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# Demand for central bank reserves and monetary policy implementation frameworks: the case of the Eurosystem

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# Abstract

This paper discusses commercial banks' demand for central bank reserves under two alternative monetary policy framework configurations, namely: (i) an interest rate corridor system with scarce liquidity, and (ii) a floor system with ample liquidity. It outlines the interaction between the monetary implementation framework used to steer short-term market interest rates and banks' demand for reserves. We find that by implementing a floor system, the Eurosystem has eliminated the opportunity costs of holding reserves and enabled banks to hold relatively large buffers of reserves compared with the corridor system. Additionally, the demand for reserves may have increased endogenously, as the environment of ample liquidity conditions has incentivised many banks to adapt their business models. In parallel, the demand for reserves has also increased for more exogenous reasons such as post-global financial crisis liquidity regulation and increased liquidity concentration. Our estimates indicate an increase, over recent years, in the level of excess liquidity required in the euro area to avoid a rise in short-term market rates. Moreover, the dependency on the adopted monetary policy instruments and the external environment highlights the increased uncertainty in estimating future levels of required reserves.

**Keywords:** ECB, Eurosystem, central bank reserves, monetary policy implementation, liquidity management

**JEL codes:** E41, E44, E50, E51, E58

## Non-technical summary

This paper sheds light on the changes that have taken place in euro area banks' demand for central bank reserves due to the Eurosystem's unconventional policies and a changing external environment after the global financial crisis (GFC). Central bank reserves are overnight balances that banks hold in an account at the central bank. Reserves are the most liquid and risk-free asset available in the financial system and play a pivotal role in settling payments; as such, they are the backbone of banks' liquidity management. The demand for central bank reserves may be influenced by several factors specific to banks themselves, such as: their business models and financial market activities, their risk tolerance levels, and the occurrence of fragmentation in the money markets. At the same time, the central bank sets the terms and conditions at which it provides these reserves when conducting its monetary policy. It can also adjust its monetary policy implementation framework according to policy preferences on the desired controllability of short-term money market rates or the extent of its intermediary role in banks' liquidity management. It is therefore important for central banks to understand how banks' demand for reserves interacts with the monetary policy implementation framework.

After many years in which the Eurosystem steered money market rates in an interest rate corridor system with relatively scarce liquidity, the injection of large amounts of reserves stemming from unconventional monetary policies shifted the operating framework to a floor system with ample liquidity. While in a corridor system the positive spread between money market rates and the remuneration rate for holding (excess) liquidity implied an opportunity cost for holding reserves and a relatively low demand for reserves, and in a floor system these opportunity costs disappeared. As a result, banks' demand for reserves increased and it is now easier for them to hold a precautionary buffer of excess liquidity to address liquidity fluctuations rather than relying on money markets for their liquidity management. For some banks, holding reserves can even be relatively attractive from a risk/return investment perspective, given that money market rates and yields of liquid assets such as short-term government bonds have declined below the deposit facility rate.

Beyond the impact of a floor system, the central bank may also affect the demand for reserves through the modalities of its unconventional monetary policy instruments. The two-tier system, introduced in October 2019 to mitigate the side effects of negative interest rates, contributes to an increased attractiveness of holding reserves. Moreover, when monetary policy operations are conducted at more favourable rates, with longer maturities and a broader collateral framework – as with the latest targeted longer-term refinancing operations, TLTRO III – banks tend to borrow more, which results in a higher aggregate amount of reserves in the system.

Financial regulation and the concentration of reserves across the banking system also increasingly affect the demand for reserves. The liquidity coverage ratio (LCR) may increase the attractiveness of participating in refinancing operations, if holding excess liquidity is attractive compared to holding other high-quality liquid assets

(HQLA). Reserves also contain attractive characteristics from a capital regulation or market risk perspective.

Even in an environment of ample liquidity, it is important to monitor the factors that can lead to higher liquidity concentration. For example, new business models may emerge – or already existing ones may intensify – in which some banks place the funds mainly at the central bank in order to accommodate the liquidity storage preferences of their customers rather than their own need for liquidity insurance. Fragmentation across jurisdictions and between banking sectors is an important driver of liquidity concentration. Such fragmentation could re-emerge, even though money market conditions are currently quite robust. These new dynamics could complicate a transition towards lower levels of reserves, since there is a risk that the absorption of reserves could generate unwarranted volatility on the money markets, if the demand is not appropriately estimated.

While estimating the demand for reserves remains challenging, central banks will need to rely on both quantitative and qualitative data to avoid unwarranted tightening of their monetary policies when scaling down their balance sheet. The difficulty in estimating the optimal level of reserves needed to operate in a floor system (the floor required excess liquidity or FREL) stems from the uncertain demand for reserves – due in turn to structural factors such as regulations and liquidity concentration – and central banks' inexperience in scaling down a large balance sheet. A proxy can be estimated using historical data on money market rates and the amounts of reserves in the system, although results heavily depend on the sample period, as well as the instruments, to achieve a certain level of liquidity. In addition, banks' sensitivity to the price of reserves may help understanding of the demand for reserves. Finally, qualitative feedback and surveys may complement the quantitative information.

# 1 Introduction

Over the last few years, the Eurosystem has gained experience in conducting monetary policy under various operational settings. The steering of short-term interest rates has been one of the cornerstones of the Eurosystem's monetary implementation framework<sup>1</sup>, that depends on banks' demand for central bank reserves (henceforth referred to as "reserves"). Before the global financial crisis (GFC), the Eurosystem provided just enough central bank liquidity to credit institutions in the euro area to allow them to satisfy the reserves they are required to hold on their accounts with the Eurosystem and to balance structural demand factors stemming from autonomous factors. Beyond meeting this minimum reserve requirement (MRR), banks only held small volumes of "excess liquidity"<sup>2</sup> in order to maintain some working balances, which they mainly used to pay the central bank for the cash withdrawals of their customers<sup>3</sup>. The Eurosystem's monetary policy refinancing operations for banks therefore gradually increased with the increase of banknotes in circulation.<sup>4</sup> This changed with the GFC in the last quarter of 2008. In an environment of higher perceived credit and liquidity funding risk, interbank money markets dried up and the Eurosystem provided significant amounts of liquidity in order to address banks' increased demand. Subsequently, the accumulation of reserves was fuelled by central bank measures aimed at fulfilling the ECB's price stability mandate in a low inflation environment and to offer favourable borrowing conditions. These measures included both outright asset purchases and longer-term and targeted refinancing operations. They resulted in an expansion of the Eurosystem balance sheet to historically high levels and shifted the monetary policy regime from an interest rate corridor system to a floor system.<sup>5</sup> In addition, other factors outside the control of the central bank contributed to the accumulation of reserves and to an increase in the demand for them, such as: liquidity regulation, increased risk aversion, the related more conservative banks' internal risk management, and the concentration of liquidity holdings.

