



Summary

Well-functioning fixed income and currency markets are important for the stability of the financial system. These markets are needed in order for financial firms to be able to make their payments and protect themselves from different types of financial risks. The transactions that are conducted often contain a time-critical element, which therefore makes it important for financial and non-financial firms to complete these transactions on time. One key factor for being able to complete time-critical transactions is that markets are sufficiently liquid.

In this FI Analysis, we identify a number of quantitative indicators that capture vulnerabilities relevant for liquidity in the fixed income and currency markets. Along the lines of Finansinspektionen's (FI) earlier work with indicators, we focus on vulnerabilities and therefore include only indicators that are more structural in nature.

The indicators show a slightly elevated level of vulnerability for liquidity in the financial markets. Several indicators contribute to this, for example the rising costs for market makers as well as the greater use of Swedish National Debt Office's repo facility. The price of currency swaps is at a historically high level, which in a crisis scenario could have a negative effect on financing liquidity.



Introduction

Finansinspektionen's (FI) goal is to contribute to financial stability through well-functioning markets and strong consumer protection. Financial stability refers to the ability of the financial system to maintain its core functions – making payments, transforming savings into financing and managing risks – even in the presence of unfavourable circumstances.

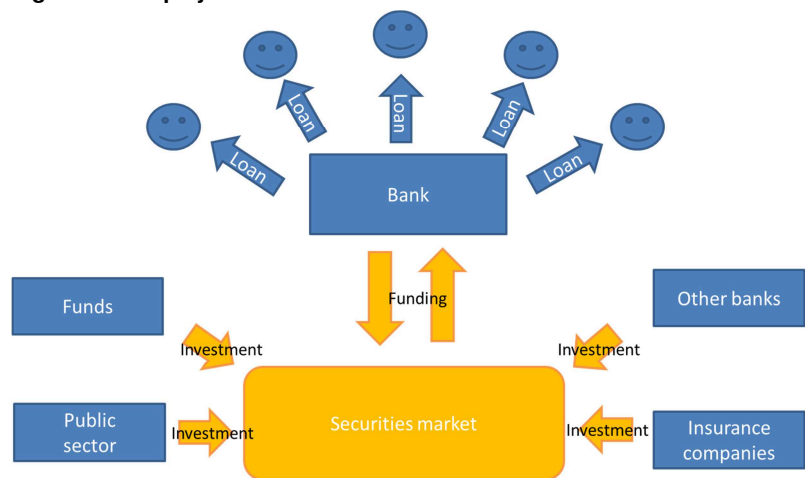
FI regularly monitors the vulnerabilities in the financial system. As a complement to its ongoing supervision and other activities, FI has also developed indicators to identify whether certain vulnerabilities in the financial system are high or low.¹ To date, these indicators have focused on factors that are of particular relevance for monitoring resilience in the banking, household and insurance sectors. We are now supplementing this analysis with indicators that follow the vulnerability levels of liquidity in the fixed income and currency markets. We use thresholds to generate signals in the same way as we have done before. This work should be viewed as an initial analysis that will be developed and changed over time.

The purpose of FI's indicators is to evaluate vulnerabilities that in the long run could threaten financial stability or in any other way create problems for the real economy.

Securities markets and financial stability

In order for the financial system to be able to maintain its fundamental functions *for* society, it needs to be possible to maintain these functions *within* the financial system, which primarily means that financial firms must be able to make payments and manage risks. In order to do this, financial firms need to have functional infrastructure and markets.

Figure 1: Interplay between borrowers and the financial markets



As demonstrated in Figure 1, a number of transactions must occur between financial firms in order for a bank to be able to provide a

¹ See Finansinspektionen (2015 a).

mortgage. This is why the securities market plays such a central role in the financial system being able to maintain the fundamental functions for society. If financial firms are unable to make payments or manage risks due to dysfunctional securities markets, these firms will find it difficult to provide financial services to their customers and other market participants. In a worst-case scenario, this could result in market participants experiencing acute problems in obtaining funding, and in the end being forced into bankruptcy.

Financial markets also play a central role in enabling market participants to finance their operations, for example by issuing bonds or shares. Figure 1, for example, shows that a bank is dependent on the securities market to finance loans for its customers. These loans cannot be called due before their maturity date, and if the securities market were to stop functioning this could lead to funding problems in the long run. The securities markets are therefore necessary for the financial system to be able to transform savings into funding and thus provide society with these services.

Finally, one of the financial market's main tasks is to set prices that contain information. Prices are an important source of information about the status of firms, states and the economy at large, but they also can show how expensive or inexpensive it is to take risks. Prices serve as a basis for decisions regarding allocation of capital and risk-taking in both the real economy and the financial system.

The transactions firms need to make to manage risks are often time-critical. If a firm cannot limit a certain exposure before the price changes dramatically, the firm could suffer losses and in a worst-case scenario go bankrupt. From a stability perspective it is therefore particularly important to monitor the fundamental functions for making payments and managing risks.

