

WORKING PAPER

The Norwegian overnight interbank market during the Covid pandemic

**NORGES BANK
RESEARCH**

8 | 2023

AUTHORS:

Q. FAROOQ AKRAM

JON H. FINDRENG

LYNDSIE SMITH



NORGES BANK

Working papers fra Norges Bank, fra 1992/1 til 2009/2 kan bestilles på e-post: servicesenter@norges-bank.no

Fra 1999 og senere er publikasjonene tilgjengelige på www.norges-bank.no

Working papers inneholder forskningsarbeider og utredninger som vanligvis ikke har fått sin endelige form. Hensikten er blant annet at forfatteren kan motta kommentarer fra kolleger og andre interesserte. Synspunkter og konklusjoner i arbeidene står for forfatterens regning.

Working papers from Norges Bank, from 1992/1 to 2009/2 can be ordered by e-mail: servicesenter@norges-bank.no

Working papers from 1999 onwards are available on www.norges-bank.no

Norges Bank's working papers present research projects and reports (not usually in their final form) and are intended inter alia to enable the author to benefit from the comments of colleagues and other interested parties. Views and conclusions expressed in working papers are the responsibility of the authors alone.

ISSN 1502-8143 (online)
ISBN 978-82-8379-284-3 (online)

NORGES BANK
WORKING PAPER
8 | 2023

THE NORWEGIAN
OVERNIGHT INTERBANK
MARKET DURING THE COVID
PANDEMIC

The Norwegian overnight interbank market during the Covid pandemic

Q. Farooq Akram, Jon H. Findreng and Lyndsie Smith*

June 16, 2023

Abstract

We analyse the behaviour of the Norwegian unsecured overnight interbank market in response to heightened uncertainty and the central bank's liquidity support measures following the Covid-19 pandemic. The liquidity measures enabled banks to fulfil their liquidity needs primarily through participation in extraordinary liquidity auctions. The distribution of central bank reserves across banks did not change due to these measures, but interbank trading fell sharply. Ample liquidity support through the auctions and low interbank trading contributed to low and overly stable overnight rates. Actually, throughout our sample period from 2017 to 2021, the overnight rates remained largely unaffected by fluctuations in uncertainty and overall liquidity conditions.

Keywords: *The Covid-19 pandemic; distribution of central bank reserves; overnight interbank market; liquidity policy.*

JEL Codes: G21, E42, E47, E58.

*This paper should not be reported as representing the views of Norges Bank. The views expressed are those of the authors and do not necessarily reflect those of Norges Bank. We have received useful comments from an anonymous referee, Martin Brown, Kjetil Stiansen, Olav Syrstad, Angelo Ranaldo, Kasper Roszbach, Matthias Weber and other seminar participants at St. Gallen University and Norges Bank. Correspondence: farooq.akram@norges-bank.no.

1 Introduction

The economic uncertainty associated with the Covid-19 pandemic was particularly high during its early phase, around mid-March 2020. This led to substantial shifts in investors' risk appetite and a flight to safer assets, affecting all financial markets. Fiscal and monetary policy authorities worldwide implemented a number of unprecedented and extraordinary measures to address the turmoil in various markets and contain the economic and financial fallout of the pandemic; see e.g. [FSB \(2020\)](#) and [BIS \(2020\)](#).¹ There is a need to investigate the effects of various policies on participants, transaction volumes, and prices in the relevant markets.

We investigate the behaviour of the Norwegian unsecured overnight interbank market in response to the uncertainty and liquidity support measures implemented by Norges Bank following the pandemic; see e.g. [Norges Bank \(2021\)](#). To reduce uncertainty regarding the availability of liquidity (central bank reserves), Norges Bank auctioned large amounts of fixed-term loans with relatively long maturities. These loans were auctioned concurrently with overnight fixed-term deposits to maintain the level of overall central bank reserves at the target level. The fixed-term loans and deposits were auctioned at interest rates close to the policy rate.²

We find that banks were able to fulfil their liquidity needs through active participation in Norges Bank's extraordinary loan and deposit auctions. Moreover, the distribution of central bank reserves across banks remained almost as before these auctions and our data do not suggest precautionary liquidity hoarding or discount-window borrowing suggestive of liquidity stress. However, the extraordinary liquidity support contributed to a sharp decline in interbank trading. The ample liquidity support, coupled with low interbank turnover, may also have contributed to subdued variation in overnight interbank rates. The unsecured overnight interest rates mostly acted as categorical, or discrete, variables with only a few possible values. On several days, actual Norwegian Overnight Weighted Average (NOWA) rates, were

¹<https://www.fsb.org/wp-content/uploads/P171120-2.pdf> and <https://www.bis.org/publ/arpdf/ar2020e.pdf>.

²An overview of Norges Bank's response to the Covid-19 pandemic is available from: <https://www.norges-bank.no/en/topics/news-events/norges-bank-og-koronaviruset/>.

not reported due to particularly low interbank trading.³ Our analysis is based on both public and proprietary data covering the period from 1 January 2017 to 26 February 2021.

Our empirical analysis suggests a trade-off between ameliorating liquidity uncertainty and maintaining interbank trading. Norges Bank effectively became the sole counterparty to all interbank market participants for most of the period of extraordinary liquidity support. The unsecured overnight rates conveyed limited information about the overall liquidity and its distribution in the interbank market, especially when the extraordinary support measures were in place. We do not assess the extent to which the scope and duration of exceptional liquidity support for banks were warranted, as the potential outcomes of insufficient liquidity support are challenging to ascertain.

While offering perhaps the first empirical analysis of the Norwegian unsecured overnight interbank market during the Covid-19 pandemic, this paper also contributes to the empirical literature on banks' behaviour in interbank markets during high uncertainty and market stress, and on the possible relationships between central banks' liquidity policies and interbank trading and interest rates.

Several studies have reported, or argued for the possibility of, extensive precautionary liquidity hoarding by interbank market participants in response to anticipated liquidity stress, leading to a decline in interbank trading and increased interest rate volatility. Examples include studies of the US Federal funds market and the UK overnight interbank market by [Ashcraft et al. \(2011\)](#) and [Acharya and Merrouche \(2013\)](#), respectively. However, other studies have not found evidence of such interbank market behaviour; see, for example, [Afonso et al. \(2011\)](#) and [Furfine \(2002\)](#), and [Fuhrer \(2018\)](#) for evidence based on the Federal funds market and the Swiss interbank market, respectively.

³NOWA (Norwegian Overnight Weighted Average) interest rates are calculated based on traded overnight interest rates as reported by banks active in the Norwegian interbank market; see <https://www.norges-bank.no/tema/markeder-likviditet/nowa/> for details. Prior to January 2020, there were eleven NOWA panel banks who reported loans where a NOWA bank acted as lender. From January 2020 onwards, NOWA rates are interest rate on unsecured loans between banks that are active in the Norwegian overnight market. For details, see <https://www.norges-bank.no/tema/markeder-likviditet/nowa/> and [Norges Bank \(2019\)](#).

We observe a decline in interbank trading during the market uncertainty associated with the Covid-19 pandemic, but our evidence suggests this primarily occurred after the provision of extraordinary liquidity support by the central bank. [Fuhrer \(2018\)](#) also observed a decline in turnover in the Swiss interbank market in response to generous liquidity support by the Swiss National Bank during financial stress periods including post-Lehman Brothers’ default in 2008.

The remainder of this paper is organised as follows. Section 2 briefly describes the behaviour of the Norwegian unsecured interbank market over the sample period and especially during the pandemic. Section 3 outlines key features of Norges Bank’s extraordinary liquidity support measures since about mid-March 2020. This section also elaborates on the response of banks in different size ranges to these measures. Section 4 presents an econometric analysis to shed further light on interbank trading and overnight interest rates. Section 5 concludes.

2 The interbank market during the pandemic

The VIX index in Figure 1 indicates the sizable economic uncertainty after the

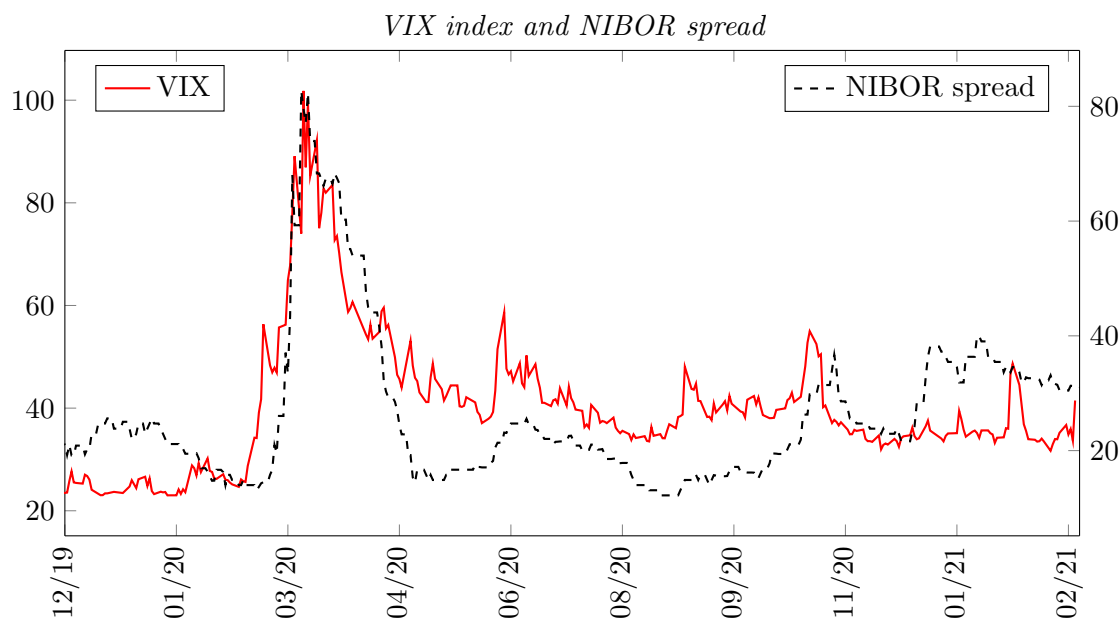


Figure 1: Left axis: expected volatility over a 30-day period represented by the Chicago Board Options exchange Volatility Index (VIX). Right axis: the spread between 3-month NIBOR and the overnight index swap (OIS) as calculated by Norges Bank (NIBOR spread) in basis points. Observations for business days from 1 December 2019 to 26 February 2021. Here and elsewhere in this paper, the values on the horizontal axes are dates in the format mm/yy.

international spread of Covid-19 was declared a pandemic on 11 March 2020 by the World Health Organization. The VIX index, an indicator for expected volatility derived from options on the S&P 500 index, rose sharply and peaked about five times above its earlier values on 19 March 2020. It reversed gradually afterwards but remained around fifty percent above its pre-pandemic levels at the end of the sample period in late February 2021.

