STAFF MEMO

A high-frequency financial conditions index for Norway

NO. 1 | 2023

FRIDA BOWE
KARSTEN R. GERDRUP
NICOLÒ MAFFEI-FACCIOLI
HELENE OLSEN

NORGES BANK

ISSN 1504-2596 (online)
ISBN 978-82-8379-258-4 (online)

A high-frequency financial conditions index for Norway*

Frida Bowe† Karsten R. Gerdrup‡ Nicolò Maffei-Faccioli§ Helene Olsen¶

4 January 2023

Abstract

We have constructed a financial conditions index for Norway (FCIN). The FCIN offers a daily update on Norwegian financial conditions based on data from January 2003 on bank lending rates, bond spreads, the foreign exchange market, the stock market and the housing market. The index is constructed by the use of principal component analysis and has an average value of zero and a standard deviation of one. A positive value indicates that financial conditions are tighter than the historical average, while a negative value suggests that financial conditions are looser than the historical average. The FCIN is constructed to provide real time insight into financial conditions for the Norwegian economy beyond what is already included in the policy rate and market policy rate expectations. Here we depart from other studies which typically aim at assessing financial conditions more broadly. The index is meant to complement monetary policy analyses and improve our assessments of economic activity.

Keywords: Financial conditions index, forecasting, principal component analysis, financial shocks.

JEL classification: C32, C53, E32, E44.

*The views and conclusions expressed in this publication are those of the authors and are not necessarily shared by Norges Bank. They should therefore not be reported as representing the views of Norges Bank. The authors would like to thank Leif Brubakk, Arne Kloster and Ørjan Robstad as well as participants at seminars at Norges Bank for useful input and comments. The authors are responsible for any errors and omissions.

†Norges Bank; email: frida.bowe@norges-bank.no
‡Norges Bank; email: karsten.gerdrup@norges-bank.no
§Norges Bank; email: nicolo.maffei-faccioli@norges-bank.no
¶Norges Bank; email: helene.olsen@bi.no

1 Introduction

In this paper, we introduce a financial conditions index for Norway (FCIN). The main purpose of the FCIN is to aggregate information from the most important market rates and asset prices that influence GDP for mainland Norway through, eg bank lending, household consumption and business investment. The goal is to aid Norges Bank's assessments on the monetary policy stance. We include relatively few variables to keep the index as transparent and easy to interpret as possible and to make it easy to reproduce. Variables often included in other studies, such as growth in credit and money, are therefore not included. In a separate exercise, we do, however, show that adding a broader set of variables does not change the index materially (see Appendix C).

Our index is intended to extract information on financial conditions beyond those already contained in the policy rate. Hence, we do not include interest rates in levels, but use different bond market spreads and lending rate spreads, all of them adjusted for the policy rate and market policy rate expectations. Since equity financing constitutes a sizeable share of firm liabilities, we also include the Oslo Børs Benchmark Index (OSEBX) and a corresponding measure of volatility. The OSEBX is heavily influenced by international financial markets, but is also affected by movements in commodity prices, which are important for the Norwegian economy.

As a small, open economy, we also find it useful to include the exchange rate. However, since the Norwegian krone exchange rate tends to depreciate when financial conditions tighten (typically when oil and gas prices are low and/or volatility in international financial markets is high) and appreciate when financial conditions are expansionary, we exclude the krone exchange rate in levels in the FCIN, as it largely reflects information already contained in other financial variables. In a more advanced framework, one could ideally have identified exogenous shocks to the krone exchange rate and included those shocks in the index. However, this would hamper reproducibility and transparency, a priority for our index, and is thus left for future work. Nevertheless, we do include volatility in the krone since it reflects the cost of foreign exchange rate hedging, which in turn affects financial conditions for a number of economic agents.

Finally, we include house price growth as housing wealth is the primary source of household equity and mortgage collateral in Norway. To take into account the impact of current interest rates on house prices, we test a version of the FCIN where we purge house prices of the endogenous contribution from the policy rate, similar to Hatzius et al. (2010) (see Appendix B). The exercise does not change the FCIN noticeably, and we therefore keep the index as simple as possible by including the publicly available series for house prices in the final version.

We find that our FCIN is strongly correlated with GDP, where an expansionary FCIN is associated with higher GDP growth and a contractionary FCIN is associated with lower GDP growth. We investigate further the properties of our FCIN by including it in a structural vector autoregression (SVAR) where we identify shocks to the FCIN and the key policy rate. We find that a contractionary shock to the FCIN leads to lower GDP growth, lower inflation and a lowering of the policy rate. Furthermore, we find that the FCIN works as an amplifier by contracting financial conditions further when the policy rate is raised and by expanding financial conditions when the policy rate is lowered. The latter result is consistent with theories of financial accelerators (see e.g. Bernanke and Gertler (1989)), whereby monetary policy affects borrower net worth and agency costs. Lastly, we find that small expansionary or contractionary FCIN shocks yields relatively similar effects in absolute terms, while the effect of larger shocks to the FCIN is non-linear. Large contractionary FCIN shocks have a more pronounced impact on GDP growth than similar expansionary shocks. This highlights the importance of the asymmetries of financial shocks and the need for the policymaker to be especially attentive to contractionary FCIN shocks.

Our FCIN builds on a substantial literature on FCIs from other central banks[1], the International Monetary Fund (IMF), the Organisation for Co-operation and Development (OECD), investment banks, and from academia. The different FCIs vary as to the choice of variables, frequency and estimation method. Our main point of departure is to concentrate on the liability side, even though this is not done completely consistently, since asset prices play at least a dual role, by both influencing the cost of equity and by affecting collateral values and agents' ability and willingness to borrow. We follow the approach of Danish (Jensen and Pedersen, 2019) and Swedish (Alsterlind et al., 2020) central banks, in focusing on a narrow indicator set and keeping the index as simple as possible. However, we depart from them in two ways: First, we follow Hatzius et al. (2010) and others in using principal component analysis to construct our FCIN. Secondly, as our FCIN aims to capture the evolution of overall financial conditions beyond the policy rate, we only include interest rates adjusted for the policy rate and market policy rate expectations. Unlike Hatzius et al. (2010), we do not 'purge' the indicator from macroeconomic drivers. There have also been previous attempts at estimating an FCI for Norway, among others by Vonen (2011). This index differs from the FCI constructed by Vonen (2011) regarding both the information set and frequency.

The paper is organised as follows. In Section 2, we describe the data included in the index and how we construct the index. We analyse the properties of the index in Section 3; its ability to explain historical events, how it compares with indices from other countries, and lastly a more formal analysis of the economic impact of shocks to the index. We provide a summary in Section 4.

2 Constructing our FCIN

2.1 Financial system

The financial system in Norway resembles that in many European countries by being largely bank-based. The bond market is less important as a source of finance than in, eg the U.S. However, a sizeable share of non-financial firms' liability side is based on equity financing. In Tables 1 to 3, we show the main liability items for banks, households and non-financial firms.

Table 1 shows that banks finance their lending and other activities largely by deposits and market

[1] Eg Sveriges Riksbank (Alsterlind et al., 2020), Danmarks Nationalbank (Jensen and Pedersen, 2019), the Bank of England (Kapetanios et al., 2017), the European Central Bank (ECB) (Paries et al., 2014) and the Federal Reserve Bank of Chicago (Federal Reserve Bank of Chicago, 2022).

Table 1: Bank and mortgage company liabilities, Q4 2021.
In billions of NOK

Deposits	4.624	(52.7%)
Bonds and short-term paper	2.605	(29.7%)
Loans	568	(6.5%)
Other debt	296	(3.4%)
Equity	672	(7.7%)
Total liabilities		(100%)

Source: Financial sector balance sheets, Statistics Norway

Table 2: Household liabilities, Q4 2021.
In billions of NOK

Bank loans	4.077	(35.4%)
Other debt	264	(2.3%)
Equity	7.171	(62.3%)
Total liabilities		(100%)

Source: Financial sector balance sheets, Statistics Norway

Table 3: Non-financial firm liabilities, Q4 2021.
In billions of NOK

Bonds and short-term paper	867	(5.4%)
Loans	4.903	(30.7%)
Other debt	1.831	(11.4%)
Equity	8.395	(52.5%)
Total liabilities		(100%)

Source: Financial sector balance sheets, Statistics Norway

funding. Bond financing mainly consists of senior bonds and covered bonds. Equity financing is less important since banks generally are highly leveraged.