Fixed income and currency markets hold a unique position

The fixed income and currency markets are particularly important for financial stability. These markets help financial firms manage their need for liquid funds, which in turn are needed to manage payments. Households and non-financial firms make smaller payments and transfer money from one account to another. The payments made by financial firms are larger and also more time-critical. The first step is often to borrow against or sell a financial asset to generate cash. The second step is to execute the payment in the financial infrastructure. Well-functioning monetary, repo and secondary markets, just like the financial infrastructure, are an important part of financial firms being able to make their payments.²

² One way to view the difference between household and financial firms' payments and the importance of the markets in this context is to start with the definition of "money". For households, money in a deposit account is a store of value. By making transfers from the same account, this money can be used as a medium of exchange when paying for goods and services. Deposits also function for standards of deferred payments if households have mortgages and the bank is allowed to withdraw deposited funds to settle the debt. Financial firms are not covered by the deposit insurance. Their stores of value are financial assets. In order for these stores of values to be used for payments, the firms need to conduct transactions in the market. They need to sell or borrow against their store of value to generate funds for payment.

Financial firms also use the currency and fixed income markets to manage many of their market risks. By adapting their exposures to falling or rising market rates and currency fluctuations, financial firms can protect themselves against factors that are outside of their control and thus maintain their operations even when subject to financial stress.

From a stability perspective, fixed income and currency markets are therefore unique. They are systemically important and in this paper we therefore focus exclusively on these markets.³

Liquidity is important for a well-functioning market

One prerequisite for the financial firms to be able to maintain fundamental functions is the availability of counterparties on the market that trade with one another. Market liquidity is usually defined as the possibility to conduct a transaction quickly, at a reasonable cost and with little impact on prices. In other words, market liquidity indicates how easy/difficult it can be to conduct a transaction on a financial market. If there is a lack of market liquidity, firms may have problems making payments and managing risks.

In order for a market participant to be able to purchase an asset, the purchase must first be funded, either through existing funds or a loan from, for example, the repo market. Funding for an asset is associated with a cost, which thus indirectly affects the market participant's ability to hold the asset. The availability of funding, in other words, affects market liquidity. For this reason, there is also another type of liquidity, funding liquidity, that describes how easy or inexpensive it is for market participants to fund their operations and holdings. If it is easy or inexpensive to fund their operations and holdings, market liquidity improves, and vice versa. But market liquidity also affects funding liquidity. If market liquidity is poor, this means that the liquidity premium in the market will rise.⁴ Rising liquidity premiums are the same as rising funding costs and thus represent a deterioration in funding liquidity.⁵

In other words, both types of liquidity are closely related, and in this paper we include both in our definition of liquidity.⁶

³ Finansinspektionen (2014).

⁴ A liquidity premium is the premium that an asset commands, in the form of a lower price, due to the uncertainty borne by the buyer when the buyer no longer knows if they can sell the asset when needed.

⁵ See also Brunnermeier and Pedersen (2009) for a more in-depth description of how funding liquidity and market liquidity affect one another.

⁶ IMF (2015) also introduces yet another liquidity term: monetary liquidity. This is the liquidity that central banks can inject or withdraw from the banking system through its monetary policy activities, such as repos, certificates or liquidity facilities. Monetary liquidity affects funding liquidity by, for example, affecting the asset and the cost of financing. An expansive monetary policy improves funding liquidity.

Forces driving market and funding liquidity

MARKET MAKERS

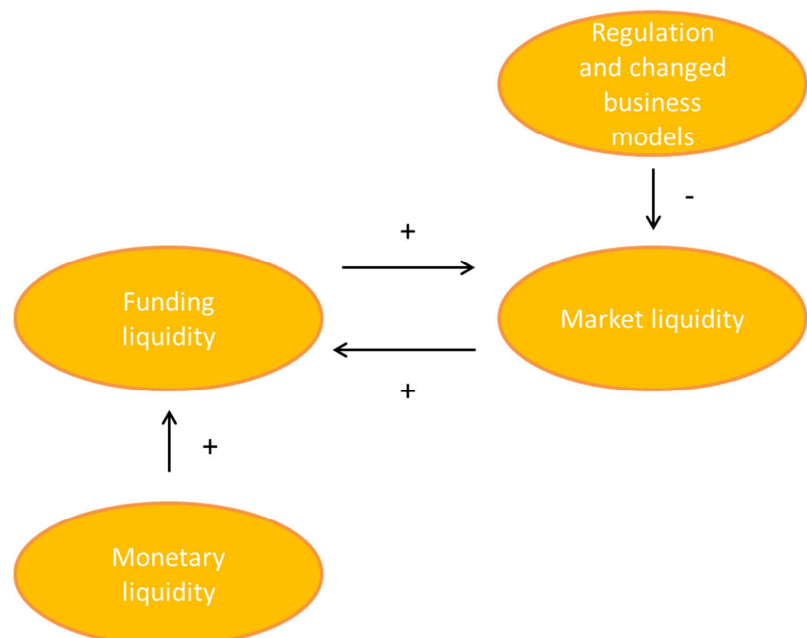
On the fixed income and currency markets, a deal often goes through a market maker, i.e. a middleman between the buyer and seller. The market maker maintains an inventory of financial instruments to bridge temporary imbalances between buyers and sellers. Because deals often occur via market makers, their ability to discharge their function affects liquidity in the market. Key factors are the market makers' ability to manage the market risk of their holdings and their ability to fund their positions.

