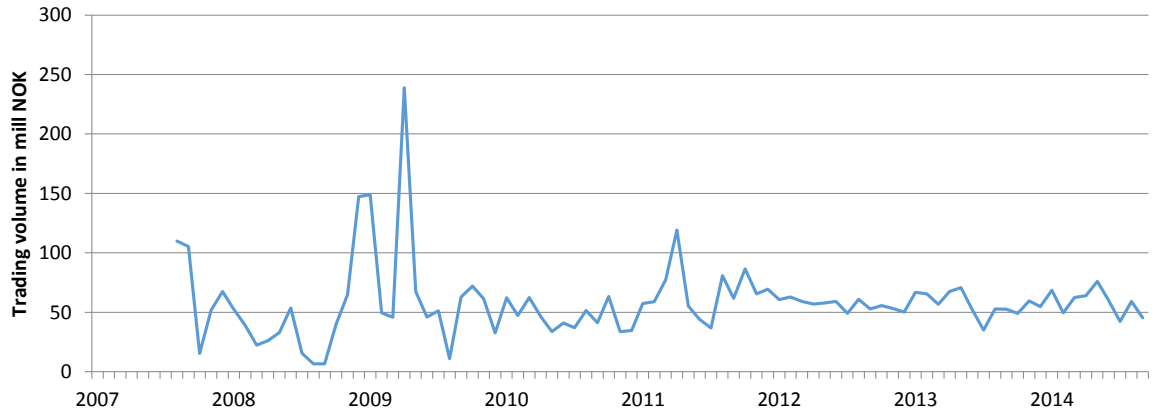


Figure 24: Average trade size (monthly average) – Norwegian covered bond market

Since 2010, the average trade size in Norwegian covered bonds has been quite stable with a minor down-sloping trend towards 2014 (Figure 26). Towards the end of the period, the level has stabilized around an average trade size of NOK 50.000.000. Before 2010, the average trade size was much more volatile.

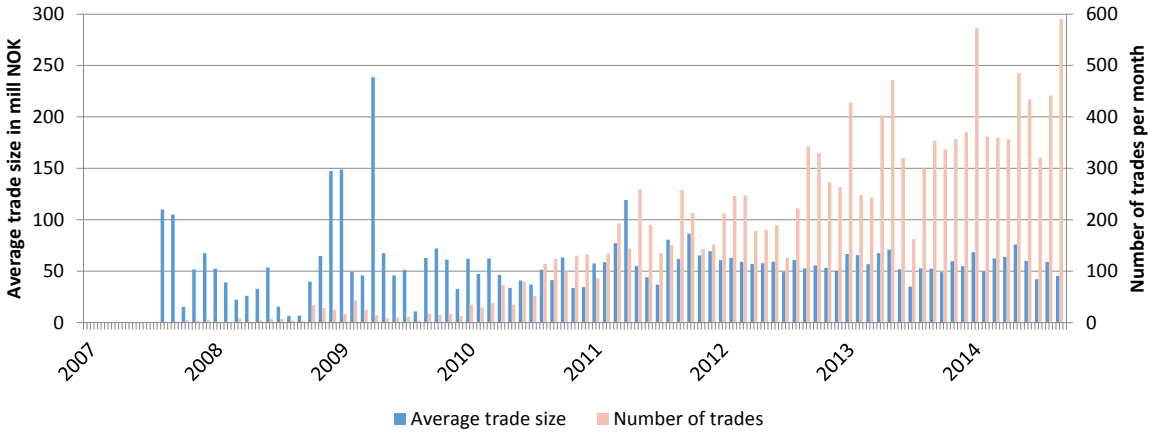


Figure 25: Average trade size and number of trades – Norwegian covered bond market

By including the development in number of trades, we can easier explain the development of average trade size for Norwegian covered bonds. Looking at Figure 27, the average trade size is represented by the blue columns with the level showing on the left axis, while the number of trades per month is in orange and the level corresponds to the right axis. As can be seen from the graph, the main reason for the spike in 2009 is because of some few and abnormally large trades. In the beginning of the period, the number of trades was very low, meaning that a single trade might have a relatively larger impact on the average size than in months with

many trades. In addition to this, the peak occurs in a period where the world is experiencing a financial crisis and unusually few trades are executed. Risk premiums on bonds were higher and investors were probably more skeptical of trading with each other. We will not go in to detail about this spike every time, so for all later graphs in which the spike appears we refer to this discussion.

9.2.2 Norwegian covered bond market vs other covered bond markets

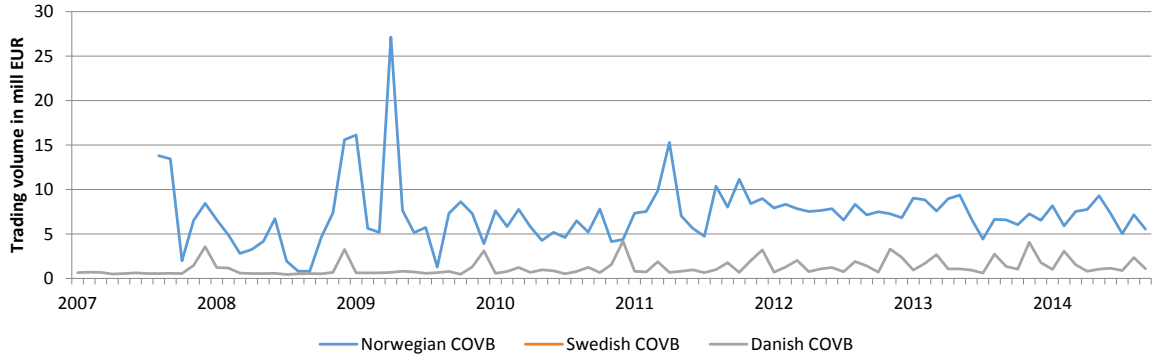


Figure 26: Average trade size (monthly average) – Scandinavian covered bond markets

To further analyze the average trade size in the Norwegian covered bond market, we have chosen to compare it to some other covered bond markets. In Figure 28, we have included the average trade size for the Danish market[79]. Compared to this, the liquidity in the Norwegian market is high in terms of average trade size. This observation did not occur just a couple of times but is consistent throughout the whole period. The Danish averages are also backed by a great amount of observations, so the explanation for this must be that Danish market participants usually carry out smaller trades than in the Norwegian market.

9.2.3 Norwegian covered bond market vs government bond markets

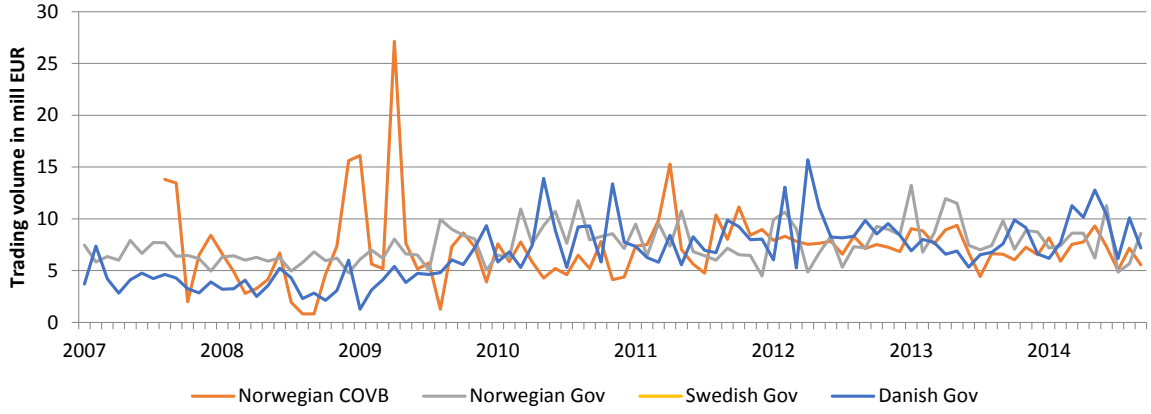


Figure 27: Average trade size (monthly average) – Norwegian covered and Scandinavian government bonds

[79] As discussed in the Data chapter we do not have data on number of trades for Swedish covered bonds

	Period	2010	2011	2012	2013	2014*
Yearly average, EUR	**Norwegian COVB**	5 759 574	**8 692 315**	7 557 246	7 330 194	7 077 940
	Norwegian Gov	**8 555 952**	7 292 253	7 997 409	**9 029 979**	7 596 374
	Swedish Gov	-	-	-	-	-
	Danish Gov	8 245 417	7 534 495	**9 343 954**	7 326 773	**9 095 877**

*Until October

Table 7: Average trade size (yearly average) – Norwegian covered and Scandinavian government bonds

As discussed in the chapter on government bonds, each country has its own government bond issuing facility and all Scandinavian countries have outstanding bonds. The first we can see from Figure 29 is that during the last couple of years, the liquidity in terms of average trade size has been more or less as good in the Norwegian covered bond market as in the Scandinavian government bonds markets[80]. Furthermore, there were some peaks for average trade size in Norwegian covered bonds around the start of 2009 and one in mid-2011. The peak in 2009 is earlier explained by few and large transactions, while for the peak in 2011 there are more trades but the trades are larger than normal. Based on this we do not find it correct to conclude that the Norwegian covered bond market is more liquid. To support this statement, Table 7 shows that the Norwegian yearly average trade size was the lowest in all three years from 2012-2014. The numbers in bold represent the highest yearly trade size, and hence the highest liquidity.

9.2.4 Different groups of bonds in the Norwegian covered bond market

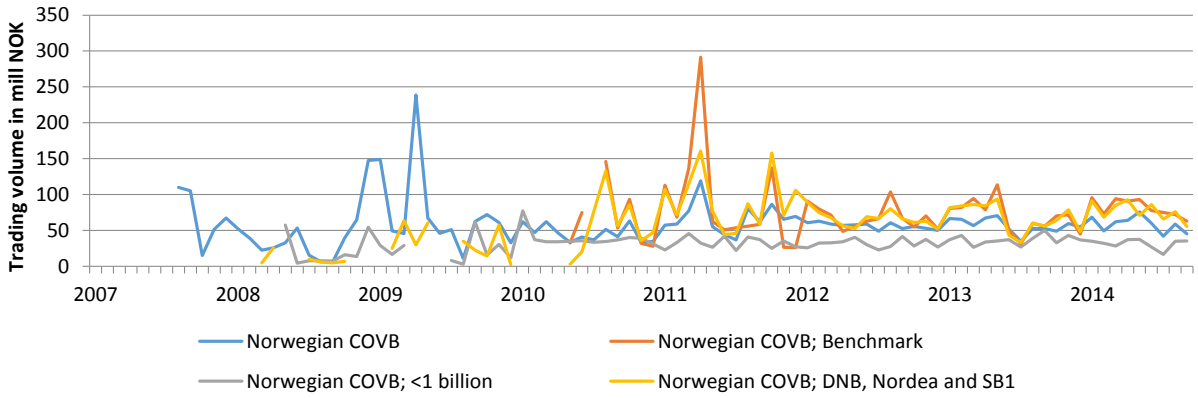


Figure 28: Average trade size (monthly average) – Groups of Norwegian covered bonds

As stated earlier, after having seen how the Norwegian covered bond market has performed in comparison to other bond markets, we split the market into different smaller groups. This is to investigate which types of Norwegian covered bonds that have had the highest and lowest liquidity. *Norwegian COVB* includes the entire covered bond market. *Norwegian COVB; Benchmark* only includes bonds in the newly established Norwegian Covered Bond

[80] We do not have data on number of trades for Swedish government bonds

Benchmark[81]. *Norwegian COVB; <1 billion* consist of the smallest bonds, with less than NOK 1 billion outstanding. *Norwegian COVB; DNB, Nordea and SB1* is a sample that includes bonds issued by the three biggest issuers in terms of outstanding volume.

