Staff memo

An index for financial conditions in Sweden

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Summary

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Financial conditions is a broad concept that is often used to summarise the state of financial markets. There are several reasons why the central banks analyse the developments in financial conditions. Monetary policy affects production, employment and inflation via the financial system and financial conditions thus affect the monetary policy transmission mechanism. Financial conditions can also affect economic activity and are thus part of the regular analysis of economic activity on which monetary policy is based. However, *financial conditions* cannot be observed directly and there are various approaches to identify and construct representative indicators.

A financial conditions index (FCI) aims to reflect financial conditions by summarising the status of a number of indicators on some important sub-markets in the Swedish financial system. In this Staff memo we present one such index, where we have chosen to divide the Swedish financial system into five important sub-markets: the housing market, the bond market, the money market, the stock market and the foreign exchange market. Our FCI is a simple aggregate of indicators reflecting developments on these five sub-markets.

We use our index to analyse developments in financial conditions in Sweden since the start of the 1990s, and we show that the index provides a reasonable description of developments. We also show that our index is robust, in the sense that it, despite its simplicity, indicates a similar development as other indices constructed using more complex methods.

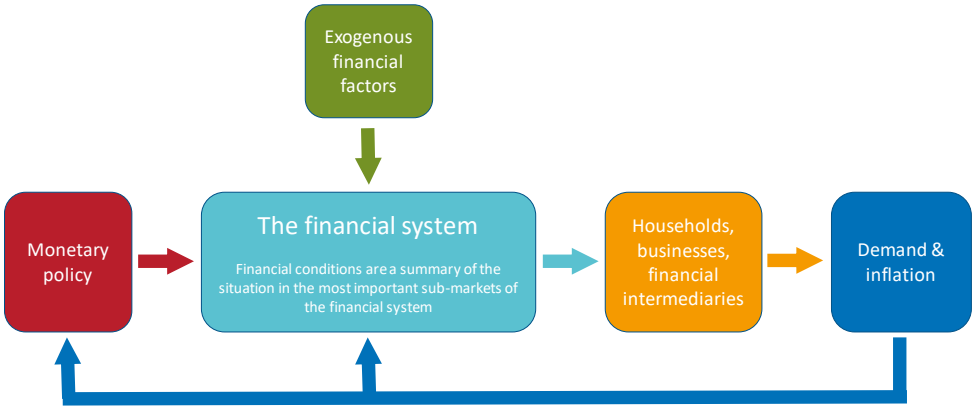
[1] We would like to thank Jesper Hansson, Jens Iversen and Ulf Söderström for valuable discussions and views on earlier drafts. The opinions expressed in this staff memo are those of the authors and are not to be seen as the Riksbank's standpoint.

1. Introduction

The objective of monetary policy in Sweden is to maintain price stability, defined as an annual rate of change in the CPIF of 2 per cent. The primary monetary policy tool used by the Riksbank to achieve this is the repo rate, although other tools, such as asset purchases, may also be used for monetary policy purposes. By adjusting the repo rate and the forecast of the future repo rate level, the Riksbank affects other prices and interest rates in the financial system. Changes in the financial prices and interest rates faced by households, companies and banks impact their financial decisions and thereby demand and inflation. If, for instance, inflation prospects are assessed as too low, the Riksbank would normally make its monetary policy more expansionary by either directly cutting the repo rate or by communicating that the repo rate will become lower in the future. More expansionary monetary policy usually leads to lower lending rates and higher housing and stock prices. These changes give rise to increased demand for goods and services in the economy, which in turn contributes to inflation rising.

The concept *financial conditions* is a summary of the state of the financial markets and the interest rates and conditions met by households and companies when they need to borrow or invest capital. It is thus a broad concept, which covers, among other things, financial prices such as lending rates and stock prices, but also risk premiums and access to credit. Monetary policy has an impact on financial conditions, which in turn affect the financial decisions made by participants in the economy. This is illustrated in Figure 1, which shows a simplified picture of the interaction between monetary policy, financial conditions and the real economy.

Figure 1. The interaction between monetary policy, financial conditions and the real economy



However, there are many factors in addition to monetary policy that affect financial conditions. For instance, expectations of stronger economic growth usually lead to higher stock prices, as the companies' profits in this case can be expected to rise faster than otherwise. In addition, more exogenous financial factors may affect the financial markets. This could, for instance, concern investors being less willing to hold risky assets. That would normally entail lower stock prices and higher risk premiums. One example of this is the financial crisis, which culminated in 2008, when risk premiums and volatility on the financial markets rose at the same time as stock prices fell. This had an effect on both developments in the real economy and inflation. The financial crisis provides a clear example of exogenous factors on the financial markets changing the financial conditions for households and companies in a way that spills over into the real parts of the economy.

Consequently, it is important for the Riksbank to understand the interplay of monetary policy, financial conditions and the economy. Obtaining a representative overall picture of the financial conditions requires monitoring and analysing the sub-markets and indicators that are most important for demand and inflation. However, this is no simple task, as there is an enormous amount of information on the financial markets. There is a large number of

financial instruments whose prices can affect the decisions made by households, companies and financial intermediaries. A structured analysis of the financial conditions can therefore begin by forming an opinion of which financial sub-markets are the most important, and then summarising the developments on these markets in a few indicators that can be monitored and analysed over time. An appropriate aid to this analysis is to construct an index for financial conditions.

As a concept, *financial conditions* is usable in analysis, but it is not possible to observe these conditions directly. To use financial conditions in an economic analysis, they must first be measured in some way.[2] A financial conditions index (FCI) aims to reflect financial conditions by summarising the status of a number of indicators on some important sub-markets in the Swedish financial system. There are several advantages for a central bank to use an FCI as a compliment to analysing individual assets and instruments. For one thing, this can guide the external communication of monetary policy. One can, for instance, talk about whether the financial conditions as a whole are more or less expansionary than normal, and how they have developed recently. For similar reasons, an FCI can also clarify the internal analysis of the financial conditions. Many of the usual macroeconomic models used by central banks are advanced in the way they model the real economy, but relatively simple with regard to the financial system. One may therefore need a summarising measure of the financial conditions to provide a richer picture of the financial system. Analysis of an FCI can therefore act as a robustness check that aims to capture important financial aspects that are not captured by the usual macroeconomic models. One example is Adrian et al. (2019), which studies whether an FCI has anything to say about the risks to economic forecasts.

In this article we present an FCI for Sweden that can be used in a structured analysis of financial conditions. The article is organised as follows: In section 2 we discuss how different international organisations have chosen to construct indices for financial conditions and how they use them in their analysis. In section 3 we argue in favour of dividing the Swedish financial system into five important sub-markets. We present the indicators we use to monitor and analyse developments on these sub-markets and we discuss how the variation in the indicators, according to economic reasoning, should affect financial conditions. This discussion is important for how we then construct our index for financial conditions. In section 4 we present the details of how we construct our FCI. The index summarises five different factors; one factor for each sub-market. These factors are in turn constructed as averages of a number of indicators that describe the state of each respective sub-market. This construction means that it is easy to describe which sub-markets are the main driver behind developments in the index. We also show a simple method to divide the index into an endogenous part (which is caused by monetary policy and economic activity – the red and blue arrows in Figure 1) and an exogenous part (caused by disruptions within the financial system – the turquoise arrow in Figure 1). In section 5 we use the index to analyse developments in financial conditions in Sweden since the beginning of the 1990s. It turns out that the index reflects a reasonable, intuitive picture of developments: All of the sub-markets affect financial conditions in a clear manner and the different sub-markets have particular significance for financial conditions at different points in time. The division of the change in financial conditions due to endogenous and exogenous reasons is well in line with what one might have expected. For example, the expansionary financial conditions prior to the financial crisis were largely due to exogenous financial reasons as opposed to endogenous response to monetary policy and economic activity. In Section 6 we discuss robustness. We show, for instance, that other common but also more complicated methods for constructing an FCI give similar results to our method. One advantage with our method is that it simplifies the economic interpretation of developments, as the same time as the index is robust when including new data. Section 7 contains a brief summary.

[2] Similarly, the output gap can in many ways be a useful concept in economic analysis, but it is not directly observable either, and therefore needs to be measured indirectly.

Terms we use in this Staff memo
The term **variable** is used here to mean a pure, untreated time series. After a variable has been transformed in different ways it is termed an **indicator**. The reason for this is that the original variable gains a different interpretation than it had to begin with. Transformations where we divide a variable by another one are also a stage in creating indicators. When we in one way or another form linear combinations of indicators via totalling, an average or in some other way, we call it a **factor**.

2. FCIs in other central banks and international organisations

Analysing financial conditions is of central importance to central banks, but it is also important to international organisations, as monetary policy has an impact through the financial system. As part of their analysis work, these organisations often use FCIs. Some examples are the BIS (Bank for International Settlements, 2018), the Bank of England (Kapetanios, Price and Young, 2017), the ECB (Darracq Pariès, Maurin and Moccero, 2014) and the Federal Reserve Bank of Chicago (Brave and Butters, 2010; Brave and Kelley, 2017).

Some international organisations use an FCI to forecast macroeconomic variables. The focus is then on the latter part of the stylised picture of the interaction between monetary policy, financial conditions and the real economy in Figure 1 (how the financial conditions affect the conditions and choices of households, companies and intermediaries, which then affect the real economy and inflation – the turquoise and yellow arrows in Figure 1).

There is extensive academic literature showing how different types of exogenous disruptions in the financial system affect the macro economy. These disruptions contain information on economic developments that is not already captured by macroeconomic variables. One way of obtaining this information is to construct an FCI, where the indicators are selected on the basis of their ability to forecast macroeconomic variables, such as GDP and inflation. An article by the Bank for International Settlements (2019) shows that the forecasting ability of an FCI is significantly stronger in times of increased financial stress. This type of FCI is common among the private participants in the financial sector, such as Bloomberg (Rosenberg, 2009), Goldman Sachs (Hatzius and Stehn, 2018), Morgan Stanley and Citi Group (D'Antonio, 2008).

In addition to analysing developments in the real economy and monetary policy, central banks and other international institutions are often interested in analysing financial stability. As a part of this analysis they often use a so-called Financial Stress Index (FSI), which have a substantial overlap with indices aimed at measuring financial conditions. One important difference between the two types of index is that the FSI tends to focus more on indicators representing risks related to, for example, indebtedness among various economic agents and banks' balance sheets, while the FCI has more focus on prices, interest rates and risk premiums. Kliesen, Owyang and Vermann (2012) discuss in greater detail how FCIs and FSIs relate to one another and also show that the different types of index in the United States nevertheless tend to be relatively similar. With regard to Sweden, the FSI described by Johansson and Bonthron (2013) is different from the FCI described by Fransson and Tysklind (2017). Examples of other institutions that use FSIs are the IMF (Swiston, 2008), the OECD (Guichard, Haugh and Turner, 2009), the Federal Reserve Bank of Kansas City (Hakkio and Keeton, 2009), the Federal Reserve Bank of St. Louis (Kliesen and Smith, 2010) and the ECB (Kremer, Holló and Lo Duca, 2012). The use of FSIs has become much more common after the financial crisis, which made clear that stress in the financial system can have serious macroeconomic consequences.