Figure 1 also shows the NIBOR spread peaking at about 100 basis points on 16 and 19 March 2020. This reflected a general increase in banks' money market funding costs in international markets due to the pandemic. The 3-month NIBOR rate is the most widely used reference rate in the Norwegian money market. See Alstadheim et al. (2021) for an overview of the turbulence in Norwegian financial markets in March 2020.

Figure 2a indicates a significant temporary decline in interbank trading during the early months of the pandemic. The figure displays the five-day rolling averages of daily volumes in the Norwegian unsecured overnight interbank market. The daily volume was relatively stable in the pre-pandemic period with an average daily interbank trading volume of about NOK 17bn. However, the daily interbank trading volume declined to about a half on average over the 6-month period 13 March–15 September 2020. Moreover, for 23 consecutive days over the period 8 May 2020–11 June 2020, interbank trading volume was below NOK 1bn per day. As a result, data on actual trading volume and NOWA rates were not published. The figure shows that interbank trading recovered swiftly to levels above pre-pandemic levels from 15 September 2020 onwards.

The behaviour of overnight interest rates contrasts sharply with that of longer maturity unsecured interest rates, such as the 3-month NIBOR rate. Figure 2b shows that the spread between the NOWA rate and the (overnight) policy rate is mostly negative and stable throughout most of the sample period. Large positive values mostly occur at the end of months, especially quarters. Since early 2020, the spread mostly varies between -1 and 0 basis points, except that actual values over the period from 8 May 2020 to 11 June 2020 are missing due to particularly low

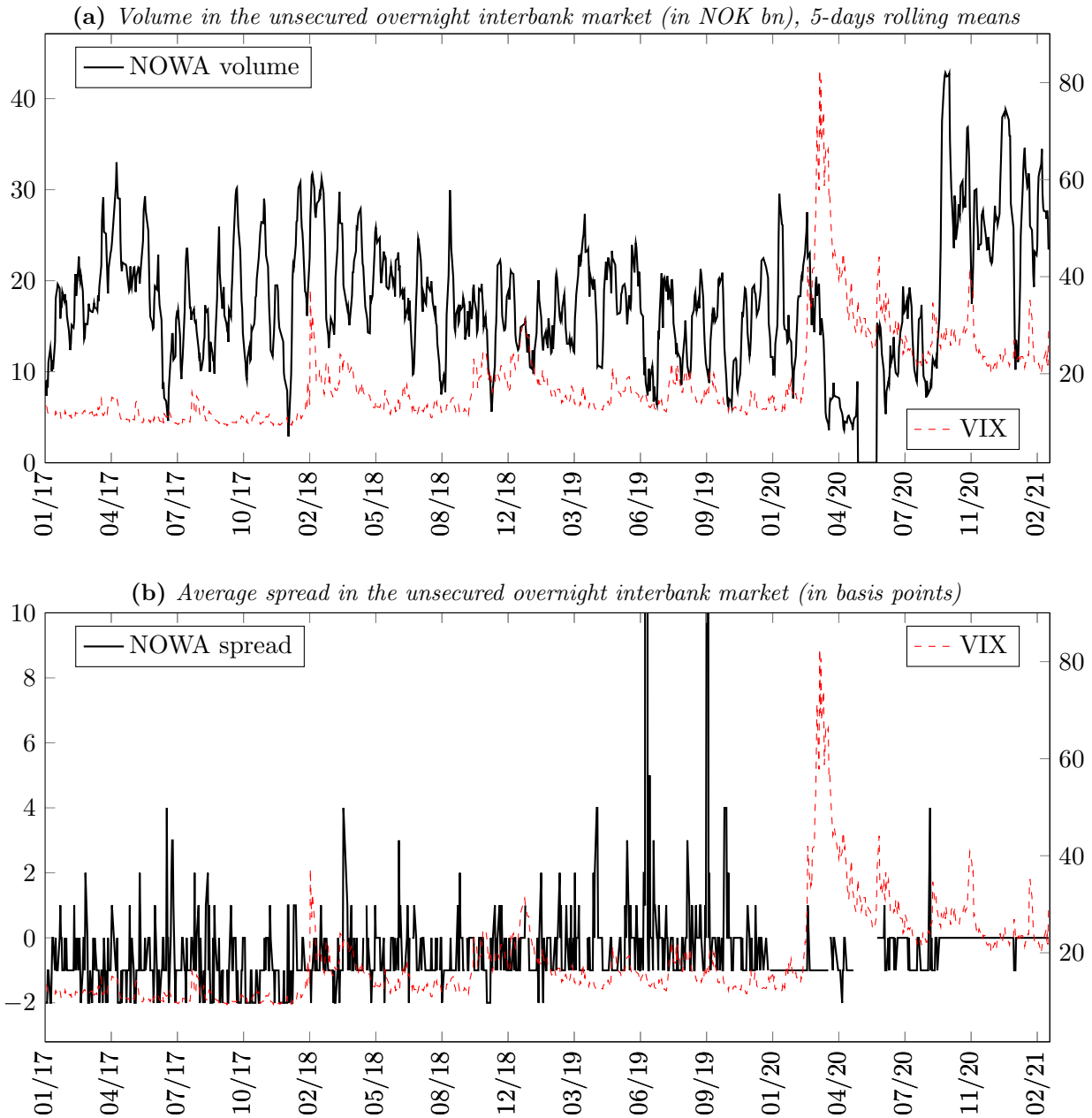


Figure 2: (a) Five-day rolling averages of daily trading volume in the unsecured overnight interbank market associated with NOWA rates in NOK bn. (b) NOWA spread is equal to the NOWA rate minus the policy rate in basis points. Right axes: the VIX index. Observations for business days from 1 January 2017 to 26 February 2021. The NOWA spread appears as a missing observation on days when the NOWA rate is estimated. There are two extreme observations for the spread (43 and 191), both occurring at quarter-ends in 2019Q2 and 2019Q4 respectively, which fall outside the graph.

interbank trading volumes; we leave out observations that may not represent actual interest rates. Notably, the spread values were -1 basis point on each of the trading days throughout the entire first quarter of 2020, including 19 March 2020 and the days around it when economic uncertainty was at its peak; cf. Figure 1.⁴

⁴Negative values of the NOWA spread may arise because banks possessing (central bank) reserves exceeding their quotas have to place the surplus reserves at the ‘reserve rate’, which is

Figures 2a and 2b suggest that the particularly low interbank trading volumes, as well as the subdued variation in the NOWA rate, occurred several weeks after the peaks in the VIX index and the NIBOR spread. Specifically, interbank trading declined below NOK 1bn for about a month from 8 May 2020 onwards. However, despite the substantial drop in interbank trading, liquidity distribution across all banks largely remained stable over time, as shown next.

2.1 Liquidity policy, and distribution during the pandemic

Norges Bank's liquidity policy regime can be briefly described as follows. Payments between the customers of different banks may be credited to and debited from the banks' unrestricted overnight deposit accounts with Norges Bank. These deposits are remunerated at either the policy rate or the 'reserve rate', which is one percentage point below the policy rate. Banks have been allotted individual quotas for how much they can deposit overnight at the policy rate.⁵ In the following, a bank's unrestricted overnight deposits at Norges Bank will be referred to as 'reserves' or 'liquidity', while the sum of all banks' (central bank) reserves will be referred to as 'total reserves'.

The quotas sum to NOK 45bn, while the operational target for total reserves is NOK 35bn +/- 5bn. Banks should therefore be able to avoid depositing their reserves at the reserve rate by lending to other banks in need of liquidity or with unfilled liquidity quotas. Banks in need of liquidity (reserves) have incentives to borrow from their peers rather than from Norges Bank at the discount window at the so called 'D-loan' rate, which is one percentage point above the policy rate.

In spite of the above noted decline in the overnight interbank trading during the early phase of the pandemic, the distribution of total reserves across all banks remained quite stable over time. Figure 3 reports Gini coefficients of total reserves'

100 basis points below the policy rate. Consequently, these banks may accept interbank lending marginally below the policy rate. Another reason could be that banks transacting on the behalf of banks without access to Norges Bank's standing facilities may lend in the interbank market at interest rates below the policy rate.