This paper sheds light on changes that may have affected euro area banks' demand for reserves. It aims at better understanding the determinants of the excess liquidity needed to steer short-term rates in different set-ups, such as new liquidity regulation and factors that depend on the central bank's monetary policy implementation framework and its impact on the attractiveness of holding reserves. This paper considers the demand for reserves under two alternative schemes, namely: (i) an interest rate corridor system with scarce liquidity, which was in place pre-crisis in the

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- <sup>1</sup> Previous misconceptions about a quantitative use of reserves through its effect on monetary aggregates via a "money multiplier" are not discussed here; for a classic rebuttal, see Bindseil (2004).
  - <sup>2</sup> Excess liquidity is defined as the sum of overnight current account holdings of reserves in excess of MRRs, plus holdings of equivalent central bank deposits, namely the overnight deposits held at the deposit facility.
  - <sup>3</sup> See, for example, Bindseil, Camba-Méndez, Hirsch and Weller (2004).
  - <sup>4</sup> For more details on this so-called structural liquidity deficit of the banking system see, for example, ECB (2002) and Bundesbank (2015), p. 36.
  - <sup>5</sup> On the transition from a corridor to a floor system (post-GFC), and a comparison between the Eurosystem and the US Federal Reserve System perspectives, see, for example, Grossmann-Wirth (2019).

Eurosystem and at other major central banks; and (ii) a floor system with ample liquidity, which is currently adopted by the Eurosystem<sup>6</sup> and most major central banks.

The remainder of this paper is organised as follows. Section 2 discusses how the demand for reserves interacts with the monetary policy implementation framework by highlighting the differences between a corridor and a floor system. The section furthermore introduces the concepts of “corridor required excess liquidity” (CREL) and “floor required excess liquidity” (FREL), and discusses whether a floor system creates an endogenous demand for reserves among counterparties. Section 3 highlights new structural factors that have emerged in recent years and that ended up affecting the demand of reserves. Section 4 presents various ways to measure the level of FREL and investigates the extent to which banks are still sensitive to price conditions set by the central bank. Section 5 concludes by highlighting a few policy considerations.

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<sup>6</sup> See Schnabel (2020).

## 2 How the monetary policy implementation framework affects the demand for central bank reserves

### 2.1 The role of central bank reserves in the monetary policy implementation framework

Reserves are overnight balances held by commercial banks at the central bank and enable banks to meet their payment obligations. Together with currency in circulation<sup>7</sup>, they are the most liquid and risk-free asset available in the financial system and play the pivotal role in settling payments. They therefore serve as the backbone of banks' liquidity management.

Banks' preferences to hold part of their liquid asset buffer in the form of reserves may vary across banks and over time. Banks will typically economise the size and composition of their liquid assets buffer, while their demand for reserves is driven by three structural factors. First, the perception of a higher likelihood and size of liquidity shocks increases their precautionary demand for reserves in anticipation of unexpected payments. This is driven by structural factors including banks' business models and their financial market activity, but can also depend on economic conditions, as well as their access to – and the efficiency of – payments and settlement systems<sup>8</sup>. Second, the ability to monetise other liquid assets impacts the need to hold reserves. Access to reliable and liquid money markets and to central bank credit facilities may lower the need for holding a sizeable share of the buffers in the form of reserves. Finally, central banks and regulators can impose or incentivise banks to hold a certain level of reserves above the buffer they would otherwise hold. Central banks use MRRs or other liquidity buffering schemes, while regulators require banks to hold a buffer of high-quality liquid assets (HQLA), that include central bank reserves, to meet expected 30 days liquidity outflows (see also Section 3.1).

By determining the availability and attractiveness of reserves in the design of the monetary policy implementation framework, central banks influence banks' preference to hold reserves. While ensuring that ancillary objectives such as the smooth settlement of payments and avoiding disruptions in banks' liquidity management are met, the central bank uses its ability to set the amount of reserves in the system and the conditions at which banks can obtain and deposit them at the central bank<sup>9</sup> – this with the aim to steer short-term interest rates according to the desired monetary stance. By influencing the relative pricing of holding and obtaining

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<sup>7</sup> Banknotes and coins.

<sup>8</sup> See ECB (2002).

<sup>9</sup> Commercial banks with access to central bank facilities cannot on aggregate significantly reduce the amount of reserves outstanding. However, they can modify their individual reserve holdings based on their individual demand for reserves, meaning that the distribution of reserves within the system may change.

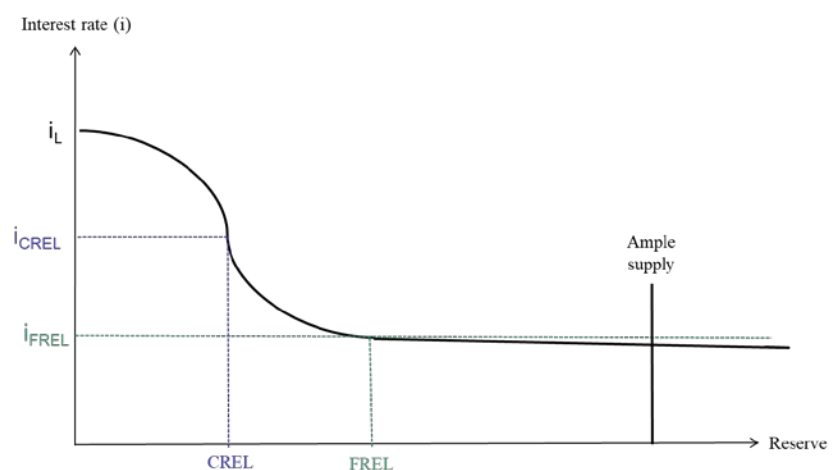


reserves in comparison to other liquid or “money-like” assets, such as money market instruments and short-term government bonds, the central bank interferes in banks’ liquidity management, ensuring the control over money market rates. In other words, banks’ demand for reserves depends on the monetary policy implementation framework.

## 2.2 How the monetary policy implementation framework influences the holding of reserves

The overnight money market interest rates decline with the increase in reserves balances, according to the aggregated demand of individual banks. In this paper CREL is identified as the optimum level of reserves to operate in a corridor system, while FREL is identified as the minimum level of reserves needed to operate in a floor system. In a stylised way, the demand curve is horizontal, i.e. infinitely elastic to the interest rate at the lending rate  $i_L$ , at which the central bank credibly commits to provide the amount of reserves as needed to clear the market (Chart 1).<sup>10</sup> The demand curve also becomes infinitely elastic to the interest rate at the rate for remunerating reserves,  $i_{FREL}$ . Overnight interbank money market rates should not fall below this floor according to arbitrage logic. Banks could otherwise make a riskless profit by borrowing at the lower money market rate and depositing at a higher rate at the central bank. In the middle section, between  $i_L$  and  $i_{FREL}$ , the (interbank) money market will ensure efficient distribution of reserves in the system and clear at a rate somewhere between the lending and the deposit rate – depending on the share of banks that have an excess or shortage of reserves –, and typically in the middle of the corridor in a “symmetric corridor system”<sup>11</sup>.