A further example of how an FCI can be used is discussed in Adrian et al. (2019). The authors use an FCI to analyse the allocation of future GDP growth in a way that is difficult to

achieve with the macroeconomic models usually used by central banks and international organisations. The IMF has begun to apply this method in its country monitoring (Prasad et al. 2019).

3. The Swedish financial system

As described above, the first step in our construction of an index for financial conditions in Sweden is to analyse what characterises the Swedish financial market. We review the most important distinguishing features of households', companies' and financial intermediaries' (mainly the banks') balance sheets, and in the analysis five sub-markets crystallised as important to financial conditions: (i) the housing market; (ii) the stock market; (iii) the money market; (iv) the bond market; and (v) the foreign exchange market. On an aggregate level the sub-markets, in terms of outstanding balance, are comparable. We have chosen not to rank the sub-markets, instead we regard each market as equally important for financial conditions. It is therefore natural for us that the final index, which is presented in Section 4, represents the sum of the five markets. This straightforward construction of the index makes it easy to interpret, as one can discuss the development of the index in terms of how the different sub-markets have developed. The analysis below also shows which indicators are most suitable to summarise developments on each sub-market.

3.1 The characteristics of the Swedish financial system

Households' aggregate balance sheet is dominated by housing on the asset side and mortgages on the liabilities side, where the average interest-rate fixation period for mortgages is relatively short.[3] In addition to mortgages, households also have other loans, without collateral, such as study loans, car loans and other credits. These loans also tend to be signed at interest rates with short fixation periods. Changes in housing prices affect the value of household assets and thereby the possibility to extend the mortgage to release liquid funds for consumption, for instance. The value can also be affected by changes to the actual holding of housing. For instance, by wear and tear in existing homes or through new investments. However, the part of the change in value that is due to these things is marginal and including this effect would entail a sacrifice in the form of using data published with a relatively long time lag. We have therefore chosen to only include the part of the change in value that occurs through changes in prices.

The value of household assets affects the lending conditions households are offered by the banks. For instance, both mortgage rates and amortisation conditions are closely linked to households' loan-to-value ratios (the ratio between own capital and liabilities). Higher housing prices thus mean more expensive financial conditions for the average household. Another important part of households' own capital is the size of their debts, where an increase in their debts entails, all else being equal, higher interest rate costs and an increased exposure to higher future interest rates. Stocks constitute a large share of households' financial assets, either direct ownership of stocks or indirect ownership through pension rights and mutual fund holdings. Households are thus exposed to stocks prices through a wealth channel, where rising stock prices increase household wealth, and their access to credit, and thus their consumption and investment decisions.[4] All in all, we can note that the financial conditions for households will become more expansionary from lower lending rates,

[3] Approximately 65 per cent of mortgages are signed at an interest rate with a 3-month maturity, and 34 per cent at maturities of between 3 months and 5 years. Source: Statistics Sweden.

[4] Di Maggio, Kermani and Majlesi (2018) show that Swedish households have a greater propensity to increase their consumption when receiving dividends than when stock prices change. It may therefore be important to look at the *total* return on stocks, which includes dividends. However, we will be focusing on price changes since they provide a better reflection of the market's view on companies' future profits, which in turn affects companies' ability to finance themselves through the stock markets. Regarding households, it is worth adding that shareholdings are concentrated to the wealthiest households, while for instance the lower half of the assignment own only 7 per cent of the total stock of shares (see the discussion in Di Maggio, Kermani and Majlesi, 2018).

primarily for short maturities, higher stock returns, higher housing prices, and lower debts. On aggregate, households are to a large degree exposed to the housing market, stock market and money market through their mortgages.

Companies fund themselves through three primary channels: equity, bank loans and corporate bonds.[5] Rising stock prices and low volatility on stock markets make it easier and cheaper for companies to fund themselves by issuing new shares. The volatility is in some contexts used as a measure of the risk premium on the stock market. A measure of this in Sweden was previously calculated by SIX Financial Information, but they stopped doing so a few years ago. Historically, the volatility on the Swedish stock market has been similar to the volatility on the US stock market, so we have included the well-known VIX as a measure of the equity risk premium on the Swedish stock market.[6] With regard to bank loans and other financing alternatives from the banks, interest rates are often with short fixation periods. On the other hand, bonds by nature have somewhat longer maturities, which makes it appropriate to study bond yields on longer, for example 5-year, maturities.

In addition, a weaker krona means that Swedish export companies become more competitive and contributes to making the financial conditions more expansionary. For the companies that mainly import product they sell on the domestic market (for instance, retail traders), a weak krona mainly contributes instead to less expansionary conditions. On the aggregate, however, a weaker krona contributes to more demand for goods and services produced in Sweden. A weaker exchange rate is thus considered to be more expansionary financial conditions.

Financial conditions will also become more expansionary if Swedish interest rates are low in relation to those abroad, given the level of the exchange rate. A low interest rate differential in relation to the rest of the world signals, all else being equal, confidence in the inflation target and the Swedish financial system. As an indicator of this, we include the difference between Swedish and German government bonds with a 2-year maturity.

All in all, the financial conditions for companies become more expansionary from lower bank interest rates with short maturities (both on a level with and in relation to interest rates abroad), lower corporate bond yields with medium to long maturities, higher stock prices, lower volatility and a weaker krona. Companies thus have a clear exposure to the money market, bond market, stock market and foreign exchange market.

It is important to also monitor the financial conditions faced by the **intermediaries** on the financial markets. Although households and companies are the economic agents that ultimately contribute the most to demand in the economy, changes in the financial conditions for intermediaries can rapidly spill over and affect the financial conditions for households and companies. One example of this is mortgages, which are largely financed by banks and mortgage institutions issuing covered bonds. Changes in yields on these bonds affect the cost of the mortgages and tend to spill over to the mortgage rates to households. The banks' ability and willingness to issue mortgages, and their requirements regarding households' credit ratings, can be affected by liquidity and the functioning of the bond market. Disruptions in this market are usually reflected in credit risk premiums, which makes it relevant to monitor the difference between the yields on covered bonds and government bonds with the same maturity, for instance 5 years. Mortgages are also financed through deposits from households and companies, which means that the difference between lending and deposit rates may contain important information about credit supply as well as the banks' profitability. With regard to the money market, another important indicator in these contexts is the difference between a 3-month interbank rate (STIBOR) and the yield on a 3-month treasury bill. STIBOR is a reference rate that reflects the transactions between banks and it is linked to some credit risk, but also affected by the general liquidity situation on the money market. The yields on treasury bills are not directly affected by this, so the interest

[5] We focus on the liability side of companies' balance sheets, since the asset side is dominated by real assets, and the value of those assets do not depend directly on financial conditions.

[6] VIX is an abbreviation of the Chicago Board Options Exchange (CBOE) Volatility Index. The Index is calculated by the CBOE and measures the expected volatility in 30 days' time on the US stock exchange S&P 500. The calculations are based on prices of stock options.

rate differential often increases when frictions arise in the interbank market that lead to more expensive financing for the banks. All in all, we can note that both the bond market and the money market are central to understanding the financial conditions affecting intermediaries.

The **public sector** is also an important agent in the financial system, especially as the market for government securities (treasury bills and government bonds) comprises a benchmark for pricing on the private bond market (where mortgage bonds, or covered bonds, are clearly the largest market) and a substitute for other markets (primarily the money and stock markets). The slope of the yield curve for government bonds, in the form of the interest rate differential between a 10-year government bond and a 3-month treasury bill, captures both interest rate expectations and compensation for duration risk. These two, expectations and duration risk, are common to all bond markets.

Table 1 shows a compilation of the sub-markets and indicators generated in this discussion. The final column in the table shows a plus or minus sign, which states whether an increase in the indicator is assumed to be linked to financial conditions becoming more or less expansionary.[7] We also compile the different markets according to their value in SEK billions (outgoing balance 2018) in Table 2, measured from the liabilities side with data from the Financial Accounts. It is evident that the sub-markets are comparable in size and they all constitute an important part of the total financial system.

Table 1. Market indicators

Markets	Indicators[8]	Effect on financial conditions
Housing market	House prices (HOX)* °	+
	Household liabilities°	–
Stock market	Stock market index (OMX)°	+
	Volatility (VIX)	–
Money market	STIBOR 3m	–
	STIBOR 3m – 3-month treasury bill	–
	Listed mortgage rate (Nordea 3m) – STIBOR 3m	–
	Lending rate – deposit rate	–
Bond market	10-year government bond – 3-month treasury bill	–
	5-year covered bond – 5-year government bond	–
The foreign-exchange market	Nominal effective exchange rate (KIX)	+
	Interest rate differential Sweden – Germany, 2-year government bonds	–

*Prior to 2005 the series is spliced back to developments in the property price index (FPI)

°The series is divided by nominal GDP. Nominal GDP is interpolated to monthly frequency.

It should be added that our choice of indicators is based on historical observations of prices and balance sheets, and it is not self-evident that the same indicators will remain as relevant in the future. This type of criticism is highlighted by, for instance, Dudley (2010). It is therefore important to constantly review the set of indicators and perhaps make adjustments

[7] Similar divisions of the financial system into different sub-markets have previously been made by, for instance, Johansson and Bonthron (2013) and Giordani et al. (2015).
[8] A list of variables and sources are included in the appendix.

dependent on the circumstances. The normalized indicators for the respective sub-markets are shown in the appendix.[9]

Table 2. The size of the markets in SEK, at end of 2018

Asset type	SEK billions	Per cent of total, %
Property° and tenant-owned apartments	10 804	33
Stocks	7 972	24
Interest-bearing (e.g. bonds)	6 950	21
Bank deposits	7,233	22
Total assets	32 959	100
*of which foreign currency exposure**	*4 944-13 169*	*15-40*

°Houses and second homes

*It is not entirely clear how one should measure foreign currency exposure and the results vary, depending on the method and data source. One way is to investigate gross external liabilities in the Financial Accounts, FIR, which are not, however, broken down into currencies. The balance of payments statistics are broken down into currencies, but do not provide any information on whether the exposure is to foreign or domestic actors. The lower figure for foreign currency exposures is based on using the net external position from the Financial Accounts. The higher figure is based on measuring foreign currency exposures from the balance of payments statistics.

Sources: Financial Accounts and Balance of payments statistics, Statistics Sweden

4. Method and approach

In this section we describe how we construct our index for financial conditions in Sweden. According to academic literature on the subject, the most common method of constructing an FCI is to use statistical methods such as principal component analysis or dynamic factor models; see, for instance, Darracq Pariès, Maurin and Moccero (2014), Hatzius et al. (2010), and also Fransson and Tysklind (2017), Brave and Butters (2010) and Matheson (2012). We have chosen a much simpler method that entails totalling five factors that represent the sub-markets we have discussed in Section 3.

We have two main reasons for using this method. Firstly, our method means that the interpretation of our index becomes much simpler in relation to if we had used more complicated statistical methods. For instance, our index can be simply broken down into contributions from each sub-market (and each indicator), which makes it easy to understand which sub-markets contribute to tighter financial conditions, and which sub-markets contribute to more expansionary financial conditions. Secondly, we have made analyses that indicate that the variables chosen and the way they are transformed may be more important for the profile of the composite FCI rather than the method used to weight the indicators into an index (for reasonable variations in the weights). Section 6 (and appendix 2) also include examples of our index being similar to indices calculated using more complex statistical methods.