The major Swedish banks are some of the most prominent market makers in the Swedish fixed income and currency markets. The conditions for market makers to fulfil their role in the Swedish financial system thus are related to the conditions for the Swedish banks.

REGULATION AND ACCESS TO SECURITIES

Some critics believe that the regulations introduced after the 2008 financial crisis weakened market liquidity, but FI and other authorities and researchers have measured liquidity during normal conditions and found no visible deterioration.⁷ One conceivable explanation for this could be that the restrictive effects of the regulations have been compensated for by higher monetary liquidity and more favourable conditions for banks to raise funding.

Figure 2: Driving forces affecting market and funding liquidity



Note: Schematic overview of how the different types of liquidity influence one another. The plus sign indicates phenomena that in the past few years have facilitated the supply of liquidity and the minus sign indicates the opposite tendency. The overview focuses on some of the driving forces but should not be viewed as a comprehensive representation.

⁷ See, for example, AMF (2015), FCA (2016) and Finansinspektionen (2015 b).

When firms use derivatives or raise certain types of loans, they need to pledge collateral to their counterparties. The amount of collateral is in proportion to the market value of the exposures.⁸ Normally, collateral must have high creditworthiness, such as treasury bonds or cash. A lack of collateral could therefore have a negative effect on liquidity in the market.⁹

STRESS

Liquidity in the market varies over time. In our analysis we are primarily interested in vulnerabilities that weaken liquidity during periods of stress.¹⁰ It is when liquidity is compromised that problems may arise that threaten financial stability.

When there are high levels of uncertainty and stress in the market, many participants want to change their holdings. If many of them choose to sell their assets at the same time, this could result in falling asset prices, causing some participants to experience losses. Falling asset prices also mean that the amount that could be borrowed using the asset as collateral falls. These factors in turn require more collateral or smaller loans. If participants find it difficult to gain access to collateral, or if the costs of financing certain positions become too high, the participants may be forced to close their positions. This could result in a downward, self-reinforcing spiral for prices.¹¹

During stress, the liquidity that arises is of a one-way type, i.e. easy to buy but a lot harder (alternatively: more expensive) to sell. Imbalances of this type are not consistent with well-functioning markets, and market liquidity is usually low.

Market makers are also affected in a stressed scenario since they act as buyers when many customers want to sell, which means their inventory grows. At the same time, the market value of their inventory falls while costs to hold or their access to fund their inventory is hampered. Market makers' willingness or capacity to act as a middleman is therefore reduced when the market is subjected to stress.¹²

⁸ For centrally cleared derivative positions, a market participant must provide an initial margin.

The size of this margin is dependent not only on the size of the exposure but also how volatile the market is. As the market prices change, the position entails a latent profit or loss. The latent loss must be covered by variation margins, while the profit can be credited to the holder of the position.

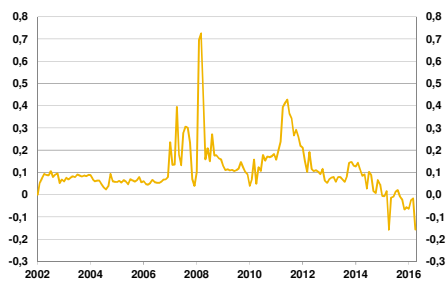
⁹ See Baranova, etc. (2016).

¹⁰ High liquidity can also lead to problems since there is then a risk that liquidity risks will be underpriced. This, in turn, could exacerbate a trend in which market participants take on too much risk. In such a scenario, however, the main problem is not that liquidity is high but rather that market participants take on too much risk. Ideally we capture this by assessing the risk level taken by market participants.

¹¹ The phrase "fire sale" is used to describe when participants are forced to close their positions in this way. See Shleifer and Vishnu (2011) for a detailed description of the course of events and possible explanations. See also Gorton and Metrick (2012) and Geanakoplos (2003) regarding how higher requirements on collateral can exacerbate a downward price spiral.

¹² During the financial crisis in 2008, market makers absorbed one-way liquidity to varying extents depending on the market and the instrument in question. In Sweden, market makers most likely increased primarily the covered bonds in their inventories since these bonds are an important source of funding for banks. Market makers therefore face particularly large incentives to protect these markets. This is probably an important reason why these markets worked relatively well during the financial crisis. However, it also meant that the banks increased their risk-taking. In the USA, studies show that market makers instead decreased their inventories (IMF, 2015) and reduced their risk-taking by reducing their leverage (see Adrian and Shin, 2009), which in all probability contributed to a decline in market liquidity.