The first observation we make from Figure 30 is that the data from 2007-2010 consists of few observations. Secondly, there are important spikes in beginning of 2009 and mid-2011. In general, a case where you have a sample that comprises the whole market (Norwegian COVB), compared to smaller samples that all sum up to the market, some samples will have a higher average and some lower than the entire market. For the peaks around the start of 2009 however, none of the samples have a higher average than the market. This means that we have not included the bonds that are causing the spike in any of our smaller groups, and thus we cannot analyze the spike further. The same cannot be said about the spike in 2011. In this case, the main contributors for the increased market average trade size are bonds in benchmark group.

The third and last observation we can make from Figure 30 is that trades in bonds with less than NOK 1 billion are smaller on average. In practice, this indicates that it is harder to sell large amounts of this type of bond. Similarly, the bigger bonds in the benchmark and the bonds issued by the largest issuers have a *higher* average trade size which points to a higher liquidity.

According to the average trade size measure, we do not find any evidence that the Norwegian market is more or less liquid than other bond markets. However, we have reason to believe that larger bonds in the Norwegian market are more liquid than smaller bonds.

[81] The benchmark was not established before June 2014. However, the bonds included in the benchmark today did exist before its introduction.

9.3 Turnover rate

In order to further evaluate the liquidity of the Norwegian covered bond market and other Scandinavian bond markets, we will next look at turnover rate.

9.3.1 Norwegian covered bond market

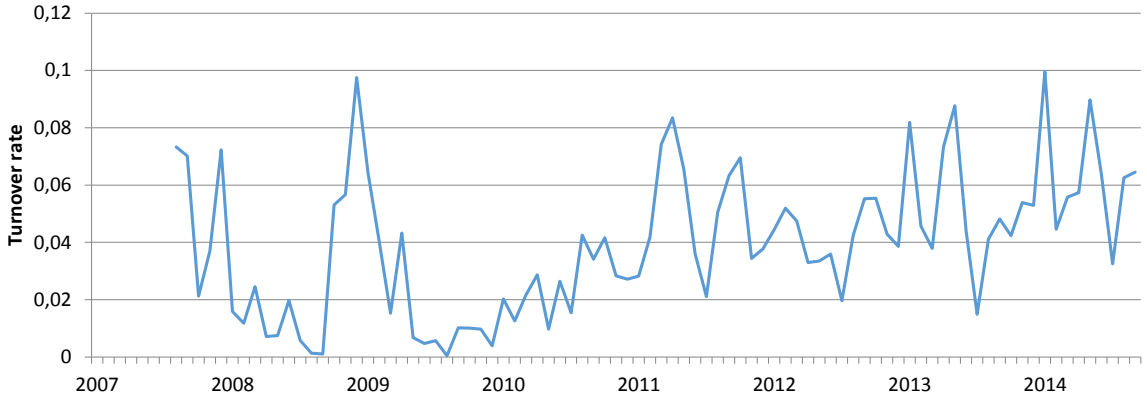


Figure 29: Turnover rate (monthly average) – Norwegian covered bond market

With the exception of a few months in 2009 that we have discussed earlier, the turnover rate for the Norwegian covered bond market was low during the financial crisis 2008-2010 (Figure 31). Since 2011, the turnover rate has increased and on average the rate is at a higher level than before. This indicates that the liquidity of the market has improved. On the other hand, the rate has been relatively volatile in the last couple of years, which makes it hard to conclude on whether the market has stabilized on a high level or not.

9.3.2 Norwegian covered bond market vs other covered bond markets

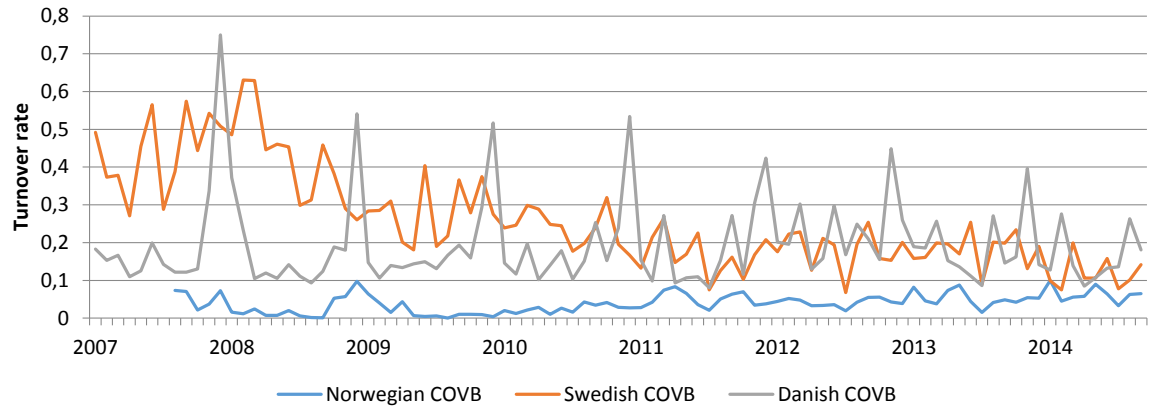


Figure 30: Turnover rate (monthly average) – Scandinavian covered bond markets

	Period	2010	2011	2012	2013	2014*
Yearly average (of monthly rates)	Norwegian COVB	0,026	0,050	0,042	0,052	0,063
	Swedish COVB	**0,238**	0,167	0,182	0,182	0,118
	Danish COVB	0,193	**0,182**	**0,231**	**0,186**	**0,161**

* Until October

Table 8: Turnover rate (yearly average) – Scandinavian covered bond markets

By looking at the Norwegian market separately, we identified an improvement over the last years. However, when comparing it to the Swedish and Danish covered bond market the turnover rate is notably lower than its counterparts' rates (Figure 32). The Swedish market had a very high turnover rate in the years of 2007-2009, but which later decreased towards the level of the other markets. The turnover rate for the Danish covered bond market has been volatile but on average somewhere in between the Norwegian and Swedish markets' rates. There are clear seasonal effects with spikes at the end of each year. Later, the volatility in the Danish market has decreased but the average level has more or less stayed the same. In total, this development has led to a convergence of turnover rates and by 2014 the Danish and Swedish rates are very similar. In fact, according to Table 8 the Danish market's yearly average surpassed the turnover rate of Swedish covered bonds in 2011, and has stayed at a higher level since then. The Norwegian market's low turnover rate indicates a lower liquidity and it has been dominated by the two other markets for most of the time.

9.3.3 Norwegian covered bond market vs government bond markets

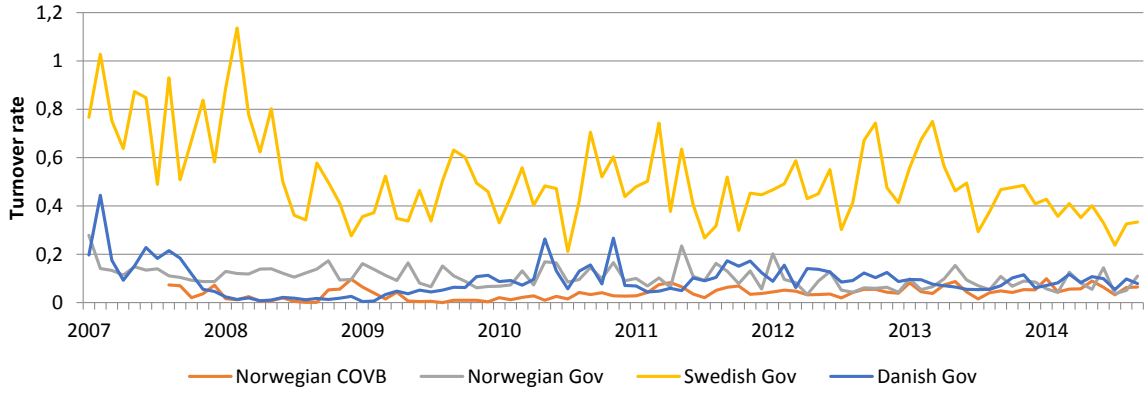


Figure 31: Turnover rate (monthly average) – Norwegian covered and Scandinavian government bonds

	Period	2010	2011	2012	2013	2014*
Yearly average (of monthly rates)	**Norwegian COVB**	0,026	0,050	0,042	0,052	0,063
	Norwegian Gov	0,113	0,110	0,080	0,087	0,078
	Swedish Gov	**0,465**	**0,454**	**0,500**	**0,500**	**0,353**
	Danish Gov	0,125	0,099	0,111	0,076	0,088

*Until October

Table 9: Turnover rate (yearly average) – Norwegian covered and Scandinavian government bonds

Compared to the Scandinavian government bond markets, the Norwegian covered bond market is again not performing that well (Figure 33). The Swedish government bond market performs much better than the other markets in terms of turnover rate. Furthermore, the Norwegian and Danish government bond market experienced a higher rate than the Norwegian covered bond market early in the period. Recently however, the turnover in

Norwegian covered bonds has increased to similar levels as the Norwegian and Danish government bond markets (can also be seen from Table 9).