4.1 Transformations of financial variables

The way one chooses to transform the variables included in an FCI can have a significant impact on the profile of the composite index. We have found relatively little discussion of this in the economic literature on FCIs. Instead, a considerable share of the discussion concerns the technical methods used to weigh together an index. However, Hatzius et al. (2010) discuss whether data should be expressed in levels, differences, logarithms or as the share of

[9] The concept "normalized" refers to a transformation whereby the variable's deviation from its mean value is divided by the standard deviation. In this way we obtain indicators whose variation can be interpreted in terms of standard deviations from their respective mean value. A longer discussion on the pros and cons of the different transformations of variables can be found in the Section below.

one variable to another, and so on. It is not self-evident whether, for instance, interest rate data should be included in an FCI on levels or as the spread to a benchmark variable. We have chosen to use volatility (VIX), the short-term interest rate (Stibor) and the exchange rate in levels. Other interest rates than Stibor are expressed as the spread to a selected benchmark interest rate. The variables with an obvious trend, house prices, stock prices and liabilities, are expressed in relation to nominal GDP.

As described in, for instance, Hatzius et al. (2010) it is common to first normalize the variables (X_i) included in an FCI. The purpose of this is to create comparability between variables measures on different scales (e.g. stock prices and exchange rates), and between more stable versus more volatile variables (e.g. interest rate margins and stock market volatility). One normalizes a variable by deducting from the variable's mean value (μ_i) and dividing by its standard deviation (σ_i):

$$x_{i,t} = \frac{X_{i,t-\mu_i}}{\sigma_i}.$$

The variable then takes on the form of an indicator whose variation can be interpreted in terms of the number of standard deviations from its mean value.[10] In this way, all of the variables end up on the same scale, and a change in, say, stock prices becomes comparable with a change in interest rate margins. If the indicator follows the normal distribution, movements within a standard deviation are not unusual, while variations within the interval of one to two standard deviations are unusual and movements over two standard deviations are regarded as improbable. However, there is nothing to say that financial indicators need to have a normal distribution.

4.2 An index for financial conditions: a simple approach

In Section 3 we have discussed which financial sub-markets we find most important in Sweden and which indicators we have chosen to represent these sub-markets. In Table 1 we describe the signs we allocate to each indicator so that it reflects the financial conditions in the way we find economically intuitive.

As we discussed in Section 3, we are expecting an upturn in housing prices to be related to more expansionary financial conditions, while an increase in liabilities to be related to tighter financial conditions. These two indicators constitute **the factor for the housing market**, and reflect households' home equity on the housing market. **The factor for the stock market** is comprised of the indicators for stock market prices (OMX) and a measure of volatility on the stock market (the US volatility index VIX). Higher prices on the stock market are linked to more expansionary financial conditions, while higher volatility is linked to increased risk premiums and thereby tighter conditions. As we describe in Section 3, this factor reflects companies' financing situation, but also households' wealth development. In **the factor for the money market**, an increase in the short interbank market rate is linked to tighter financial conditions. Larger differences between the interbank rate and the treasury bill, larger differences between the listed mortgage rate and the interbank rate and an increased spread between the banks' lending and deposit rates are related to tighter financial conditions. In **the factor for the bond market**, a steeper (upward sloping) yield curve has a tighter effect on financial conditions, in the same way as a rise in the yield on covered bonds in relation to the corresponding yields on government bonds. A steeper yield curve is either related to expectations of a higher future policy rate or an upturn in the term premium. In line with the reasoning in Section 3, we see that a weakening of the krona is linked to more favourable financial conditions, while an upturn in the interest rate differential between

[10] As the mean value (μ_i) and the standard deviation (σ_i) are calculated on the basis of historical data, $x_{i,t}$ will be revised when more data becomes available. However, in Section 6.2 we show how these revisions have declined over time and that they have had a minimal impact on the index since 2001. Normalising variables that are different from one another is often done when compiling surveys on sentiment in the economy. See, for instance, how the National Institute of Economic Research has constructed its business tendency surveys and how Nyman (2010) constructed an indicator for resource utilisation in Sweden.

Sweden and Germany is something that we interpret as a signal of tighter financial conditions. The average of these two indicators constitutes **the factor for the foreign exchange market**. The way that the different sub-market indicators and the resulting factors develop over time is shown in Figure 14–18 in the Appendix.

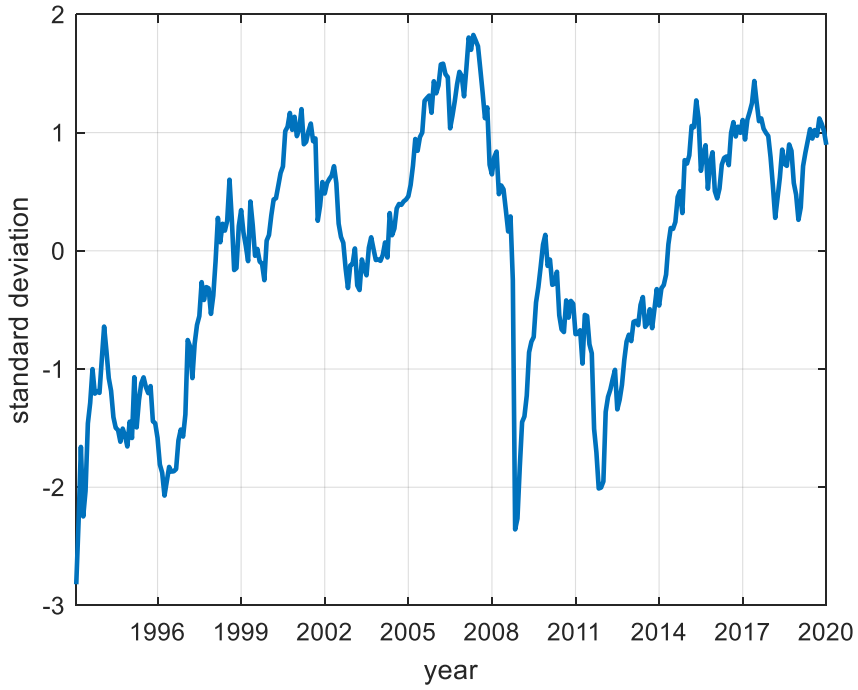
Compared with the international academic research, we have chosen a simpler method to generate factors, as an average of the indicators representing each sub-market. We then construct the final index as the sum of the five factors that should reflect the developments on each sub-market; $FCI_t = \sum_{j=1}^{5} \bar{f}_t^j$ where $\bar{f}_t^j$ is factor *j*. The five factors are normalized so that they have a mean value of zero and a standard deviation of one. This implies that each sub-market have the same weight (average contribution) in the final composite index. In a final step, the composite index is (re-)normalized so that the mean value is zero and the standard deviation is one. This results in an index that is easy to interpret and can be replicated without using any complicated statistical model to weigh together the indicators included in Table 1.

Even if we have used a method that on the surface differs from the methods usually described in the academic literature, our method is more closely linked to the more common methods than it appears. This is discussed in greater detail in Section 6 and the Appendix.[11] Our method thus has the advantages of being robust and simple to interpret and calculate. The disadvantage with our method, however, could be that the factors comprising the index are not independent of one another in a statistical sense. For instance, we cannot be certain that the stock market factor is independent of the exchange rate factor. However, it is far from obvious that a methods generating independent factors offer a better representation of the "true" trend and patterns of the underlying financial conditions. Although our way of constructing the factors makes it easy to see which indicators have caused the change in the index, it is not easy to draw conclusions about the underlying causes. It could, for instance, be the case that the factors reflect the same underlying driving forces, such as during the financial crisis when the stock market index fell at the same time as the krona exchange rate weakened. However, for the final index this need not necessarily be a major problem, for various reasons. Firstly, we show in Section 6 and in the Appendix that our FCI is very similar to the indices that can be calculated using purely statistical methods, where the factors are in many cases independent of one another. Secondly, it is reasonable to believe that the sub-markets are sometimes affected by the same underlying forces. When, for instance, a large number of sub-markets contribute at the same time to expansionary financial conditions, it is reasonable to believe that there are a few common driving forces behind the developments. Our index makes it clear when this is and isn't the case.

Figure 2 shows our index for financial conditions in Sweden. Positive values indicate expansionary financial conditions, while negative values indicate tighter financial conditions. According to our index, financial conditions in Sweden were much tighter at the beginning of the 1990s, in connection with the 1990s crisis in Sweden. During the 2000s, financial conditions began to be expansionary and were at their most expansionary in 2007, prior to the financial crisis. When the financial crisis hit, financial conditions became tighter once again. After a period of recovery, financial conditions weakened again, in connection with the euro crisis, but have since then been expansionary. The main elements in the development of the index shown in Figure 2 thus appear to be reasonable, which we discuss further in Section 5. The profile of our FCI is similar to the index described in Fransson and Tysklind (2017), although the methods used to construct the indexes are quite different.

[11] We describe in the appendix how the strategy we follow here can be derived from restrictions in an original dynamic factor model. To link the different sub-market indicators to a specific factor we have introduced zero restrictions for how certain indicators interact with a specific factor. We introduce these zero restrictions to be able to identify a specific factor to reflect a particular sub-market. In this way, for instance, the factor describing the bond market will not affect (at the same time) the indicators linked to the stock market.

Figure 2. FCI according to a simple approach
Standard deviation

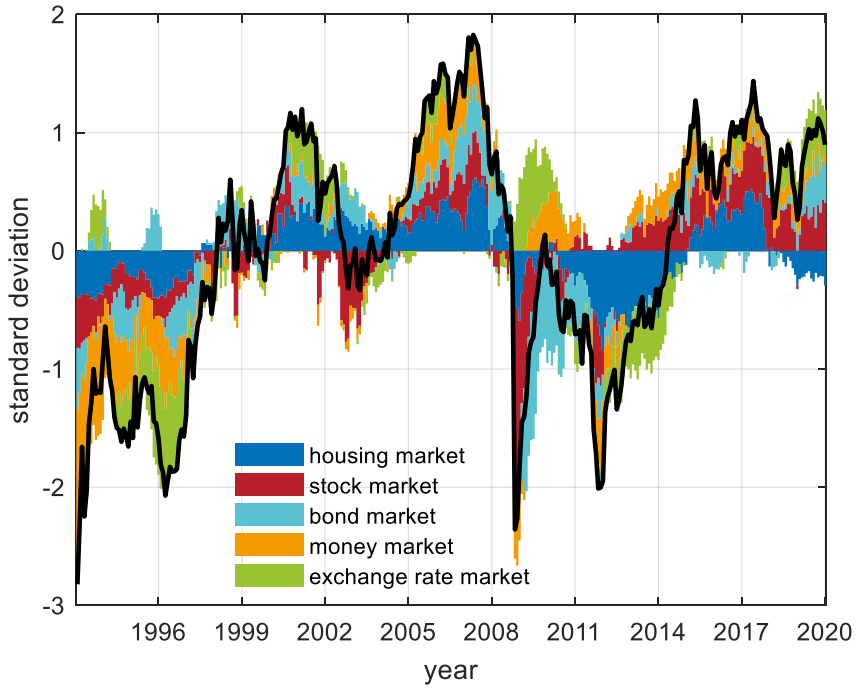


Sources: The Riksbank and the authors' own calculations

4.3 The contributions of different sub-market factors to the development of financial conditions

Our FCI is easy to interpret as it consists of five factors that represent developments on each of the five financial sub-markets. Figure 3 shows the respective sub-market's contribution to the final composite FCI over time.