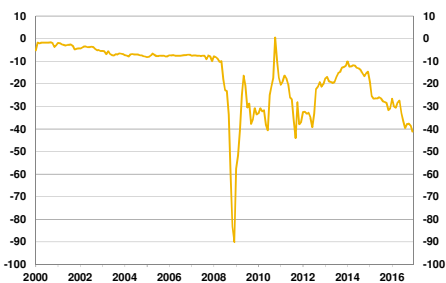
Diagram 1: Interbank spread
(percentage points)



Note: Interest rate difference between one-month STIBOR and one-month STINA. See Footnote 15 for a more in-depth explanation of the STINA contract.

Source: Reuters.

Diagram 2: USD funding
(basis points)



Note: The diagram shows the price of a one-year currency swap in USD/SEK. The price is expressed as the interest increment above STIBOR that a market participant gets (or pays) in SEK in exchange for paying (or getting) LIBOR in dollars. This corresponds to the interest rate difference between a LIBOR loan in USD that is swapped to SEK and the STIBOR rate over the same maturity.

Source: Reuters.

This once again illustrates how funding liquidity and market liquidity can affect one another. When subject to stress, the cost of holding a position goes up, i.e. funding liquidity is impaired. This can enhance a downward price spiral, which has a negative effect on market liquidity. This description also illustrates that market stress and low liquidity are closely related and in reality cannot be separated.

Liquidity indicators

In its work with indicators, FI divides them into triggers and vulnerabilities.¹³ In general, FI focuses on vulnerabilities since they emerge slowly and often can be influenced by regulation. FI excludes triggers that most often are exogenous – sudden shocks – since they are difficult to predict and hard for FI to offset. This analysis is no exception; we are focusing on vulnerabilities, i.e. indicators that are more structural in nature. Many traditional measures of market liquidity, such as turnover, price impact, etc., are more closely related to trigger-related indicators and have therefore been analysed separately.¹⁴

INTERBANK SPREAD

Traditionally, banks use the interbank market for short-term loans. During the financial crisis in 2007–2009, there was considerable uncertainty about the severity of the problems in the banking system and the lending cost on the interbank market rose sharply, particularly for longer maturities.

The interbank spread indicator measures how expensive it is for banks to fund themselves with a one-month maturity in relation to an interest rate that is close to the repo rate.¹⁵ The spread captures a possible funding cost for the banks. During periods of stress it also captures uncertainty about banks' solvency since rising counterparty risk leads to a wider spread. All else equal, a widening spread therefore leads to an elevated level of vulnerability for liquidity (see Diagram 1).

USD FUNDING

Swedish banks use foreign markets to finance just over one-fourth of their operations, of which, borrowing in USD is dominant. Funding in foreign currency is not only used to fund foreign loans, but also to fund Swedish assets. This enables the banks to raise loans in USD that they then convert to SEK through a currency swap. It is therefore very important to follow the market for currency swaps. If this market were to stop functioning or if transactions become very expensive, banks may be forced to seek other, potentially more expensive, sources of funding.

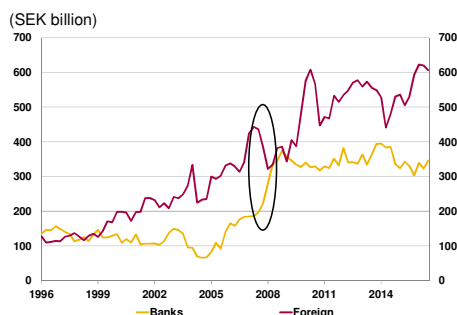
Diagram 2 shows the price of currency swaps. It describes how much more inexpensive or expensive it is to borrow in USD and convert the loan to SEK compared to borrowing directly in SEK. In this case, a

¹³ See Finansinspektionen (2015 a) for more details about triggers and vulnerabilities.

¹⁴ Finansinspektionen (2015 b).

¹⁵ More specifically, we use the interest rate difference between the one-month interbank rate and one-month STINA. STINA is an interest rate instrument that corresponds to the average expected interbank rate from day T+1 to day T+2, i.e. a one-day rate that applies from tomorrow to the day after tomorrow. One-month STINA corresponds to the average expected one-day rate for the next month. Because the rate that applies from day T to day T+1 – i.e. from today to tomorrow – is determined by the Riksbank, the STINA rate usually lies close to the expected repo rate for a period of one month.

Diagram 3: Foreign investors sold covered bonds to banks 2007–2008



Note: The diagram shows how the holdings of covered bonds abroad and at the banks have changed over time.

Source: Statistics Sweden.

negative value indicates that it is more inexpensive to borrow in USD and convert the loan to SEK than to borrow directly in SEK. A negative value also normally indicates a high demand for USD. USD is used in many international transactions and is an important source of funding for many states and companies. There is therefore a structurally high demand for dollar, which has meant that the price of currency swaps has been negative since the beginning of the 2000s, with a few exceptions.

Under favourable conditions, and assuming that an investor is able to borrow in USD, a negative price means that it is inexpensive to convert these borrowings into SEK. However, during the financial crisis in 2007–2009, the Swedish banks were no longer able to borrow directly in USD. For market participants who needed access to USD, the negative price therefore became problematic since it was expensive to borrow in SEK and convert to USD. The sharply negative price in 2008 can also be a sign that the market had stopped functioning efficiently.