The liability side of the household balance sheet is relatively straightforward in that it includes loans from banks. Households have also a sizeable equity share of around 62 percent. This is due to ample housing wealth. Non-financial firms borrow mainly from banks and finance their activities to a lesser degree through the market. Equity financing constitutes the largest source of funding. Around 35 percent of equities are publicly traded. It should be noted that the size of the balance sheet of non-financial firms is somewhat inflated due to intercompany borrowing and lending (eg to/from subsidiaries).

2.2 Data

In constructing the index, we group our data into four main categories: the stock market, the credit market, the housing market and the foreign exchange market. The different categories help us understand the driving forces behind the FCIN and explain movements in the index.

Stock indices reflect market participants' current information and expectations of future macroeconomic conditions. Moreover, higher asset prices increase the borrowing capacity of households and firms as well as their wealth, which in turn leads to higher consumption (Erdem and Tsatsaronis, 2013). Higher-than-average stock indices are therefore associated with expansionary financial conditions, while lower stock indices are associated with contractionary financial conditions. As an indicator of underlying developments in asset prices, the price-to-book ratio of companies on OSEBX is included in the index relative to a two-year moving average. High stock market volatility is usually a sign of market fear and turmoil (Whaley, 2000) which is associated with higher uncertainty about future returns. To measure volatility, the index includes the 14-day-moving standard deviation of OSEBX total returns.

The credit market block includes several variables aimed at capturing the cost of borrowing, adjusted for the policy rate and market policy rate expectations. Consequently, the risk premium in Nibor, ie the spread between the three-month money market rate in Norway and the average expected overnight rate (OIS), is included in the index through the variables in the credit market block. This is because Nibor is a reference rate which affects banks' funding costs and, in turn, lending rates to firms and households. We include the average spread on residential mortgage rates, estimated relative to the policy rate, and firm lending rates, estimated relative to market policy rate expectations, in the index. Higher spreads may be a result of factors such as reduced competition between banks and from new entrants, but may also reflect lenders' requirement for a loss buffer. Nevertheless, a higher spread is associated with higher borrowing costs for households and firms.

In the bond market, banks and firms pay a risk premium above Nibor. When investors require greater compensation to lend to the bond issuer, the cost of bond financing increases. We therefore include the credit premiums on new five-year senior bank bonds and covered bonds, as well as for Norwegian manufacturing, power and utilities, commercial real estate and oil-related high-yield and investment-grade bonds. As stated above, all credit premiums are measured as risk premiums above market policy rate expectations.

To capture the foreign exchange market, the volatility of the import-weighted krone exchange rate index (I-44) is included in the index. Movements in the krone exchange rate may affect firms differently, for instance, depending on whether the firm is a net exporter or importer or if the firm holds foreign or domestic currency debt and assets. However, exchange rate volatility increases uncertainty regarding costs and revenues for both net importers and exporters and affects the cost of hedging foreign exchange rate risk. We therefore include exchange rate volatility in the financial conditions index. Increased volatility is associated with tighter financial conditions.

Housing wealth accounts for the majority of Norwegian households' wealth, and around three quarters of households own the property they live in (Statistics Norway, 2022). Consequently, changes in house prices impact household equity, and in turn households' ability to borrow and the cost of credit (Mian et al., 2013; Aron et al., 2012; Grindaker, 2017). We therefore include house prices in the financial conditions index, where increased house prices contribute to looser financial conditions and lower house prices to tighter financial conditions.

To obtain a meaningful result from the principal component analysis, the variables must be without deterministic or stochastic trends. We therefore normalise each data series, and for some of the series we perform additional transformations as specified in Table 4.

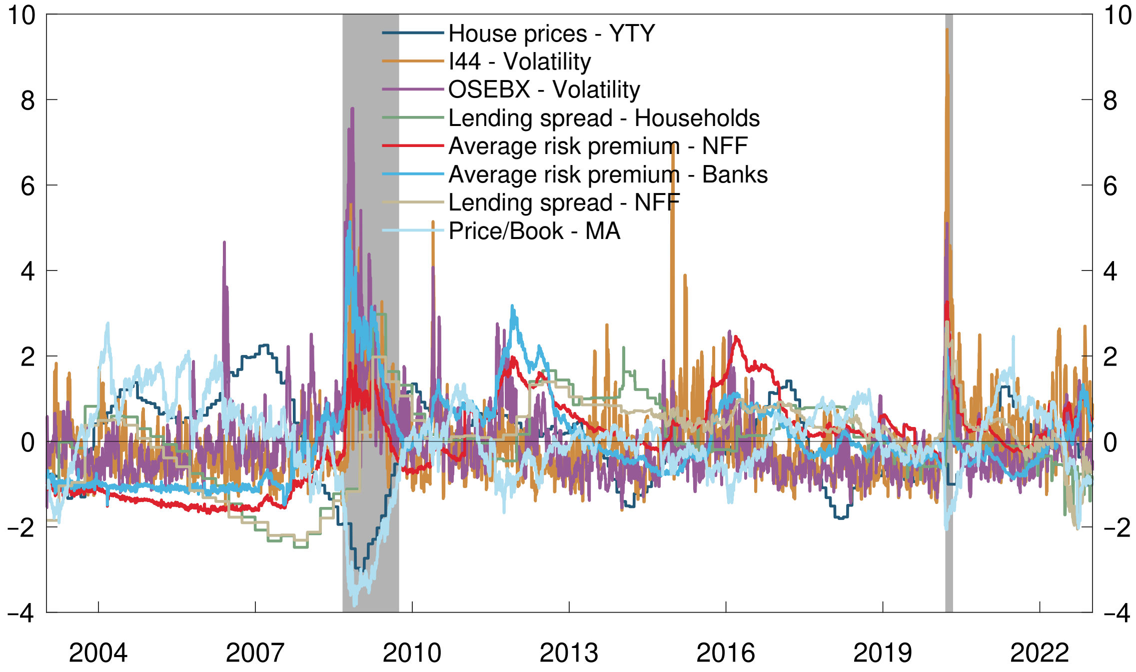

Figure 1: Transformed data series

Series	Period[1]	Transformation[2]	Frequency	Sources
Stock market				
Oslo Børs Benchmark Index (OSEBX), total return	3 Jan 2003	3	Daily	Thomson Reuters
Price to book ratio, OSEBX	3 Jan 2003	2	Daily	Bloomberg
Foreign exchange market				
Import-weighted krone exchange rate. 44 trade partners	3 Jul 1989	3	Daily	Bloomberg
Credit market				
Indicative risk premium on investment-grade corporate bonds for commercial real estate[3]	6 Jan 2011	1	Weekly	Nordic Bond Pricing
Indicative risk premium on investment-grade corporate bonds, where commercial real estate bonds are excluded[3]	6 Jan 2011	1	Weekly	Nordic Bond Pricing
Indicative risk premium on oil-related high-yield corporate bond[3]	6 Jan 2011	1	Weekly	Nordic Bond Pricing
Indicative risk premium on high-yield corporate bond where oil-related bonds are excluded[3]	6 Jan 2011	1	Weekly	Nordic Bond Pricing
Risk premium new five-year senior bank bonds[3]	3 Jan 2003	1	Weekly	Nordic Bond Pricing
Risk premium new five-year covered bonds[3]	19 Jul 2007	1	Weekly	Nordic Bond Pricing
Mortgage loans, floating interest rate.[4] Weighted average, 20 largest banks	29 Jan 2013	1	Daily	Finansportalen
Lending rate on outstanding mortgages to households.[4] Quarterly average	Jan 2003 - Jan 2013[5]	1	Quarterly	Statistics Norway and Norges Bank
Interest rates on outstanding loans in banks and mortgage companies.[3] Non-financial firms. Loans in total	Dec 2013	1	Monthly	Statistics Norway
Lending rate on total outstanding loans to non-financial firm.[3] Quarterly average	Jan 2003 - Nov 2013[5]	1	Quarterly	Statistics Norway and Norges Bank
Housing market				
House price index. Seasonally adjusted	Jan 2003	4	Monthly	Eiendomsverdi, Finn.no, Real Estate Norway and Norges Bank

[1] If not otherwise specified the end date is 31 December 2022.
[2] The following transformations are used: 1 = Level, 2 = Level relative to two-year moving average, 3 = 14-days moving standard deviation, 4 = 12-month growth.
[3] Percentage points over the expected policy rate
[4] Percentage points over the policy rate
[5] The series are included up until the end date, when alternative data at a higher frequency became available.