Figure 3. FCIs and contributions from the sub-markets
Standard deviation



Sources: The Riksbank and the authors' own calculations

Figure 3 shows the contributions by each of the five sub-market factors to the development of our FCI over time. The simple way in which the index is constructed makes it possible to focus on one individual factor if one wishes to place greater relevance on an individual factor than the index does. Indicators and factors can also be removed and added without this changing any aspect of the other indicators and factors. For example, if we adjust the factor for the housing market and change the way in which the indicators are transformed, or if we add or remove indicators, this will not change the way in which the other factors, such as the foreign exchange market factor, are calculated. This makes the construction of the index more robust than purely statistical methods in which interpretations of the factors can easily be affected by the addition or removal of an indicator to or from the analysis.

4.4 An index that excludes the influences of the economic cycle and monetary policy

One decisive matter in the usage and interpretation of an FCI concerns whether financial conditions are favourable due to the contributions made by the economic cycle and monetary policy or if there is something in the financial markets that is having a beneficial effect. Another way of putting it is whether financial conditions are changing endogenously due to cyclical reasons or whether financial conditions have been changed by factors that are exogenous to the economic cycle. The effect these exogenous financial factors have on the financial conditions are illustrated by the green arrow in Figure 1.

The discussion of the division into endogenous and exogenous changes is a central part of Hatzius et al. (2010) and Brave and Kelley (2017), as the ability to separate the part of the financial conditions that is due to monetary policy and the economic cycle from the part that is due to genuine financial causes on the financial markets can substantially improve the interpretation of an FCI. To make this breakdown, we use the simple and transparent approach described in Hatzius et al. (2010). This method is also used by the Federal Reserve

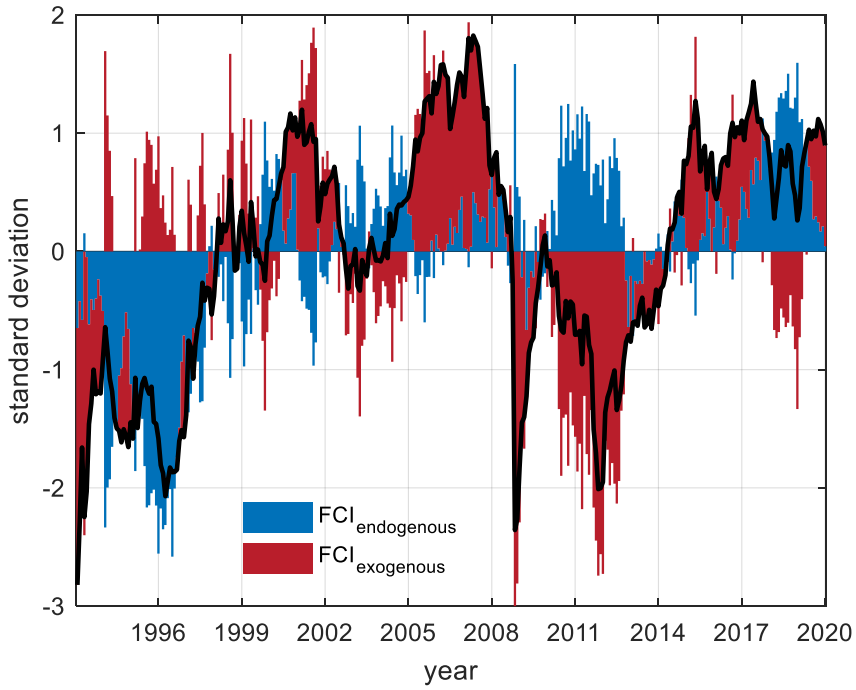
Bank of Chicago.[12] The separation of each financial indicator (x_t^i) from the part that can be explained by contemporary economic variables and the stance of monetary policy (Z_t) can be made by estimating the regression:[13]

$$x_t^i = A_i Z_t + v_t^i.$$

The part of the variation in the financial indicator that cannot be explained by the cyclical variables is included in the error term v_t^i, and thus represents the purely exogenous (to the economic cycle and monetary policy) variations on the financial markets. In Figure 4, we have used three cyclical variables on a monthly basis: unemployment, the National Institute of Economic Research's Economic Tendency Indicator and the repo rate so that; $Z = (constant, unemployment_t, economic\ tendency\ indicator_t, repo\ rate_t)$ to break down the financial indicators into an endogenous and an exogenous part. In the next step after which we have weighed these together to form the index described in section 4.[14]

In Figure 4, we show the result of the breakdown achieved using the regression above, where the black curve represents the FCI shown in Figure 2 and Figure 3. The blue bars illustrate contributions to the FCI from the part of the financial conditions that stems from the economic cycle (the endogenous part), while the red bars illustrate contributions to the FCI from purely exogenous changes to the various sub-markets.

Figure 4. FCI broken down into contributions from endogenous and exogenous changes
Standard deviation



Sources: The Riksbank and the authors' own calculations

[12] See https://www.chicagofed.org/publications/nfci/index.
[13] This regression is estimated using the least squares method for each individual variable with monthly data for the entire sample period, 1993–2019.
[14] The Tendency Survey of the National Institute of Economic Research only exists on a quarterly basis for the years 1993–1995. For these two years, we have interpolated monthly data for this variable.

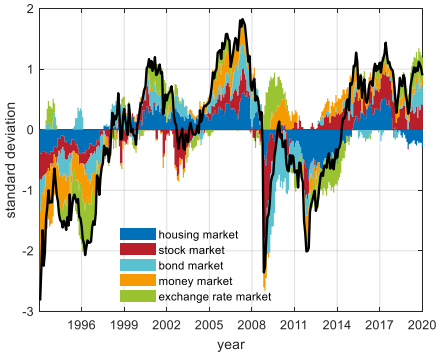
5. How have the financial conditions in Sweden developed?

In this section, we use our FCI to discuss how the financial conditions have developed in Sweden since 1993.

5.1 Interpreting an index for the financial conditions in the monetary policy analysis

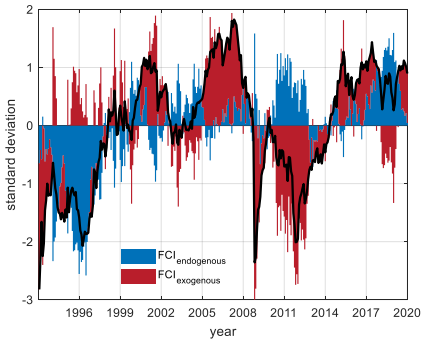
In the section above, we presented figures showing how the various factors (or sub-markets) have contributed to the development of the financial conditions and how the development of the financial conditions can be divided into endogenous and exogenous changes. To make it easier to follow the next step in our reasoning, we have collected this into Figure 5 and Figure 6.

Figure 5. FCIs and contributions by the sub-markets
Standard deviation



Sources: The Riksbank and the authors' own calculations

Figure 6. FCI broken down into contributions from endogenous and exogenous changes
Standard deviation



Sources: The Riksbank and the authors' own calculations

In Figure 5, we see that, at the start of the 1990s, the financial conditions in Sweden were marked by the aftershock of the crisis of the 1990s. Together with tight conditions on the Swedish money market, the downturns in the housing market and in the stock market that followed the crisis contributed towards the financial conditions as a whole becoming tight. In the mid-1990s, a high interest rate differential with Germany, like the relatively strong krona, also contributed to the financial conditions remaining tight. The high interest rate differential was connected with the financial markets' distrust of the funding of Sweden's national debt after the crisis of the 1990s. Figure 6 indicates that financial conditions at the start of the 1990s were tight for reasons that were specific to the financial markets, but that, in the mid-1990s, conditions continued to be tight due to endogenous factors related to the downturn in economic activity.

At the turn of the millennium, financial conditions were more or less neutral, and all factors were close to their average values. In the following years, the foreign exchange market, bond market and housing market contributed to the financial conditions becoming expansionary. In Figure 6 it can be seen that this was primarily linked with purely (exogenous) financial explanations as the economic cycle cannot explain the expansionary financial conditions at this point. The stock market also temporarily contributed to the expansionary conditions at the turn of the millennium, but this reversed in 2001 and 2002, in the wake of the dot-com crash. In Figure 6, it can be seen that this tightening of financial conditions was caused by the positive contribution from exogenous financial factors gradually fading and later reverting. Overall, the financial conditions were not unambiguously tight during the

episode after the burst of the dot-come bubble and the housing market and bond market contributed towards the financial conditions as a whole being relatively normal.

During the latter part of the 2000s, all markets contributed towards gradually more expansionary conditions. Figure 6 shows that this cannot be explained by cyclical variables. The run-up to the financial crisis, with the expansionary conditions that prevailed then, was therefore linked to genuine financial factors.

The financial conditions deteriorated in conjunction with the financial crisis of 2008, very much because conditions on both the stock market and the housing market became tighter, but also because of tighter conditions on the money market. In Figure 5, it can be seen that the foreign exchange market counteracted the tight conditions on the other markets in conjunction with the financial crisis. In the following year, conditions on the money markets also contributed to the financial conditions becoming less tight before finally normalising in 2010. One underlying reason was probably the highly expansionary monetary policy during this period.

On the other hand, during the euro crisis, the money markets contributed towards the financial conditions becoming tighter, although a significant part was also related to the continued accumulation of household debt at the same time as the development of prices on the housing market became restrained. The later part of the euro crisis was also characterised by the appreciation of the krona, which contributed towards financial conditions in Sweden becoming tighter than would otherwise have been the case. During this episode, Figure 6 indicates that economic developments suggested that the financial conditions should have been more expansive than they actually were. For example, the National Institute of Economic Research's Economic Sentiment Indicator was within one standard deviation of its normal position over almost the entire period. At the same time, for example, the indicators for the money market and stock market were much lower than normal. The effect of the financial shocks was also more long-term in comparison with the episode for the financial crisis.

Since 2014, financial conditions in Sweden have been expansionary. In Figure 5, we see that the Swedish housing market has made a positive contribution over a large part of this period, but that the conditions were also expansionary on the stock market and money market. Figure 6 shows that this was due to genuine (exogenous) financial causes that cannot be explained by the economic cycle. It would be reasonable to interpret this as being at least partly due to a heavily expansionary monetary policy with asset purchases and very good access to liquidity, which has created more expansionary conditions on the money market than normal. In 2017 and 2018, the expansionary financial conditions were maintained by the improvement of economic activity. On the other hand, the financial conditions became less expansionary around the end of 2018 when genuine financial reasons prevailed. Figure 5 shows that this was connected with downturn on the stock market, at the same time as the money market and the bond market were no longer making an expansionary contribution. In 2019, economic developments tailed off as an explanation for the expansionary conditions, while, at the same time, genuine financial explanations took over as the cause of the recovery and ongoing expansiveness of the financial conditions. Figure 5 shows that the weak krona and developments on the bond market, with falling yields, have contributed towards keeping the financial conditions expansionary. These effects clearly outweighed the effect of the housing market, which has made a contribution in a tighter direction for some time. The positive contribution from the bond market has to do with both the slope of the yield curve becoming less steep and bond yield margins being lower than cyclical reasons justify. The slope of the yield curve thus indicates that long yields are unusually low, given the economic situation. One way of interpreting this is that expectations of a more expansionary monetary policy are higher than they usually are in a situation in which the economic cycle is slowing down, and that risk premiums that would normally be rising are continuing to be low.