9.3.4 Different groups of bonds in the Norwegian covered bond market

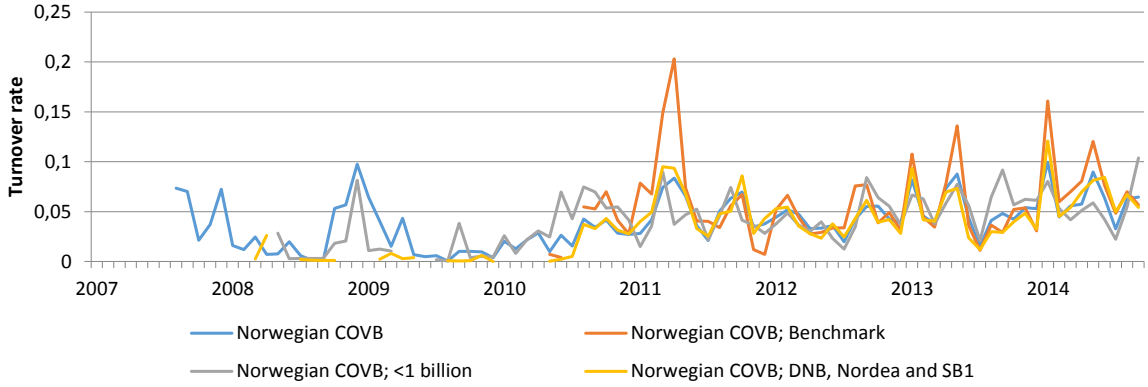


Figure 32: Turnover rate (monthly average) – Groups of Norwegian covered bonds

	Period	2011	2012	2013	2014
Yearly average (of monthly rates)	**Norwegian COVB**	0,050	0,042	0,052	0,063
	Benchmark	**0,069**	**0,047**	0,054	**0,083**
	<1 billion	0,048	0,042	**0,060**	0,056
	DNB, Nordea and SP1	0,055	0,039	0,044	0,070

* Until October

Table 10: Turnover rate (yearly average) – Groups of Norwegian covered bonds

Again, we try to break down the Norwegian market in an attempt to identify parts of the market that differ from the market as a whole. As for the first years the market existed, available data is poor and it is difficult to draw any conclusions. In recent years all groups seem strongly correlated which makes it hard to identify differences (Figure 34). However, since 2011 the largest bonds in the market, represented by the Norwegian Covered Bond Benchmark have the highest peaks. This indicates that if any, the larger the bonds, the higher the turnover rate. This statement is also supported by the results presented in Table 10 where benchmark bonds had the highest turnover rate in three of the last four years.

When evaluating the turnover rate, the Norwegian covered bond market is lagging a bit behind the other Scandinavian covered bond markets. The Norwegian market also performs worse than its peers when comparing it to the three Scandinavian government bond markets. Consequently, Norwegian covered bonds seem less liquid than other bonds when looking at this measure.

9.4 Roll's bid-ask spread measure

9.4.1 Norwegian covered bond market

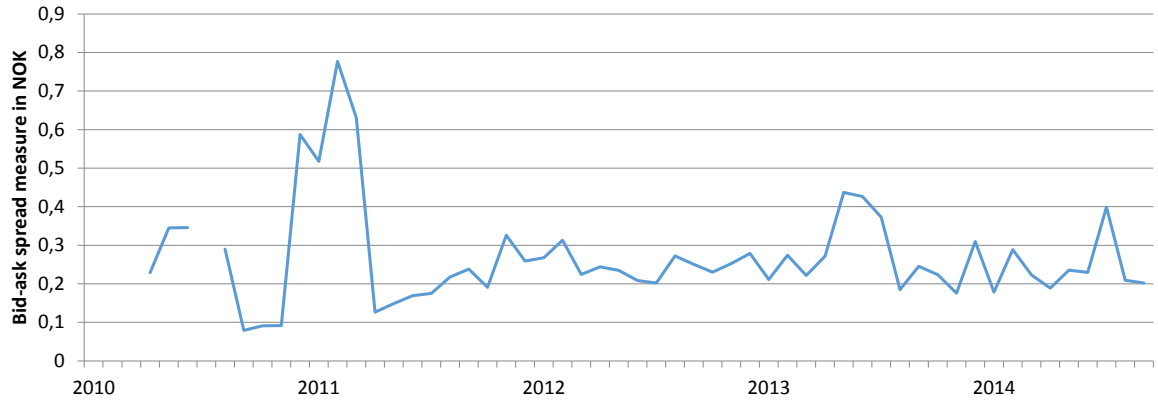


Figure 33: Roll's bid-ask spread measure (monthly average) – Norwegian covered bond market

The first thing the reader might notice from Figure 35 is the lack of data in the start-up phase of the Norwegian market from 2007-2010. In order to come up with an estimate of the measure, at least 32 consecutive trades are required. We do not have that many trades before 2010. As we have seen in Figure 27 there were very few trades in the first two-three years that the market existed, and thus the measure is not applicable. For the time period where we have data, we can see that the spread is quite stable except for the period around the beginning of 2011 (Figure 35). As for the rest of the period, the spread has an average between NOK 0.2 and 0.3.

9.4.2 Norwegian covered bond market vs other covered bond markets

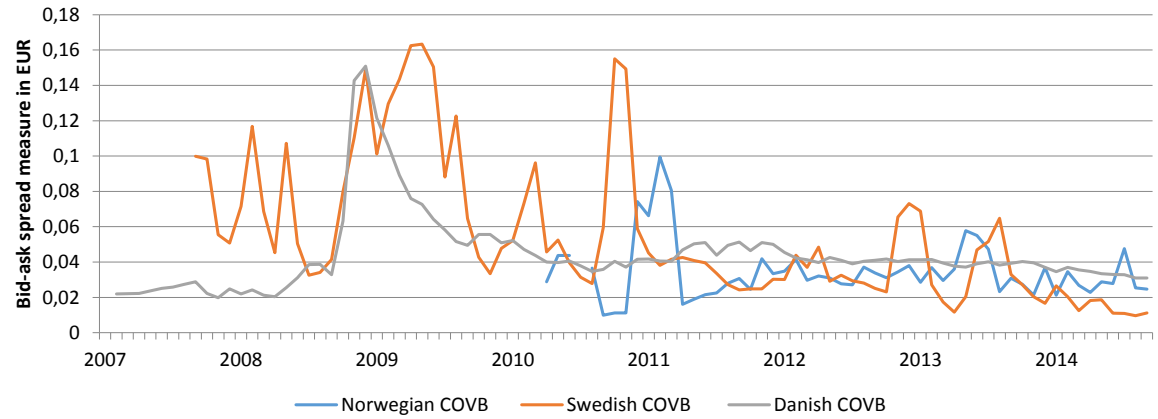


Figure 34: Roll's bid-ask spread measure (monthly average) – Scandinavian covered bond markets

Both the Swedish and the Danish markets have longer history and we are thus able to estimate bid-ask spreads from 2007 (Figure 36). During the crisis years of 2008-2010 the reactions in the Swedish and the Danish markets were similar and the spread increased a lot. For the Danish market, the spread came down quickly, but the Swedish spread stayed volatile for a couple of years more. However, since 2011 all spreads have come down to more or less

the same levels. As for the development of 2014, the Norwegian spread is lower than for the two other markets, which indicates that the liquidity of the Norwegian covered bonds is relatively high.

9.4.3 Norwegian covered bond market vs government bond markets

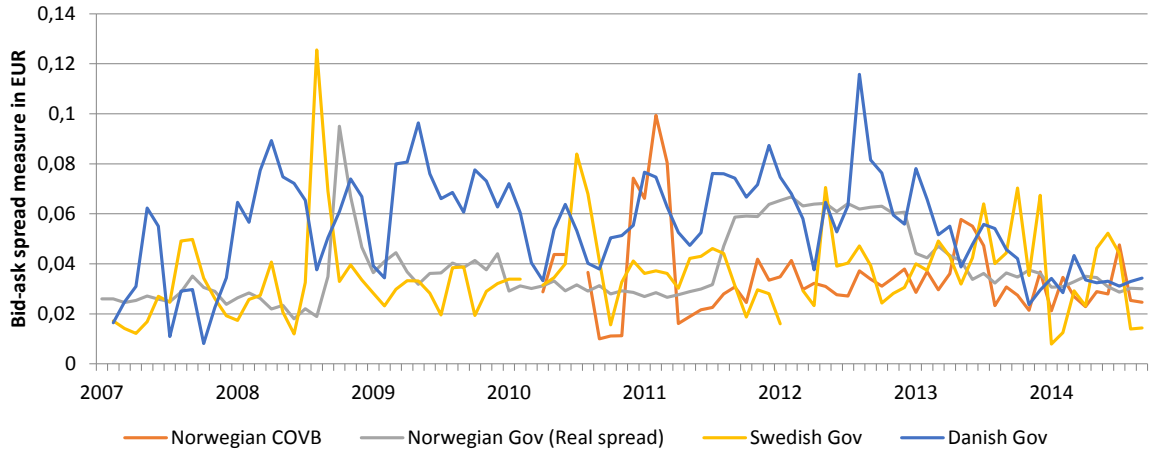


Figure 35: Roll's bid-ask spread measure (monthly average) – Norwegian covered and Scandinavian government bonds

	Period	2010	2011	2012	2013	2014*
Yearly average, EUR	**Norwegian COVB**	0,041	**0,037**	**0,033**	**0,035**	**0,029**
	Norwegian Gov	**0,030**	0,041	0,063	0,039	0,031
	Swedish Gov	0,043	**0,037**	0,034	0,047	0,031
	Danish Gov	0,052	0,067	0,069	0,049	0,033

* Until October

Table 11: Roll's bid-ask spread measure (yearly average) – Norwegian covered and Scandinavian government bonds

The main trend in Figure 37 is that in the beginning of the period the data varies a lot, but towards October 2014, all numbers converge. As the only market in our data set, we were able to obtain real bid-ask spreads for the Norwegian government bond market. This is presented by the grey line labeled *Norwegian Gov (Real spread)* in the figure. The real spread is relatively stable around EUR 0.03 but with a spike in end of 2008 and a period of wider spreads in late 2011 and 2012. As for the other markets, spreads in Danish government bonds are the most volatile, which is supported by Table 11. The Swedish market performs well most of the time but also has some unstable periods. The Norwegian covered bond market obviously has a shorter data history than the government bond markets, but for the period that we have calculated measures, the market performs well. This is especially clear if we look at the numbers in Table 11.

9.4.4 Different groups of bonds in the Norwegian covered bond market

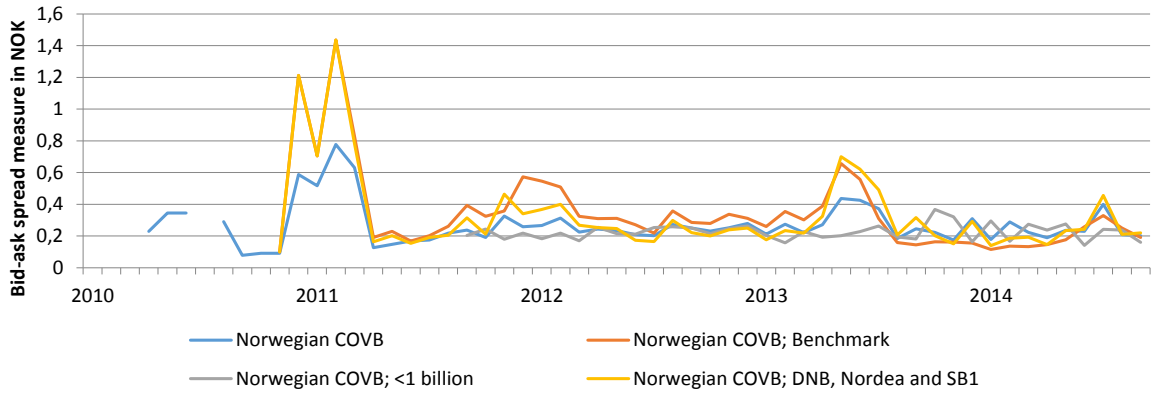


Figure 36: Roll's bid-ask spread measure (monthly average) – Groups of Norwegian covered bonds

	Period	2010	2011	2012	2013	2014
Yearly average, EUR	**Norwegian COVB**	**0,325**	0,287	0,25	0,277	0,231
	Benchmark	0,735	0,436	0,328	0,300	**0,187**
	<1 billion	-	**0,219**	**0,228**	**0,224**	0,215
	DNB, Nordea and SP1	0,735	0,372	0,255	0,321	0,222

* Until October

Table 12: Roll's bid-ask spread measure (yearly average) – Groups of Norwegian covered bonds

For the average trade size and turnover rate, we have seen that there is a higher liquidity in larger bonds. Interestingly, for the bid-ask spread measure, we see the opposite (Figure 38). Even though the correlation appears very strong, the increase in the spread at the start of 2011, start of 2012 and mid-2013 are largest for the bigger bonds. An increased spread indicates a higher cost of trading which again indicates worse secondary market liquidity. However, the differences are small and we are not able to make any firm conclusions on the observations made from just looking at the graph. By looking at the results from Table 12 it is clear that smaller bonds have performed best most of the period.