**Chart 1**  
Stylised rate-reserve relationship



Source: ECB.

<sup>10</sup> Banks would need to have enough eligible collateral.

<sup>11</sup> See Poole (1968) for the classic model.

The monetary policy implementation framework influences the holding of reserves. In a corridor system (see 2.2.1), steering short-term rates close to the policy rate ( $i_{CREL}$ ) depends on reserves being sufficiently scarce in order to ensure that the central bank needs to provide liquidity. The spread between the rate for lending in the money market and the remuneration rate for central bank liquidity reflects the opportunity cost for holding reserves. Interbank money market rates therefore price a scarcity value for reserves.<sup>12</sup>

In a floor system the central bank satiates the banking system with reserves. The central bank ensures that supply of liquidity is large enough to keep rates at levels around the policy rate (see 2.2.2). This is the remuneration rate for banks depositing reserves ( $i_{FREL}$ ) in contrast to the policy rate for banks borrowing reserves ( $i_{CREL}$ ). In a floor system the interbank money market becomes less relevant as liquidity is ample and there is less need to transact between banks; at the same time, transactions between banks and non-banks become more relevant. Steering the operational target<sup>13</sup> in a floor system is based on an arbitrage mechanism between central bank eligible counterparties (i.e. banks) that borrow from other entities (so-called non-banks) and hold the proceeds as reserves. This keeps short-term rates close to, but still below,  $i_{FREL}$ .<sup>14</sup> In principle, the central bank can steer short-term rates in a floor system, if excess liquidity exceeds a certain minimum. Excess liquidity can even be ample, which allows the central bank to pursue further objectives by using its balance sheet. These other objectives may then determine the maximum level of excess liquidity.

## 2.2.1 Demand for central bank reserves under a corridor system

At its inception, in 1998, the Eurosystem decided to conduct monetary policy on the basis of a system characterised by scarce reserves. In this system, the Eurosystem provided a level of reserves (see CREL in Chart 1) which was just enough for the banking sector to meet its MRR and to balance structural demand factors stemming from autonomous factors (such as banknotes in circulation and government balances at central banks) plus a small amount of excess liquidity (that was mainly held for technical reasons<sup>15</sup>). Money market rates were steered towards a level in between the deposit facility rate (DFR) and the rate of the marginal lending facility

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<sup>12</sup> For example, Borio and Disyatat (2009) and Borio (2019). In addition, Keister et al. (2008), and Beckworth (2018) explain, in detail, why opportunity costs are the key factor for distinguishing corridor and floor systems.

<sup>13</sup> Keeping short-term money market rates close to the policy rate.

<sup>14</sup> Banks require a yield spread, for example, because they view the associated increases in their balance sheets as costly in terms of required regulatory capital and internal oversight (“marginal balance sheet costs”). Gagnon and Sack (2014) explain the arbitrage mechanism as well as marginal balance sheet costs. The yield spread, however, can also reflect a profit margin and signal the market power of some banks.

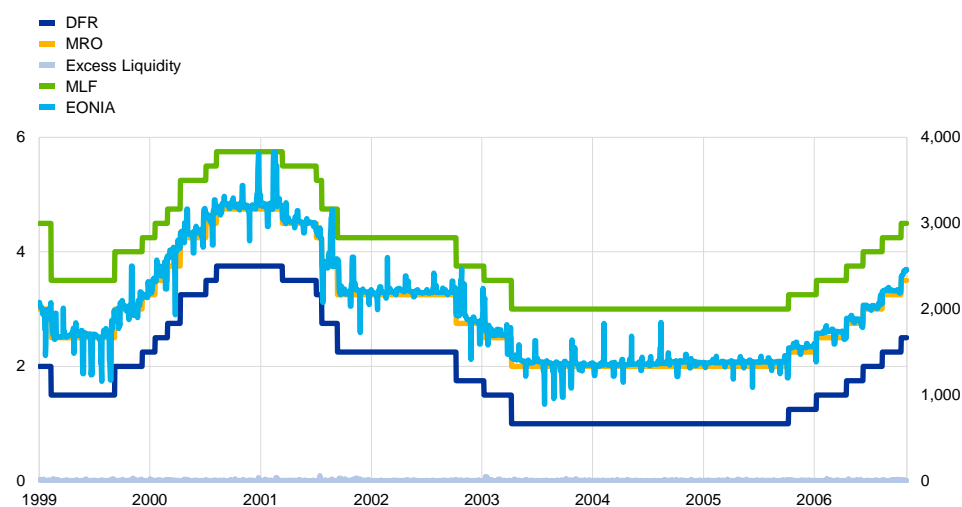
<sup>15</sup> Banks held some excess liquidity because of unexpected payments and operating costs associated with “staying late in the office”. On the last day of the reserve maintenance period, excess reserves were also a “buffer” held to reduce the risk of non-compliance with reserve requirements, see ECB (2005, pp. 25-26). See also Kahn (2010) for a similar explanation why banks held excess reserves pre-GFC in the United States.

(MLF) – these latter two determining the “corridor” (see Chart 2).<sup>16</sup> The fact that banks were able to rely on balanced conditions motivated them to trade reserves close to the rate for main refinancing operations (MRO) ( $i_{CREL}$  in Chart 1), minimising volatility in money market rates. To enhance the steering of money market rates and signal (changes in) the monetary policy stance, the Eurosystem provided reserves in lending operations at the key policy rate  $i_{CREL}$ .

## Chart 2

### Developments of excess liquidity and selected interest rates between 1999 and 2006

(left-hand side: percentages; right-hand side: EUR billions)



Source: ECB.

The generous intraday credit facility and the design of the MRR facilitated the control over money market rates in this corridor system. Banks could use their eligible collateral mobilised with the Eurosystem to obtain intraday liquidity free of charge. This broadly catered for liquidity demand to conduct (gross) payments over the day, therefore reducing banks' incentive to hold a buffer of reserves for payment motives and making the MRR the leading reserve demand factor. Imposing an average reserve requirement over the maintenance period meant banks were not forced to fine-tune their reserve holdings on a daily basis. Minimum reserves served as a liquidity buffer for banks and helped to stabilise interbank money market rates. Holding them implied no opportunity cost, as they were remunerated at the MRO rate that was close to money market rates.<sup>17</sup> In this way the individual banks' demand curve flattened at levels around the MRR, resulting in contained money market volatility.

In the Eurosystem's corridor system, a bank which held reserves exceeding the MRR faced opportunity costs. Holding reserves (exceeding the MRR) was relatively expensive for banks in such a corridor system. As money market rates were steered

<sup>16</sup> The figure displays the EONIA rate that measured the effective interest rate prevailing in the euro overnight market. It is calculated as a weighted average of the interest rates on unsecured interbank overnight lending transactions denominated in euro, as reported by a panel of banks.