5.2 Is an FCI useful in economic and monetary policy analysis?

In section 5.1, we have analysed the development of the financial conditions in Sweden since the 1990s, using the FCI we have constructed as a starting point. Overall, the broader aspects of our FCI seem reasonable: the financial conditions were tight directly after the Swedish crisis of the 1990s. Before the financial crisis, the financial conditions were obviously expansionary in a way that could not be explained by the economic cycle and, during the financial crisis, they became tight. They were also tight during the euro crisis but, since 2014-2015, the financial conditions in Sweden have been expansionary. The contributions of the sub-markets to the financial conditions also seem reasonable and all markets are contributing without any market dominating developments. The relationship of the various markets to each other also seems reasonable. After the financial crisis, when the financial conditions were tight, the foreign exchange market had a counteracting effect. This is compatible with the way a floating exchange rate acts as a shock absorber for a small, open economy in times of crisis, when conditions are tight on many other financial markets.

The details of how to carry out a breakdown of endogenous and exogenous changes of the financial conditions can always be discussed. What we present here is simple but its overall outline still seems reasonable. During the episode preceding the financial crisis, the financial conditions were expansionary for exogenous reasons. During the financial crisis, the conditions were tight for exogenous reasons but there were also purely cyclical elements. The financial crisis thus differs from the euro crisis, when the financial conditions were tight due to the stress on the financial markets, even though this did not entail the same economic concerns in Sweden as during the financial crisis.

The FCI we have presented here takes the form of an index with the mean value of zero, like most of the FCIs used by other central banks and international organisations. This resembles the way that measures of resource utilisation and business tendency surveys are often constructed. It thereby also becomes possible to conduct the discussion in the same way, which is to say in terms of it being (much) higher or lower than normal. By construction, the index has a tendency to return to zero after a deviation. In the same way as for measures of resource utilisation, it can thus be assumed that longer periods of deviation will be reversed, sooner or later.[15] An index for the financial conditions could thus have approximately the same status in the economic and monetary policy analysis as measures of resource utilisation, which are highly uncertain and sometimes very rough measures of something that nevertheless plays a central part in the analysis. However, one decisive question for the usefulness of a special index for the financial conditions is whether the index is robust. We therefore devote the following section to the illustration of alternative ways of defining an FCI.

6. Robustness

In this section, we discuss the robustness of our FCI. We show that, if other statistical methods are used to calculate the FCI, the profile of the final index remains approximately the same, but harder to interpret. We also make a number of changes in the index we have presented and investigate how stability appears over time.

6.1 Alternative methods for weighing indicators together into an index

As we mentioned above, in the international literature, the index for the financial conditions is often constructed using statistical methods. One advantage of using a statistical method is that the method is well-defined and maximises the probability of capturing an underlying

[15] It is certainly conceivable that mean values may change but this is a very slow process, given that the indicators have a long history.

pattern in the selected indicators. Common methods for constructing indices in this context include **principal component analysis** or **dynamic factor analysis**; see Hatzius et al. (2010) and Stock and Watson (2016) for a more detailed account. Among other things, the Riksbank has used statistical methods of this kind to construct measures of underlying inflation, financial conditions and resource utilisation, as well as in the work of making forecasts of economic growth; see Fransson and Tysklind (2017), Johansson, Löf, Sigrist and Tysklind (2018), Nyman (2010) and Andersson and den Reijer (2015).

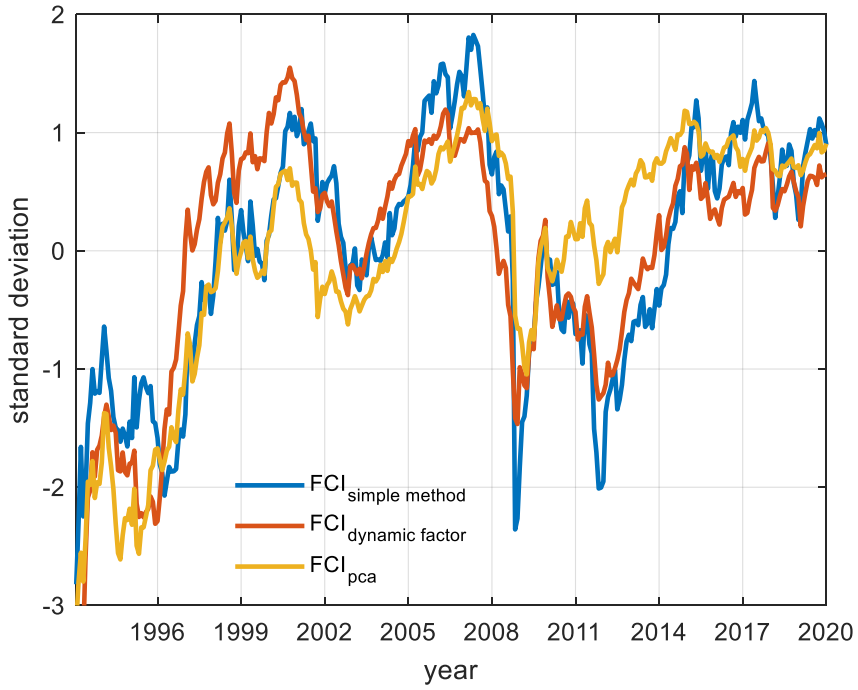
Constructing an index for the financial conditions from individual indicators using a **principal component analysis (PCA)** is the most widely-used method in the literature; see, for example, Darracq Pariès, Maurin and Moccero (2014), Hatzius et al. (2010). Principal component analysis is a statistical method that is described in more detail in Jackson (1991), in which the actual basic concept concerns finding a common pattern in an amount of variables that could be more or less correlated. When we apply principal component analysis to the indicators presented in Table 1, we conclude that five factors represent the underlying indicators sufficiently well. We aggregate the five different factors into a final index as a weighted total of the included factors, $FCI_t^{pca} = \sum_{j=1}^{5} \omega_j \bar{f}_t^j$ where $\bar{f}_t^j$ are the normalized factors, and the factors and the weights ω_j are the respective factors' explanation of the average variation of the indicators. This means that we are following here the method described by Fransson and Tysklind (2017). To make it possible to interpret the final index in the same way as the parts, the index is renormalized in a final step so that the mean value is zero and the standard deviation is one.[16] However, it is not really possible to interpret how the individual indicators then affect the financial conditions.

The other common statistical method used to construct an index for the financial conditions is **dynamic factor analysis**; see, for example, Stock and Watson (2016). Dynamic factor analysis has been used by Brave and Butters (2010), Matheson (2012) and others. We have estimated a dynamic factor model for the indicators shown in Table 1. In this case, the five different factors are aggregated into a final index as $FCI_t^{dynamic\ factor} = \sum_{j=1}^{5} \bar{f}_t^j$, where $\bar{f}_t^j$ are the normalized factors.

The two alternative variations of the FCI are shown together with the index we propose in Figure 7. The different methods for calculating the FCI give similar results. Given the indicators and the transformations we have chosen, it is shown that different statistical methods ultimately give relatively similar results.

[16] The mean value of several normalising factors does not necessarily have a standard deviation equal to one as there may be correlation between the series.

Figure 7. FCI according to different calculation methods
Standard deviation



Sources: The Riksbank and the authors' own calculations

Restrictions can also be introduced to the estimates of the dynamic factor model so that only indicators from a certain sub-market are placed together with a specific factor. This allows the factors to be identified as sub-market factors. The estimates of the dynamic factor model can also be simplified further, and restrictions can be added so that the indicators are linked to one factor (or sub-market) in the manner we have assumed in Table 1. Although the actual technique gets more complicated, this gives us an index that is significantly easier to interpret. In the appendix, we show examples of how this can be done in a dynamic factor model. We also show that the FCI that we calculate can actually be seen as a number of restrictions that are placed in a dynamic factor model.

Our simple method means that we then obtain an index in which we can give an economic intuition for how the individual indicators affect the financial conditions. This simplicity also makes it easy to replicate the index without requiring complicated statistical methods.[17] If the ambition for the index for financial conditions is both to give a compressed description of the financial conditions for the environment in which monetary policy operates and to provide a measure that can be used in a wider analysis, a simple method may be preferable. Simple methods also tend to be robust (see the discussion in section 6) and easy to use in various contexts.

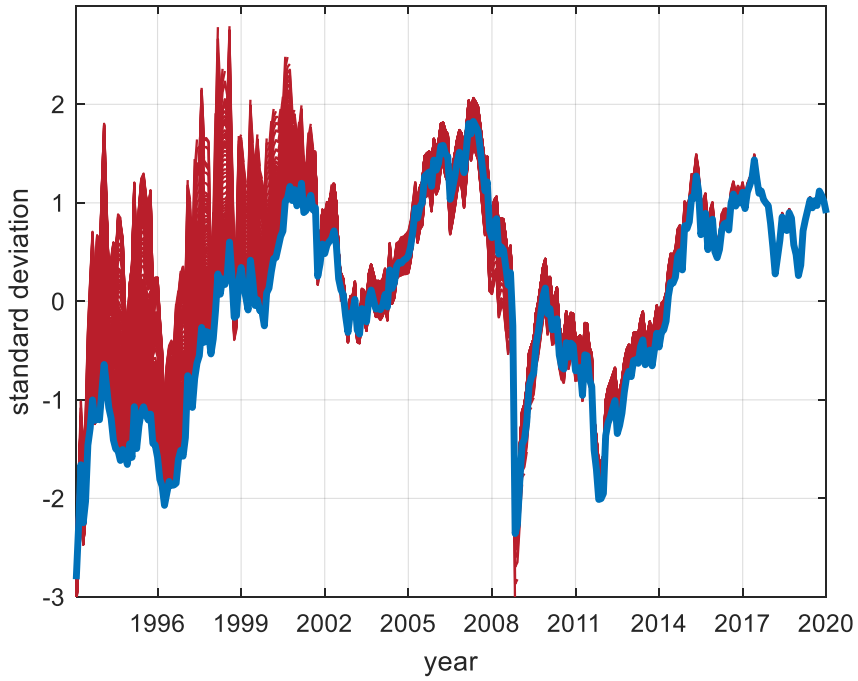
In addition to the statistical methods, there are also other ways of weighing indicators together into an index that illuminates the financial conditions. One such process is presented by Swiston (2008) and Davis, Kirby and Warren (2016), who calculate **weights on the basis of various indicators' impact on the real economy**. This does not automatically produce economically intuitive weights. Other methods that can be considered include using **weights describing the market's purely quantitative significance** as a basis, such as the relative market's size, calculated in kronor. However, nothing explains why the stock market, for example, deserves particularly great attention simply because its market value in Sweden is relatively high compared with other countries.[18]

[17] No complicated statistical models are actually needed to replicate the index, only that the various components are gradually renormalized.
[18] Likewise, the market for those transactions made at the risk-free interest rate, which is to say those transactions made between the Riksbank and its counterparties and the price of them, is a relatively small market that nevertheless has a relatively strong significance for the financial system.