As for the other measures, we conclude that there is no reason to believe that Norwegian covered bonds are less liquid than the other Scandinavian bonds when looking at the bid-ask spread. The results from employing Roll's bid-ask spread measure stating that smaller bonds are more liquid than larger bond conflicts with our previous results.

9.5 Relative price change

The final liquidity measure is the relative price change measure.

9.5.1 Norwegian covered bond market

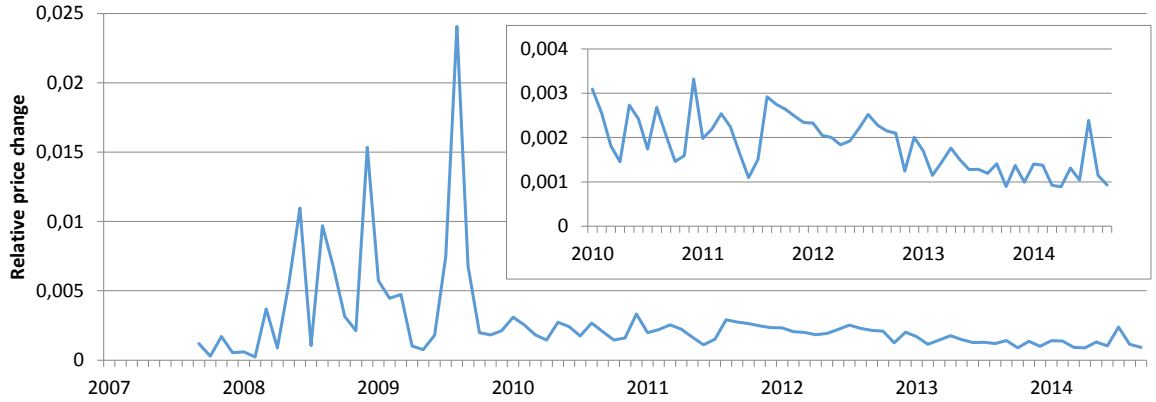


Figure 37: Relative price change (monthly average) – Norwegian covered bond market

The level of relative price changes for the Norwegian covered bond market was relatively high and volatile during the period 2008-2009 (Figure 39). However, from the beginning of 2010, the level has decreased considerably and stabilized around 0.0015 for the rest of the period. From the extracted graph in the upper right corner of the figure it is also clear that there has been a weak downward trend, which indicates increased liquidity. The volatile period before 2010 might again be due to few covered bonds in the market so that some extreme observations count a lot. Another explanation might be that before 2010 the financial crisis spread fear in the market as mentioned earlier, which lead to increased risk premiums.

9.5.2 Norwegian covered bond market vs other covered bond markets

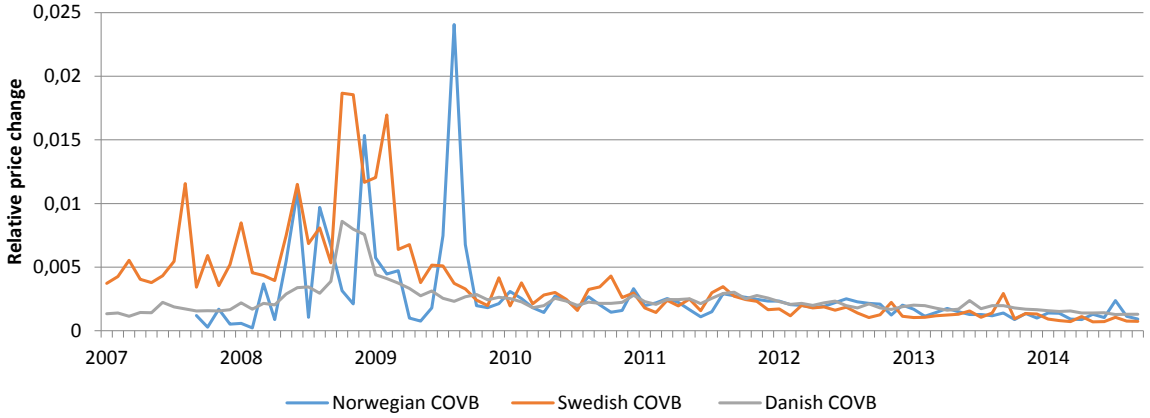


Figure 38: Relative price change (monthly average) – Scandinavian covered bond markets

	Period	2010	2011	2012	2013	2014*
Yearly average	Norwegian COVB	0,0022	**0,0022**	0,0020	**0,0014**	0,0012
	Swedish COVB	0,0029	0,0023	**0,0016**	**0,0014**	**0,0008**
	Danish COVB	**0,0023**	0,0026	0,0020	0,0019	0,0014

* Until October

Table 13: Relative price change (yearly average) – Scandinavian covered bond markets

When comparing the Norwegian market to the other Scandinavian markets we can state that the developments are similar (Figure 40). Even though the biggest spike in relative price change for Norwegian covered bonds is larger and comes one year later than the Swedish, all three measures come down to more or less the same levels after 2010. The reason for the higher volatility before 2010 it is most likely the same for the Danish and Swedish market as it was for the Norwegian. The financial crisis scared investors, risk premiums started to increase and prices became volatile.

By looking at the graph, it is hard to separate the different markets after 2010, which is why Table 13 is especially useful in this case. Looking at the numbers in the table we can see that the Swedish market has the lowest measure in most years, which indicates the highest liquidity. Compared to the Swedish, that the Norwegian yearly average is 50% higher, while the Danish is 75% higher in 2014 (Table 13). It is hard to say how much this says about the liquidity, because measures in for all markets are low compared to period before 2010. Even though there were larger absolute differences in the turbulent period of 2009, the relative differences are almost as large per October 2014 as they were then. Anyhow, there are no strong arguments for stating that the Norwegian market liquidity differs from the other markets based on this measure.

9.5.3 Norwegian covered bond market vs government bond markets

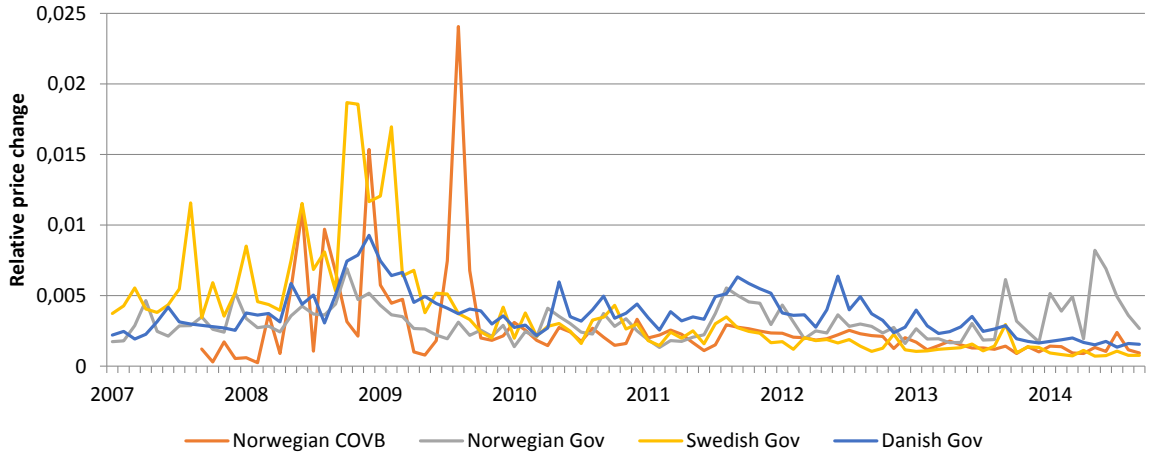


Figure 39: Relative price change (monthly average) – Norwegian covered and Scandinavian government bonds

	Period	2010	2011	2012	2013	2014*
Yearly average	**Norwegian COVB**	**0,0022**	**0,0022**	0,0020	**0,0014**	0,0012
	Norwegian Gov	0,0028	0,0032	0,0028	0,0023	0,0050
	Swedish Gov	0,0029	0,0023	**0,0016**	**0,0014**	**0,0008**
	Danish Gov	0,0036	0,0045	0,0038	0,0026	0,0016

* Until October

Table 14: Relative price change (yearly average) – Norwegian covered and Scandinavian government bonds

Although the only sample that is included in both Figure 40 and Figure 41 is Norwegian COVB, the figures are quite similar - turbulent times before 2010 followed by a strong convergence and low and stable measures. Among the government bond markets, Danish bonds have shown lower liquidity in most of the years from 2010 to 2013, while in late 2013 and 2014 the Norwegian government bonds have emerged as the least liquid market. We do not have any specific explanation for why the Norwegian government bond market experienced higher relative price changes in 2014 than earlier. Again, the Swedish market comes out strong (Table 14) with a relatively liquid government bond market. Norwegian covered bonds also perform well and there is no reason to state that the liquidity is low based on these relative price change measures.