<sup>17</sup> Excess reserves (intended as reserves above MRRs on the current accounts) were remunerated at the lowest between 0% and the DFR, while deposits at the deposit facility were remunerated at the DFR.

towards the middle of the corridor, it was therefore relatively attractive for a bank to lend its excess liquidity in these markets (rather than depositing them at the central bank at the bottom of the interest rate corridor). A corridor system therefore incentivised banks to manage fluctuations in their reserves holdings via interbank money markets – instead of holding a buffer of reserves. As a result, the additional demand for central banks reserves was very low, ensuring a lean central bank balance sheet. As an example, before the GFC banks in the euro area previously had a negligible demand for excess liquidity (approx. €1 billion).

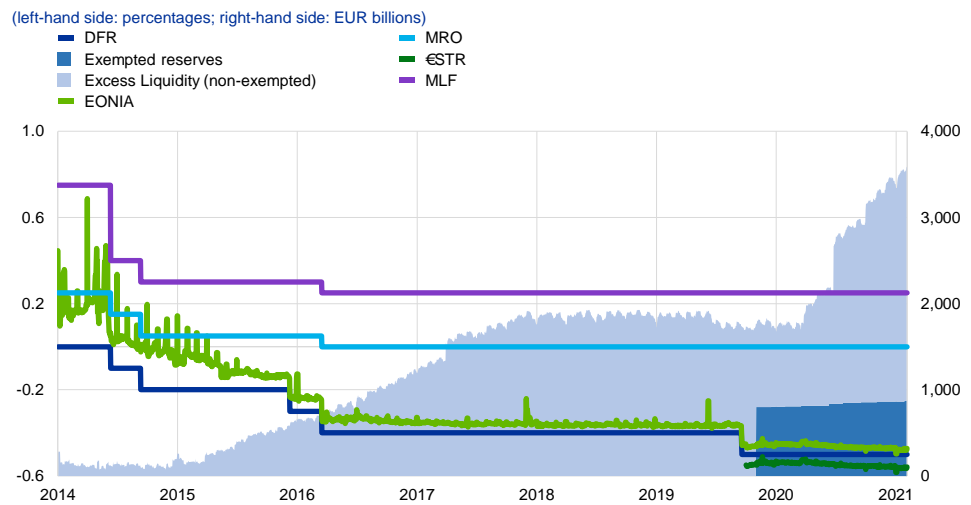
A well-functioning corridor system requires an efficient distribution of reserves in the system. If banks face money market frictions, such as regulatory obstacles, perceived liquidity or counterparty risk or – in the case of secured transactions – collateral shortages, this could hinder the efficient distribution of reserves and increase the volatility of money market rates. Moreover, in operating a corridor system, MRRs should constitute the leading factor in the demand for reserves. If instead some banks have a desire to hold a significant precautionary buffer of reserves, exceeding the enforced MRR, other banks would have a shortage. This would require the central bank to conduct fine-tuning operations more often or accept higher volatility.

## 2.2.2 Demand for central bank reserves under a floor system

The Eurosystem unofficially operates in a floor system, since it has started to strongly and persistently increase liquidity with the start of large-scale asset purchases in 2015. TLTROs accompanied asset purchases and contributed to the strong increase of liquidity. This contrasts with previous, though temporary provision of ample liquidity during the sovereign debt crisis (very-long-term refinancing operations (VLTROs) in 2011 and 2012). As a result, the marginal costs of holding reserves for banks are equal to the DFR because the amount of reserves in the system exceeds the demand for reserves imposed by the MRR. Money market rates tend therefore towards the DFR, which is currently the de facto key monetary policy rate in the Eurosystem ( $i_{FREL}$  in Chart 1).

**Chart 3**

**Developments of excess liquidity and selected interest rates since 2014**



Source: ECB.

Note: "Exempted reserves" are those reserves exempted under the two-tier system since October 2019 (see below).

A floor system eliminates the opportunity costs for holding reserves and allows banks to hold larger buffers of reserves. In principle, as opportunity costs for holding reserves (i.e. the spread between money market rates and the DFR) are absent in a floor system there are no incentives for interbank money market activity. Banks are facilitated to hold a higher precautionary buffer of excess liquidity to address liquidity fluctuations instead of relying on money markets for their liquidity management. In the long-run, this may affect: prudent liquidity management; market infrastructure; and possibly also knowledge of money market transactions, with fewer market-makers and less IT investment, for example.<sup>18</sup> Such hysteresis may in turn reinforce the need for an additional liquidity buffer, contributing to a less efficient distribution of reserves, which in turn may lead to an additional factor in the demand for reserves.

For some banks, holding reserves can even be relatively attractive from a risk/return investment perspective. They can charge other investors, that do not have access to the central bank deposit facility, a fee for depositing reserves (therefore the euro short-term rate (€STR) trades below the DFR (Chart 3)).<sup>19</sup> In an environment of ample reserves this may drive money market rates and yields of other similarly liquid assets, such as short-term government bonds, below the DFR, although at varying degrees and speed across the euro area (Chart 4). This makes it more attractive for banks to hold reserves rather than other liquid assets. In the current situation of a floor system and ample liquidity, there is some evidence that banks now consider their projected payment needs to estimate their preferred level of excess liquidity holdings, given the attractive yield of reserves. This effect may become more pronounced if some banks specialise in the arbitrage mechanism that helps to

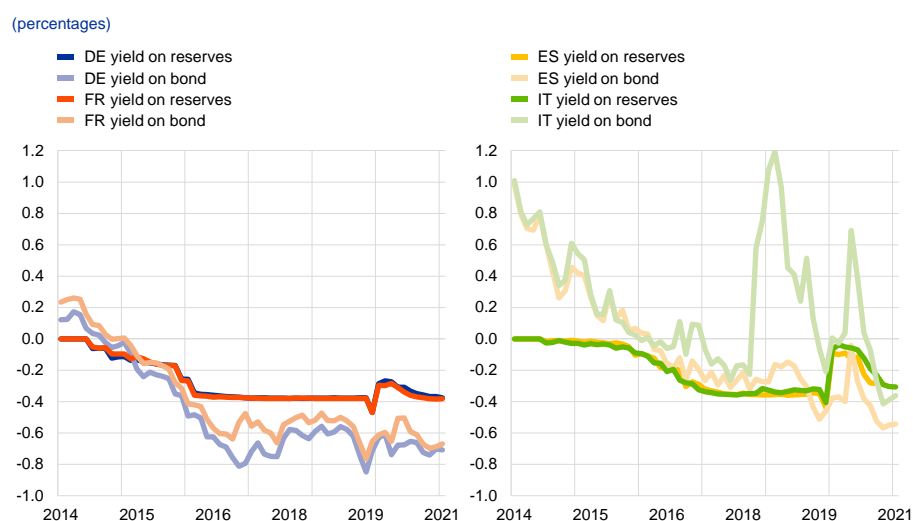
<sup>18</sup> See BIS (2019).