Table 4: Data

2.3 Methodology

We use a principal component analysis (PCA) to identify the linear combination of the variables that explain the most of the variation in the data set (Abdi and Williams, 2010)[2]. The index thereby retains as much of the information from the original data set as possible, while reducing the data to a single daily observation. The PCA determines weights, or loadings, of the variables that are, as stated in Brave and Butters (2011), consistent with the different variables importance for the historical fluctuations in the broader data set. Consequently, variables that capture more of the underlying variation in the data set will receive a higher weight in the index. As highlighted by Angelopoulou (2013), this approach is intended to remove the noise in the data and capture fundamental developments, without imposing a structure on the data set.

Most of the data series are observed daily, except for the credit premiums' where we have weekly observations and house prices, which are at monthly frequency. As the analysis requires a constant frequency, we assume constant risk premiums and house prices over the entire week and month. The series that have a short history of high-frequency data are joined together with a similar series on a lower frequency (see table 4).

2.4 Results

The first component explains about 40 percent of the total variation in the variable set, while the second component around 25 percent (see Table 5). Thus, more of the variation in the data set is explained by the first principal component than previous FCIs estimated for Norway (Vonen, 2011) as well as FCIs for the euro area and certain euro area countries (Angelopoulou, 2013) where the first component explains between 20 percent and 30 percent of the variation.

The factor loadings represents the relationship between a given variable and the FCIN and the relative weight of the different variables. A positive factor loading indicates that a higher value is associated with an increase in the FCIN, while for a negative factor loading the opposite is the case. As shown in Table 5, the factor loadings suggests that all variables have sizeable weights and the expected sign for the first component.

The factor loadings for the first component suggests that asset prices are negatively associated with the FCIN. This is due to the fact that higher-than-average stock indices and house prices are associated with looser financial conditions. In contrast, volatility in stock markets and foreign exchange markets, as well as higher risk premiums and lending spreads are all positively associated with the FCIN. A rise in either of the variables increase the index value (contractionary financial conditions), while a decline lowers the FCIN (expansionary financial conditions). These are all intuitive results in line with a priori expectations.

The credit market has the largest aggregated weight of the sub-markets in the first component. Since the Norwegian financial system is mainly bank- and credit-based, we consider this an

[2]We have used matlab's (version R2020b) own pca function to construct the principal components in the FCIN. The same applies to the FCIN that only uses high-frequency data as reported in appendix C. For the broad FCIN, also reported in appendix C, we use a dynamic factor model that allows for a combination of an unbalanced data set and different frequencies. For the dynamic factor model, we use the nb_fmdyn function from NBTOOLBOX.

appropriate outcome. Given the high degree of variation explained by the first component and economically meaningful loadings, we believe there is support for following much of the FCI literature and interpreting the first principal component as a financial conditions index.

The factor loadings for the variables in the second and third factor are heavily influenced by only a few variables, and the signs are not always economically intuitive. The second component is mainly influenced by stock market volatility (negatively) and the lending spread on bank lending rates to households and firms (positively). The third index mainly captures house prices (positively) followed by exchange rate volatility (also positively).

Series[1]	Factor 1	Factor 2	Factor 3
Stock market			
Volatility, Oslo Børs Index (OSEBX), total return	0.90	-1.35	0.65
Price-to-book ratio, OSEBX	-1.32	0.89	0.93
Foreign exchange market			
Volatility, Import-weighted krone exchange rate. 44 trade partners	0.86	-0.60	2.36
Credit market			
Average risk premium on corporate bonds, non-financial firms	1.40	0.43	0.61
Average risk premium on senior bank bonds and covered bonds	1.46	-0.26	0.22
Spread on residential mortgage loans	0.79	1.67	-0.28
Spread on outstanding loans to non-financial firms	0.92	1.67	0.77
Housing market			
House prices	-1.05	0.15	2.90
Share of total variance explained	42.71	25.11	10.35

[1] All variables are standardized prior to inclusion.

Loadings are scaled to have a unit variance for ease of comparison. Re-estimation of the index will naturally change the loadings of the variables.

Table 5: Factor loadings

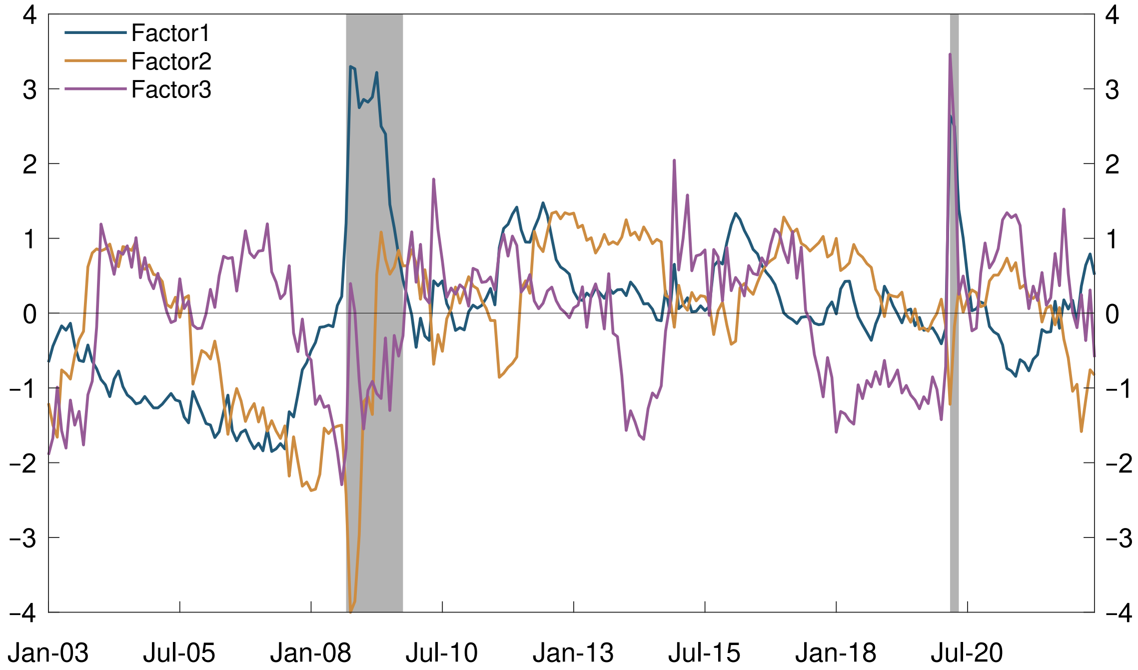

Figure 2: Three first factors

3 Analysis of the properties of our FCIN

3.1 The index through history

Figure 3 plots the index from the first quarter of 2003 to the first quarter of 2022. Up until the global financial crisis, the FCIN shows that financial conditions were expansionary in Norway, mostly due to conditions in the credit market. Over this period, house prices in Norway increased steadily and credit conditions loosened. The FCIN increased substantially in 2008, again driven by changes in credit market conditions, but it was also heavily influenced by the stock- and housing markets as well as heightened exchange rate volatility.

A few years after the global financial crisis, the index increased once more, against the backdrop of the European debt crisis. From early August 2011 to March 2013, the index indicates tighter-than-average financial conditions. The final two main spikes in the index follows the oil price fall in 2014-2015 and the spread of Covid-19 at the start of 2020. The index rose through March 2020 to its highest level since the global financial crisis. However, the index indicates that financial conditions quickly loosened with lower credit premiums and volatility.