9.5.4 Different groups of bonds in the Norwegian covered bond market

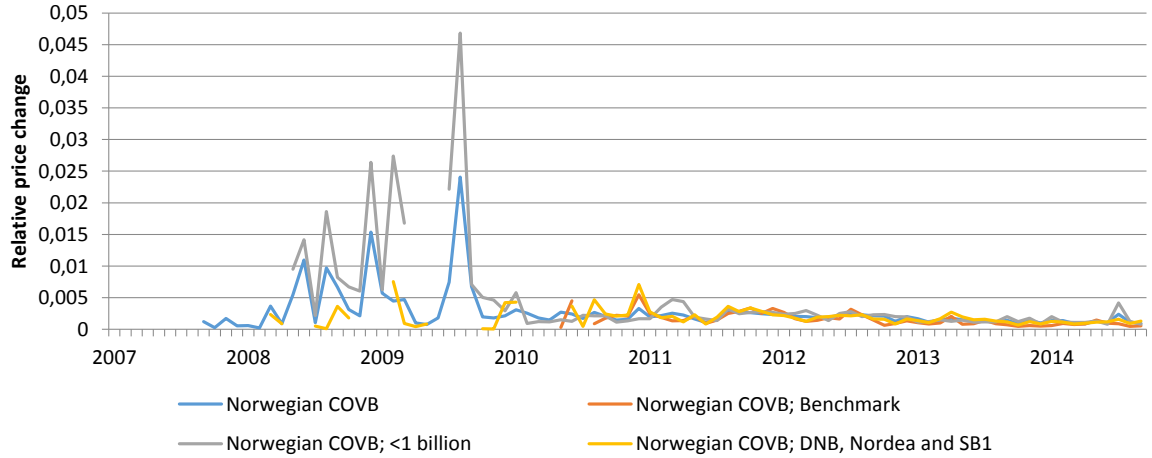


Figure 40: Relative price change (monthly average) – Groups of Norwegian covered bonds

	Period	2010	2011	2012	2013	2014
Yearly average	**Norwegian COVB**	0,0022	0,0022	0,0020	0,0014	0,0012
	Benchmark	0,0028	**0,0021**	**0,0016**	**0,0009**	**0,0008**
	<1 billion	**0,0017**	0,0028	0,0023	0,0013	0,0015
	DNB, Nordea and SP1	0,0035	0,0023	0,0017	0,0015	0,0012

* Until October

Table 15: Relative price change (yearly average) – Groups of Norwegian covered bonds

After discussing the liquidity measure *relative price change* our conclusion is that the Norwegian covered bond market performs slightly well. In order to understand which parts of the market that has contributed to the results we split the market into groups shown in Figure 42. What is clear from looking at the figure is that smaller bonds were less liquid during the turbulent year of 2009, supported by the highest peaks. As 2010 started, most bonds were on the same low levels and there have only been some minor spikes up until October 2014. Furthermore, what we can read out of Table 15, which is hard to spot in Figure 42, is that benchmark bonds have the lowest measure every year for the last four years.

9.6 Summary of results

Type		Performance	Score
Average trade size	**Covered bonds**	Average/strong	0,5
Average trade size	**Government bonds**	Average	0
Turnover rate	**Covered bonds**	Weak	-1
Turnover rate	**Government bonds**	Weak/average	-0,5
Roll	**Covered bonds**	Average	0
Roll	**Government bonds**	Average/strong	0,5
Rel price change	**Covered bonds**	Average	0
Rel price change	**Government bonds**	Average/strong	0,5
SUM		**Average**	**0**

Table 16: Summary of results

In Table 16 we will present the main results on liquidity in the Norwegian covered bond market compared to other bonds markets. In total, there are eight comparisons by which we have judged the market – four liquidity measures where we compare the market to the two other Scandinavian covered bond markets and the Scandinavian government bond markets respectively. Based on our subjective assessment of the performance, we assign a score between -1 and 1, where -1 represents weak and 1 represents strong performance. Finally, we have added up all the individual scores to a total score for the entire market.

As the last row in Table 16 indicates, our subjective conclusion is that the liquidity in the secondary market of Norwegian covered bonds is *average* compared to the other Scandinavian bond markets. On some measures, it performs better and on some worse, but overall, the total assessment does not indicate that the liquidity is neither higher nor lower.

Type of measure	<1 billion or Benchmark?
Average trade size	Benchmark
Turnover rate	Benchmark
Roll measure	< 1 billion
Rel price change	Benchmark
SUM	**Benchmark**

Table 17: Summary of results for Norwegian market

In Table 17 we briefly sum up the liquidity level of large and small bonds, characterized by benchmark bonds and bonds smaller than NOK 1 billion respectively. As the table shows, benchmark bonds are more liquid measured on three out of four measures. Hence, benchmark bonds contribute the most to the liquidity level in the Norwegian covered bond market.

9.7 Other results

Before we move on to the chapters about criticism and conclusion, we will discuss some results that are difficult to see directly from graphs in this chapter, but that may have affected the liquidity development.

9.7.1 Regulation

As discussed earlier the new European regulations (CRD IV) based on the Basel III accord have not yet been fully implemented. However, they are gradually phased in and most banks will position themselves for the stricter regulation by changing their portfolios and capital structure. Furthermore, covered bonds are highly recognized both as a liquid asset and as a stable and long-term funding source. Everything else alike, this should increase the demand for covered bonds. As securities become more attractive, the turnover rate might not increase significantly because investors do not want to sell. On the contrary, the rate might fall since the outstanding volume in the market will rise due to the increased supply of bonds, while turnover stays unchanged. We also have reason to expect improvement in the bid-ask spread measure. Since investors demand more covered bonds due to the regulatory recognition, more bid and ask prices will be quoted. Consequently, that should lead to a tighter spreads and larger depths.

Again, we do not have hard evidence on whether new regulation has improved the liquidity or not. The most relevant figure is the Roll bid-ask spread measure for all Scandinavian covered bond markets (Figure 36). The trend for all the markets is downward sloping, meaning that liquidity is improving. This might be an outcome of the banks' increased demand for covered bonds because of CRD IV, but it may also be an outcome of the markets returning to normal conditions after the financial crisis.

9.7.2 Government Swap Agreement

As for regulations' possible influence on liquidity, it can also be difficult to see how the swap agreement has affected the market from our results. As we have stated earlier, the market has grown a lot, but during the first years after 2007 the main issuance growth was absorbed by the swap agreement, and the bonds were therefore taken out of the market (Figure 11, part a). In general, the absolute turnover should increase when the outstanding volume increases, but since the government held onto these bonds, that did not happen. Consequently, we would expect a drop in turnover rate, and if we look at Figure 31 that is what we can observe. Except for the earlier discussed peak around the start of 2009, the turnover rate was low through 2008 and 2009, followed by an increase over the next years. Overall, this fits well

with the development of the swap agreement where the government and mortgage institutions reversed the swaps gradually with the last reversal in mid-2014.

9.7.3 Norwegian Covered Bond Benchmark

The last of the three aspects we believe has influenced liquidity is the introduction of the Norwegian Covered Bond Benchmark in June 2014. As mentioned earlier, the purpose of this benchmark is to increase the availability and thus the liquidity in the largest covered bonds listed on Oslo Børs.

Y/Y change 2013/2014	Avg. trade size	Turnover rate	Roll bid-ask spread	Rel. price change
June	+54 %	+112 %	-54 %	+11 %
July	+140 %	+337 %	+6 %	-40 %
August	+20 %	+91 %	+58%	-44 %
September	+13 %	+95 %	+32 %	-20 %
Conclusion	**Improved**	**Improved**	**Worsened**	**Improved**

Table 18: Development in liquidity measures for bonds included in the Norwegian Covered Bond Benchmark

Benchmark bonds are one of the sample groups used in the liquidity analysis, and is made up of all bonds comprised in the benchmark by 30 September 2014. In Table 18, we present the results of a year-on-year comparison for each of the four measures, in an attempt to identify the eventual effects the benchmark has had on the liquidity (For more info, see Appendix 2). The main results are that the average trade size has gone up, the turnover rate has increased, the bid-ask spreads have increased and the relative price changes have gone down. Changes in three of the four measures imply that the introduction of the benchmark has led to improved liquidity. Again, there might be other reasons for why these changes are in favor of increased liquidity, such as the recovery after the financial crisis and effects from new regulations.

10. Criticism

By looking at the results presented in Table 16 in of the previous chapter, we conclude that the liquidity of the Norwegian secondary covered bond market is average. In this chapter, we will discuss what might have brought noise to our results, and affected our conclusions. We will start by discussing whether it is preferable to compare liquidity in different domestic markets, before we go more into detail by elaborating on the weaknesses of the data set and on the liquidity measures and their assumptions.

According to Hein (2003), it is not preferable to compare different domestic government bond markets. He argues that the importance of the different dimensions of liquidity depends partly on the market structure, number of market participants, market size and market behavior. Finally, he says that comparing markets across borders is a difficult task since a liquidity measure might give different indications on the level of liquidity. Consequently, we must keep in mind that the three markets are different, and that it might affect our results. For example in 2013, the total turnover in the Danish covered bond market was DKK 6000 billion while the Norwegian barely surpassed NOK 200 billion. The structure is also very different where the Danish system is a pass-through system, but the Norwegian and Swedish are not. In order to way up for these differences, we have included several measures hoping that the total assessment will make adjust for some of the concerns Hein (2003) presents.

When going in to more particularities, the data sets that we have used should be addressed. As mentioned in the Data chapter, we did not manage to get complete data sets for all bonds in all markets. We have not been able to assess Swedish floating rate covered bonds, the entire Danish covered bond market or specific characteristics on Danish and Swedish covered bonds. However, we feel that most data sets are large enough in terms of bonds included to be used as a proxy for the whole market. Furthermore, price data turned out to be the trickiest data to gather which made us go for a simpler version of the price impact measure and to use average trade size instead of median trade size. This has obviously also affected the quality of the Roll's bid-ask spread measure and the relative price change which use price data as input. Without frequent data, the assumption behind the bid-ask spread measure stating that the price *continuously* fluctuates within an interval will become challenged. For the relative price change measure, price changes that occur over a longer period with few observations might not be because of low liquidity but rather due to new information. Concerning the price data we have, some of them are only closing day data, which means that we do not have more than one observation per trading day. In periods where we have few days with trades, there can be

as much as several weeks between trades. This might create noise because liquidity measures assume frequent observations meaning that the only reason for a large price change is low liquidity in the market. When there are a couple of weeks between two trades, the price change does not necessarily mean that the liquidity is low and sellers have to accept a lower price, but rather that there has come new information to the market, which will affect the pricing of bonds. Such information can for example be a change in the central bank's deposit rate or a change in the market risk premiums.

Another reason for why a change in price is not necessarily due to low liquidity is that bonds follow a natural price path towards their par value. This problem is most relevant for fixed coupon bonds. With floating coupon bonds however, the coupon rate is regularly adjusted to the market rate, so the market price is relatively close to par at all times. In order to adjust for the natural price path of fixed rate bonds, we could have used a formula introduced by Downing, Underwood and Yuhang (2005). However, this process is very time-consuming and the drift rate is believed to be fairly small, so we expect the change in results to be small and have therefore not adjusted our data.

As a final remark, there might be errors in our data set that we have not been able to remove. Such errors will alter our analysis, but due to the large data sets used, single incorrect numbers are not expected to affect our conclusions in a large degree.

11. Conclusion

In this paper, we have investigated the liquidity in the Norwegian secondary covered bond market. We have compared this to the secondary covered and government bond markets in the other Scandinavian countries, Sweden and Denmark. Further, we have looked at groups of Norwegian covered bonds according to certain characteristics, to analyze this market more thoroughly. We have also focused on recent developments such as new regulation through Basel III, the reversal of the Government Swap Agreement and the implementation of the Covered Bond Benchmark, to study any changes in liquidity related to these.