From a stability perspective, a price close to zero is good, and extreme prices, whatever the sign, can give rise to problems and impaired liquidity (Diagram 2).

INVESTOR BASE

The one-way liquidity that can arise in a stressed scenario is not conducive for well-functioning markets. Typically, one-way liquidity arises when many investors want to sell (or buy) at the same time. There is evidence that some groups of investors are more likely to sell in a stressed scenario than others, and that investors thus can contribute to impaired liquidity during periods of stress.¹⁶

At the end of 2007 and beginning of 2008, foreign investors sold covered bonds for a value of just over SEK 100 billion (Diagram 3). This constituted approximately 10 per cent of the outstanding stock. For a foreign investor, the Swedish market is often of peripheral importance. During periods of global stress, when investors may need to reduce their risk exposure, positions in the Swedish market therefore become candidates for divestment.

Funds have also been highlighted as a group of investors that can enhance one-way liquidity during periods of stress since they demonstrate herding tendencies.¹⁷ Herding tendencies are particularly apparent for funds owned by private individuals, which could be because they have less experience and knowledge than professional investors.

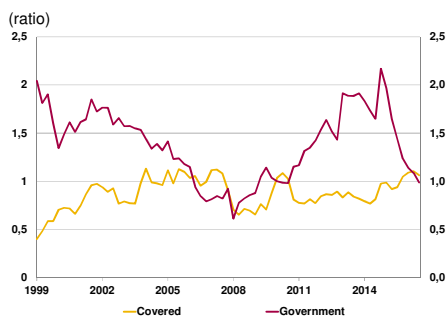
At the same time there is also evidence that other investor groups act in a manner that supports the market during a crisis, often by being reliable buyers. Unlike all the large investor collectives, insurance companies were the only ones who purchased covered bonds every quarter, except one, during the period 2007–2009. Banks also purchased covered bonds during the period 2007–2008 and were the primary counterparties when foreign investors sold large posts. Finally, the Riksbank's quantitative easing has meant that the central bank is a regular buyer of treasury bonds even during volatile market conditions.

The investor base indicator compares investors who are more likely to sell their holding during periods of stress to investors who are more

¹⁶ IMF (2015).

¹⁷ Choi and Sias (2009), IMF (2015).

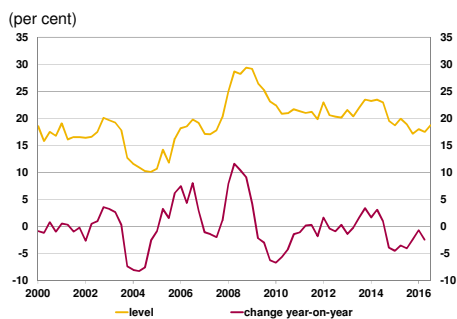
Diagram 4: Investor base indicator



Note: The diagram shows the ratio between investors during a crisis who largely tend to sell their holdings and investors who do not.

Source: Statistics Sweden.

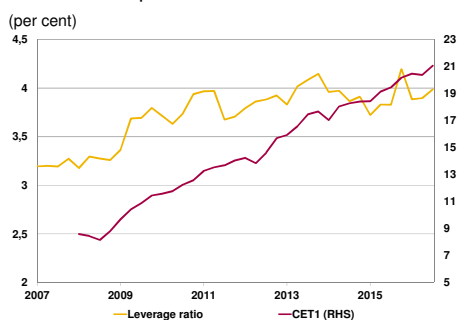
Diagram 5: Banks' holdings of covered bonds



Note: The diagram shows the percentage of the outstanding stock of covered bonds held by Swedish banks (Level) and the annual rate of change in their holding (Annual Change).

Source: Statistics Sweden.

Diagram 6: Leverage ratio and CET 1 capital ratio



Note: The diagram shows the average leverage ratio and the CET 1 capital ratio for the four major Swedish banks.

Source: FI.

likely to buy.¹⁸ A high percentage of conceivable sellers indicate a vulnerability that increases the risk of impaired liquidity (Diagram 4).

BANKS' HOLDINGS OF COVERED BONDS

The banks are the largest market makers in the fixed income and currency markets. They set buy and sell prices and undertake to trade with their customers. Since the Swedish banks are largely funded through covered bonds, they have a vested interest in this particular market working well. If many investors sell their holdings in covered bonds at the same time, the banks face greater incentive to absorb the selling pressure in those bonds than in other instruments, which is what happened during the financial crisis 2007–2009 (Diagram 3).

High selling pressure means one-way liquidity which is not conducive for well-functioning markets. If banks purchase large volumes of covered bonds over a period of one year and/or have large holdings, this elevates the vulnerability for liquidity (see Diagram 5).

MARKET MAKERS' COSTS FROM REGULATIONS

After the financial crisis in 2007–2009, the G-20 countries concluded that the banks had taken on too much risk. In order to prevent or increase resilience to similar risk-taking, the world's governments decided to tighten the regulations on banks and the financial markets. This has occurred through a number of initiatives, including new requirements on banks' capital and liquidity.