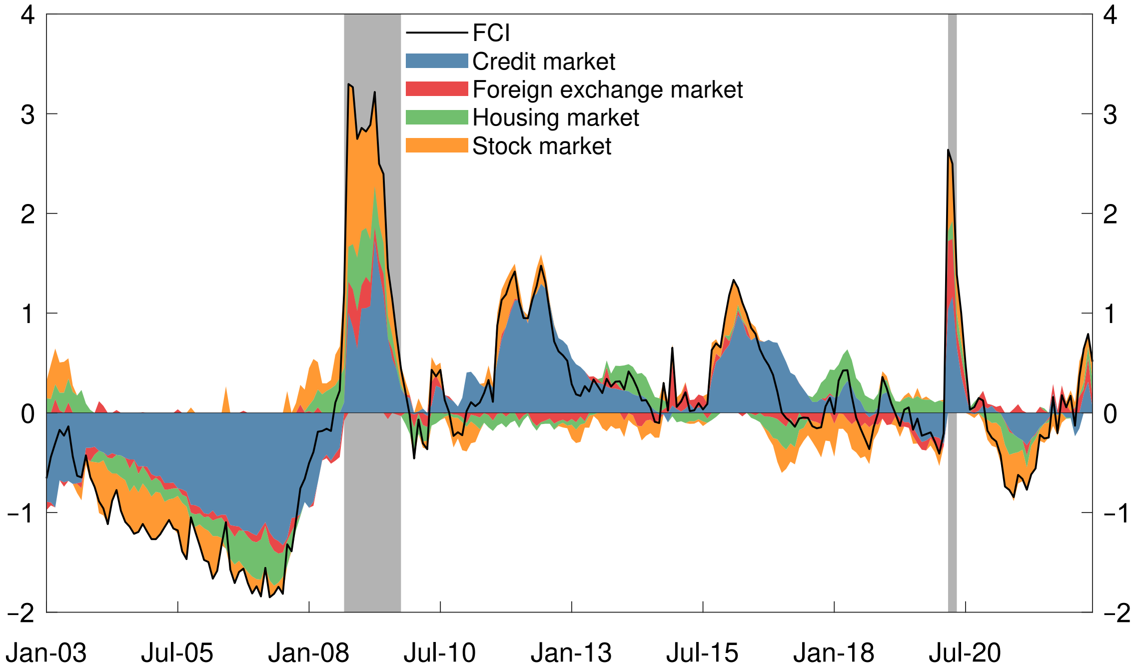

Figure 3: FCIN from January 2003 until December 2022. Monthly average

3.1.1 Comparison with international FCI's

Figure 4 compares the developments in the FCIN with FCIs for the US, euro area and other advanced economies produced by the IMF. Though the indices are estimated using slightly different methods and include a different variable set, it is still interesting to compare developments in our FCIN with other indices. The time series indicate that financial conditions in Norway are highly correlated with the US, euro area and other advanced economies. The figure shows that financial conditions were expansionary in most advanced economies leading up to the global financial crisis of 2008, before tightening markedly. Norway, was less severely hit by the financial crisis than the US and euro area, and the FCIN mirrors these developments. The second spike in the FCIN is the European debt crisis, followed by the oil price fall in 2014-2015. The latter was a shock that affected the Norwegian economy negatively as a net energy exporter but did not lead to a tightening of financial conditions in most other advanced economies. Finally, all the indices indicate a tightening during the Covid-crisis, followed by expansionary financial conditions. The recent tightening of monetary policy appears to have been followed by a tightening of broader financial conditions in most advanced economies.

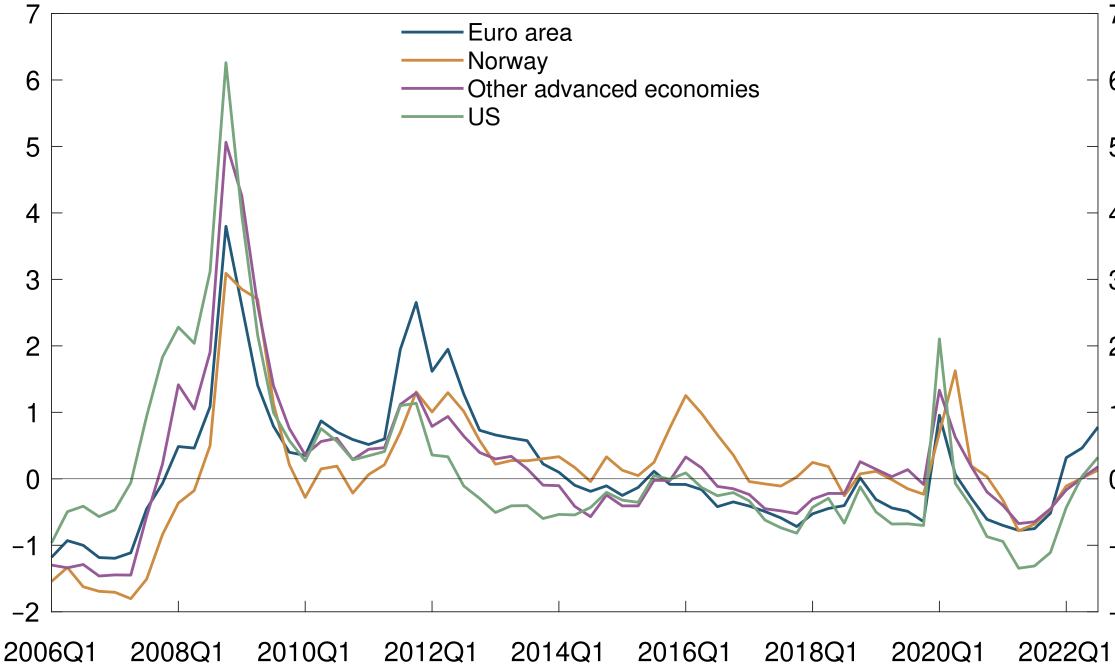

Figure 4: FCIN transformed to quarterly average
Sources: IMF (2022) and Norges Bank

3.2 Structural VAR

To examine the relationship between the FCIN and the real economy, we include the index in a VAR model of the Norwegian economy. We aim to identify a financial shock to see how inflation, output and the policy rate responds to the shock. More specifically, we include, in this order, real GDP for mainland Norway (in logarithms), the CPI-ATE (in logarithms), the FCIN and the policy rate. Since the policy rate is trending downwards over time, we subtract a measure of the trend in the policy rate, in our case the five-year swap rate five-years forward, in the VAR. In the light of the recent focus on the non-linear transmission of financial shocks in the literature, we assess whether the financial shock hits the economy differently depending on whether it is contractionary or expansionary. We follow the methodology of Forni et al. (2022) first by identifying the financial shock using the estimation strategy of Gilchrist and Zakrajšek (2012), and second by estimating the possible non-linear transmission mechanism by using the estimated shocks and non-linear functions from the first step in a VARX.

We estimate the following model in the second step:

$$y_t \quad = \mu + A(L)y_t + \beta_0 g(\hat{u}_{ft}) + \alpha_0 \hat{u}_{ft} + B_{-f0} u_{-ft} \tag{1}$$

where $\hat{u}_t$ is the estimate of the financial shock, $A(L) = \sum_{k=1}^{p} A_k L^k$ is a matrix of degree-p polynomials in the lag operator L, α_0 is the vector of coefficients corresponding to the financial shock, β_0 is the vector of coefficients associated with the nonlinear function of the financial shock, B_{-f0} is the matrix formed by the $n-1$ columns of B_0 excluding α_0 and u_{-ft} is the $(n-1)$-dimensional vector containing the remaining structural shocks other than the financial shock.

From equation (3) we can observe that the impulse response functions to u_{ft} and $g(u_{ft})$ are $\alpha(L) = (I - A(L))^{-1}\alpha_0$ and $\beta(L) = (I - A(L))^{-1}\beta_0$, respectively. The total effect of a financial conditions shock is therefore non-linear and is obtained by combining the two terms as:

$$\text{IRF}(u_{ft} = u^*) \quad = \quad \alpha(L)u^* + \beta(L)g(u^*). \tag{2}$$

Now, suppose $g(u_{ft}) = u_{ft}^2$, which, as discussed below, is our baseline specification. The total effect of the shock will then be:

$$\text{IRF}(u_{ft} = u^*) \quad = \quad \alpha(L)u^* + \beta(L)(u^*)^2. \tag{3}$$

In equation (3) the coefficients $\beta(L)$ generate an asymmetry between positive and negative shocks. Consider, for example, a one-standard-deviation shock. When $u^* = 1$, the effect is $\alpha(L)+\beta(L)$. When $u^* = -1$, the effect is $-\alpha(L)+\beta(L)$. Additionally, a non-linearity in terms of magnitude also arises. For $u^* = 1$, the effect is $\alpha(L)+\beta(L)$; for $u^* = 2$, the effect is $\alpha(L)2+\beta(L)4$. Therefore, a shock of double magnitude will not have twice the effects.