Our research has been conducted by gathering data on outstanding volumes of bonds in the market, historical trading prices and trading volumes per bond from 2007 until October 2014. We have implemented several liquidity measures to our data that complement each other, in order to get a comprehensive picture of the development in liquidity. By comparing different markets in several time periods, we have obtained a good base for drawing conclusions on any liquidity developments.

Over the last years, the liquidity in the Norwegian covered bond market has improved considerably along with the growth of the market. From an unstable period with few bonds in the market in 2007 and 2008, all measures point at higher liquidity from 2010/2011 in more stable market conditions. The main result from our research is that the liquidity in the Norwegian secondary covered bond market is neither higher nor lower than the liquidity in the other Scandinavian bond markets. There are however important differences between some markets. While the average trade size in the Norwegian covered bond market is in the same range as the Scandinavian government bond markets, it is notably higher than in the Danish covered bond market. The turnover rate in the Norwegian covered bond market is relatively lower than in all the comparable markets. The large and highly developed Danish covered bond market and the Swedish government bond market stand out with significantly higher turnover rates. According to the liquidity measure Roll's bid-ask spread however, the liquidity in the Norwegian market is on par with the other covered bond markets, and higher than the Scandinavian government bond markets. Looking at the relative price change measure, the results from all markets are quite similar, and we are not able to draw conclusions about higher or lower liquidity. The measures we have employed give us contradictory results at times, but in total, we conclude that the liquidity in the Norwegian covered bond market is on average compared to other Scandinavian markets.

Looking at different groups of bonds within the Norwegian covered bond market, we conclude that the bonds included in the Covered Bond Benchmark have the highest liquidity. On all measures except Roll's bid-ask spread measure, the results were unambiguous. We also studied the change in liquidity for the bonds included in this benchmark, to consider the possible effect of its introduction in June 2014. Also here we found evidence for improved liquidity on all measures except Roll's bid-ask spread measure. There are however uncertainties whether the improved liquidity in bonds included in the benchmark is due to the implementation of this, better market conditions in general, or other aspects we are not able to identify. Finally, we have not been able to prove what part new regulations and the reversal of the Swap Agreement has played in the liquidity development.

Our research has proven that the secondary covered bond market in Norway can be characterized as relatively mature and well-functioning. In 2014, the market is quite active, and includes a repo market which is important to keep the market efficient. Liquidity is important for reducing the risk premium demanded by investors and for a market to work properly. These aspects are important for the recognition of the market as stable, liquid and efficient in relation to regulation, for example those introduced by Basel III, when it comes to the riskiness and liquidity of assets. It is also important to gain attention from foreign investors, who might demand proof of stability and liquidity before considering investing in a foreign and relatively young market. Ultimately, these developments are important for ensuring low funding costs for the issuing banks, which should also result in lower rates on house owners' mortgages.

This paper addresses the secondary covered bond market in Norway, and even if we briefly discuss the primary market, that is an area which might be interesting for future research. As the market grows and quickly changes, there might be many interesting aspects in relation to that. Further, we have not included a thorough discussion or any analysis on the repo markets related to the Scandinavian covered bond markets. In Norway, that is a quite new feature, and both an empirical analysis and an analysis on how that affects liquidity seem interesting. Investigating the liquidity in the Norwegian covered bond market at a later stage is also a possibility. Our research on the effect on liquidity in relation to the reversal of the Government Swap Agreement and the implementation of the Covered Bond Benchmark is affected by a short period of time to analyze. By investigating that at a later stage, it should be possible to draw more sound conclusions of the direct effect of these measures on the liquidity in the market.

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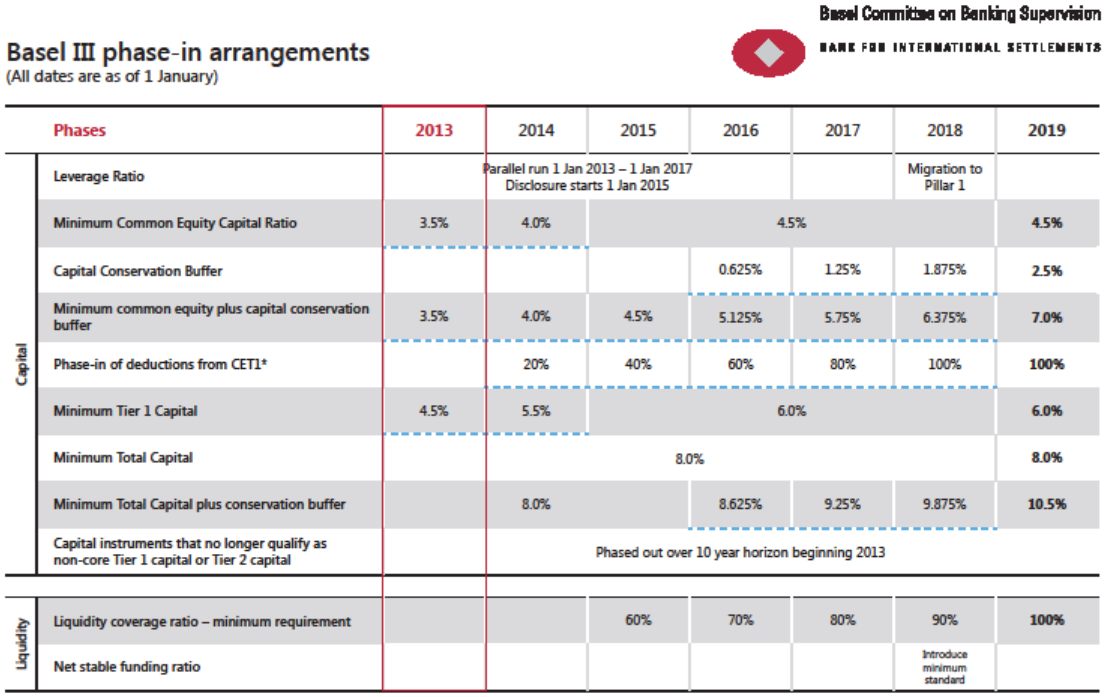
13. Appendix



Basel Committee on Banking Supervision

BANK FOR INTERNATIONAL SETTLEMENTS

Basel III phase-in arrangements
(All dates are as of 1 January)

	Phases	2013	2014	2015	2016	2017	2018	2019
Capital	Leverage Ratio		Parallel run 1 Jan 2013 – 1 Jan 2017 Disclosure starts 1 Jan 2015				Migration to Pillar 1	
	Minimum Common Equity Capital Ratio	3.5%	4.0%	4.5%				4.5%
	Capital Conservation Buffer				0.625%	1.25%	1.875%	2.5%
	Minimum common equity plus capital conservation buffer	3.5%	4.0%	4.5%	5.125%	5.75%	6.375%	7.0%
	Phase-in of deductions from CET1*		20%	40%	60%	80%	100%	100%
	Minimum Tier 1 Capital	4.5%	5.5%	6.0%				6.0%
	Minimum Total Capital		8.0%					8.0%
	Minimum Total Capital plus conservation buffer		8.0%		8.625%	9.25%	9.875%	10.5%
	Capital instruments that no longer qualify as non-core Tier 1 capital or Tier 2 capital		Phased out over 10 year horizon beginning 2013					
Liquidity	Liquidity coverage ratio – minimum requirement			60%	70%	80%	90%	100%
	Net stable funding ratio						Introduce minimum standard	

* Including amounts exceeding the limit for deferred tax assets (DTAs), mortgage servicing rights (MSRs) and financials.
– – transition periods

Appendix 1: Basel III phase-in arrangements

	Average trade size		Turnover rate		Roll		Rel PC	
		Change YoY		Change YoY		Change YoY		Change YoY
June 2013	50 494 681		0,0361		0,5565		0,0008695	
July	31 361 702		0,0110		0,3099		0,0014406	
Aug	60 156 627		0,0366		0,1585		0,0008672	
Sept	55 950 704		0,0291		0,1442		0,0007016	
June 2014	77 862 745	54 %	0,0765	112 %	0,2579	-54 %	0,0009636	11 %
July	75 168 317	140 %	0,0483	337 %	0,3296	6 %	0,0008704	-40 %
Aug	72 361 290	20 %	0,0699	91 %	0,2501	58 %	0,0004830	-44 %
Sept	63 046 980	13 %	0,0568	95 %	0,1906	32 %	0,0005578	-20 %