6.2 Stability and smoothing of the index

Grice (2001) emphasises that one of the reasons for simplifying a factor analysis is that the results become more stable over time when the index is re-estimated (apart from potential gain in interpretation). One way of illustrating this stability is to sequentially compute our FCI, starting in 1995. In Figure 8, we see that the index seems to be stable from 2001 onwards.[19] As the weights do not change, the instability that occurs can only originate from changes in the estimation of the mean values and standard deviations of the series included.

Figure 8. FCI over time
Standard deviation



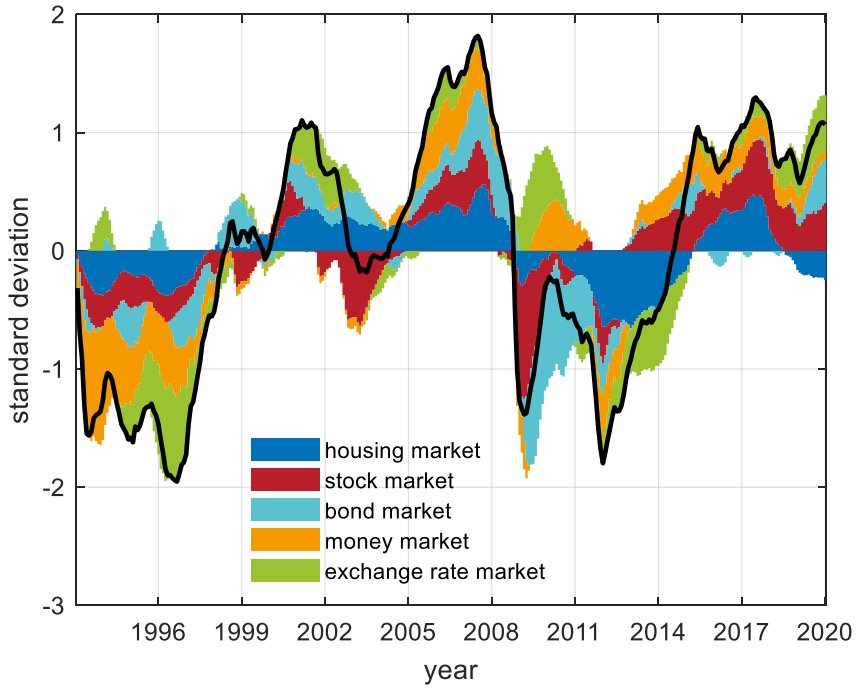
Sources: The Riksbank and the authors' own calculations

Note: The red lines in the figure are the FCI computed recursively with the existing data for each month and then updated when data for a new month becomes available.

In practical use, a smoothing of the FCI can be considered so that each movement in an indicator does not impact with full force. We can thus be more interested in the actual trend in financial conditions rather than fixing our attention on movements from one month to the next. However, taking such a step leads to a discussion on which method should be used and by how much an index should be smoothed to derive the trend development.[20] Below we show such an example in which we try to capture the longer-term trend development of the index.[21] The consequence of this is that the index is smoothed out significantly, but as is illustrated in Figure 9, the information in the index is not changed in any pivotal sense by this.

[19] We compute the index recursively by each month adding another observation, updating the estimations of the mean value and standard deviation of each series respectively and then renormalising the variables to indicators.
[20] Here there is a clear advantage in using a Kalman filter in the calculation. As it is easy to set the signal noise to an appropriate level, a smoothed series can be obtained that is also robust in real time and in which history does not change when new data emerges.
[21] In the example, the signal noise condition has been set at 0.2 in the Kalman filter and indicates that the various indicators, on average, contain a relatively low signal value. The consequence will be that small and shorter-term variations in the indicators do not affect the final index quite so much. In our proposed index, we assume that none of the indicators has any noise (the noise is set at zero in practice), so that the signal noise condition is not defined.

Figure 9. A smoothed FCI
Standard deviation



Sources: The Riksbank and the authors' own calculations

If there is more interest in highlighting the large fluctuations in financial conditions, a smoothed index may be preferable. In practical use, however, it can complicate the interpretation as it has to be explained and presented how significant changes in an indicator need to be to be reflected in the FCI. As can be seen in Figure 9, rapid and temporary changes in the index have now been smoothed, and, for example, the financial conditions become tighter during the euro crisis, as they lasted longer, compared with the financial crisis. The tightening of the expansionary conditions at the end of 2018 has been smoothed in this version of the FCI. A smoothing can thus be both an advantage and a disadvantage.

6.3 Alternative transformations and sensitivity of the FCI

Use of short time series poses a risk of instability in the index when the mean value (μ_i) and standard deviation (σ_i) are constantly re-estimated. For this reason, we have made recursive estimations of the FCI in Figure 8 and found that this does not seem to be a major problem.

However, an important issue concerns how series with trends or with a strong persistence (such as interest rates) should be handled. Certain financial variables, such as stock prices, housing prices, as well as debt and money supply, are variables with trends. Transforming these variables such that they are expressed in relation to GDP is one way of handling the trends. If the variables exhibit a strong persistence, simply defining mean value (μ_i) and standard deviation (σ_i) may be problematic. Transforming the variable into changes is an option that can be considered. However, we have chosen to use variables in levels or as ratios as far as possible. Despite this choice of transformation, we have indicators that exhibit trend-like behaviour. In Figure 14 in the appendix, we see that both indicators for the housing market have a trend-like appearance. But we see that the factor itself does not have a trend-like appearance. This is a conscious choice that actually has an economic motive (see discussion in Section 3) but also results in the factor for the housing market becoming a stationary variable. In the same way, Figure 17 illustrates that certain indicators on the money market also have a trend-like appearance, but in the same way as for the housing market, this trend is counterbalanced by a counteracting trend in other indicators and thus

via the construction of the factor. On the stock market, the indicator for market value gives the hint of a trend. The actual factor for the stock market has changed sign a number of times since 1993 so this trend is not considered dominant.

Even though we wish to claim that our FCI is relatively robust for alternative variants, this is a truth with modification, and indicators that have strong trends not counteracted by any other indicator will affect an FCI in a palpable way.

6.4 Index flexibility and change: living matter

The way we construct our FCI means that it is easy to change the index as and when necessary. As our FCI is a summation of five factors, the actual index changes if we change one of the factors, but the other factors are unchanged. This means that the interpretations we make are relatively robust.

Figure 10. FCI
Standard deviation

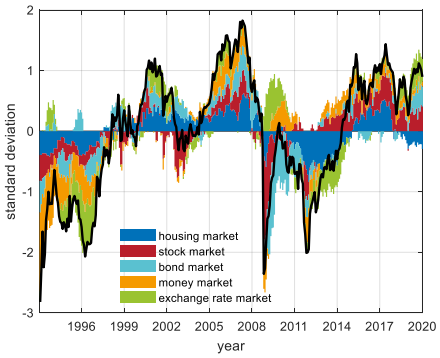


Figure 11. FCI without VIX
Standard deviation

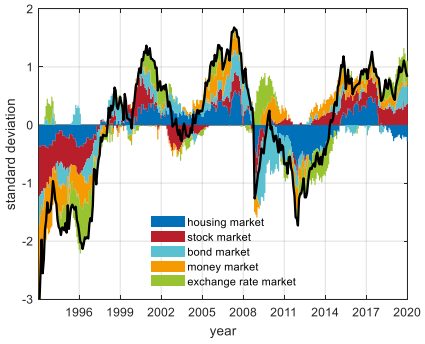


Figure 12. FCI with company spread
Standard deviation

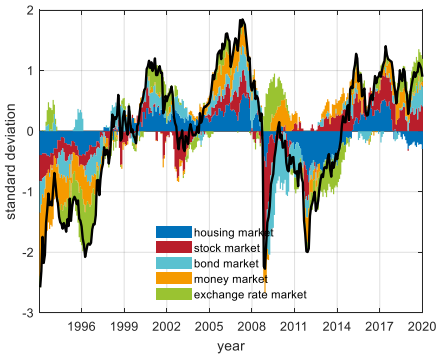
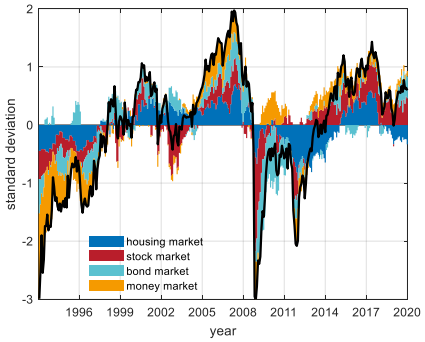


Figure 13. FCI without foreign exchange market
Standard deviation



Sources: The Riksbank and the authors' own calculations
Note: In the figure, the data ends September 2019.

As an example, we show the implication for the FCI of removing VIX as an indicator for the stock market in Figure 11 which can be compared with the original FCI in Figure 10. The consequence for the FCI is that the financial conditions were not quite as tight during the financial crisis when VIX is excluded, but the other factors are, by design, the same as before. This does not change the contribution analysis particularly much.

In the same way, we can also introduce new variables into the analysis. We lack data for yields on corporate bonds prior to 2013, but this is a variable that it may be natural to include if possible, as an indicator for the bond market. In Figure 12 we have therefore included the spread between a corporate bond and a government bond, both with a maturity of five

years, as an indicator.[22] When we compare this with the original index, which has been reproduced for convenience in Figure 10, we see that the factor for the bond market changes slightly from 2013.

As the different factors are constructed independently of one another, one can also omit a factor in the analysis, if one so wishes. In Figure 13 we have omitted the entire foreign exchange market, so that the FCI has only four sub-markets, compared with the original one shown in Figure 10. This of course affects the FCI calculated, but per construction, the other factors are not affected.

The simple method we have used to construct an FCI is thus relatively robust and can easily be adjusted when new conditions make it necessary to change the index and add or remove certain indicators. The parts (sub-market factors) can still be analysed separately and are not affected if other parts of the index change.

7. Summary

In this Staff memo we have presented a simple method for constructing an index, an FCI, that aims to provide an overall picture of conditions on a number of important financial markets in Sweden. Providing an overall picture can mean disregarding important nuances and that the analysis of financial events may suffer. At the same time, there is a strength in being able to provide an overview and a summary of the events on many different financial markets. Constructing an aggregate measure therefore always entails a balancing act.

For the variables we have used in this Staff memo, the choice of technical method for constructing an index is not a decisive factor. Although the method we have chosen is very simple, we obtain roughly the same picture of developments on the financial markets in Sweden with more complicated methods of constructing an index.

In all probability, the financial system will change over time and new aspects will be added and old patterns will disappear. Even if we find that the FCI we have calculated provides a reasonable picture of financial conditions in Sweden, there is reason to constantly reconsider the usefulness of a summarising index.

[22] As we can implement our index as a dynamic factor model, we use the fact that this indicator can be treated as a missing variable in the Kalman filter.