In following the estimation strategy of Gilchrist and Zakrajšek (2012), we first recursively order the slow-moving variables (real GDP and the CPI-ATE) over the FCIN, and the fast-moving policy rate below the index. In this step we obtain an estimate of the financial shock. Then we estimate the possibly non-linear transmission mechanism with the use of the estimated shocks and non-linear functions of these. In the baseline estimation, we use $g(u_{ft}) = u_{ft}^2$ as a non-linear function of the shock, in order to consider potential asymmetries in terms of both the sign and the size of the shock. We refer to Forni et al. (2022) for a thorough explanation of the methodology.

We estimate the VARX model with quarterly data for Norway over the sample period from 2003Q1 to 2021Q4, using $p = 2$ lags of the dependent variable as suggested by the average of AIC, BIC and HQC criteria.

3.2.1 Financial shock

Figure 5 reports the results of the two-step procedure described above. We consider a one-standard-deviation innovation in the FCIN, namely a contractionary financial conditions shock. The solid black lines are the point estimates, while the grey areas are the 68 percent and 90 percent confidence bands. The first column shows the linear response to the shock, while the second column reports the responses of the square term. The horizontal axis measures time in quarters from impact to 20 quarters after innovations have occurred.

A one-standard-deviation contractionary financial conditions shock leads to a decrease in the policy rate that is evident for approximately two years. Real GDP decreases following the shock, but recovers after about 1.5 years. The CPI-ATE reacts with a lag and decreases a year after the shock. Prices do not recover over the five-year horizon within the 68 percent confidence bands. When focusing on the responses to the square term, we observe a significantly negative and persistent effect on GDP and the CPI-ATE. This means that the negative effect of a contractionary financial conditions shock on GDP and the CPI-ATE is magnified by the non-linear term. The positive effect of expansionary financial conditions shock is dampened.

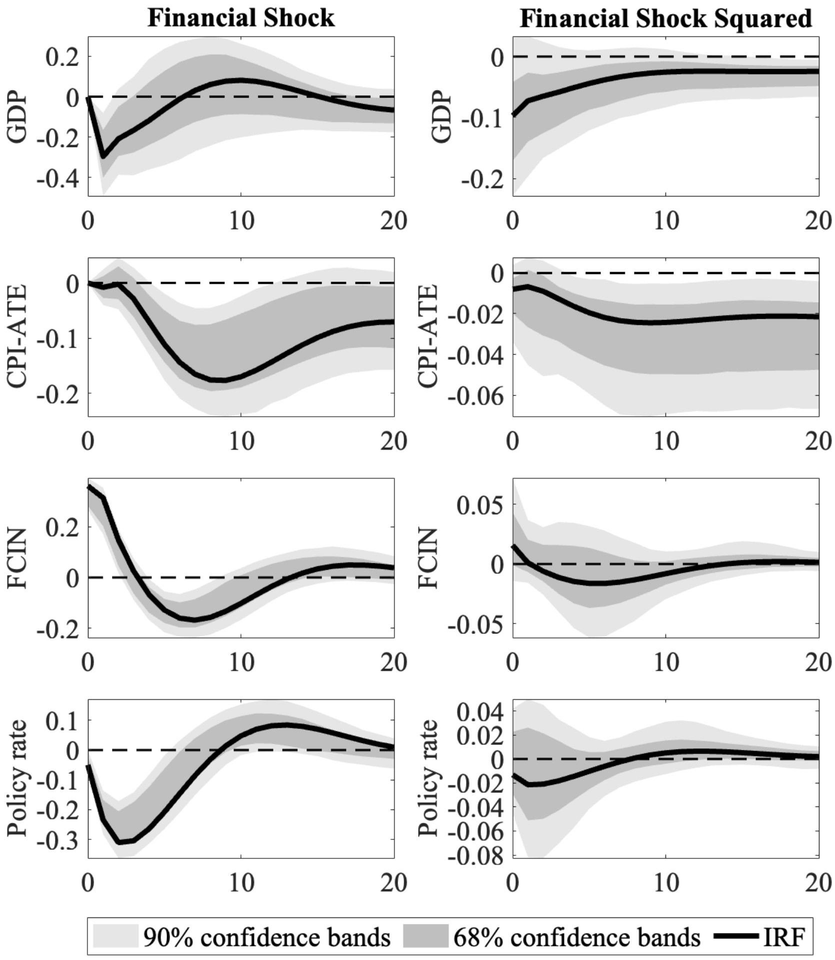

Figure 5: FCIN shock. The impulse responses of GDP, inflation, the FCIN and the policy rate to a one-standard-deviation tightening financial conditions shock. The shaded areas are 90% and 68% confidence bands.

In addition to assessing the effect of a one-standard-deviation shock to the FCIN, we want to see whether the economy reacts asymmetrically to positive and negative shocks and to different magnitudes of the shock. In Figure 6 we compare the responses to positive and negative shocks to the FCIN for different magnitudes of the shock. The dotted red lines are the response to an expansionary FCIN shock, but in order to compare the magnitudes we have included them with a negative sign. From the figure, we see that GDP and the CPI-ATE react more to the contractionary FCIN shock than to the expansionary. When comparing to a four-standard-deviation shock with the FCIN, the asymmetry in the response of GDP and the CPI-ATE becomes even larger. The finding that larger shocks are more asymmetric is reasonable, as it reflects the fact that the positive effects of financial booms are smaller than the negative consequences of financial disruptions. This is consistent with the findings of Forni et al. (2022).

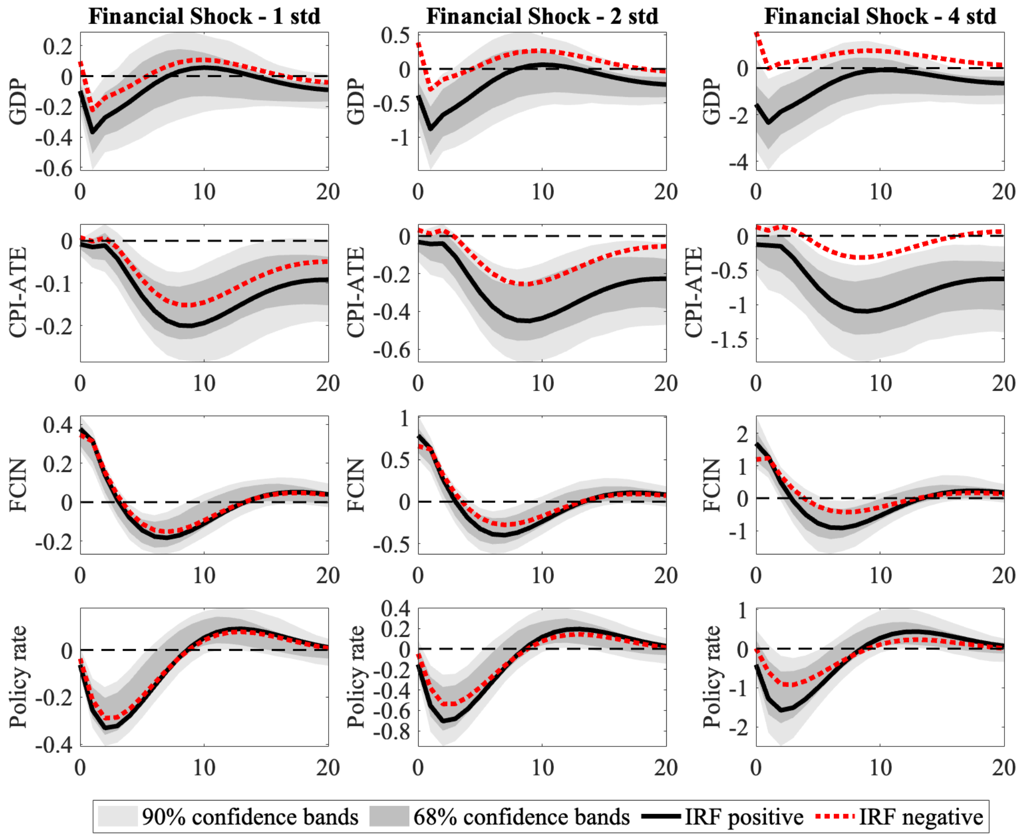

Figure 6: FCIN shock. The solid black line is the response to a positive shock (contractionary) and the dotted red line is the magnitude of the response to a negative shock (expansionary), with flipped sign. The shaded areas are 90% and 68% confidence bands.