Appendix 2: Overview of calculations on introduction-of-benchmark effects

Average trade size				
	Norwegian Covered Bonds		Danish Covered Bonds	
Period	Average (NOK)	Observations	Average (DKK)	Observations
2007	**58 894 737**	**19**	**6 719 809**	**820 113**
1			4 756 962	**76 095**
2			5 310 424	**57 548**
3			5 047 393	**66 532**
4			3 592 544	**61 965**
5			4 122 151	**62 276**
6			4 641 842	**89 343**
7			4 008 299	**76 880**
8	110 000 000	2	4 144 095	**64 246**
9	105 250 000	2	4 321 636	**61 756**
10	15 300 000	5	4 140 323	**69 211**
11	51 750 000	4	10 850 980	**68 650**
12	67 500 000	6	26 533 308	**65 611**
2008	**62 932 540**	**126**	**6 142 397**	**830 976**
1	52 500 000	2	9 213 435	**80 617**
2	39 000 000	2	8 817 906	**59 591**
3	22 375 000	8	4 448 565	**53 708**
4	26 000 000	2	4 020 118	**68 110**
5	32 750 000	4	4 064 783	**59 521**
6	53 571 429	7	4 241 838	**75 755**
7	15 642 857	7	3 318 812	**76 101**
8	6 500 000	4	3 970 847	**53 581**
9	6 666 667	3	4 141 531	**68 568**
10	39 808 824	34	3 950 048	**104 713**
11	64 803 571	28	5 103 687	**82 082**
12	147 440 000	25	24 226 238	**48 629**
2009	**74 079 021**	**194**	**6 628 689**	**834 221**
1	148 911 765	17	4 683 837	**68 992**
2	49 453 488	43	4 746 059	**48 945**
3	45 840 000	25	4 716 199	**65 466**
4	238 785 714	14	5 118 726	**57 892**
5	67 375 000	8	5 947 191	**54 132**
6	46 000 000	10	5 374 368	**63 058**
7	51 272 727	11	4 172 700	**70 676**
8	11 000 000	4	4 892 326	**77 541**
9	62 813 529	17	5 835 644	**77 709**
10	72 133 333	15	3 536 709	**110 294**
11	61 294 118	17	9 657 084	**76 896**
12	32 730 769	13	23 125 263	**62 620**
2010	**44 512 725**	**943**	**8 265 430**	**690 425**
1	62 157 143	35	4 246 120	**77 401**
2	47 310 345	29	5 880 382	**45 030**
3	62 394 737	38	9 097 546	**50 623**
4	46 342 466	73	5 071 652	**45 119**
5	33 671 429	35	7 226 393	**44 015**
6	41 043 750	80	6 384 176	**65 492**
7	37 009 615	52	3 886 475	**61 189**
8	51 425 439	114	5 914 743	**59 344**
9	41 266 129	124	9 264 228	**66 304**
10	63 320 000	100	4 762 620	**74 891**
11	33 692 308	130	11 574 184	**52 194**
12	34 556 391	133	31 240 978	**48 823**
2011	**67 537 415**	**2 058**	**9 654 316**	**555 362**
1	57 453 488	86	6 023 711	**58 344**
2	58 802 239	134	5 389 947	**41 812**
3	77 230 570	193	13 953 805	**47 367**
4	119 170 139	144	5 103 930	**41 970**
5	55 162 162	259	6 096 336	**40 242**
6	44 078 947	190	7 233 625	**35 151**
7	36 892 593	135	4 830 809	**38 389**
8	80 698 675	151	7 408 164	**48 010**
9	61 848 062	258	13 133 909	**50 131**
10	86 397 653	213	5 085 081	**53 680**
11	65 426 573	143	14 975 709	**51 027**
12	69 486 842	152	23 830 787	**49 239**
2012	**56 516 460**	**2 819**	**9 976 897**	**716 064**
1	60 697 642	212	5 311 020	**90 193**
2	62 827 236	246	9 507 074	**50 161**
3	59 030 364	247	15 112 176	**52 400**
4	56 821 229	179	5 557 131	**55 852**
5	57 522 099	181	7 980 900	**48 241**
6	59 115 789	190	9 165 898	**81 053**
7	48 996 032	126	5 687 045	**72 388**
8	60 932 432	222	14 189 679	**44 602**
9	52 755 102	343	10 390 206	**53 624**
10	57 136 637	333	5 190 775	**75 694**
11	53 136 861	274	24 614 514	**49 526**
12	49 699 248	266	17 583 629	**42 330**
2013	**58 522 762**	**4 011**	**11 458 560**	**500 337**
1	66 524 419	430	7 037 481	**63 607**
2	65 635 600	250	12 644 026	**36 478**
3	56 561 475	244	19 926 082	**34 563**
4	67 315 594	404	7 973 317	**46 396**
5	70 792 600	473	8 008 942	**41 799**
6	51 931 250	320	6 941 345	**40 217**
7	34 953 704	162	4 389 494	**48 133**
8	52 796 358	302	20 477 091	**34 434**
9	52 398 305	354	10 103 072	**38 384**
10	48 689 706	340	7 714 424	**51 732**
11	60 145 251	358	30 205 669	**35 104**
12	54 487 968	374	13 160 802	**29 490**
2014	**58 976 299**	**3 966**	**10 236 922**	**363 424**
1	69 114 726	584	7 621 044	**41 131**
2	49 112 329	365	22 828 404	**31 444**
3	62 441 667	360	11 553 761	**32 290**
4	63 969 863	365	5 991 497	**35 040**
5	75 882 716	486	7 846 561	**34 268**
6	59 791 762	437	8 550 605	**37 986**
7	41 329 305	331	6 514 044	**52 267**
8	58 857 942	447	17 397 509	**39 606**
9	45 322 335	591	8 129 853	**59 392**
10				
11				
Total	**58 116 652**	**14 136**	**8 986 175**	**5 310 922**

Turnover rate per month				
	Norwegian Covered Bonds		Danish Covered Bonds	
Period	Average	Observations	Average	Observations
2007	**5.48%**	**19**	**21.17%**	**820 113**
1			18.28%	76 095
2			15.30%	57 548
3			16.61%	66 532
4			10.99%	61 965
5			12.54%	62 276
6			19.94%	89 343
7			14.21%	76 880
8	7.33%	2	12.19%	64 246
9	7.02%	2	12.20%	61 756
10	2.13%	5	13.02%	69 211
11	3.70%	4	33.72%	68 650
12	7.23%	6	74.99%	65 611
2008	**2.52%**	**126**	**19.27%**	**830 976**
1	1.59%	2	37.21%	80 617
2	1.18%	2	23.23%	59 591
3	2.46%	8	10.48%	53 708
4	0.71%	2	11.97%	68 110
5	0.75%	4	10.51%	59 521
6	1.98%	7	14.14%	75 755
7	0.58%	7	11.10%	76 101
8	0.14%	4	9.32%	53 581
9	0.11%	3	12.36%	68 568
10	5.31%	34	18.84%	104 713
11	5.67%	28	18.02%	82 082
12	9.75%	25	54.10%	48 629
2009	**1.79%**	**194**	**19.00%**	**834 221**
1	6.44%	17	14.76%	68 992
2	4.03%	43	10.61%	48 945
3	1.53%	25	13.94%	65 466
4	4.32%	14	13.37%	57 892
5	0.68%	8	14.39%	54 132
6	0.47%	10	14.91%	63 058
7	0.58%	11	13.12%	70 676
8	0.05%	4	16.63%	77 541
9	1.02%	17	19.38%	77 709
10	1.01%	15	15.91%	110 294
11	0.97%	17	29.35%	76 896
12	0.39%	13	51.65%	62 620
2010	**2.57%**	**943**	**19.27%**	**690 425**
1	2.03%	35	14.62%	77 401
2	1.26%	29	11.69%	45 030
3	2.17%	38	19.73%	50 623
4	2.87%	73	10.16%	45 119
5	0.98%	35	13.98%	44 015
6	2.64%	80	17.88%	65 492
7	1.54%	52	10.34%	61 189
8	4.26%	114	15.08%	59 344
9	3.41%	124	25.33%	66 304
10	4.16%	100	15.22%	74 891
11	2.83%	130	23.85%	52 194
12	2.71%	133	53.36%	48 823
2011	**5.05%**	**2 058**	**18.19%**	**555 362**
1	2.82%	86	15.36%	58 344
2	4.18%	134	9.81%	41 812
3	7.42%	193	27.15%	47 367
4	8.35%	144	9.33%	41 970
5	6.55%	259	10.65%	40 242
6	3.60%	190	10.93%	35 151
7	2.11%	135	8.04%	38 389
8	5.05%	151	15.33%	48 010
9	6.33%	258	27.16%	50 131
10	6.95%	213	11.62%	53 680
11	3.44%	143	30.51%	51 027
12	3.77%	152	42.40%	49 239
2012	**4.18%**	**2 819**	**23.12%**	**716 064**
1	4.44%	212	20.11%	90 193
2	5.19%	246	19.56%	50 161
3	4.74%	247	30.24%	52 400
4	3.30%	179	12.93%	55 852
5	3.35%	181	15.81%	48 241
6	3.58%	190	29.76%	81 053
7	1.96%	126	16.80%	72 388
8	4.23%	222	24.86%	44 602
9	5.51%	343	20.95%	53 624
10	5.72%	333	15.51%	75 694
11	4.28%	274	44.87%	49 526
12	3.85%	266	25.98%	42 330
2013	**5.18%**	**4 011**	**18.61%**	**500 337**
1	8.16%	430	18.93%	63 607
2	4.58%	250	18.55%	36 478
3	3.77%	244	25.65%	34 563
4	7.29%	404	15.24%	46 396
5	8.73%	473	13.60%	41 799
6	4.38%	320	11.19%	40 217
7	1.48%	162	8.60%	48 133
8	4.12%	302	27.09%	34 434
9	4.78%	354	14.55%	38 384
10	4.22%	340	16.20%	51 732
11	5.39%	358	39.62%	35 104
12	5.26%	374	14.16%	29 490
2014	**6.32%**	**3 966**	**16.08%**	**363 424**
1	10.12%	584	12.77%	41 131
2	4.42%	365	27.57%	31 444
3	5.51%	360	13.90%	32 290
4	5.79%	365	8.50%	35 040
5	8.88%	486	10.78%	34 268
6	6.33%	437	13.27%	37 986
7	3.25%	331	13.57%	52 267
8	6.23%	447	26.33%	39 606
9	6.38%	591	18.08%	59 392
10				
11				
Total	**3.95%**	**14 136**	**19.44%**	**5 310 922**

Relative price change				
	Norwegian Covered Bonds		Danish Covered Bonds	
Period	Average	Observations	Average	Observations
2007	**0.000870**	**15**	**0.001587**	**3 640**
1			0.001341	272
2			0.001406	264
3			0.001143	308
4			0.001441	257
5			0.001419	287
6			0.002237	296
7			0.001884	333
8			0.001711	359
9	0.001203	2	0.001561	324
10	0.000283	4	0.001586	380
11	0.001709	4	0.001563	323
12	0.000535	5	0.001667	237
2008	**0.005577**	**92**	**0.003821**	**3 126**
1	0.000586	2	0.002205	340
2	0.000230	1	0.001707	299
3	0.003686	4	0.002149	252
4	0.000892	2	0.002029	263
5	0.005483	2	0.002895	270
6	0.010972	6	0.003391	294
7	0.001057	5	0.003444	289
8	0.009691	3	0.002943	240
9	0.006664	3	0.003881	237
10	0.003151	29	0.008601	269
11	0.002120	20	0.007993	171
12	0.015349	15	0.007571	202
2009	**0.004360**	**148**	**0.002965**	**4 381**
1	0.005731	14	0.004409	227
2	0.004459	22	0.004110	197
3	0.004728	19	0.003743	346
4	0.001005	13	0.003333	366
5	0.000765	6	0.002755	358
6	0.001796	7	0.003136	388
7	0.007460	10	0.002556	429
8	0.024058	4	0.002324	357
9	0.006767	15	0.002677	376
10	0.001980	13	0.002860	419
11	0.001813	14	0.002439	443
12	0.002131	11	0.002633	475
2010	**0.002205**	**711**	**0.002258**	**7 547**
1	0.003091	23	0.002526	509
2	0.002544	22	0.002267	463
3	0.001814	29	0.001817	580
4	0.001451	53	0.001979	509
5	0.002730	24	0.002563	529
6	0.002420	57	0.002338	668
7	0.001737	40	0.002003	666
8	0.002677	76	0.002249	685
9	0.002046	102	0.002162	729
10	0.001458	80	0.002152	729
11	0.001592	99	0.002235	752
12	0.003320	106	0.002787	728
2011	**0.002204**	**1762**	**0.002560**	**9 812**
1	0.001978	70	0.002288	756
2	0.002190	110	0.002073	681
3	0.002538	163	0.002449	788
4	0.002242	118	0.002463	630
5	0.001654	224	0.002521	727
6	0.001097	173	0.002138	662
7	0.001503	111	0.002556	735
8	0.002918	142	0.002942	832
9	0.002748	223	0.003037	961
10	0.002637	183	0.002524	902
11	0.002480	113	0.002777	1 060
12	0.002341	132	0.002580	1 078
2012	**0.002031**	**2512**	**0.002023**	**14 466**
1	0.002328	187	0.002293	1 255
2	0.002049	222	0.002074	1 181
3	0.002002	222	0.002158	1 283
4	0.001835	158	0.002007	1 066
5	0.001923	161	0.002199	1 094
6	0.002208	173	0.002328	1 239
7	0.002523	114	0.001973	1 282
8	0.002282	206	0.001801	1 258
9	0.002152	295	0.002111	1 167
10	0.002098	290	0.001790	1 314
11	0.001245	245	0.001671	1 302
12	0.002010	239	0.001905	1 025
2013	**0.001351**	**3522**	**0.001858**	**14 870**
1	0.001692	392	0.002009	1 371
2	0.001145	217	0.001970	1 156
3	0.001451	214	0.001778	1 120
4	0.001761	334	0.001615	1 227
5	0.001494	408	0.001702	1 198
6	0.001277	285	0.002374	1 176
7	0.001281	142	0.001740	1 385
8	0.001190	264	0.001976	1 269
9	0.001410	311	0.001980	1 274
10	0.000894	298	0.001797	1 375
11	0.001367	319	0.001692	1 266
12	0.000994	338	0.001655	1 053
2014	**0.001243**	**3477**	**0.001415**	**11 440**
1	0.001400	529	0.001581	1 395
2	0.001376	317	0.001523	1 185
3	0.000922	317	0.001558	1 236
4	0.000889	310	0.001400	1 184
5	0.001312	430	0.001404	1 194
6	0.001038	374	0.001426	1 180
7	0.002383	294	0.001278	1 397
8	0.001145	394	0.001301	1 267
9	0.000927	512	0.001310	1 402
10				
11				
Total	**0.009945**	**12 239**	**0.002084**	**69 282**