<sup>19</sup> From 2 October 2019 until its discontinuation on 3 January 2022, EONIA is calculated as the €STR plus a fixed spread of 8.5 basis points, with the €STR reflecting the trading activity of the previous TARGET2 business day. Whereas EONIA consists of interbank transactions, €STR also includes "borrowing" transactions of banks with other financial counterparties, that do not have access to the central bank deposit facility.

control short-term rates in a floor system. Liquidity demand could increase despite being ample on aggregate, because the hoarded liquidity is not available to others (see Chapter 3 on concentration effects)<sup>20</sup>. Conceptually, it would mean that the shape and position of the demand curve in Chart 1 changes in such a way that FREL is determined at a level of reserves that is higher than expected. Moreover, the demand curve could differ strongly between banks.<sup>21</sup>

#### Chart 4

#### Yield on central bank reserves vis-à-vis short-term government bonds



Source: ECB, Bloomberg.

Notes: "Yield on reserves" is calculated as the average interest on all reserves in excess of minimum reserve requirements, weighted by relative amounts based on their remuneration, over the maintenance period (MP). "Yield on bond" represents the two-year yield on government bonds. The higher yield on reserves towards the end of 2019 is due to the introduction of the two-tier system by the Eurosystem.

The demand for reserves – and therefore the level or range of FREL – is (at least partially) endogenous to the implemented monetary policy framework and may vary over time. First, the attractiveness of reserves holdings may be increased by introducing a beneficial remuneration on part of the reserves. For example, the Eurosystem introduced a two-tier system on its deposit facility in October 2019. The two-tier system exempts a part of credit institutions' excess liquidity holdings from negative remuneration at the DFR and is meant to address side effects of the negative interest rate policy on the transmission of monetary policy. The introduction of the two-tier system reshapes the demand curve of Chart 1 (shifting part of the demand curve to the right for the tiered volume and negative rates, see, for example, Secchi, 2019). Yet, the current level of ample reserves and the relatively minor frictions in redistributing reserves across banks and jurisdictions, to fill the unused tiers, ensure that there is no effect on money market rates.

<sup>20</sup> Norges Bank (2011) observed an increased demand for liquidity during the time it conducted a pure floor system.

<sup>21</sup> The suggested demand curve is not completely flat or horizontal because of heterogeneity. Reserves may be in excess of aggregate needs, though an individual bank may not be able to borrow in the interbank market in case of a liquidity shock and is therefore willing to pay more to borrow reserves. This willingness to pay should gradually decrease as reserves increase. At some level of reserves the demand curve would become flat. For more details, see Afonso et al. (2020).

Second, the conditions of the Eurosystem open market operations might also drive the demand for reserves. The Eurosystem has operated a large variety of credit operations over the last years. While participation in these credit operations is primarily driven by funding considerations (relative attractiveness in comparison to market funding, in terms of pricing as well as in regulatory treatment), it also increases the overall amount of reserves in the system. In particular, the relatively low pricing of the latest TLTRO series, compared to the DFR<sup>22</sup>, has made it attractive for banks to increase their funding from the central bank, which has translated into additional amounts of reserves.

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<sup>22</sup> The interest rate for lending reserves can be 50 basis points below the interest rate for depositing them at the DFR.

### 3 Additional factors affecting the demand for central bank reserves in the new financial environment

While banks' demand for reserves is at least partly endogenous to the monetary implementation framework, factors such as regulation or the concentration of reserves across the banking system increasingly affect the demand for reserves. Albeit not under the control of the central bank, these factors may interact with the monetary policy framework and need to be well understood and considered when designing an implementation framework. This chapter focuses on the new structural factors affecting the demand for reserves which have emerged more recently under the revised regulatory framework and a monetary policy framework with ample excess liquidity, namely the LCR regulation (Section 3.1) and the concentration of reserves fuelled by, inter alia, fragmentation across jurisdictions<sup>23</sup> (Section 3.2).

#### 3.1 Liquidity coverage ratio regulation

The liquidity coverage ratio (LCR) requirement may affect the demand for excess liquidity as banks may prefer to hold excess liquidity as insurance against liquidity outflows.

The LCR is calculated as the ratio between the amount of HQLA over the estimated amount of net liquidity outflows arising under a pre-defined hypothetical 30 calendar day stress-scenario. Banks are required to maintain an LCR of at least 100%.<sup>24</sup>

HQLA comprise cash or assets of high credit and liquidity quality that can be converted into cash at little or no loss of value. In addition to marketable assets, such as certain government bonds and the most liquid private debt, HQLA may include reserves held in a central bank – provided that the credit institution holding these reserves is permitted to withdraw such reserves at any time during stress periods.<sup>25</sup> The conditions for such withdrawal have been specified in an agreement between the relevant competent authority and the ECB or the central bank.<sup>26</sup>

Therefore, compared to pre-GFC, the LCR represents a new factor affecting the demand of banks for HQLA, including excess liquidity. Still, the relative demand for

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<sup>23</sup> In the context of this study, fragmentation is defined as an environment in which banks located in some jurisdictions are in part prevented from trading with banks located in other jurisdictions of the euro area.

<sup>24</sup> The LCR minimum level had been gradually phased-in between October 2015 and January 2018 (see Article 460(2) of Regulation (EU) No 575/2013).

<sup>25</sup> See Title II of Delegated Regulation (EU) 2015/61: the LCR requirement differentiates between assets of extremely high liquidity and credit quality (or Level 1 assets), and assets of high liquidity and credit quality (or Level 2 assets). The latter is divided into Level 2A and Level 2B assets. Each level is subject to specific requirements on haircuts and limits of the overall liquidity buffer. Withdrawable reserves held in a central bank are treated as Level 1 assets not subject to any haircut.

<sup>26</sup> In the euro area, HQLA include the reserve holdings exceeding the average daily required reserves and the recourse to the deposit facility (see ECB (2015)).



each type of HQLA is generally not structural but depends on several factors such as their availability and risk/return considerations.

In the current environment of ample liquidity conditions, banks hold a substantial amount of excess liquidity that contributes to the high LCR levels. According to recent data by the Single Supervisory Mechanism (SSM), the weighted LCR among euro area banks had been above 140% since its implementation and had increased from 141.9% to 165.5% between the first quarter of 2018 and the second quarter of 2020 (Chart 5a).<sup>27</sup>

Excess liquidity is a key component of the HQLA liquidity buffer in an environment of ample liquidity supply by the central bank. Grandia et al. (2019) show that almost half of banks' liquidity buffer for the LCR is excess liquidity. Moreover, this share has recently peaked to nearly 60%, following large liquidity injections in response to the COVID-19 crisis (Chart 5b). According to the European Banking Authority (EBA)<sup>28</sup> a reduction of the amount of excess liquidity could, *ceteris paribus*, have a sizeable impact on the LCR. Under this hypothetical scenario, for a sample of 120 banks in EU, a reduction of excess liquidity by 90% (from about €1,400 billion to €140 billion)<sup>29</sup>, would lead to a decrease in the LCR, on average, from 146.4% to 95%<sup>30</sup>. Therefore, in an environment with less excess liquidity and assuming unchanged projected liquidity outflows, credit institutions might need to hold higher volumes of marketable HQLA.