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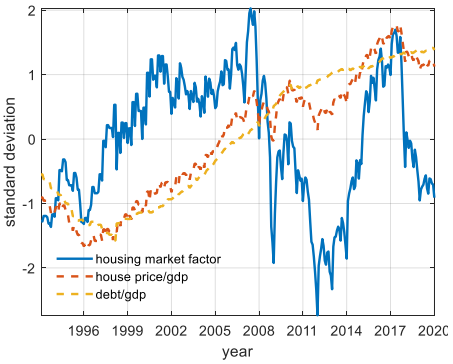
Appendix

A1: Indicators for the important financial markets in Sweden and list of variables

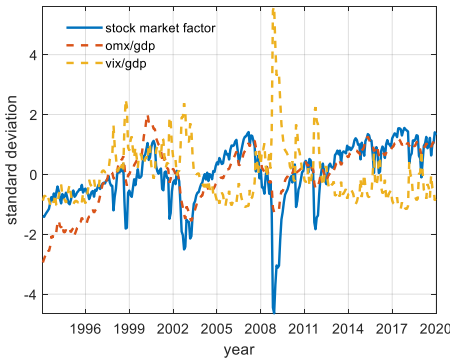
In this section, we show the normalized variables (i.e. the indicators) for each market and the five different factors (unbroken blue line) that we calculate. The respective indicators and resulting factors for the various sub-markets have all been normalized so that they have a mean value of zero and a standard deviation of one.

Figure 14. Housing market
Standard deviation



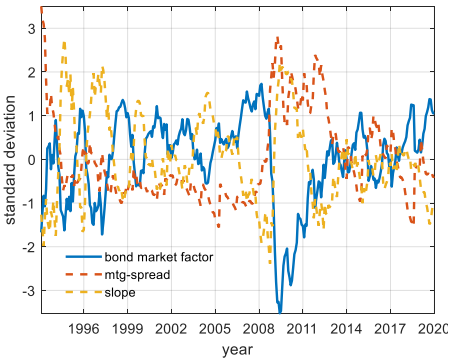
Sources: The Riksbank and the authors' own calculations

Figure 15. Stock market
Standard deviation



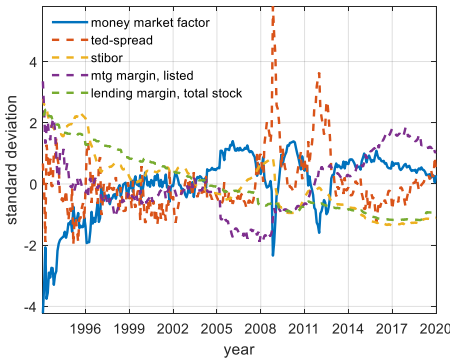
Sources: The Riksbank and the authors' own calculations

Figure 16. Bond market
Standard deviation



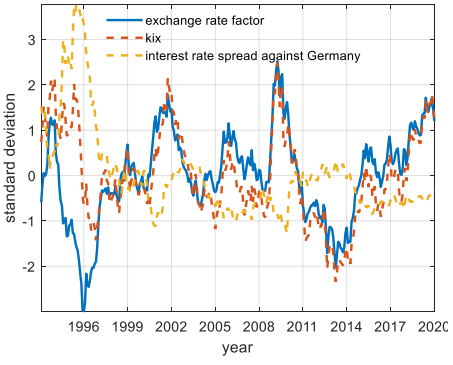
Sources: The Riksbank and the authors' own calculations

Figure 17. Money market
Standard deviation



Sources: The Riksbank and the authors' own calculations

Figure18. Foreign exchange market
Standard deviation



Sources: The Riksbank and the authors' own calculations

Table 3. List of variables
Monthly data (unless otherwise stated)

Variable	Notes	Source/sources
Nominal GDP°	Seasonally adjusted and interpolated	Macrobond and Statistics Sweden
House prices (HOX)	Residential buildings*	Macrobond and Valuegard
MFI lending to households (NPISH)	Entire stock	The Riksbank, Statistics Sweden and Macrobond
Stock market index (OMX)	NASDAQ-ALL stocks, price return	Nasdaq OMX and Macrobond
Volatility (VIX)	Expected volatility according to options prices	CBOE and Macrobond
STIBOR 3m		Nasdaq OMX and Macrobond
Swap 5 year		Macrobond
3-month treasury bill	Benchmark	Macrobond
Listed mortgage rate (Nordea 3m)	3 months	Nordea and Macrobond
Lending rate for households (NPISH)	All maturities, entire stock	The Riksbank, Statistics Sweden and Macrobond
Deposit rate	All maturities, entire stock	The Riksbank, Statistics Sweden and Macrobond
10-year government bond°°	Benchmark	Macrobond
5-year government bond°°	Benchmark	Macrobond
2-year government bond	Benchmark	Macrobond
5-year covered bond	Benchmark	Macrobond
Krona index (KIX)	Nominal effective exchange rate	The Riksbank and Macrobond
2-year government bonds, Germany	Benchmark	Macrobond

° The quarterly series has been interpolated (equal values) into monthly data.

°° End of month.

* Between 1993 and 2005, the development of Statistics Sweden's real estate price index has been used to create a history for the series.

A2: A dynamic factor model for the financial conditions in Sweden

The advantage of the very simple FCI that we present in the main text is that we can interpret the indicators included in an economically intuitive way. In this appendix, we show that our FCI can be seen as a special case of a general dynamic factor model (DMF) in which we have introduced restrictions. Despite these restrictions and simplifications, we can note that we do not see any decisive differences from those indices calculated with purely statistical methods.

One comprehensive reference for this section is Stock and Watson (2016), in which the authors demonstrate that the general form of a DMF consists of two equations:

$$f_t = \varphi(L) f_{t-1} + \eta_t \quad \text{(A1)}$$

$$x_t = \lambda(L) f_t + \varepsilon_t \quad \text{(A2)}$$

where a $N \times 1$ vector, x_t, with time series of observed variables due to a limited number $(N > q \times 1)$ non-observed factors, f_t, and a $N \times 1$ idiosyncratic disturbance term, ε_t, which has the expected value of zero. Both f_t, η_t and ε_t can be series correlated. On the other hand, η_t and ε_t are assumed to be independent so that $E(\varepsilon_t \eta_t') = 0$. The matrices $\varphi(L)$ and $\lambda(L)$ are lag polynomials with the dimensions $q \times q$ and $N \times q$, respectively. The ith row of $\lambda(L)$, $\lambda_i(L)$ is the dynamic factor loading of the ith observed variable and the product $\lambda_i(L) f_t$ is the common component of the ith observed variable. The jth column of $\lambda(L)$, $\lambda_j(L)$ is the factor loading for the ith observed variable that is linked to the jth factor, f_{jt}.

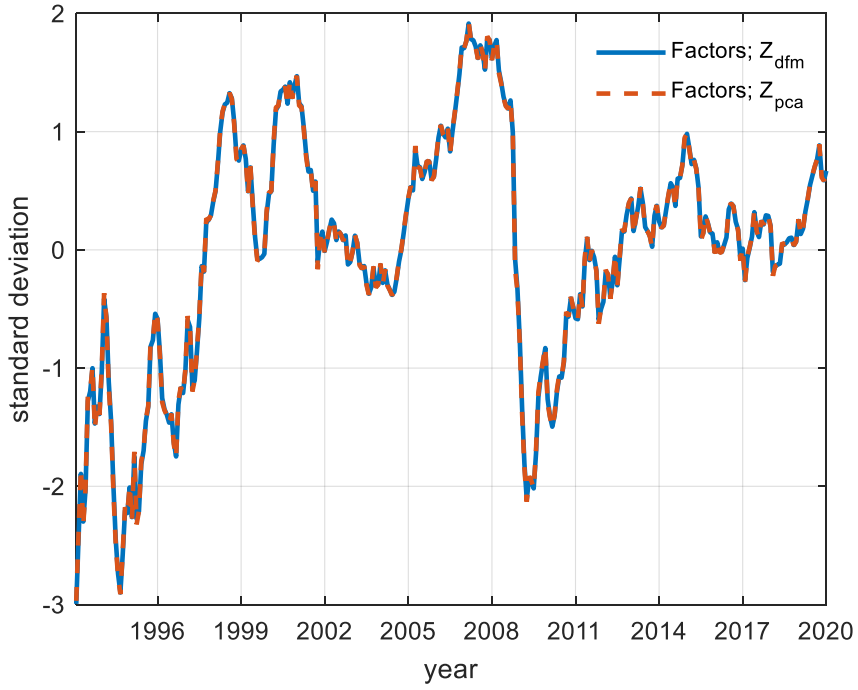
A replication of the principal component analysis of the dynamic factor model

Stock and Watson (2016) discuss the conditions when a principal component analysis is an estimate of a dynamic factor model.[23] Here, we show under which conditions a dynamic factor model replicates the principal component analysis based on the variables reported in Table 1. The unweighted sum of the factors deriving from the principal component analysis are replicated by a dynamic factor analysis in which $\lambda(L) = Z$, where Z is a 12×5 loading matrix with columns formed of the five own vectors deriving from the principal component analysis. Apart from allowing $\lambda(L) = Z$ we need to introduce a further restriction meaning that the disturbance term in equation (A2) is a very small number so that $\varepsilon_t \sim iid(0, \sigma \to 0)$. Under these conditions, the factor model replicates the same factors as the principal component analysis (up to one scale factor which is handled in the normalisation).

To calculate an FCI, we then summarise the five first principal components and the five first factors and then renormalize these sums so that we obtain a normalized index with the mean value of zero and a standard deviation of one. In Figure19, we show the two FCIs that can be calculated in this manner.

[23] See section 2.3, Stock and Watson (2016).

Figure 19. Normalized sum of the five first factors according to a principal component analysis and a dynamic factor model
Standard deviation



Sources: The Riksbank and the authors' own calculations

As we can observe in Figure 19, both FCIs are identical and illustrate how the result of the principal component analysis is replicated by the factor analysis under certain conditions.

An estimated dynamic factor model

We can also estimate the factor model without placing any special restrictions on $\lambda(L)$ or ε_t. To follow the earlier example above, we assume that there are five non-observed factors and thereby allow the factor dynamic to follow a VAR(1) process so that $\varphi(L) = \phi$, where ϕ is a 5×5 matrix with unknown parameters to estimate. We assume that the factors are independent so that only the five diagonal elements in ϕ must be estimated. We also allow $\lambda(L) = Z$ where Z is a 12×5 matrix with unknown factor loadings to be estimated.