3.2.2 Monetary policy shock

Figure 7 shows the impulse responses to a contractionary monetary policy shock. In response to a one-standard-deviation monetary policy shock, represented by an increase in the policy rate of approximately 0.2 percentage points on impact, the FCIN increases with a lag, and peaks a year after the increase in the policy rate. Thereafter, the index drops below zero and hits a trough after three-years before returning to baseline. Thus, a monetary policy shock is amplified by tighter financial conditions for approximately three-years.

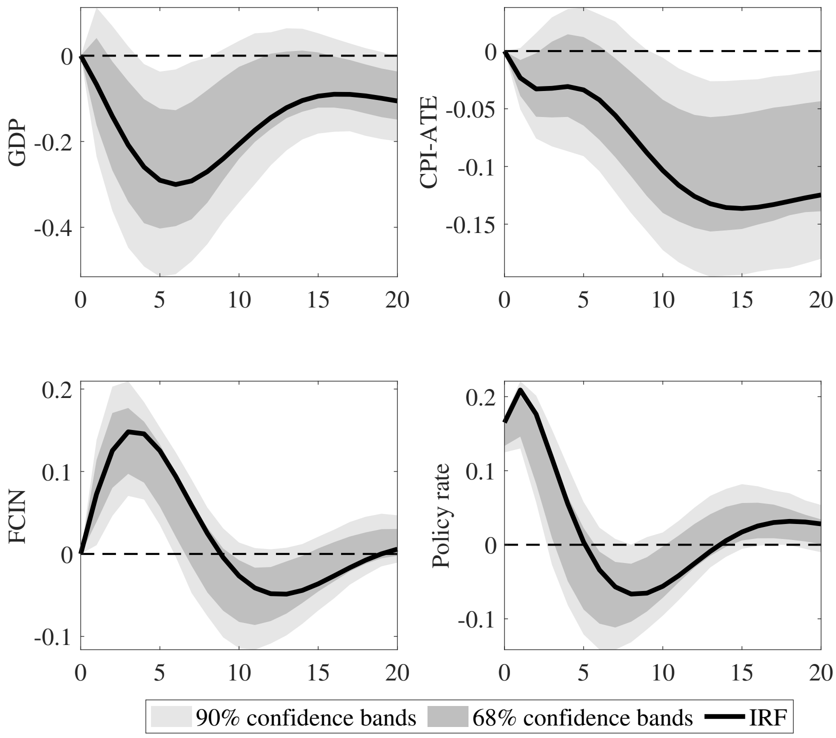

Figure 7: One-standard-deviation contractionary monetary policy shock. The shaded areas are 90% and 68% confidence bands.

3.2.3 Shock decomposition

Figure 8 plots the historical decomposition for each variable. The shaded light grey area is the sum of the contributions of all shocks apart from the financial shock, the grey area is the financial shock and the dark grey is the square of the financial shock. From the plot of GDP, we find that the financial shock played a big role in the downturn around the global financial crisis in 2008. Norway was not hit as hard by the financial crisis as many other European countries or the US, but it still represented a decline in activity (Grytten and Hunnes, 2014). As the plot shows, a large share of the decrease in GDP can be attributed to tighter financial conditions, largely transmitted from global financial conditions. We see that the decrease in the policy rate around the financial crisis can also be attributed to the change in financial conditions. The decline in GDP in March 2020 is fully attributed to shocks other than financial shocks. On the contrary, shocks to financial conditions pulled GDP up slightly during the Covid-19 pandemic.

As for non-linearities, they play a large role in explaining the effect of financial shocks. In particular, around the financial crisis of 2008, non-linearities magnify the effect of the financial shock on GDP. In the same time period, the linear and non-linear part of the shock transmission pull core inflation in opposite directions. While the linear part of the shock increases inflation, the non-linear portion pulls inflation down. From 2012 and until the Covid-19 pandemic, both the linear and non-linear terms pull core inflation down.

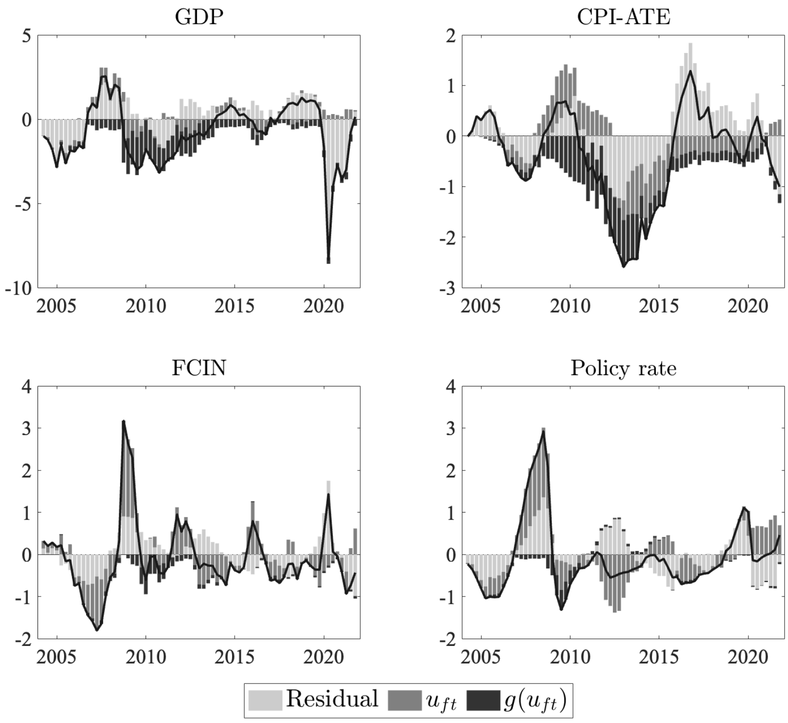

Figure 8: Historical decomposition. The solid black line represents the sum of the contributions of each shock in the system. The grey and dark grey areas represent the contributions of the financial shocks and its square. The light grey area are all shocks other than the financial shock, namely the residual shocks in the system.

4 Summary

In this paper, we have constructed a financial conditions index for Norway (FCIN) which can be updated daily to complement monetary policy analyses at Norges Bank and improve the Bank's assessments of economic activity. The index is based on bank lending rates, bond spreads, the foreign exchange market, the stock market and the housing market. The index is constructed by the use of principal component analysis. The FCIN is constructed to provide real-time insight into financial conditions for the Norwegian economy beyond what is already included in the policy rate and market policy rate expectations. Here we depart from other studies, which typically aim at assessing financial conditions more broadly.

We show that the index picks up the main historical events that have affected the Norwegian economy and is furthermore correlated with FCIs for other countries. We identify a shock to the FCIN in a structural VAR and examine in a second step the impact on GDP for mainland Norway, core inflation and the policy rate. First, we find that GDP and inflation react more to a contractionary FCIN shock than to an expansionary shock. Secondly, we find that this asymmetry becomes even more pronounced for larger shocks. Thirdly, we find evidence that a monetary policy shock is amplified by a change in financial conditions. A historical shock decomposition shows that financial factors can explain weaker economic developments during and after the global financial crisis. However, the fall in output during the pandemic is fully attributable to factors other than the financial shocks.

References

Abdi, H. and Williams, L. J. (2010). Principal component analysis. *WIREs Computational Statistics*, 2(4).

Alsterlind, J., Lindskog, M., and von Brömsen, T. (2020). An index for financial conditins in sweden. *Riksbank staff memo*.