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<sup>27</sup> See [SSM supervisory data for Q2 2020](#); the statistical population includes significant institutions at the highest level of consolidation covered by the SSM operating in participating EU countries.

<sup>28</sup> See EBA (2020).

<sup>29</sup> Based on data as of Q3 2019.

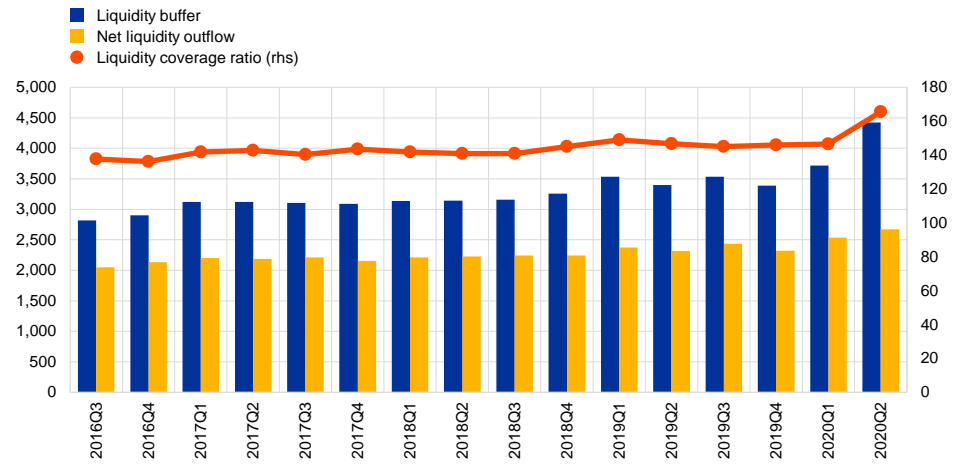
<sup>30</sup> The effect is larger for banks in the jurisdictions with the largest amount of excess liquidity (the LCR decreases from 149.31% to 89.6% in Germany and from 133.06% to 71.65% in France) compared with banks in jurisdictions with lower holdings (e.g. from 148.41% to 117.98% in Italy and from 157.74% to 114.26% in Spain). The effect is likely over-estimated as the release of HQLA being posted as collateral for maturing longer-term operations is not taken into account. See EBA (2020).

**Chart 5**

LCR composition and liquidity buffer composition

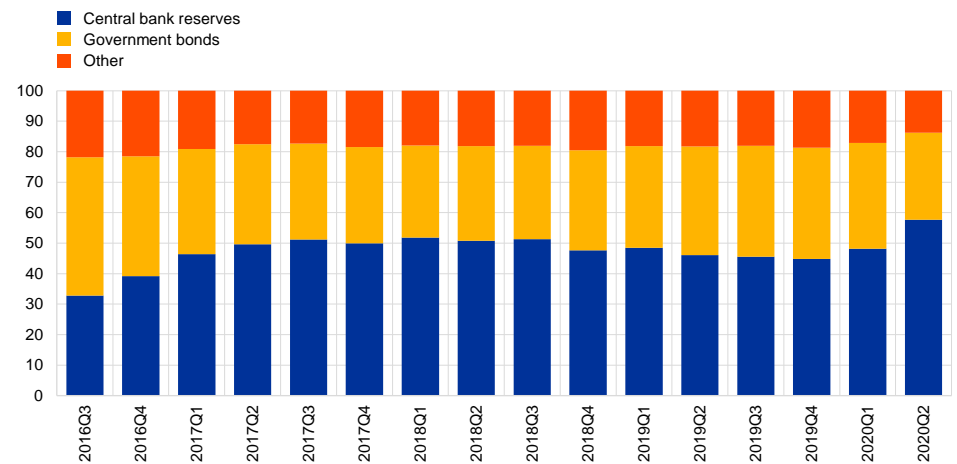
**a) LCR composition**

(EUR billions)



**b) Liquidity buffer composition**

(percentages)



Sources: SSM and ECB (2020c).

The HQLA-related demand for excess liquidity is expected to vary over time depending on the return environment and the opportunity costs of holding central bank liquidity. Given ample excess liquidity, banks in jurisdictions with relatively low government bond yields and a home bias<sup>31</sup> tend to hold high shares of excess liquidity in their HQLA buffer<sup>32</sup> thus contributing to the concentration of excess liquidity across countries (see Section 3.2). However, the demand for excess liquidity can decrease when domestic government bond yields increase above the remuneration rate of excess liquidity. This could happen, for example, if excess liquidity became less ample. Such endogeneity contributes to the difficulty in disentangling the impact of regulation on the demand for excess liquidity, and

<sup>31</sup> Banks have a tendency to concentrate their sovereign bond holdings in their domicile country. In the absence of a euro area common safe asset, banks in each euro area country hold a higher share of domestic sovereign bond and a lower share of other euro area sovereigns (see Giuzio et al. (2020)).

<sup>32</sup> See Baldo et. al. (2017) and Grandia et al. (2019).

therefore deriving the demand function for excess liquidity in the new environment of ample excess liquidity<sup>33</sup>.

In the context of liquidity risk, some institutions may prefer to hold excess liquidity because it does not need to be liquidated in the market before it is used to meet outflows<sup>34</sup>, although the LCR requirement in principle does not differentiate (in terms of haircut) between the liquidity value of excess liquidity and government bonds that are eligible as Level 1 HQLA.

In a risk-averse environment, reserves are more attractive as they are not subject to valuation changes.<sup>35</sup> If the trade-off between excess liquidity and government bonds in HQLA portfolios is analysed from a risk/return perspective, banks' preference for each asset class is dependent on its expected return as well as its volatility. As the liquidity buffer for the LCR calculation is based on the market value of the relevant assets, banks may have a preference to hold excess liquidity – the value of which is stable over time. Using portfolio theory, Ihring et al. (2018) conclude that, banks with a higher risk tolerance are expected to show a lower demand for excess liquidity compared to those which are more sensitive to interest rate risk.<sup>36</sup> In their analysis of US banks, they found that about half of the large banks give more weight to risk/return considerations in managing the compositions of their HQLA pools, resulting in relatively constant HQLA shares, while the other half appear bound by business model needs or other factors, resulting in a relatively large and volatile excess liquidity share of HQLA. Applying the same theoretical framework to the euro area in the period 2011-2018, it emerges that the optimal share of excess liquidity in an optimal portfolio is not constant in different sub-periods.<sup>37</sup> At the same time, the share of excess liquidity in an optimal portfolio is also higher than zero in the pre-APP sub-period (2011-2014), which was characterised by higher excess returns of government bonds with respect to the DFR. Therefore, it is rational to hold a share of excess liquidity in the HQLA portfolio even in those periods (under the assumption that banks consider both expected returns and volatility of returns in their portfolio choices). These considerations suggest that banks have, *ceteris paribus*, a preference to hold a share of excess liquidity within the HQLA buffer that would

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<sup>33</sup> See Afonso et al. (2020) for a discussion of the reserve demand in the post-crisis period.