FI has taken measures that aim to strengthen banks' resilience and reduce their risk-taking, which are of central importance if the banks are to be able to withstand unforeseen stresses. These measures have also meant that the market makers' costs for taking on risks and financing their inventories have increased. These increased costs can make it more difficult to manage large flows. This indicator highlights several of these negative side effects.¹⁹

It is primarily the LCR regulation²⁰ and the higher capital requirements that affect the market makers. As the Net Stable Funding Ratio (NSFR²¹) is phased in, this will also be of significance. For market makers, these measures mean in part higher costs but also limit their ability to bear risk, which can lead to decreased revenue.

The ambition of this paper is not to capture all of the effects. Instead, we use standardised measures that focus on the implicit costs resulting from higher capital requirements. We use both a measure of the banks' leverage ratio²², which does not take risk into consideration, and the Common Equity Tier 1 capital ratio, which does consider risk (Diagram 6). Since the return requirement on equity is higher than the

18 More specifically, funds and foreign investors are classified as conceivable sellers of covered bonds and treasury bonds. Insurance companies and banks are conceivable buyers of covered bonds, while the Riksbank and insurance companies are conceivable buyers of both covered bonds and treasury bonds.

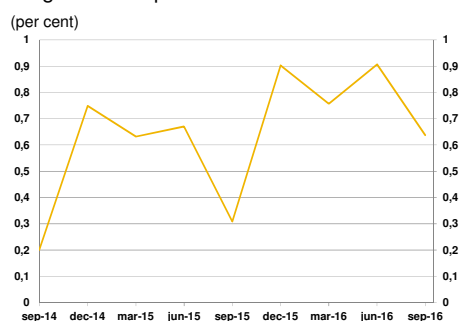
19 See Bao and others (2016) for an empirical analysis of the negative effects of the *Volcker rule* on market makers' ability to act as an intermediary.

20 Liquidity Coverage Ratio (LCR) is a requirement expressed within the framework of the new capital requirement regulations (CRD IV) requiring a bank to have sufficient liquid assets to honour its short-term obligations during a "stressed" 30-day period.

21 Net Stable Funding Ratio (NSFR) is a liquidity measure that places a bank's stable funding in relation to its illiquid assets in a stressed one-year scenario.

22 Common Equity Tier 1 capital in relation to adjusted total assets. See the *core leverage ratio* indicator in Finansinspektionen (2015 a) for more information.

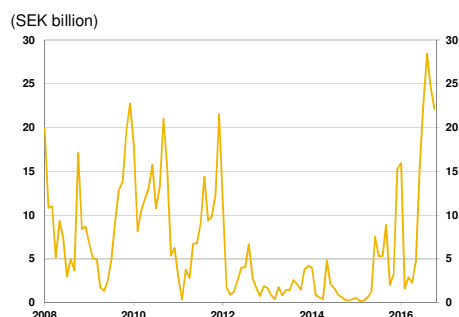
Diagram 7: Surplus buffer



Note: The diagram shows the difference between CET 1 capital and the CET 1 capital requirement for the four major Swedish banks, where this ratio is the lowest.

Source: FI.

Diagram 8: Repo facility at the Swedish National Debt Office



Note: The diagram shows how much the market makers use the Swedish National Debt Office's t/n repo facilities.

Source: Swedish National Debt Office.

cost of debt financing, this means that the larger the share of capital that is tied up in the market makers' inventory the more expensive the holdings become. Market makers are therefore facing incentives to decrease their inventories, which impairs their ability to manage one-way liquidity. This indicator therefore demonstrates an elevated vulnerability that liquidity will decline as capital levels increase.

At the same time, it is not a given that the opposite, i.e. falling leverage ratio or Common Equity Tier 1 capital, is always positive for market makers. More specifically, a situation in which Common Equity Tier 1 capital falls close to regulatory requirements (for example, due to losses) would probably have a negative impact on the market makers. We are therefore including an indicator that measures the difference between the banks' Common Equity Tier 1 capital and the regulatory requirement (Diagram 7).²³ A decrease in the indicator means elevated vulnerability for impaired liquidity.

THE SWEDISH NATIONAL DEBT OFFICE'S REPO FACILITY

Access to collateral can affect the markets. Good access to collateral makes the market work better, while a shortage of collateral can have a negative impact on liquidity.²⁴ Treasury bonds are one of the most common forms of collateral, and access to these bonds is therefore important.

The Swedish National Debt Office (NDO) borrows money for the state by issuing treasury bonds to market makers, which in turn are responsible for further distribution through secondary markets.²⁵ In order to promote a well-functioning market, the NDO offers market makers the possibility of borrowing treasury bonds through what is known as "repo facilities".