⁵<https://www.norges-bank.no/en/news-events/news-publications/Circulars/2020/4quotas-in-the-system-for-the-management-of-bank-reserves/>

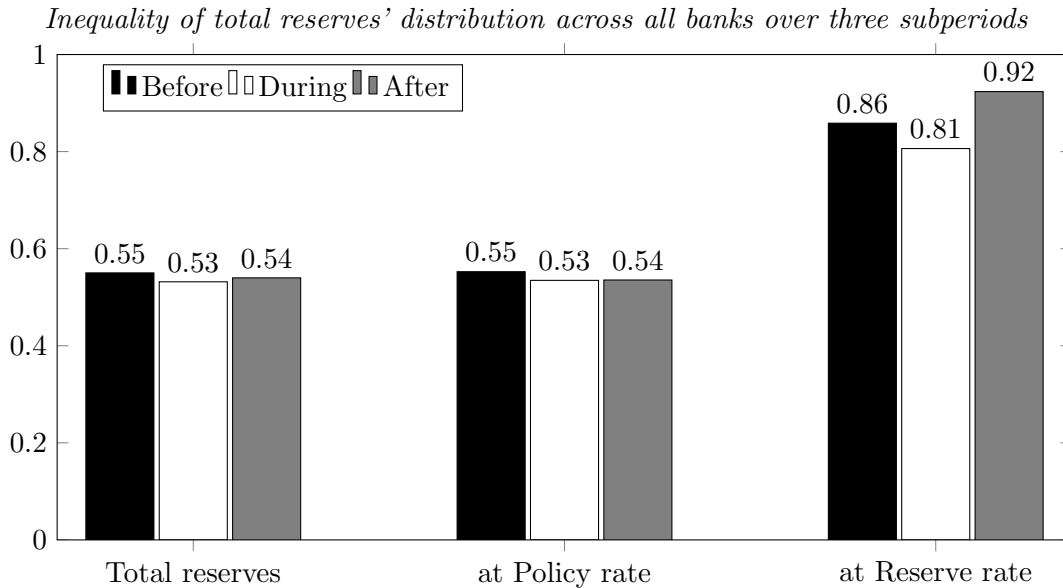


Figure 3: *The first set of bars represents values of Gini coefficients that measure the distribution inequality of total reserves across all banks. For each of the banks, they are normalised by their quotas. Total reserves are defined as the sum of banks' reserves (unrestricted overnight deposits placed with Norges Bank). Within-quota amounts are remunerated at the policy rate, while those in excess of quotas are remunerated at the reserve rate: the policy rate minus 100 basis points. The second and third set of bars represent Gini coefficients for banks' (quota-normalised) reserves placed at the policy rate and the reserve rate, respectively. Lower values of Gini coefficients indicate a more balanced, or less imbalanced distribution, of reserves across the banks compared to higher values. The values displayed are the subsample averages of the corresponding Gini coefficients. 'Before' offsetting auctions period is 1 January 2017–12 March 2020. 'During' offsetting auctions period is 13 March 2020–15 September 2020, while 'After' offsetting auctions period is 16 September 2020–26 February 2021.*

distributions across all banks in three different subperiods. The black bars represent the average of Gini coefficient values for the end-of-day distribution of total reserves and of their two subcomponents: reserves placed at the policy rate and at the reserve rate, respectively, across all banks during the subperiod 1 January 2017–12 March 2020. The middle bars represent corresponding values for the subperiod 13 March 2020–15 September 2020, a period when Norges Bank primarily undertook its extraordinary liquidity support measures. Finally, the grey bars represent corresponding values for the remaining subsample, 16 September 2020–26 February 2021, when the extraordinary liquidity support measures were reduced as they matured or were withdrawn.

Notably, the distributions of total reserves and their main part, i.e. reserves placed at the policy rate, are close to each other and stable over the three subperiods. Part of total reserves placed at the reserve rate are relatively more unequally distributed over the three subperiods than reserves placed at the policy rate. This

reflects that relatively few banks tend to end their business days with reserves placed at the reserve rate. The variations in the average Gini coefficient values across the different subperiods are well within their sample standard errors.

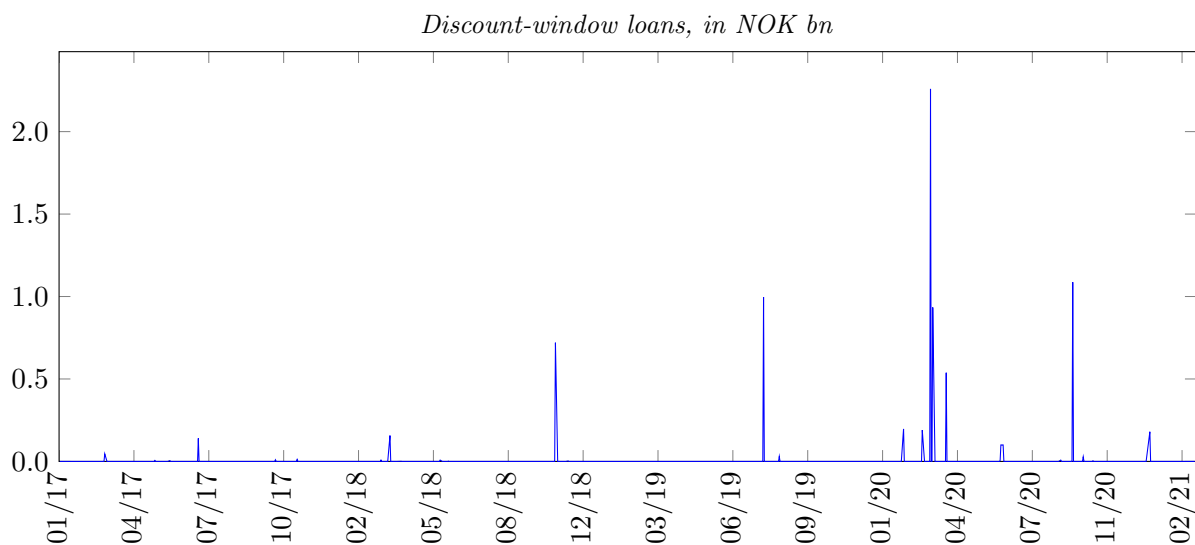


Figure 4: Discount-window loans (D-loans) are banks’ overnight borrowing from Norges Bank at 100 basis points above the policy rate. Observations for business days from 1 January 2017 to 26 February 2021.

Figure 4 shows few instances of discount-window borrowing (‘D-loans’) over the whole sample period. The relatively few instances of D-loans and the limited amounts borrowed do not indicate widespread difficulties in obtaining liquidity from the interbank market. The highest amount of D-loans on a single day throughout the sample period totalled NOK 2.3bn, occurring on 10 March 2020.

Data on individual overnight interbank loans do not suggest that banks refrained from discount-window borrowing due to a potential stigma linked to such borrowing, and paid a premium above the D-loans rate while trading in the interbank market; cf. Figure 2b.⁶ It is more likely that even notable incidents of D-loans were a result of liquidity management issues in certain banks rather than difficulties in borrowing from the interbank market.

Several market participants have mentioned inefficient liquidity management practices at relatively small banks as a possible explanation of their relatively large reserves remunerated at the reserve rate and their occasional discount-window bor-

⁶Armantier et al. (2015) find that the US banks were willing to pay a premium of roughly 44 basis points instead of using the Federal Reserve discount window during the subprime crisis in 2008–2009.

rowing, especially at the end of months. Small banks tend to manage their liquidity less finely than medium-sized and large banks, as it may not be economical for them to do so. Occasionally, liquidity management issues may also take place at the medium-sized and large banks.

3 Norges Bank’s liquidity operations

Norges Bank has been conducting competitive multi-price fixed-term auctions of both loans and deposits, referred to as F-loans and F-deposits, since early October 2011 to manage the level of total reserves and keep them at the target level (NOK 35bn +/- 5bn); see [Norges Bank \(2021\)](#). The maturities of F-loans typically range from overnight to one month, while those of F-deposits vary from overnight to two weeks.

The auctions aim to maintain total reserves close to the target level, particularly in the face of transfers between banks and the (Norwegian) Treasury’s account with Norges Bank, which may lead to relatively large fluctuations in the total reserves. For instance, tax payments and Norges Bank’s NOK purchases reduce reserves available to banks, while pension payments, salaries to public employees, social security and unemployment benefits, as well as government purchases of goods and services increase banks’ reserves.⁷

From 13 March 2020 to about the end of September 2020, Norges Bank offered extraordinary F-loans with relatively long maturities to banks. These were initiated to meet banks’ potential liquidity needs and mitigate liquidity uncertainty under the pandemic-induced stress in financial markets. The extraordinary F-loans were offered concurrently with extraordinary overnight F-deposits. Norges Bank’s liquidity system with an explicit target for total reserves implied that it had to either expand banks’ quotas for reserves with remuneration at the policy rate and raise the target for total reserves, or provide banks with alternative instruments to deposit

⁷Norges Bank conducted NOK purchases in the foreign exchange market daily over most of the period 2014-2022, in accordance with the Norwegian fiscal rule, which has regulated petroleum revenue spending since 2001; see <https://www.norges-bank.no/en/topics/liquidity-and-markets/Foreign-exchange-purchases-for-GPFG/>.