<sup>34</sup> Past comments by US Fed officials suggest that supervisory practices and incentives, especially in relation to intraday liquidity and resolution planning rules, could prevent the complete substitutability of reserves and other HQLA Level 1 tradable assets and may play a role in increasing banks' demand for reserves, at least in the United States. See, for example, Quarles (2018) and Quarles (2020).

<sup>35</sup> Market volatility affects the level of HQLA and is reported at market value. Hedging of the portfolio could reduce this effect by considering cash inflows and outflows in the LCR denominator.

<sup>36</sup> Ihring et al. (2018) provide the share of reserves in an optimal HQLA portfolio for the period from 2001 to 2016. The shares range from 0% to 80% depending on the bank's risk tolerance.

<sup>37</sup> For the euro area, the exercise is based on the assumptions that banks can invest their HQLA portfolio in only three asset classes (domestic government bonds, other euro area government bonds and excess reserves – the risk-free asset); and that they use historical realised average excess returns and volatility to gauge their expectations of future excess returns – which in turn feed into their optimal HQLA portfolio allocation. The optimal HQLA portfolio composition is calculated for two different time horizons, the asset purchase programme (APP) period (from January 2015 to December 2018) and the pre-APP period (from January 2011 to December 2014), with different expected returns but comparable levels of volatility of government bonds. The optimal shares of excess reserves, computed for banks with high and low risk aversion, are also above zero in the pre-APP sub-period, which was characterised by higher excess returns of government bonds with respect to the DFR. The results are similar across major euro area jurisdictions. The optimal shares, for banks with low risk aversion, ranges between 40% and 60% in the period from January 2011 to December 2014 and slightly above 80% in the period from January 2015 to December 2018.

depend on the interest rate environment, the volatility of financial markets and their individual risk tolerance, among other factors.

Liquidity regulation may also increase the attractiveness of central banks' operations, as it might have a positive effect on a bank's LCR. As opposed to short-term money market transactions, borrowing from the central bank does not increase net liquidity outflows, and could therefore be used to upgrade a bank's LCR (to the extent non-HQLA collateral is used in the operation and to the extent that the proceeds are kept in the form of excess liquidity or are invested into other types of HQLA). In the context of balanced liquidity conditions, Kroon et al. (2021) find that the introduction of a requirement similar to the LCR, in 2002, affected banks' behaviour in open market operations. After the introduction of the requirement, banks bid for higher volumes and paid higher interest rates for central bank funds. In the current environment of ample liquidity, Vergote and Sugo (2020) provide empirical evidence that banks activate a share of their non-HQLA to raise the overall liquidity of their balance sheet. As regulatory liquidity ratios can benefit from this liquidity transformation, the result hints at regulatory motives for take-up. Although few estimates exist, Kedan and Veghazy (2021) show LCR regulation increased demand for excess liquidity amongst euro area banks with low LCRs relative to their peers, by on average between at least €103 billion and €150 billion over the six quarters following the harmonisation announcement in 2014.

## 3.2 Concentration and liquidity distribution

### 3.2.1 Concentration across euro area jurisdictions

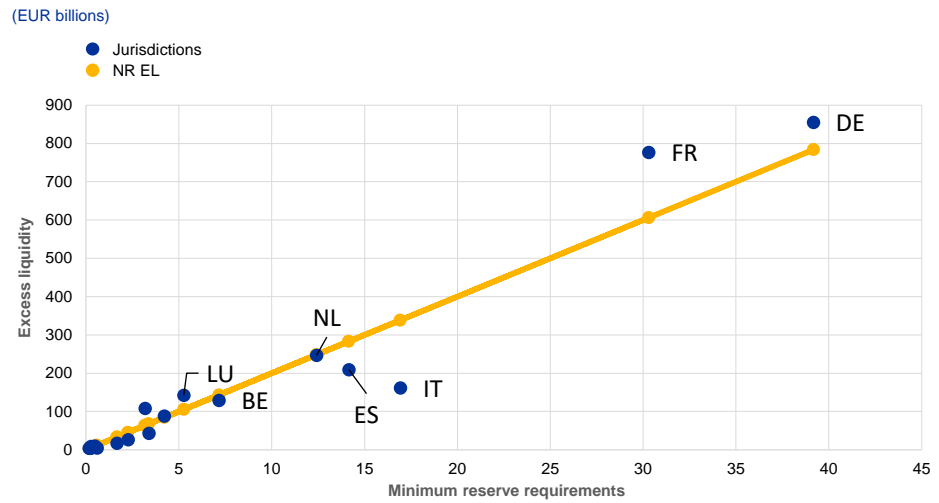
The distribution of excess liquidity may be asymmetric or concentrated, as illustrated by the current environment, with potential implications for aggregate demand. The notion of "concentration of liquidity" captures all factors underlying the liquidity held at banks that are unwilling to redistribute it. Higher concentration implies higher aggregate demand for reserves because excess liquidity is not distributed evenly across euro area countries. Albeit with caveats<sup>38</sup>, when using the MRRs as a proxy for bank size (and therefore banking sector size when aggregated at country level) a few countries hold more excess liquidity compared to the amounts of their minimum reserves, suggesting some concentration (see Chart 6).

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<sup>38</sup> Some jurisdictions may host foreign banks which have small MRRs but high levels of excess liquidity due to their role as a liquidity hub for the euro.

**Chart 6**

Distribution of excess liquidity as a function of minimum reserve requirements



Sources: ECB and ECB calculations.

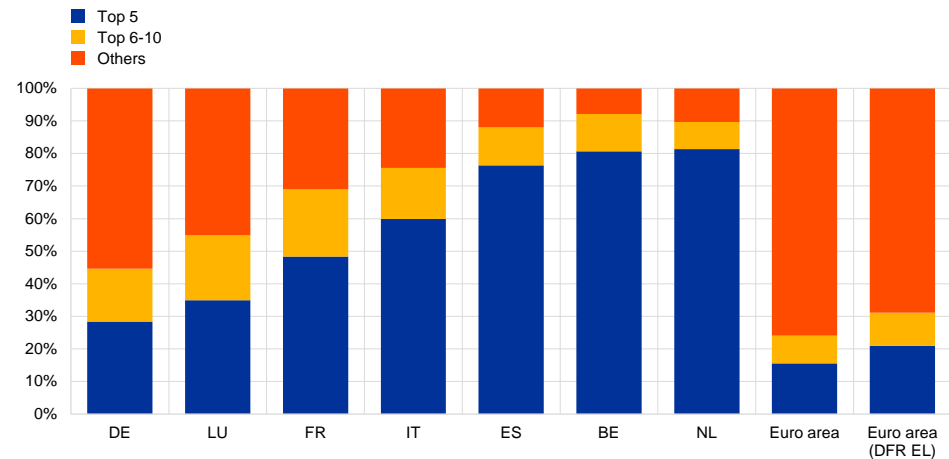
Notes: NR EL is normalised excess liquidity for each jurisdiction, i.e. the ratio between euro area total of excess liquidity and euro area total of minimum reserves applied to each jurisdiction. Information is based on annual averages for 2020.