If the market maker sells a specific bond that the firm does not have in its inventory, it needs to borrow the bond through a repo in order to deliver to the buyer. The Riksbank's bond purchases have reduced the outstanding stock of available bonds. This in turn may lead to a greater need to use the NDO's facilities. The reduced volume of outstanding bonds can thus manifest itself in a higher utilisation of the NDO's facilities, which in turn can elevate the vulnerability for impaired liquidity (see Diagram 8).²⁶

Results

In our previous work with indicators, we translate an indicator value into a signal by comparing the indicator value to two thresholds, thresholds set using a recursive approach.²⁷ Under this approach, we

²³ See the surplus buffer indicator in Finansinspektionen (2015a).

²⁴ See Baranova et al. (2016).

²⁵ More specifically, the firms that trade directly with the Swedish National Debt Office are called primary dealers. In practice, the primary dealers of treasury bonds are also market makers for these bonds. A list of primary dealers is available at www.riksgalden.se/en/For-investors/Government-securities/Primary-dealers/.

²⁶ The Swedish National Debt Office also uses the repo facilities to manage internal flows, since it is not possible to distinguish if a market maker (potential shortage of treasury bonds) or the Swedish National Debt Office (internal flows) initiates a transaction. However, the Swedish National Debt Office's flows demonstrate a clear seasonal pattern, and this pattern is not behind the rise in utilisation of the facility over the past six months.

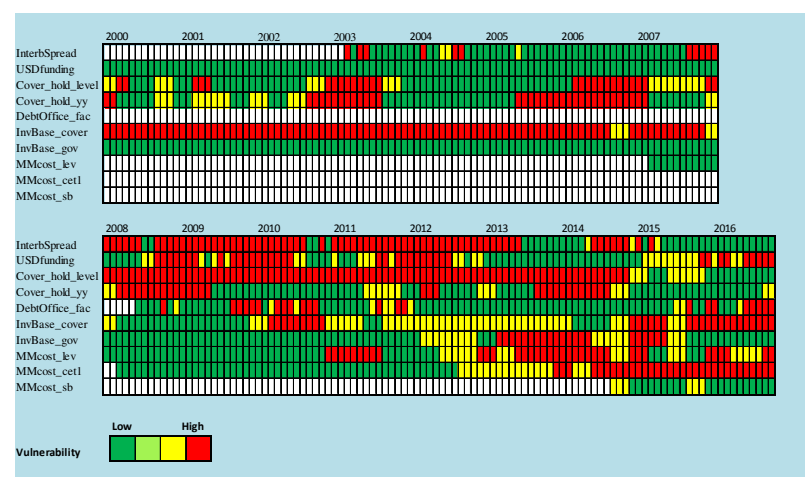
²⁷ Recursive thresholds mean that the thresholds are calculated over time and are updated with information up to the day of the calculation. In other words, a threshold calculated for

primarily set the thresholds using either a method that evaluates whether an indicator is correlated with crisis periods (conditional approach) or a method that does not (unconditional approach). Not evaluating an indicator with respect to a crisis period is in line with our focus on vulnerability indicators. A high value for a vulnerability does not necessarily mean that a crisis will occur, since an exogenous shock is also required. This means that a vulnerability can be at a high level for a long period of time without any problems arising, and in turn that the correlation with actual crises can thus be low.

We use the unconditional approach here. For indicators where high (low) values mean elevated vulnerability, the indicators turn from green to yellow when the indicator value exceeds (falls below) the 50th percentile. When it exceeds (falls below) the 70th percentile (30th percentile) the indicator turns red (high vulnerability).²⁸ The level of the percentiles originated from ESRB (2015).

Figure 3 shows the results for each indicator on a monthly basis. All indicators are based on daily observations that we then calculate using a one-month moving average. The exception is ownership of covered bonds (Cover_hold_level and Cover_hold_yy), which is based on quarterly data.

Figure 3: Liquidity indicators for systemically important markets



Source: FI.

During the IT bubble in the early 2000s, access to data was a limiting factor. Of the indicators for which we had data, the ones that signalled high vulnerability were banks' holdings of covered bonds (Cover_hold) and the investor base indicator compiled for covered bonds (InvBase_cover).

2005, for example, is only based on information that was available up to 2005. We use recursive thresholds for all indicators except the market makers' cost indicators, which follow trends and are not suitable for a recursive approach. These thresholds are instead set using expert judgements.

28 The higher the value, the higher the vulnerability for all indicators. The only exception is the indicator for USD funding. Here, we have chosen to consider a spread above 30 and below -30 as "red". Levels between 30 and 20 and between -30 and -20 are considered "yellow" and the rest are "green".

During the financial crisis, many of the indicators turned red. The interbank indicator signalled elevated vulnerability at the end of 2007 when global uncertainty in the banking sector led to a rapid increase in the funding costs of longer interbank loans. Banks also began to accumulate covered bonds as early as 2005, although initial levels were low and were therefore no cause for concern. It was first at the end of 2007 when foreign investors sold large blocks of their holdings that covered bonds on the banks' balance sheets reached worrying levels. Because the sellers were foreign investors, the investor base indicator for covered bonds showed elevated levels up to 2007. Foreigners are classified as conceivable sellers, and when these investors left the market the indicator fell and then turned green. It is therefore reasonable to say that the investor base indicator has predictive qualities, while the banks' ownership of covered bonds turns green in conjunction with – but not necessarily prior to – a crisis. This explains the high negative correlation between the indicators (see the next section). It was primarily at the end of 2008 that the price of currency swaps reached extreme levels, when the financial markets around the world were paralysed and the access of Swedish banks to USD abruptly stopped. At that point, the Riksbank implemented a temporary swap facility with the Federal Reserve in order to be able to continue to offer USD loans to the banks. This provided relief for the most acute USD shortage, but the price of the swaps stayed at historically high levels for a long time.