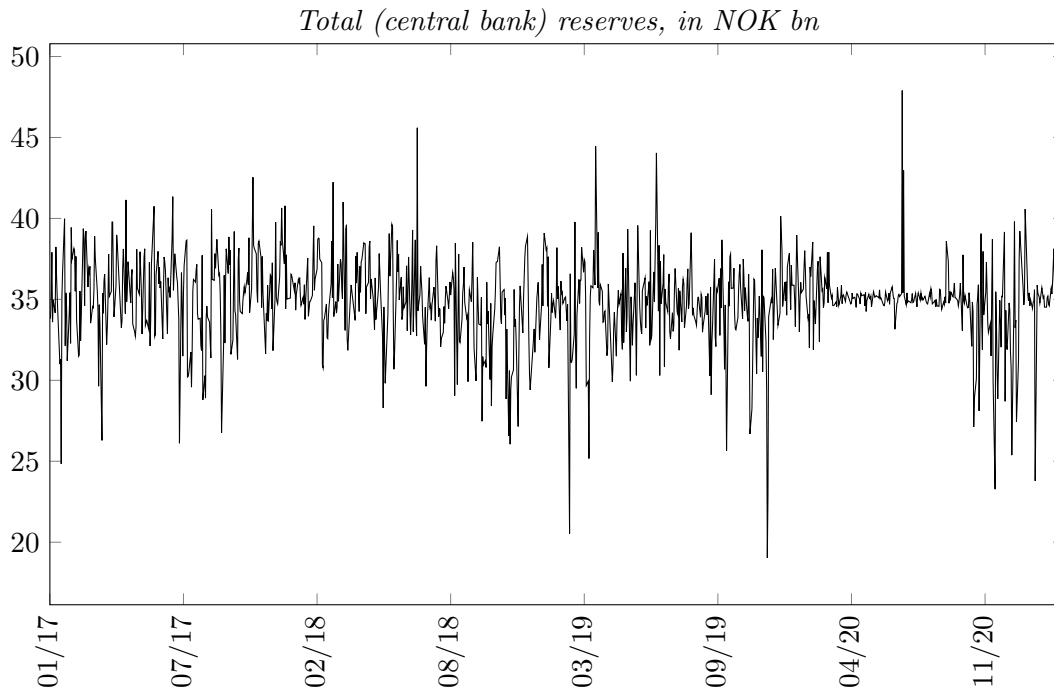


Figure 5: Total reserves are defined as the sum of banks' reserves: unrestricted overnight deposits placed with Norges Bank. The vertical axis indicates amounts in NOK bn. Observations for business days from 1 January 2017 to 26 February 2021.

the surplus liquidity made available through the extraordinary F-loans.

The overnight F-deposit auctions accompanying the F-loan auctions enabled banks to accept and place surplus liquidity outside of their overnight accounts with remuneration at the policy rate or the reserve rate. In particular, this allowed them to avoid the remuneration of overnight liquidity in excess of their quotas at the latter rate: 100 basis points below the policy rate.

Figure 5 shows that total reserves were exceptionally stable around the point target of NOK 35bn from 13 March 2020 to about 15 September 2020, when extraordinary F-loans and F-deposits were offered concurrently; see Subsection 3.1. The daily variation was considerably smaller than before or after this period. The obvious outliers are a couple of observations at the end of June 2020 and the day afterwards when total reserves exceeded NOK 45bn; see Figure 5.

The following subsection analyses Norges Bank's extraordinary F-loan and F-deposit auctions in somewhat detail and sheds light on the banks' response to these.

3.1 Extraordinary liquidity auctions

Norges Bank increased the frequency and volume of F-auctions and changed their maturity composition in view of expected liquidity stress due to the pandemic. Figures 6a and 6b display daily allotted F-loans and F-deposits for all maturities through F-auctions.⁸ To ease comparison across periods, we focus on the period

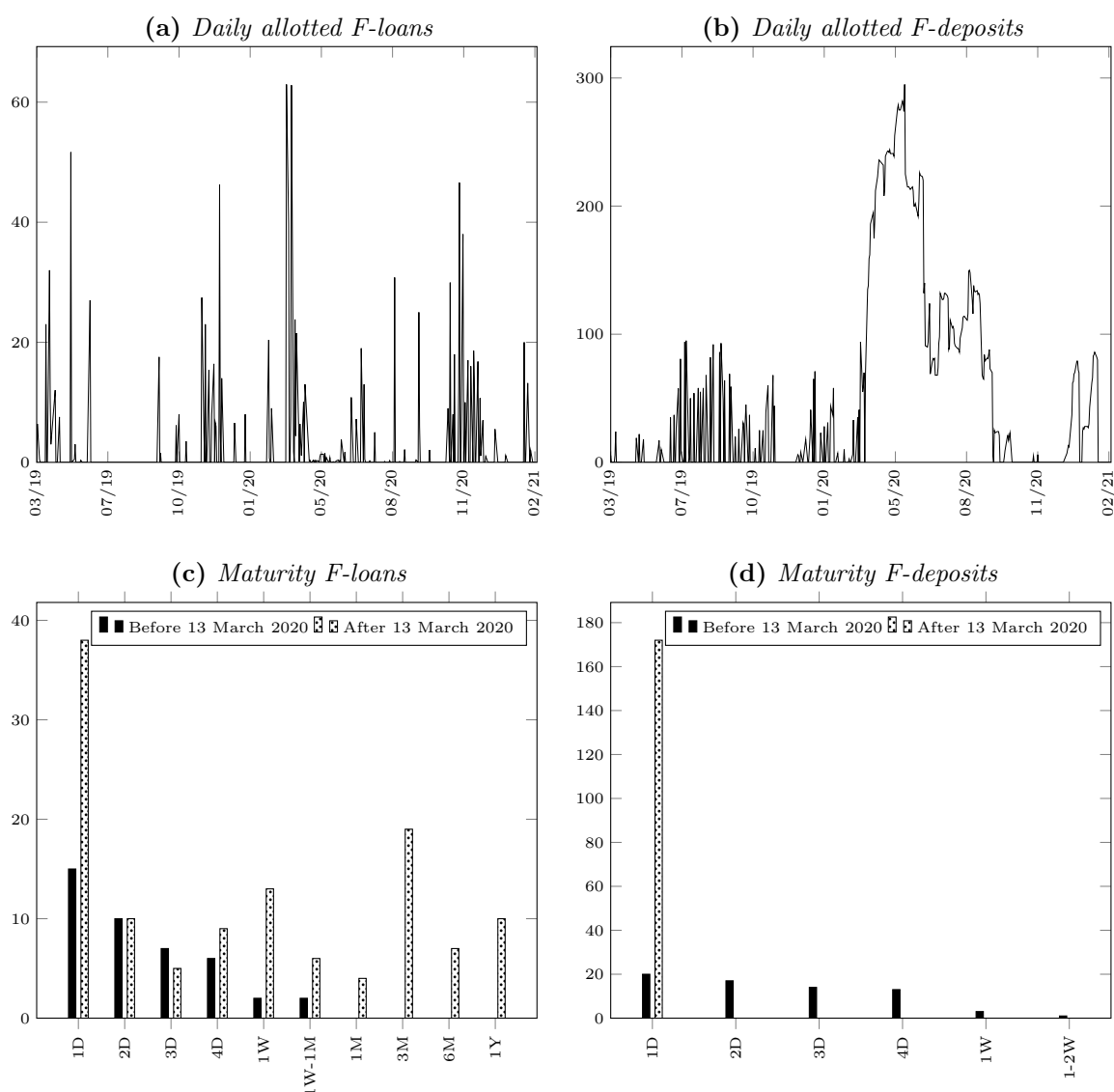


Figure 6: (a) Daily allotted F-loans for all maturities in NOK bn. (b) Daily allotted F-deposits for all maturities in NOK bn. (c) Maturity composition of F-loans. (d) Maturity composition of F-deposits. ‘Before’ and ‘After’ refer to before and after 13 March 2020, respectively, when Norges Bank started the series of large volumes of concurrent F-loan and F-deposit auctions. Here, the charts are based on observations for business days from 28 March 2019 to 26 February 2021.

28 March 2019 to 26 February 2021, which covers 350 days before Norges Bank introduced the concurrent F-loan and F-deposit auctions on 13 March 2020 and

⁸<https://www.norges-bank.no/en/topics/liquidity-and-markets/Market-operations/F-loans-and-F-deposits/Auction-history/>

350 days afterwards. Over the former 350-day period, 42 F-loans and 68 F-deposits were allotted. Over the 350-day period after 13 March 2020, however, the number of allotted F-loans and F-deposits increased by more than 2.5 times to 121 and 172, respectively. In particular, sizable F-deposit auctions were offered daily over the period 13 March–14 September 2020.

The daily volume of F-loans was particularly high in March 2020, occasionally exceeding NOK 60bn; see Figure 6a. The amounts allotted in F-deposits increased from 13 March 2020 onwards; see Figure 6b. On some days banks deposited up to NOK 300bn as F-deposits, while the highest level of F-deposits was close to NOK 100bn in the earlier period, i.e. before 13 March 2020.

While the maturity of F-loans was increased relative to earlier periods, the maturity of F-deposits was shortened to overnight. Figures 6c and 6d display the composition of maturities across all F-auctions before and after 13 March 2020, over the period of 28 March 2019 to 26 February 2021. In both periods, maturities are predominantly one business day for around one-third of the F-loans (15/42 and 38/121, respectively). The remaining F-loans had maturities up to one month before 13 March 2020. Afterwards, however, 19, 7, and 10 auctions, jointly accounting for 35.8 of the total F-loans allotted, had maturities of three months, six months, and one year, respectively.

The maturities of F-deposits were predominantly one to several business days prior to 13 March 2020. Approximately one-fifth (21.8 percent) of the F-deposits had a one-day maturity. After 13 March 2020, however, all new F-deposits had a maturity of one (business) day.⁹

Figure 7 graphs the outstanding amounts of F-loans and F-deposits over the period 1 January 2017 to 26 February 2021. Although there were generally no sizable F-loan and F-deposit auctions that counterbalanced the liquidity effects on total reserves (offsetting auctions) prior to mid-March 2020, by the end of March 2020, there were outstanding NOK 195 billion in such auctions, which is more than five times the operational target for total reserves (NOK 35bn). There were offsetting

⁹The pattern in data from 1 January 2017 to 27 March 2019 is comparable to that over the first subperiod (28 March 2019–13 March 2020) in Figures 6a to 6d.