Angelopoulou, Eleni, B. H. G. H. (2013). Building a financial conditions index for the euro area and seleced euro area countries. what does it tell us about the crisis? *Working paper series*, (1541).

Aron, J., Duca, J. V., Muellbauer, J., Murata, K., and Murphy, A. (2012). Credit, housing collateral, and consumption: Evidence from japan, the uk and the us. *Review of Income and Wealth*, 58(3):397–423.

Bernanke, B. and Gertler, M. (1989). Agency costs, net worth, and business fluctuations. *The American Economic Review*, 79(1):14–31.

Brave, S. A. and Butters, A. (2011). Monitoring financial stability: A financial conditions index approach. *Economic Perspectives*, 35(1).

Erdem, M. and Tsatsaronis, K. (2013). Financial conditions and economic activity: a statistical approach. *BIS Quarterly Review*.

Federal Reserve Bank of Chicago (2022). National financial conditions index (nfci). `https://www.chicagofed.org/publications/nfci/index`. Accessed: 2022-08-13.

Forni, M., Gambetti, L., Maffei-Faccioli, N., and Sala, L. (2022). Nonlinear transmission of financial shocks: Some new evidence. *Norges Bank Working Paper Series*, (2).

Gilchrist, S. and Zakrajšek, E. (2012). Credit spreads and business cycle fluctuations. *American Economic Review*, 102(4).

Grindaker, M. H. (2017). House prices and household consumption. *Staff Memo*, (11).

Grytten, O. H. and Hunnes, A. (2014). An anatomy of financial crises in Norway, 1830–2010. *Financial History Review*, 21(1):25–57.

Hatzius, J., Hooper, P., Mishkin, F. S., Schoenholtz, K. L., and Watson, M. W. (2010). Financial conditions indexes: A fresh look after the financial crisis. *NBER Working Paper*, (16150).

IMF (2022). Global financial stability report. `https://www.imf.org/-/media/Files/Publications/GFSR/2022/October/Data/ch1data.ashx`. Accessed: 2022-12-09.

Jensen, J. R. and Pedersen, J. (2019). Macro financial linkages in a svar model with application to denmark. *Nationalbanken Working Paper*, (134).

Kapetanios, G., Price, S., and Young, G. (2017). A uk financial conditions index using targeted reduction: forecasting and structural identification. *Staff Working Paper*, (699).

Mian, A., Rao, K., and Sufi, A. (2013). Household balance sheets, consumption, and the economic slump. *The Quarterly Journal of Economics*, 128(4):1687–1726.

Paries, M. D., Maurin, L., and Moccero, D. N. (2014). Financial conditions index and identification of credit supply shocks for the euro area. *International Finance*, 3(17):297–321.

Statistics Norway (2022). Boforhold, registerbasert. `https://www.ssb.no/bygg-bolig-og-eiendom/bolig-og-boforhold/statistikk/boforhold-registerbasert`. Accessed: 2022-10-15.

Vonen, N. H. (2011). A financial conditions index for norway. *Staff Memo*, (7).

Whaley, R. E. (2000). The investor fear gauge. *The Journal of Portfolio Management*, 26(3):12–17.

A Interest rates

In the following, we show market rates, lending rates and deposit rates that we later include in our index. Figure 9 shows borrowing rates (bonds and deposit) for banks. The time series for deposit rates is only available from 2014. In this period, the figure shows that deposit rates respond less to the policy rate than bond yields. Bond yields follow Nibor (Norwegian Interbank Offered Rate) rate plus a premium for risk such as liqudidity risk and a term spread. Bond yields are higher than deposit rates since bonds are deemed more risky, in particular senior bonds. Bond yields also increase more around episodes of turmoil, eg during the global financial crisis in 2008-2009 and during the European debt crisis from 2011-2012. The figure also shows an implicit interest rate based on the national accounts to shed light on what banks pay on average.[3] As we learned from Table 1, a large share of funding comes from deposits. It is therefore not surprising that the implicit interest rate lies between the bond yields and deposit rates.

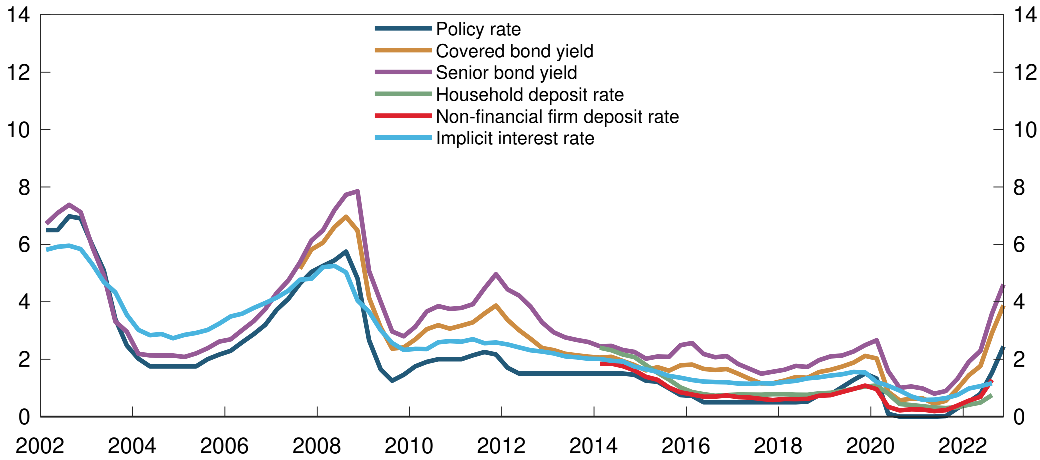

Figure 9: Policy rate and borrowing rates for banks

Figure 10 shows banks' mortgage lending rate to households. It follows the policy rate quite closely but was kept higher after 2012. One reason for this may be that a gradual phasing-in of higher capital requirements was signalled around that time, and banks responded by increasing their lending spreads. The estimated implicit interest rate is typically higher than the mortgage lending rate. A possible reason for this is that consumer credit loans and unsecured lending also are included in interest rate expenses in the calculation of the implicit interest rate.

[3]Since we have to rely here on national accounts, the implicit rate is calculated for all monetary institutions which in addition to banks and mortgage companies, also includes some money market funds.

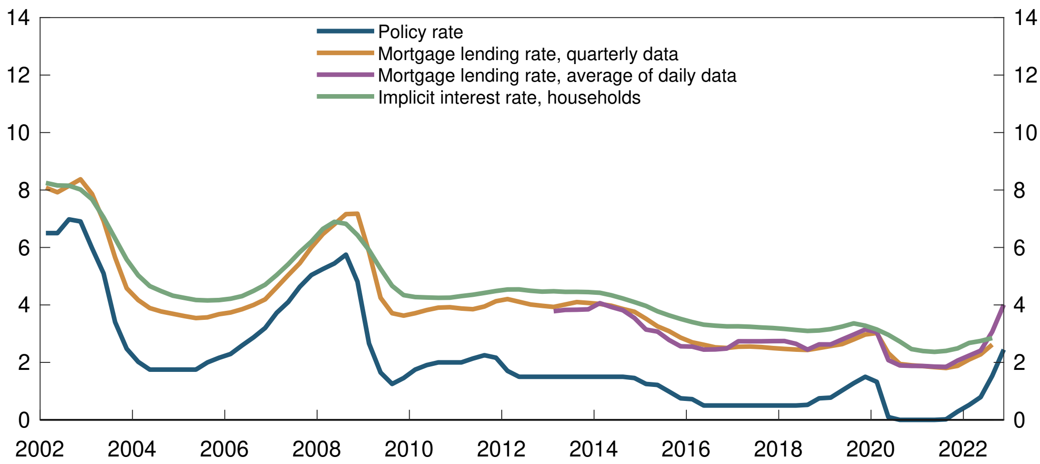

Figure 10: Policy rate and borrowing rate for households

Figure 11 shows both lending rates and bond yields pertaining to non-financial firms. We see that borrowing rates largely follow the policy rate with a certain margin as in the case of bank bonds. The margins can change due to shocks hitting specific market segments. For example, high-yield bond spreads rose after the oil price decline in 2014, owing to a higher risk assessment of oil service firms. We also see that bond spreads rose during the global financial crisis in 2008-2009. This is largely due to a higher Nibor spread. The estimated implicit interest rate follows the lending rate quite closely, even though it responds somewhat less to changes in the policy rate. This may be due to firms paying a fixed interest rate on portions of their debt. However, we have insufficient detailed information on corporate borrowing conditions for shedding more light on this. The fact that the implicit interest rate largely follows the lending rate is not surprising given that bank loans constitute an important share of firms' liabilites (see table 3).