Roll Measure				
	Norwegian Covered Bonds		Danish Covered Bonds	
Period	Average (NOK)	Observations	Average (DKK)	Observations
2007			**0.292879**	**3 640**
1				272
2			0.122865	264
3			0.184356	308
4			0.230853	257
5			0.464168	287
6			0.409510	296
7			0.081302	333
8			0.216976	359
9			0.221630	324
10			0.060758	380
11			0.168160	323
12			0.256373	237
2008			**0.501232**	**3 126**
1			0.481120	340
2			0.422316	299
3			0.576801	252
4			0.666198	263
5			0.558027	270
6			0.538198	294
7			0.487997	289
8			0.280720	240
9			0.376751	237
10			0.454052	269
11			0.550530	171
12			0.498464	202
2009			**0.529550**	**4 381**
1			0.291697	227
2			0.256043	197
3			0.595668	346
4			0.601022	366
5			0.717655	358
6			0.565905	388
7			0.492095	429
8			0.510594	357
9			0.451144	376
10			0.577235	419
11			0.543866	443
12			0.466551	475
2010	**0.324817**	**77**	**0.385765**	**7 547**
1	0.105960	1	0.536543	509
2			0.450065	463
3			0.300652	580
4	0.228781	8	0.247186	509
5	0.345195	1	0.399391	529
6	0.345478	6	0.474490	668
7			0.396816	666
8	0.290065	9	0.299563	685
9	0.078961	7	0.282553	729
10	0.090775	4	0.375912	729
11	0.091687	14	0.382289	752
12	0.586912	27	0.412861	728
2011	**0.287069**	**526**	**0.511525**	**9 812**
1	0.517599	20	0.571024	756
2	0.777240	33	0.556503	681
3	0.630364	37	0.467876	788
4	0.126195	17	0.392219	630
5	0.148443	71	0.353331	727
6	0.169147	55	0.391607	662
7	0.175277	28	0.567632	735
8	0.217806	39	0.566177	832
9	0.237688	71	0.552586	961
10	0.190412	55	0.496473	902
11	0.326260	45	0.533345	1 060
12	0.259158	55	0.649577	1 078
2012	**0.250039**	**1114**	**0.510958**	**14 466**
1	0.267275	84	0.554894	1 255
2	0.312635	95	0.505741	1 181
3	0.224259	102	0.432035	1 283
4	0.243623	69	0.279733	1 066
5	0.234668	59	0.480455	1 094
6	0.208767	80	0.391933	1 239
7	0.202192	58	0.470858	1 282
8	0.272353	93	0.861967	1 258
9	0.250716	137	0.607419	1 167
10	0.230404	125	0.569593	1 314
11	0.252547	120	0.443585	1 302
12	0.278816	92	0.416927	1 025
2013	**0.276696**	**1491**	**0.366919**	**14 870**
1	0.211221	161	0.582772	1 371
2	0.274119	85	0.490373	1 156
3	0.221458	81	0.385136	1 120
4	0.271795	142	0.410606	1 227
5	0.436818	154	0.289170	1 198
6	0.426234	119	0.356104	1 176
7	0.372693	60	0.416188	1 385
8	0.185053	113	0.403674	1 269
9	0.245494	136	0.340830	1 274
10	0.223238	127	0.313559	1 375
11	0.175726	158	0.176857	1 266
12	0.309328	155	0.220153	1 053
2014	**0.230622**	**1952**	**0.249026**	**11 440**
1	0.178339	283	0.255427	1 395
2	0.288806	159	0.212398	1 185
3	0.223165	167	0.323467	1 236
4	0.188815	169	0.250310	1 184
5	0.235299	249	0.242416	1 194
6	0.229424	248	0.246196	1 180
7	0.399058	156	0.231454	1 397
8	0.209385	224	0.245487	1 267
9	0.201899	297	0.255540	1 402
10				
11				
Total	**0.267130**	**5 160**	**0.409756**	**69 282**

Appendix 3: Example of output data on liquidity measures – Norwegian and Danish covered bonds

Trade ID	ISIN	Ticker	Date	Price	Volume	Price change	Roll Measure	Relative price change
113255	NO0010598857	DNBNB04	10/04/2012	104.7	10 000 000	0.55	0.190177	0.005281
115234	NO0010598857	DNBNB04	23/05/2012	105.4	500 000	0.27	0.194070	0.002568
115438	NO0010598857	DNBNB04	30/05/2012	105.22	15 000 000	-0.18	0.055921	0.001708
116526	NO0010598857	DNBNB04	26/06/2012	105.35	20 000 000	0.13	0.108155	0.001236
116638	NO0010598857	DNBNB04	28/06/2012	105.38	5 000 000	0.03	0.124579	0.000285
117142	NO0010598857	DNBNB04	10/07/2012	106.32	10 000 000	0.94	0.162708	0.008920
119735	NO0010598857	DNBNB04	12/09/2012	107.17	30 000 000	-0.48	0.161015	0.004459
119922	NO0010598857	DNBNB04	14/09/2012	107.45	20 000 000	0.28	0.178191	0.002613
120203	NO0010598857	DNBNB04	19/09/2012	107.41	20 000 000	-0.04	0.200667	0.000372
120202	NO0010598857	DNBNB04	19/09/2012	107.51	7 000 000	0.1	0.176951	0.000931
120389	NO0010598857	DNBNB04	21/09/2012	107.59	10 000 000	0.08	0.166626	0.000744
123459	NO0010598857	DNBNB04	12/11/2012	107.97	15 000 000	0.38	0.173233	0.003532
124125	NO0010598857	DNBNB04	22/11/2012	107.52	25 000 000	-0.45	0.169966	0.004168
124394	NO0010598857	DNBNB04	28/11/2012	108.07	15 000 000	0.55	0.307519	0.005115
124573	NO0010598857	DNBNB04	30/11/2012	107.9	3 000 000	-0.17	0.331592	0.001573
124643	NO0010598857	DNBNB04	30/11/2012	108.039	52 000 000	0.139	0.329980	0.001288
124644	NO0010598857	DNBNB04	03/12/2012	108.1	1 000 000	0.061	0.336346	0.000565
124720	NO0010598857	DNBNB04	03/12/2012	107.97	5 000 000	-0.13	0.275791	0.001203
124813	NO0010598857	DNBNB04	06/12/2012	108.05	1 000 000	0.08	0.323663	0.000741
125599	NO0010598857	DNBNB04	12/12/2012	108.057	30 000 000	0.007	0.282152	0.000065
125850	NO0010598857	DNBNB04	13/12/2012	108.23	20 000 000	0.173	0.349018	0.001601
125852	NO0010598857	DNBNB04	13/12/2012	108.25	35 000 000	0.02	0.306296	0.000185
126764	NO0010598857	DNBNB04	03/01/2013	107.92	15 000 000	-0.33	0.306495	0.003048
127089	NO0010598857	DNBNB04	07/01/2013	107.82	10 000 000	-0.1	0.293891	0.000927
128488	NO0010598857	DNBNB04	21/01/2013	107.5	15 000 000	-0.32	0.261865	0.002968
131400	NO0010598857	DNBNB04	25/02/2013	107.07	2 000 000	0.6	0.059483	0.005635
133185	NO0010598857	DNBNB04	19/03/2013	108.15	10 000 000	0.12	0.143444	0.001111
133987	NO0010598857	DNBNB04	05/04/2013	108.13	10 000 000	-0.02	0.162900	0.000185
133986	NO0010598857	DNBNB04	05/04/2013	108.17	30 000 000	0.04	0.171811	0.000370
135363	NO0010598857	DNBNB04	19/04/2013	108.34	10 000 000	0.17	0.206619	0.001572
142259	NO0010598857	DNBNB04	08/08/2013	107.47	60 000 000	-0.87	0.174022	0.008030
171161	NO0010598857	DNBNB04	04/07/2014	107.66	10 000 000	0.23	0.111370	0.002141
171499	NO0010598857	DNBNB04	09/07/2014	107.61	10 000 000	-0.05	0.136029	0.000464
171811	NO0010598857	DNBNB04	16/07/2014	107.63	28 000 000	0.02	0.135554	0.000186
172360	NO0010598857	DNBNB04	01/08/2014	107.46	114 000 000	-0.17	0.126230	0.001579
172561	NO0010598857	DNBNB04	06/08/2014	107.44	17 000 000	-0.02	0.111072	0.000186
173649	NO0010598857	DNBNB04	20/08/2014	107.02	30 000 000	-0.42	0.104980	0.003909
174008	NO0010598857	DNBNB04	25/08/2014	106.89	30 000 000	-0.13	0.065120	0.001215
175330	NO0010598857	DNBNB04	10/09/2014	107	1 000 000	0.11	0.087731	0.001029
175331	NO0010598857	DNBNB04	10/09/2014	107.02	13 000 000	0.02	0.073273	0.000187
175496	NO0010598857	DNBNB04	11/09/2014	107.06	50 000 000	0.04	0.067326	0.000374
176159	NO0010598857	DNBNB04	18/09/2014	107.21	27 000 000	0.15	0.062227	0.001401
176380	NO0010598857	DNBNB04	22/09/2014	106.92	25 000 000	-0.29	0.094241	0.002705
176719	NO0010598857	DNBNB04	24/09/2014	106.95	1 000 000	0.03	0.098386	0.000281

Appendix 4: Example of raw data and liquidity measures for a random Norwegian covered bond