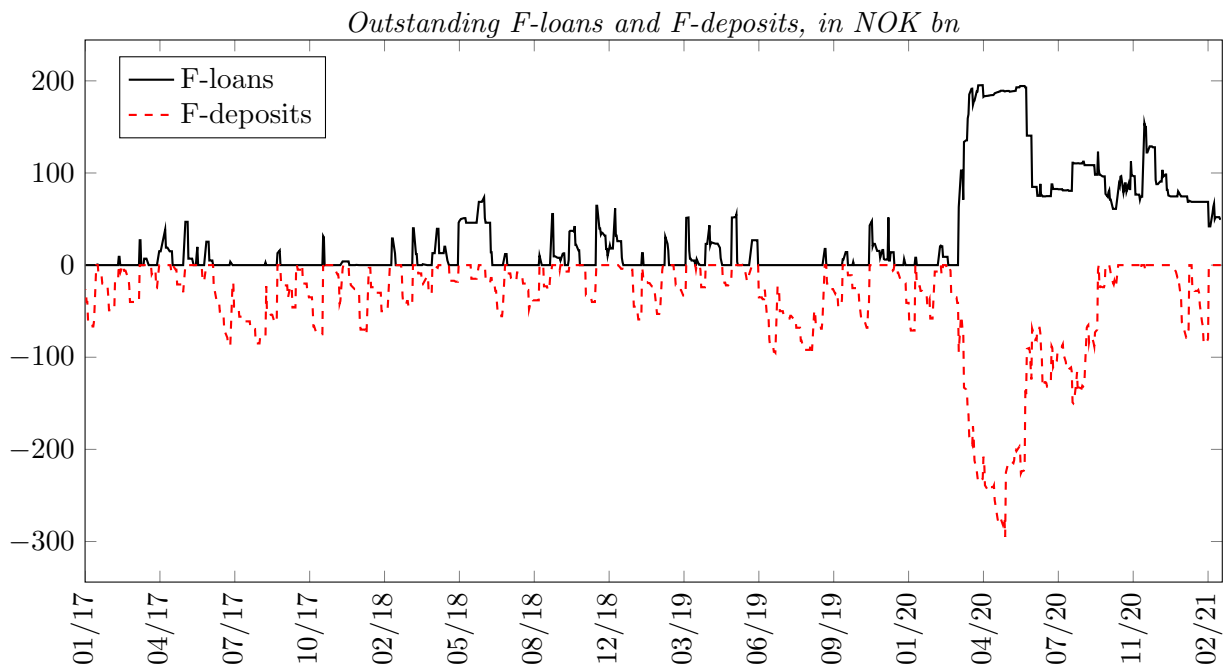


Figure 7: Outstanding F-loans and F-deposits are measured in NOK bn. Values above zero represent outstanding F-loans while values below zero represent outstanding F-deposits. The sample period covers business days from 1 January 2017 to 26 February 2021. 13 March 2020 is the first day with large concurrent F-loan and F-deposit auctions. Thereafter, there are such extraordinary F-loan and/or F-deposit auctions every day until 15 September 2020 and periodically afterwards.

auctions every business day in the period from 13 March to 15 September in 2020, with an average daily amount of NOK 125bn, and periodically afterwards.

In summary, Norges Bank provided substantial liquidity support during the pandemic, and primarily through concurrent F-loans and F-deposits. The relatively longer maturity of the F-loans may have reduced the liquidity uncertainty, while the daily F-deposits enabled banks to accept the offered F-loans at relatively low costs while retaining the flexibility to use them as freely as the (within quota and beyond quota) overnight reserves. In practice, the offered F-deposits served as ‘on-demand’ extensions of banks’ reserve quotas for remuneration close to the policy rate.

One might argue that the design of the extraordinary liquidity support made the current liquidity system largely resemble the ‘floor system’ in place prior to October 2011 with large amounts of central bank reserves and full remuneration of banks’ reserves at the policy rate; cf. [Norges Bank \(2021, pp. 22–23\)](#). Consequently, there was relatively low overnight interbank trading in this period. The shift to the quota system and a target level for total reserves in October 2011 contributed to higher activity and volumes in the unsecured overnight interbank market as the banks had

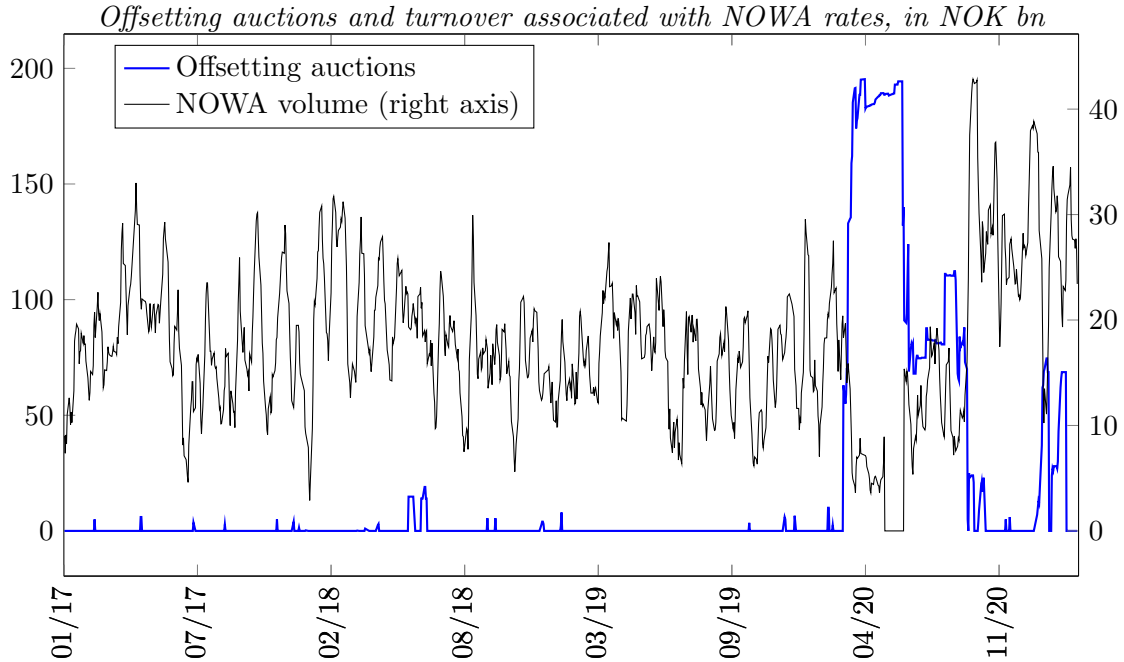


Figure 8: (a) We denote liquidity amounts auctioned through concurrent auctions of F -loans and F -deposits that do not change the available total reserves as offsetting auctions. Precisely, an offsetting auction on day $t = \min\{F\text{-loan}_t, F\text{-deposit}_t\}$. Auctioned amounts in excess of $\min\{F\text{-loan}_t, F\text{-deposit}_t\}$ add to or reduce total reserves. That is, $F\text{-loans}_t > F\text{-deposits}_t$ add to total reserves, while $F\text{-loans}_t < F\text{-deposits}_t$ reduce them. (b) Five-day rolling averages of daily trading volume in the unsecured overnight interbank market in NOK bn associated with NOWA rates. Observations for business days from 1 January 2017 to 26 February 2021.

incentives to lend reserves to each other, especially when they were expected to approach their quota limits; see Akram and Findreng (2021).

Since the pandemic, banks' remuneration on their overnight F -deposits has generally been slightly below the policy rate, while the unsecured overnight interbank rate (NOWA rate) has been mostly within the limited range of -1 to 1 basis points relative to the policy rate; cf. Figure 2b. The relatively low overnight interest rate spread, along with the availability of substantial overnight liquidity through frequent concurrent auctions of F -loans and F -deposits may have contributed to reducing the need for interbank trading and the gains from it.

Figure 8 suggests that the substantial decline in interbank from late March 2020 to mid-September 2020 coincided with the increase in the volume of the offsetting auctions. We also note a swift increase in interbank trading after the end of major offsetting auctions in mid-September 2020.

The next subsection shows that the extraordinary liquidity support was broadly availed by banks in various size ranges. The banks were also able to deposit their

liquidity with the central bank as overnight F-deposits at interest rates that were not below those in the interbank market. Interbank borrowing and lending were therefore required to a much lesser extent to meet banks' borrowing and lending needs.

3.2 Banks' response to market stress and liquidity auctions

Banks of different sizes participated actively in the auctions for F-loans and F-deposits, especially when F-loans were offered concurrently with F-deposits. Figures 9a and 9b display the averages of F-loans and F-deposits allotted to banks in three quota groups for reserves (remunerated at the policy rate), denoted as G1, G2 and G3. The figures compare allotments of F-loans and F-deposits before, during, and after the periods with the concurrent F-loan and F-deposit auctions, respectively, 1 January 2017 to 12 March 2020, 13 March 2020 to 15 September 2020, and 16 September 2020 to 26 February 2021.

We have grouped the banks in three groups consistent with Norges Bank's quota-group classification to maintain their anonymity.¹⁰ We have also scaled the allotted liquidity volumes to each of the bank groups by their respective quotas to offer a perspective on the amounts, and ease comparison across banks in the different quota groups. Almost all members of each group have equal quotas for depositing liquidity overnight at the policy rate. A few banks that act as settlement banks for smaller banks have somewhat larger quotas than their group peers. The six largest banks constituting Group 1 (G1) have about eight times larger quotas than the fifteen mid-sized banks constituting Group 2. Banks in the latter group have also been allotted eight times larger quotas than the hundred or so smaller banks in Group 3.¹¹

Before the offsetting auctions period (13 March 2020–15 September 2020), banks in Group 1 were the main participants in both F-loan and F-deposit auctions; see Figure 9a. Banks in Group 2 also participated to some extent, while Group 3 banks

¹⁰See <https://www.norges-bank.no/en/news-events/news-publications/Circulars/2020/4quotas-in-the-system-for-the-management-of-bank-reserves/>

¹¹The number of small banks was 101 in October 2020.