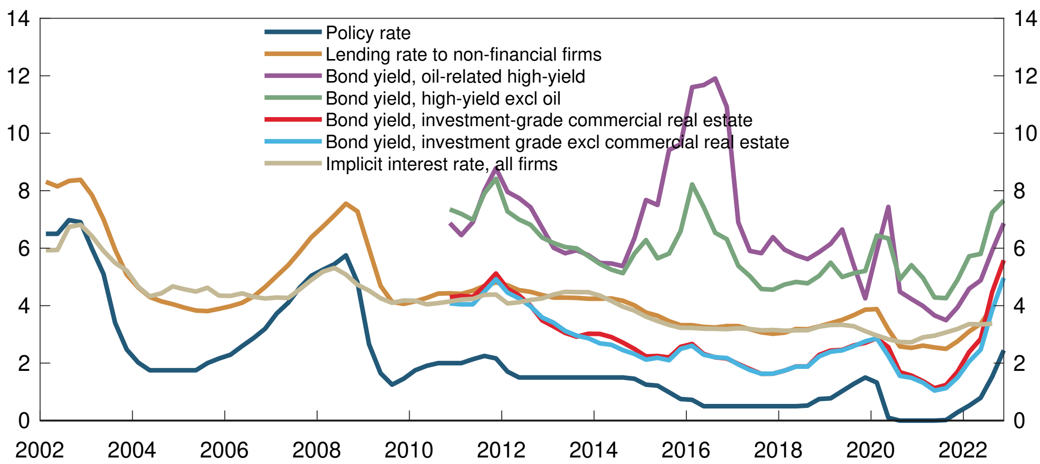

Figure 11: Policy rate and borrowing rates for non-financial firms

B FCIN with house prices purged

In this section, we show a version of the FCIN where we remove the impact of the policy rate on house prices. We do this by first regressing monthly change in house prices on monthly changes in the money market rate lagged 1-4 months. Then we include the residual in the regression in the FCIN, which by construction is uncorrelated with lagged interest rate changes.

Figure 12 shows that the index is more or less unchanged from the original version (Figure 3), but that the contribution from house prices is smaller or changes sign in periods of large changes in the interest rate. For instance, in 2022 the decline in house price inflation is largely explained by higher interest rates in the simple model. Hence, the decline in house price inflation is not interpreted as tighter financial conditions.

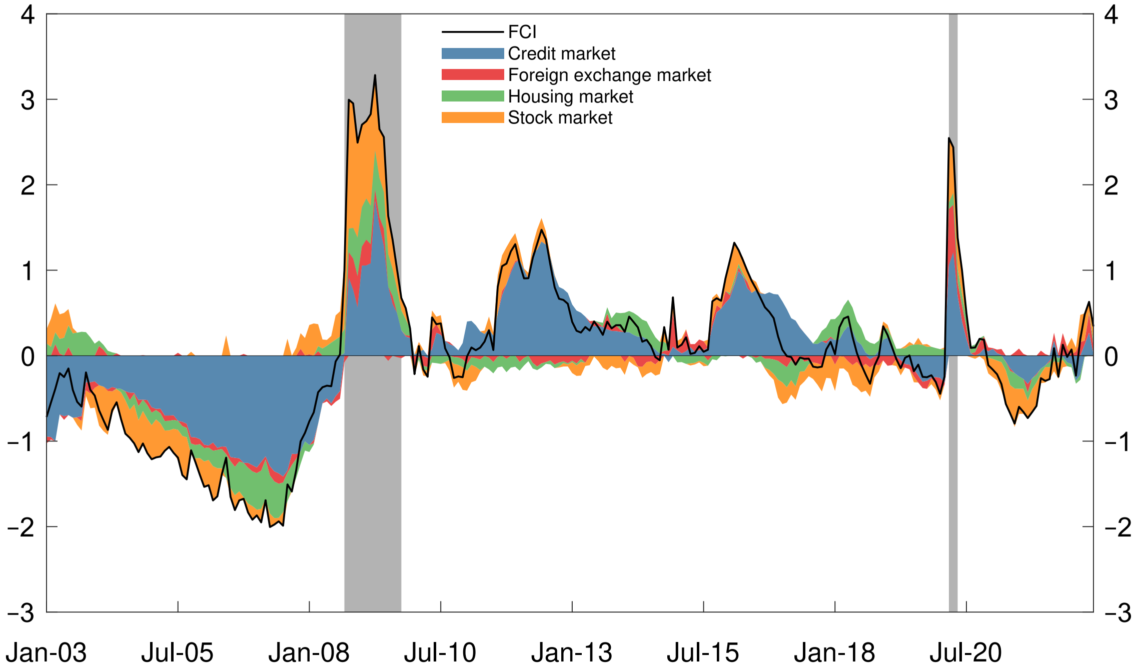

Figure 12: FCIN from January 2003 until December 2022 when house prices are purged of the effect of interest rate changes. Monthly average

C Other estimation approaches

As a robustness test we have also estimated the FCIN using different estimation approaches and including a slight variation in the variable set. There are three main approaches in addition to the one presented in this paper, that we have tested (See figure 13). First, we have estimated a broad index including a large set of financial indicators at monthly frequency by the use of a dynamic factor model inspired by Brave and Butters (2011). Secondly, we have estimated an index following Alsterlind et al. (2020) with all the variables given equal weights (including the foreign exchange rate in levels) instead of applying factor loadings. Finally, we have estimated an FCIN at daily frequency with a larger proportion of market data.

When comparing the indices, it is clear that they are highly correlated and follow each other closely. They all indicate that financial conditions were relatively loose prior to the Great Recession, before tightening markedly. Furthermore, the second largest spike in all the indices is the Covid period. Based on this robustness test, the underlying developments captured by our FCIN appear to be robust across different variable sets and estimation methods. In addition to robustness, the alternative indices are also useful as a continuous cross-check of the developments in the FCIN presented in this paper.

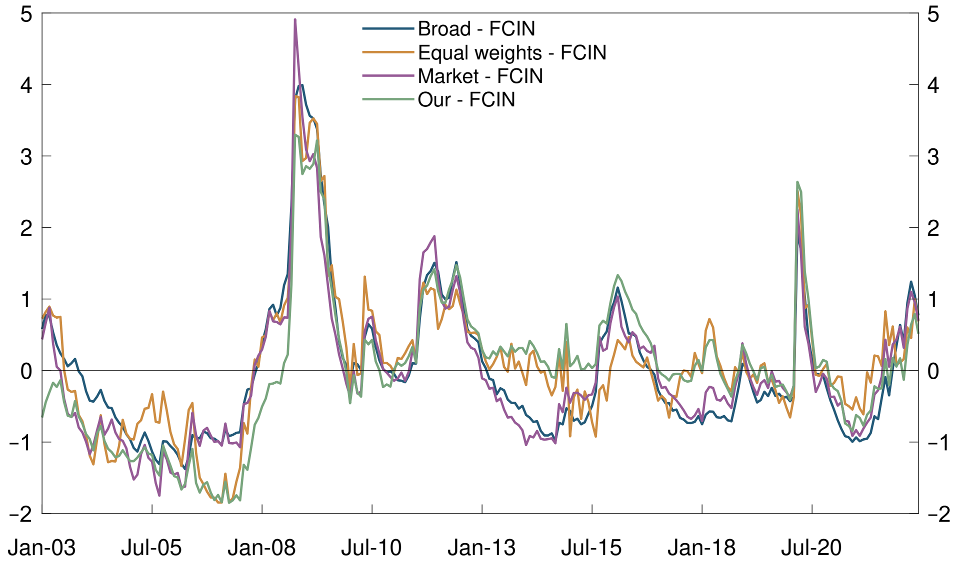

Figure 13: Different FCIs for Norway. Monthly average