Currently, the NDO's facility, USD funding, the investor base of covered bonds and two indicators that describe the market makers' costs are demonstrating elevated vulnerability – other indicators are green. The high utilisation of the NDO's facility may be the result of a pending shortage of treasury bonds due to the Riksbank's quantitative easing. As mentioned, the USD funding indicator captures a structural dimension related to the high demand for USD as a funding currency. At the same time, the price of currency swaps has become increasingly negative in recent years. From a historical perspective, the indicator is now at elevated levels and turned red at the end of 2015. Finally, the cost indicators are strongly trending and are primarily a consequence of measures implemented by FI that gradually tightened capital requirements on banks.

COVARIATION BETWEEN INDICATORS

Figure 4 shows covariation between indicators, measured by correlations. It shows that the correlation between indicators in general is not particularly high. High correlation means that the various indicators generate a similar message, while a low correlation means that they generate specific information. High correlation is not necessarily good, since the indicators then risk providing duplicate information. In order to manage high covariance, we sometimes merge the indicators into sub-categories (see the following section).

Figure 4: Correlation matrix

	InterbSpread	USDfunding	Cover_hold_level	Cover_hold_yy	DebtOffice_fac	InvBase_cover	InvBase_gov	MMcost_lev	MMcost_cet1
InterbSpread	1,0	-0,41	0,47	0,44	-0,05	-0,53	-0,24	-0,50	-0,58
USDfunding		1,0	-0,25	-0,15	-0,33	0,07	0,33	0,33	0,28
Cover_hold_level			1,0	0,69	-0,10	-0,79	-0,43	-0,65	-0,78
Cover_hold_yy				1,0	-0,20	-0,68	-0,28	-0,52	-0,41
DebtOffice_fac					1,0	0,26	-0,51	-0,17	-0,15
InvBase_cover						1,0	0,15	0,43	0,61
InvBase_gov							1,0	0,67	0,67
MMcost_lev								1,0	0,77
MMcost_cet1									1,0

Degree of correlation	
0,70	1
0,50	0,70
0,20	0,50
0,20	-0,20
-0,20	-0,50
-0,50	-0,70
-0,70	1

Note: Correlations are based on monthly observations and calculated during the period 2008–2016. The indicator MMcost_sb has been excluded since the data series is too short.

Source: FI.

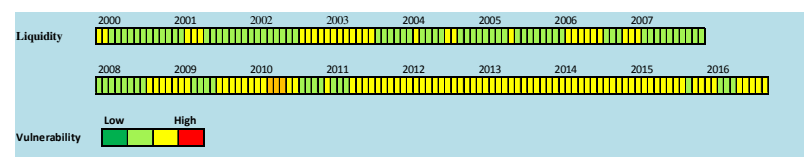
AGGREGATION

In previous analysis, FI has divided indicators into three vulnerability categories that in general describe which area the indicators are related to: solvency, liquidity and exposure. All indicators in this paper fall under the heading liquidity. FI also uses sub-categories to counter that one phenomena captured by many indicators does not dominate. By combining indicators that capture one phenomena into the same sub-category and allowing all sub-categories to carry the same weight, a better balance is achieved in the aggregation.²⁹

Sub-categories depend in part on how correlated the indicators are. If the indicators are highly correlated, and calculated in a similar way or based on similar data, it is reasonable to allow these indicators to form a sub-category.

Two of the indicators capturing costs for market makers (MMcost_lev and MMcost_cet1), as well as ownership of covered bonds, are some of the most internally correlated indicators (correlation factor of 0.78 and 0.69, respectively). They therefore constitute two natural sub-categories. We also include MMcost_sb in the first sub-category since it also measures the cost of market makers. We have not divided the other indicators into sub-categories. In a final step, the sub-categories are aggregated (see Figure 5).

Figure 5: Aggregation of liquidity indicators³⁰



Source: FI.

The aggregation of the indicators shows that vulnerability related to liquidity in the financial markets has increased steadily over the past few years. Rising costs for market makers, the high price of currency swaps, extensive utilisation of the NDO's facility and the high percentage of conceivable sellers in the covered bond market, have all contributed to the development described above. Currently, the aggregation is showing a slightly elevated level of vulnerability.

²⁹ See Finansinspektionen (2015 a) for more information about how FI uses categories and sub-categories in its work with indicators.

³⁰ This heat map differs from the heat map presented in Finansinspektionen's Stability Report (FI, 2016) since several revisions were made to it after the publication of the Stability Report.

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