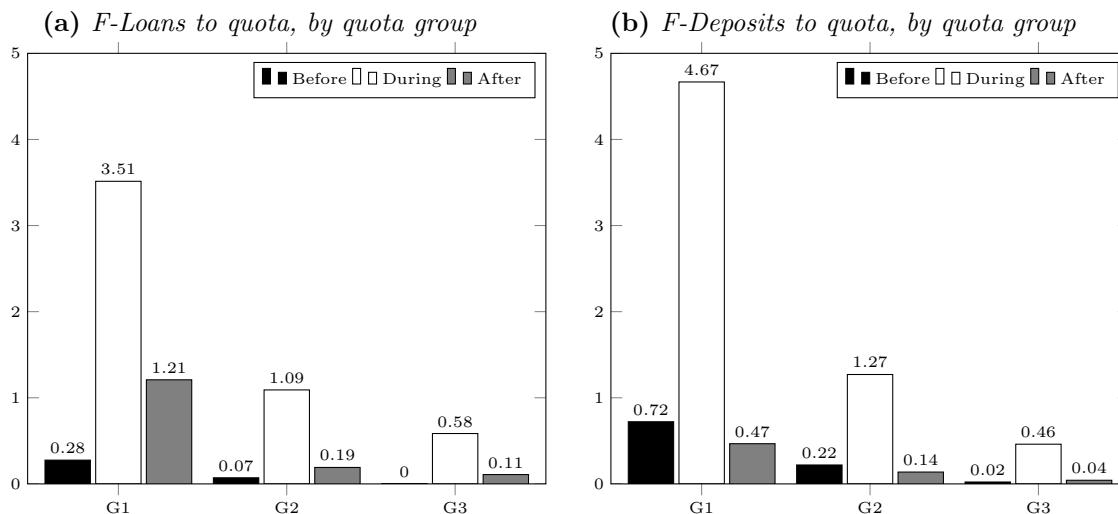


Figure 9: The average total volume banks were allocated in F-auctions, by quota-group affiliations (G1, G2, and G3) and normalised by the respective quotas. ‘Before’ offsetting auctions period is 1 January 2017–12 March 2020. ‘During’ offsetting auctions period is 13 March 2020–15 September 2020, while ‘After’ offsetting auctions is 16 September 2020–26 February 2021.

had negligible participation. Figure 9b shows that the allotted F-loans across the groups were on average 0.28, 0.07 and 0.00 as shares of the quotas of the banks in Groups 1–3, respectively. For F-deposits, the corresponding shares were generally higher than those of F-loans, at 0.72, 0.22 and 0.02, respectively.

During and after the offsetting auctions periods, banks from all quota group substantially increased their participation in both types of auctions, with a notable increase during the period with concurrent/offsetting auctions. Group 1 banks accepted and deposited liquidity amounts that were, on average, nearly 3.5 and 4.7 times larger than their quotas, respectively, by participating in F-loan and F-deposit auctions. Banks in Group 2 also acquired and deposited liquidity amounts that exceeded their quotas, averaging 1.09 and 1.27 times, respectively. Meanwhile, Group 3 banks obtained and deposited amounts that were, on average, around half of their quotas, specifically 0.58 and 0.46 times their quotas, respectively.

The offsetting auctions, i.e. auctions with F-deposits comparable to F-loans in volume, enabled banks to seek and manage large amounts of allotted liquidity at relatively low costs. Otherwise, banks’ participation in F-loan auctions could have been much smaller as they would have had to deposit relatively large amounts of liquidity allotted at interest rates above or at the policy rate, at interest rates one percentage point below the policy rate. Without offsetting F-deposits, Norges

Bank’s target for total reserves would have to be raised in line with F-loans and banks’ quotas to offer deposit facilities at or close to the policy rate. One could argue that the quotas for banks in Group 1 would need to be raised at least fivefold, for Group 2 banks more than doubled, and for Group 3 banks by over 60 percent to accommodate as much liquidity as allotted through the extraordinary F-loans; cf. Figure 9a.

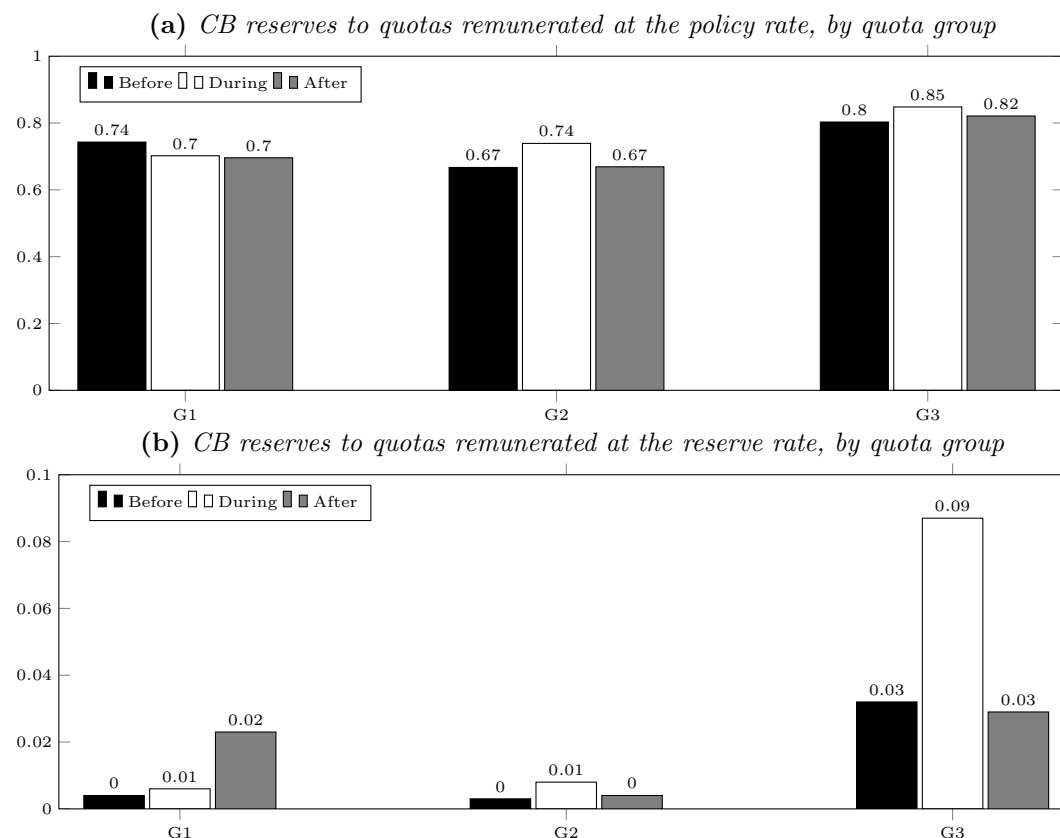


Figure 10: The averages of (central bank) reserves remunerated at the policy rate and the reserve rate, respectively, for each of the three bank groups (G1, G2, and G3) over the three subperiods. The average values are normalised by the respective quotas. ‘Before’ offsetting auctions period is 1 January 2017–12 March 2020, ‘During’ offsetting auctions period is 13 March 2020–15 September 2020, while ‘After’ offsetting auctions period is 16 September 2020–26 February 2021.

The generous liquidity provision through F-loans and one-day maturity of F-deposits allowed banks to maintain their quota-utilisation ratios near the levels observed before the extraordinary auctions. Figure 10a shows the average reserves-to-quota ratios for banks in the three quota groups at closing time before and during the offsetting auctions. The average reserves-to-quota ratios were approximately 0.70 for banks in Groups 1 and 2, and close to 0.80 percent for banks in Group 3.

Figure 10b shows that reserves placed at the reserve rate, which exceeded banks’

quotas, remained largely small relative to banks' quotas. Figure 10b shows that such 'surplus reserves' of banks in Groups 1 and 2 were relatively small as shares of their quotas. The shares increased during the period of offsetting auctions, but remained below one percent of their quotas. For banks in Groups 3, however, surplus reserves tripled from 3 to 9 percent of their quotas. The latter banks tend to have small participation rates in F-auctions and tend to utilise larger shares of their quotas, occasionally exceeding them.

The sum of allotted quotas across all banks, NOK 45bn, and Norges Bank's target for total reserves of NOK 35bn +/- 5bn, imply that the ratios between the sums of actual reserves (remunerated at the policy rate) and quotas are expected to vary around 0.78 ($\approx \frac{\text{Reserve target}}{\sum \text{quota}_i} = \frac{35}{45}$) in the interval 0.67–0.89. The available average space on banks quotas has been fairly stable before and during the period of the concurrent F-loan and F-deposit auctions (13 March 2020–15 September 2020). The shifts in the average ratios of reserves to quotas over the two subsamples are statistically insignificant at the group levels; cf. Figure 10a.

The availability of space at quotas for most banks, indicates that banks could occasionally have utilised their quotas somewhat more than they did; cf. Figure 5. That is, they could have placed a larger amount of liquidity overnight at the policy rate instead of as F-deposits at somewhat lower interest rates. F-deposit auctions results for 2020 show differences of a few basis points between the highest and lowest accepted interest rates.¹²

A possible explanation of the observed underutilisation of quotas could be relatively larger costs of exceeding the quotas than falling short of filling them. The banks have to submit their bids in both F-loan and F-deposit auctions before they fully know their daily liquidity flows due to interbank payments and loans and net transfers to the Treasury's account. Moreover, the outcomes of F-loan and F-deposit auctions are generally uncertain. In cases where relatively smaller bids and/or smaller allotments are made in F-deposit auctions compared to F-loan auctions, banks face the risk of depositing reserves in excess of their quotas at the reserve

¹²<https://www.norges-bank.no/en/topics/liquidity-and-markets/Market-operations/F-loans-and-F-deposits/Auction-history/>

rate, one percentage below the policy rate. Conversely, when relatively larger bids and/or allotments occur in F-deposit auctions compared to F-loan auctions, they risk depositing a larger amount of reserves as F-deposits at interest rates that may be just a few basis points lower than the policy rate. The asymmetry in costs could explain banks' reluctance to plan full utilisation of their quotas, particularly during the period of concurrent F-loan and F-deposit auctions when substantial amounts of liquidity were allotted.