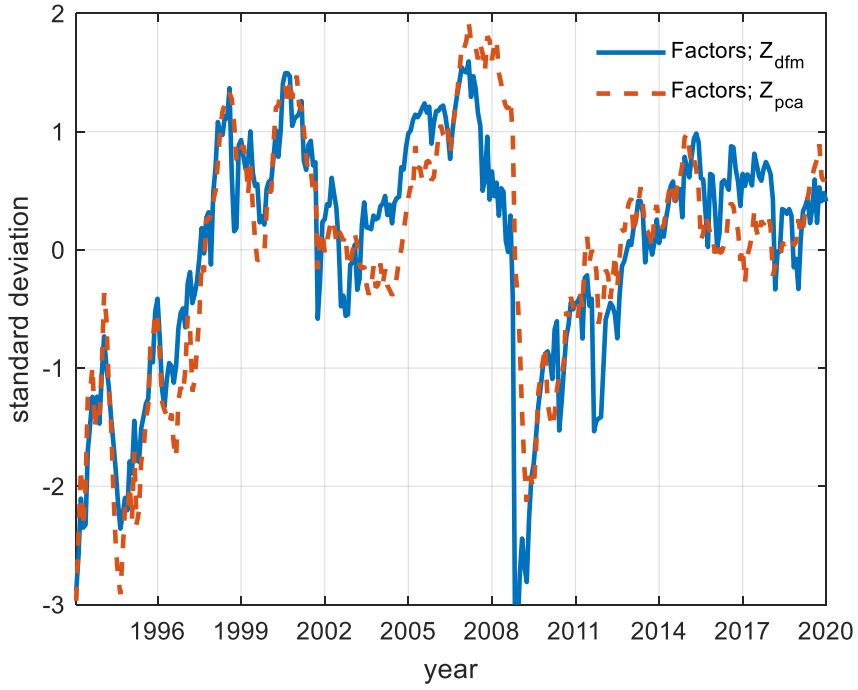
$$f_t = \phi f_{t-1} + \eta_t, \eta_t \sim iid(0, \sigma_f) \quad \text{(A3)}$$

$$x_t = Z f_t + \varepsilon_t, \varepsilon_t \sim iid(0, \sigma_x) \quad \text{(A4)}$$

Furthermore, we assume that the respective disturbance term has standard deviations (σ_f and σ_x) respectively, with 5 and 12 unknown diagonal elements respectively to be estimated. Nevertheless, 82 parameters, not including five non-observed factors, are to be estimated, so the problem is numerically complex. As starting values for Z, we therefore use eigenvalues from the principle component analysis, the starting values for the diagonal elements in ϕ are assumed to be 0.9 and all elements in σ_f are set at 0.1 and in σ_x at 0.01. The estimation is made using maximum likelihood in the Kalman filter.

As previously, we summarise the five first principal components and the five first factors in the same way, before then renormalising this sum so that we obtain an index with the mean value of zero and standard deviation of one. In Figure 20, we show the result of such an estimation.

Figure 20. Normalized sum of the five first factors according to a principal component analysis and a dynamic factor model
Standard deviation



Sources: The Riksbank and the authors' own calculations

In Figure 20, we see that the dynamic factor model estimated in this way nevertheless gives an FCI that is relatively similar to the index calculated from the principal component analysis.

Dynamic factor model with restrictions on the loading matrix

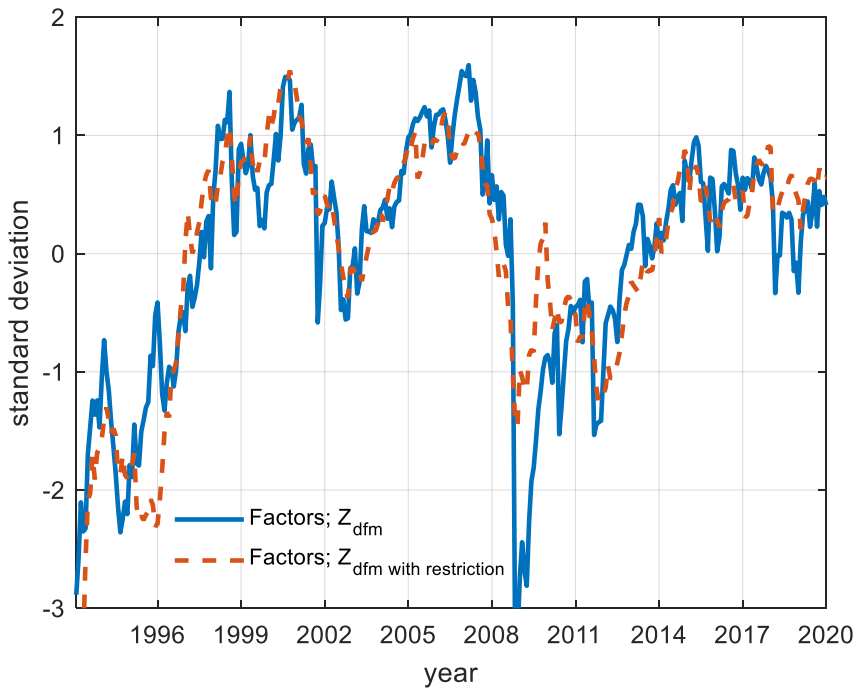
As we discuss in the main text, purely statistical methods for constructing an FCI may mean that the interpretation suffers. In the dynamic factor model (unlike the principal component analysis), it is easy to introduce restrictions that can lead to an improvement in the interpretation of the FCI. By introducing a zero restriction to certain elements of the loading matrix Z, we can set the factors so that they only affect the indicators we link to a specific sub-market.[24] Given that the indicators we present in Table 1, we can achieve this by writing equation (A2) as:

[24] These restrictions serve the same purpose as a varimax rotation, but in this case there is nothing to guarantee that the transformation is orthonormal.

$$\underbrace{\begin{pmatrix} \frac{p_t^h}{y_t} \\ \frac{d_t^h}{y_t} \\ \frac{p_t^{omx}}{y_t} \\ vix_t \\ i^{stibor\ 3m} \\ i_t^{stibor\ 3m} - i_t^{sgb\ 3m} \\ i_t^{lend\ 3m} - i_t^{stibor\ 3m} \\ i_t^{lend} - i_t^{deposit} \\ i_t^{sgb\ 10yrs} - i_t^{sgb\ 3m} \\ i_t^{mtg\ 5yrs} - i_t^{swap\ 5yrs} \\ kix_t \\ i_t^{sgb\ 2yrs} - i_t^{dem\ 2yrs} \end{pmatrix}}_{x_t} = \underbrace{\begin{pmatrix} z_{11} & 0 & 0 & 0 & 0 \\ z_{21} & 0 & 0 & 0 & 0 \\ 0 & z_{32} & 0 & 0 & 0 \\ 0 & z_{42} & 0 & 0 & 0 \\ 0 & 0 & z_{53} & 0 & 0 \\ 0 & 0 & z_{63} & 0 & 0 \\ 0 & 0 & z_{73} & 0 & 0 \\ 0 & 0 & z_{83} & 0 & 0 \\ 0 & 0 & 0 & z_{94} & 0 \\ 0 & 0 & 0 & z_{104} & 0 \\ 0 & 0 & 0 & 0 & z_{115} \\ 0 & 0 & 0 & 0 & z_{125} \end{pmatrix}}_{\hat{Z}} \underbrace{\begin{pmatrix} f_t^1 \\ f_t^2 \\ f_t^3 \\ f_t^4 \\ f_t^5 \end{pmatrix}}_{f_t} + \varepsilon_t, \varepsilon_t \sim Niid(0, \sigma)$$

In this way, the first factor only loads on the indicators dealing with the housing market, the second factor only loads on the indicators dealing with the stock market and so on. The interpretation of the model's factors thus becomes: f_t^1 = housing market, f_t^2 = stock market, f_t^3 = money market, f_t^4 = bond market, f_t^5 = foreign exchange market. When we estimate a DMF with these restrictions, we get the following results.

Figure 21. Normalized sum of the five first factors according to a dynamic factor model, with and without restrictions to factor loadings
Standard deviation



Sources: The Riksbank and the authors' own calculations

As we can observe in Figure 21, these restrictions do not entail any major change to the FCI. The tightening of the financial conditions during the financial crisis certainly becomes significantly lesser, but otherwise there is no great difference.

By introducing these zero restrictions to the loading matrix, we obtain an FCI that resembles the original one but, at the same time, we have made considerable gains in the interpretation of the index. On the other hand, we still cannot say a particularly great deal

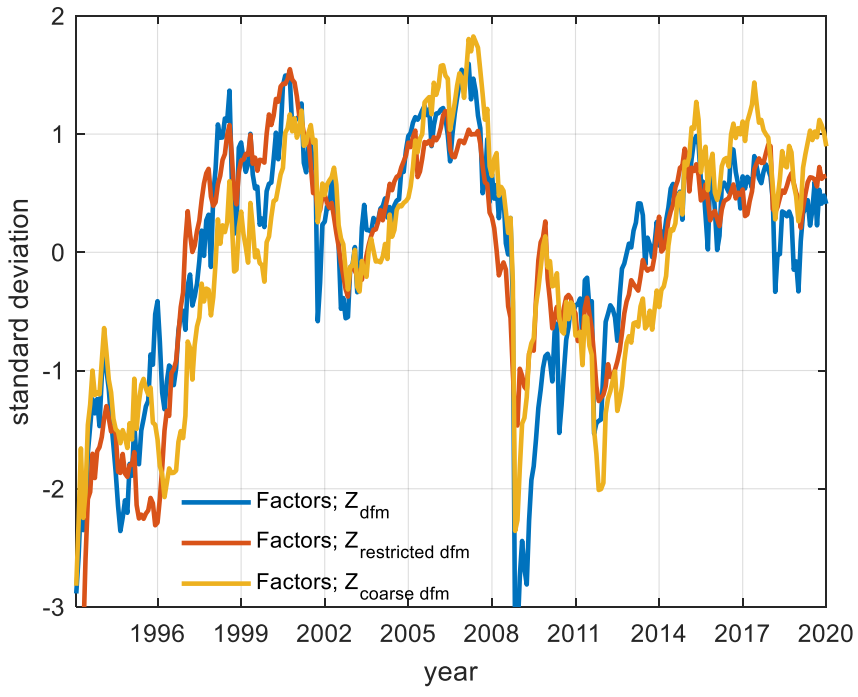
about the effect of the individual indicators on the financial conditions. It is true that we have an estimate of the elements we calculate in the loading matrix $\hat{Z}$, but there is no guarantee that it will be possible to interpret an individual value, z_{ij}.

As we discussed in the main text, a DFM can be further simplified to make it possible to interpret how the various indicators influence the financial conditions. One method used in psychological research is called 'coarse weights'; see Grince (2001) for a discussion of the concept. Here, we have been inspired by these methods and have set the element in the loading matrix Z at -1, 0 or 1. A value of 0 means that the indicator does not have any link to the factor. A value of -1 means that the indicator is negative in relation to the factor, while a value of 1 means that the indicator is positively related to the factor. We therefore allow the coefficients in the original loading matrix Z to assume the values -1, 0 or 1, which gives us the following loading matrix:

$$Z = \begin{pmatrix} z_{1\,1} & \cdots & z_{1\,5} \\ \vdots & \ddots & \vdots \\ z_{12\,1} & \cdots & z_{12\,5} \end{pmatrix} \rightarrow \hat{\hat{Z}} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & -1 \end{pmatrix}$$

Although this may be considered a relatively dramatic intervention in the factor model, we see in Figure 22 that the FCI that we can calculate (our simple approach is replicated by the 'coarse dfm') does not differ substantially from the two alternative FCIs.

Figure 22. Normalized sum of the five first factors according to a dynamic factor model, with and without restrictions to factor loadings
Standard deviation



Sources: The Riksbank and the authors' own calculations

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