4 Econometric analysis of trading and rates

In the following, we investigate econometrically the possible effects of the market uncertainty associated with the pandemic and Norges Bank's extraordinary liquidity support on overnight interbank trading and interest rates. Interbank overnight trading is represented by the daily volume associated with the NOWA rates, while the corresponding interest rates are represented by the spread between NOWA rate and the policy rate.

As above, we use the VIX index to represent economic uncertainty while the concurrent/offsetting F-loan and F-deposit auctions represent Norges Bank's extraordinary liquidity support. It aimed to counter the possible effects on the interbank market of heightened uncertainty and potentially large transfers to and from the fiscal authorities associated with their response to the pandemic. Some of the extraordinary fiscal policies with direct effects on the interbank market are represented by Norges Bank's NOK purchases on behalf of the fiscal authorities. Norges Bank's daily NOK purchases against a foreign currency imply a transfer of NOK reserves from banks' overnight accounts to the Treasury's account at Norges Bank, lowering total reserves (unless counteracted by additional liquidity supply). During the pandemic, there was up to a fivefold increase in the daily purchases.

Table 1 presents summary statistics of the main data series over the period 1 January 2017 to 26 February 2021. There has been a relatively large variation in the volume of interbank trading over the sample period. It has varied between zero

Table 1: Descriptive statistics of key time series

	Percentiles						
	Mean	S.Dev	Min	25th	50th	75th	Max
NOWA vol.	17 553	9 513	0	11 070	17 068	23 618	73 940
NOWA spread	-0.28	6.2	-2	-1	-1	0	191
VIX index	18.35	9.51	9.01	12.23	15.16	22.13	82.69
FX-GPFG	883	568	0	700	700	900	2 500
Offsetting auctions	17 123	45 081	0	0	0	0	195 323

Notes: NOWA vol. is the reported trading volume in the unsecured overnight interbank market associated with NOWA rates in NOK million. NOWA spread, i.e. the NOWA rate minus the policy rate, is in basis points. VIX index is the implied 30-day volatility from index options on the S&P 500. FX-GPFG is the government's daily purchase of NOK in the FX market in NOK million. Offsetting auctions are the minimum of outstanding F-loan and F-deposit auctions in NOK million. Summary statistics are based on observations for business days from 1 January 2017 to 26 February 2021. See Appendix A for additional data details.

and almost NOK 74bn, with an average volume of NOK 17.5bn. In contrast, the variation in the NOWA spread has been mostly bounded with 92 percent of spread values in the range of -2 and 0 basis points, while the average spread has been -0.28 basis points.

The variation in our key explanatory variables has also been substantial during the sample period and particularly since the pandemic. The VIX index has varied between 9 and 83 while the daily NOK purchases in the foreign exchange market have varied between zero and NOK 2.5bn with an average value of NOK 883m.

Figure 11 displays daily transfers of NOK to the Treasury's account, associated with the NOK purchases over the sample period. From January 2017 to 17 March 2020, the daily purchases of NOK against a foreign currency declined (non-linearly) from NOK 1bn to NOK 0.5bn. On 18 March 2020, the daily NOK purchases were increased to NOK 1.6bn and thereafter gradually to NOK 2.5bn in July 2020; they were subsequently reduced over the sample period.

The series of outstanding offsetting auctions has varied from less than NOK 1bn to NOK 195bn over the sample period; cf. Figure 8. The relatively small values are mostly a feature of the pre-pandemic period when they are likely reflecting 'fine-tuning auctions' aimed at amending errors in Norges Bank's liquidity forecasts and

Norges Bank's daily NOK purchases on behalf of the fiscal authorities, in NOK bn

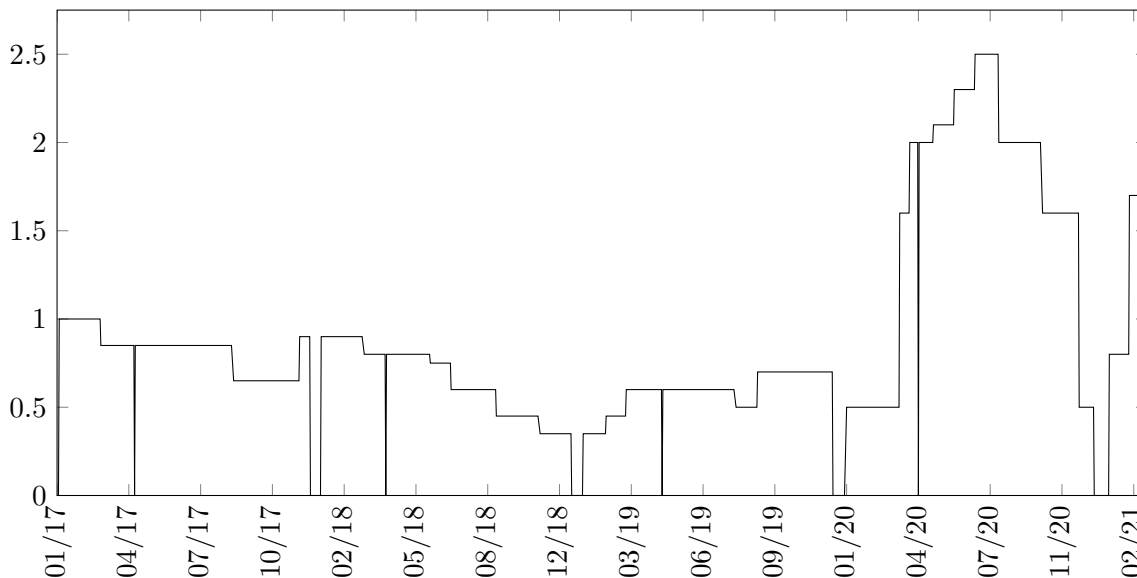


Figure 11: *Norges Bank's NOK purchases in the FX market over business days from 1 January 2017 to 26 February 2021. The vertical axis indicates daily amounts in NOK bn.*

therefore represent small adjustments in liquidity.

The possible effects of offsetting auctions on interbank trading and interest rates may depend on whether they were conducted to correct for possible liquidity forecasts errors or as instruments for providing ample liquidity to banks during the pandemic. Arguably, their effects could also be non-linear with decreasing marginal effects of the values of the offsetting auctions. That is, it may not matter whether there are offsetting auctions of, say, NOK 200bn or NOK 100bn, that is, whether offsetting auctions are almost 6 times or 3 times the central value of the target for total reserves, NOK 35bn.

Figure 12 displays a distribution of the values of offsetting auctions over bins of NOK 20bn over the period 1 January 2017 to 26 February 2021. To simplify the econometric analysis, however, we collect them into four bins, where the first one contains values between zero and NOK 20bn, while the remaining three are bins of NOK 60bn, that is 20bn–80bn, 80bn–140bn and 140bn–200bn. Offsetting auctions belonging to one of these four bins are represented by binary dummy variables in the econometric analysis presented next.

Table 2 presents estimated reduced form models of overnight interbank trading associated with the NOWA rates, and the spread between NOWA rate and the policy

Distribution of offsetting auctions by size, in NOK bn

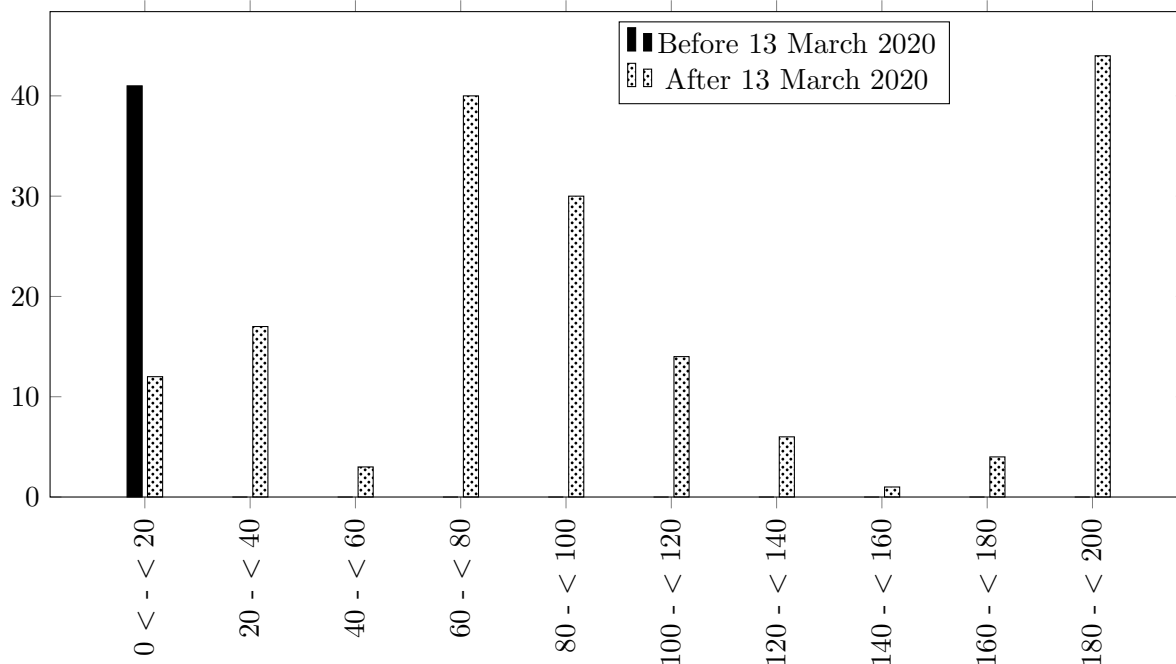


Figure 12: *Distribution of days with offsetting auctions by size. The bins represent intervals of NOK 20bn each. Offsetting auctions are the minimum of outstanding F-loan auctions and F-deposit auctions. The vertical axis, indicate the number of days with offsetting auctions in the different bins over two subsample periods. Here, ‘Before’ and ‘After’ refer to the periods 1 January 2017–12 March 2020 and 13 March 2020–26 February 2021, respectively.*

rate. The right-hand side variables are the logs of VIX and Norges Bank’s NOK purchases (when above zero), the four binary dummy variables representing the four bins of offsetting auctions and finally a binary dummy variable indicating the last day of each quarter over the sample period. The latter may represent possible changes in interbank trading and interest rates if banks e.g. hoard reserves at the end of quarters to report compliance with regulatory liquidity requirements and/or the central bank provides extra liquidity in response to such behaviour.¹³

The models also include individual binary dummy variables for each of the months to represent possible effects of general market conditions as well as vari-

¹³In a survey conducted by Norges Bank, [Norges Bank \(2014\)](#), banks cited three factors that could impact the distribution of reserves in the interbank market and their willingness to lend at quarter-ends. Firstly, capital requirements and investor preferences might result in increased demand for (central bank) reserves at quarter-ends. Capital requirements are based on risk weights, with reserves carrying a zero risk weight, while the minimum risk weight for claims on other banks is 20 percent. Banks must always fulfil capital requirements but may aim to report higher capital levels in their quarterly public reports. Secondly, a low risk weight also contributes to reducing banks’ mandatory contributions to the deposit guarantee scheme. Lastly, overnight market lending is not considered a high-quality liquid asset, affecting the liquidity coverage ratio (LCR) requirement, a crucial liquidity indicator in quarterly reports, although it must also be met at all times.

Table 2: Estimated models of interbank trading volume and interest rate spread

	ln. NOWA vol.	ln. NOWA vol.	Spread	Spread
ln. VIX index	0.657** (0.111)	0.677* (0.230)	0.439 (0.265)	-0.623 (0.864)
Off. auctions bin1	0.196 (0.128)	0.119 (0.156)	-1.002 (0.013)	-0.566 (0.987)
Off. auctions bin2	-0.322* (0.128)	-0.167 (0.190)	-0.5300 (0.634)	0.879 (1.219)
Off. auctions bin3	-1.033** (0.220)	-0.380 (0.404)	-0.468 (0.320)	1.782 (2.005)
Off. auctions bin4	-5.617** (0.604)	-5.918** (0.914)	-0.898* (0.396)	0.574 (0.775)
ln. FX-GPFG	0.040 (0.032)	0.066* (0.027)	0.079 (0.095)	0.126 (0.106)
End quarter	-4.826** (0.846)	-4.711** (0.868)	25.555 (20.089)	25.725 (19.516)
Intercept	7.643** (0.360)		-2.114 (1.185)	
Monthly dummies	NO	YES	NO	YES
Observations	1 044	1 012	1 011	1 011
R-Squared	0.487	0.668	0.151	0.204
Adj. R-Squared [†]	0.484	0.650	0.149	0.158

Notes: * and ** indicate p -values below 0.05 and 0.01, respectively. Robust standard errors are presented in parentheses below the coefficient estimates. The models have been estimated by OLS on available observations for business days from 1 January 2017 to 26 February 2021. The estimations have been conducted in Stata/MP 15.

ous policy changes over the sample period. We also assume that possible effects of changes in the data regarding the coverage and calculation of NOWA volume and NOWA rates would also be satisfactorily accounted for by the dummy variables. For reference, the table also presents models estimated without the dummy variables for months.

The (linear) models for the log of interbank trading volume by NOWA banks and the NOWA spread are estimated with OLS. The models have also been formulated as Tobit models and estimated with the ML method. In the case of both interbank trading volume and interest rate spread, no observations were reported on 32 of the days over the sample period owing to either particularly low interbank trading or the lack of it. A Tobit model may help account for the censoring or truncation of data. The estimated parameter estimates, however, remained largely the same as the OLS estimates and are therefore not reported.

The estimated models may be interpreted as follows. Columns 1-2 in the table suggest a statistically significant increase in interbank trading volume when the VIX index increases. Moreover, the last two columns suggest that the overnight interest rate spread does not respond significantly to the VIX index. These findings do not seem to support the hypothesis that banks become reluctant to lend to each other when uncertainty rises and may hoard liquidity for precautionary reasons, which may also increase interest rate volatility; cf. [Acharya and Merrouche \(2013\)](#). A possible explanation of our findings could be that some banks may have increased their interbank trading to off-load some of the extra liquidity provided by Norges Bank in response to high uncertainty over the sample period. This may contribute to a decline in interbank interest rates. The corresponding coefficient estimate in Column 4 has a negative sign, but is not statistically significant. It is also statistically insignificant in the estimated model in Column 3 where the coefficient estimate has a positive sign.

The estimated models for interbank trading suggest that interbank trading, as represented by NOWA banks' trading volume, declined when offsetting auctions were offered during the pandemic. However, only the coefficient estimates associated with the particularly large offsetting auctions, i.e. those in the range of NOK 140bn–200bn represented by 'Off. auctions bin4', are statistically significant across the estimated models in Columns 1–2. The overnight interest rate spreads have, however, not varied with the offsetting auctions in a consistent way across the estimated models of the spread. In the model estimated without the dummies for months, there is a statistically significant negative relationship between the interest rate spread and the particularly large offsetting auctions. In the models without such dummies, however, the corresponding coefficient estimate has a positive sign and is statistically insignificant.

An increase in the NOK purchases correlates with a higher level of interbank trading, possibly because of their temporary reserves-withdrawing effects. Overnight interest rate spread, however, does not seem to respond to such effects of the NOK purchases. It is found to have no significant relationship with the NOK purchases.

Finally, the estimated coefficients associated with quarter-end days suggest interbank trading tends to decline at the end of quarters. The decrease in interbank trading observed at the end of quarters might be attributed to banks' reluctance to engage in overnight trades at the end of quarters. This could also be related to the additional liquidity provided through F-loan auctions at the end of quarters, which aims to mitigate potential liquidity risks arising from such trading behavior. The interest rate spread tends to increase at quarter ends, but probably not systematically as the coefficient estimate is not significantly different from zero at standard levels of significance.

5 Conclusion

We investigated the behaviour of the Norwegian unsecured overnight interbank market in response to heightened uncertainty and liquidity support measures implemented by Norges Bank following the pandemic. Our findings suggest that banks were able to fulfil their liquidity needs through active participation in Norges Bank's extraordinary loans and deposits auctions. The distribution of central bank reserves across banks remained virtually unchanged, and the data do not indicate precautionary liquidity hoarding or discount-window borrowing suggestive of liquidity stress.

However, interbank trading experienced a sharp decline due to the extraordinary liquidity auctions and banks' broad participation in them. Norges Bank effectively became the sole counterparty for all interbank market participants during most of the period of extraordinary liquidity support. This implies a trade-off between alleviating liquidity uncertainty and maintaining interbank trading. We have not evaluated the extent to which the scope and duration of extraordinary liquidity support for banks were justified, as the potential consequences of inadequate liquidity support are hard to determine.

Additionally, we found that the unsecured interbank overnight rates remained largely unresponsive to heightened uncertainty and shifts in aggregate liquidity conditions throughout the sample period, even beyond the period with ample liquidity

support. The limited variation in overnight interbank rates around the policy rate aligns with the policy objective of keeping short-term interest rates close to the policy rate, but it may not generally be conducive to an efficient liquidity distribution among banks.

References

- Acharya, V. V. and O. Merrouche (2013). Precautionary hoarding of liquidity and interbank markets: Evidence from the subprime crisis. *Review of Finance* 17(1), 107–160.
- Afonso, G., A. Kovner, and A. Schoar (2011). Stressed, not frozen: The federal funds market in the financial crisis. *The Journal of Finance* 66(4), 1109–1139.
- Akram, Q. F. and J. H. Findreng (2021). Norwegian interbank market’s response to changes in liquidity policy. *Journal of Banking & Finance* 125, Article 106078.
- Alstadheim, R., K. B. Nordal, O. B. Syrstad, S. ter Ellen, and M.-I. Walstad Wassås (2021). Bond market fire sales and turbulence in the norwegian fx market in march 2020. *Norges Bank/Staff Memo No.2 2021*.
- Armantier, O., E. Ghysels, A. Sarkar, and J. Shrader (2015). Discount window stigma during the 2007–2008 financial crisis. *Journal of Financial Economics* 118(2), 317–335.
- Ashcraft, A., J. McAndrews, and D. Skeie (2011). Precautionary reserves and the interbank market. *Journal of Money, Credit and Banking* 43, 311–348.
- BIS (2020). *Annual Economic Report 2020*. Bank for International Settlements.
- FSB (2020). Holistic review of the March market turmoil. Working paper, Financial Stability Board.
- Fuhrer, L. M. (2018). Liquidity in the repo market. *Journal of International Money and Finance* 84, 1–22.
- Furfine, C. (2002). The interbank market during a crisis. *European Economic Review* 46(4-5), 809–820.
- Norges Bank (2014). Bankenes vurdering av Norges Banks likviditetsstyring. *Norges Bank Memo Nr 4*.

Norges Bank (2019). New principles for Nowa – possible implications. Norges Bank Paper 3, Norges Bank.

Norges Bank (2021). Norges bank's liquidity policy: principles and design. *Norges Bank Papers No. 3*.

A Data

Unless otherwise stated, the data used in the paper have been downloaded from Norges Bank's websites. The exception is data on all banks' individual reserves (unrestricted overnight deposits at Norges Bank), which have been kindly made available to us for this study. Such information has been anonymised, partly through presentation of group-wise results for banks, where the grouping is in accordance with the official liquidity quota groups as defined by Norges Bank; see the quotas at [norges-bank.no](https://www.norges-bank.no). Another exception is the VIX index, which has been obtained from Bloomberg.