In the maintenance period July to August 2020, among the seven euro area countries that together held 89% of total euro area excess liquidity, domestic concentration was more pronounced in Belgium, Spain, and the Netherlands, and less so in Germany and Luxembourg (Chart 7). However, concentration may also be favoured by the banking system structure in some countries. For example, the five largest credit institutions in terms of total assets in the Netherlands, hold nearly 85% of total assets, with the corresponding share in Spain being just under 70%.<sup>39</sup> Hence, with such a concentrated banking system, the concentration of liquidity among the top five entities is a natural by-product. Moreover, the figures may be significantly higher at the level of consolidated banking groups (rather than individual banks), especially for jurisdictions with concentrated banking systems.

<sup>39</sup> See ECB (2020a).

**Chart 7****Concentration of excess liquidity in selected jurisdictions**

(percentages)



Source: Eurosystem.

Notes: Averages between 22 July and 15 September (MP 5). Displayed countries represented 89% of total euro area excess liquidity in the maintenance period from July to September 2020. The calculation is made at monetary financial institutions level, which may significantly underestimate top 5 and top 6-10 concentration figures compared to a consolidated banking group approach, especially in those jurisdictions where the banking sector is itself concentrated.

The concentration of excess liquidity is even more apparent from an individual bank perspective. From around 2,500 counterparties, the 50 largest holders of excess liquidity account for 60% of the total.<sup>40</sup> The concentration has however evolved during the past ten years (Chart 8). In 2012, added together the 100 largest holders of excess liquidity had about 93% of the total, while the corresponding share in 2020 was 76%, albeit with a different composition of banks. This is broadly in line with the distribution of liquidity in TARGET2.<sup>41</sup> The decrease in concentration between 2012 and 2014 could be explained by greater economic integration and less risk of systemic stress.<sup>42</sup> Two factors contributed to lower concentration during the substantial increase of excess liquidity in the banking system in more recent years. First, the increasingly favourable conditions of TLTRO operations incentivised large participation in an environment of already ample excess liquidity, which resulted in a higher number of banks depositing to a larger extent the borrowed liquidity on their own current accounts with the Eurosystem, thereby increasing their excess liquidity. Second, the introduction of the two-tier system for remunerating excess liquidity holdings allowed banks to have a share of their excess liquidity<sup>43</sup> exempted from the negative remuneration at the DFR. In order to take full advantage of the two-tier system, banks with insufficient excess liquidity to fill the exempted tier have an incentive to borrow via money market or intragroup transactions from those banks with more abundant reserves. The concentration of reserves that are still remunerated at the DFR – the 100 largest holders account for about 84% – confirms

<sup>40</sup> As of maintenance period between July and September 2020.

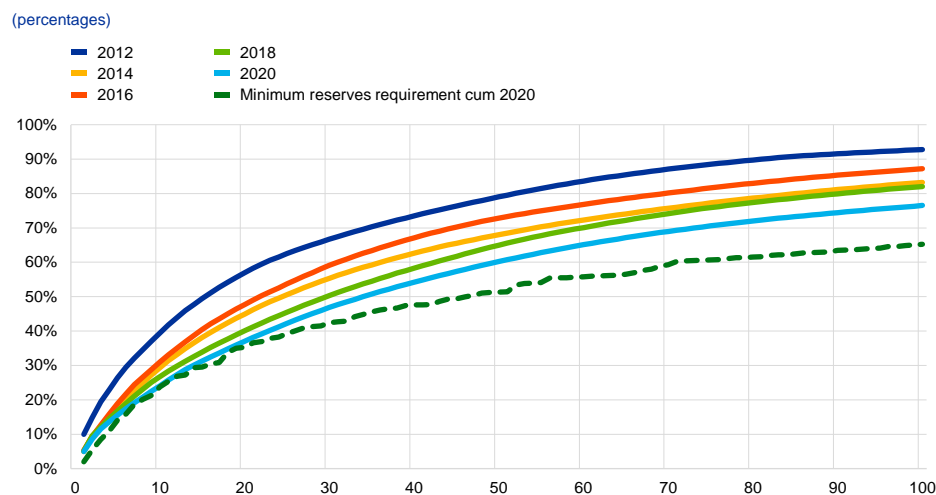
<sup>41</sup> See Duca-Radu and Polo Friz (2020).

<sup>42</sup> See ECB (2020b).

<sup>43</sup> Determined as a multiple of MRR – initially set at six. See also Deutsche Bundesbank (2021).

the significance of this measure. Overall, these two developments mostly contributed to the decrease between 2018 and 2020.

**Chart 8**  
Cumulative distribution of excess liquidity across the 100 largest euro area holders



Source: Eurosystem.  
Notes: The x-axis reports in decreasing order the 100 largest holders of excess liquidity in each period (the sample composition may therefore vary). The y-axis shows the percentage of excess liquidity held by the given bank as a percentage of total excess liquidity for that period. Excess liquidity and MRR figures are computed as annual averages. The dashed-line MRR (2020) is shown as a benchmark for illustrative purposes.

There are multiple structural factors explaining this concentration of liquidity across jurisdictions and at bank levels. First, financial centres are, by definition, locations with a concentration of market participants and stakeholders, including relevant market infrastructures such as central securities depositories, securities settlement systems and TARGET2 accounts which are used by counterparties, in particular those counterparties to the APP and the pandemic emergency purchase programme (PEPP) not located in the euro area that sold assets to the Eurosystem.<sup>44</sup> For example, Germany and France host large custodian and correspondent banks, while Germany and the Netherlands has historically been used by non-euro area banks to access TARGET2. Second, the size and structure of the national banking system and the location of banking groups' headquarters are also relevant.

Excess liquidity holdings are found to be higher for smaller and better capitalised banks and for banking groups with liquidity centralised at the head institution.<sup>45</sup> Trade finance banks, investment banks, private banks, clearing and depository institutions as well as custodians hold by far the largest shares of excess liquidity on their balance sheets. Furthermore, market participants who better synchronise their incoming and outgoing payments, manage to economise on usage of the liquidity available on their TARGET2 accounts and are less in need of intraday credit lines.<sup>46</sup> The emergences of big techs as payment providers, such as PayPal, or the emergence of new means of payments, such as stablecoins, also provide examples

<sup>44</sup> See Baldo et al. (2017) and Grossmann-Wirth and Hallinger (2018).

<sup>45</sup> See Baldo et al. (2017).

<sup>46</sup> See Duca-Radu and Polo Friz (2020).

as to why reserves can become more concentrated.<sup>47</sup> Finally, following the GFC, a general increase in risk aversion, potentially leading to increased fragmentation (see next section) and more conservative internal risk limits among banks may still be limiting cross-border liquidity flows and the broad-based interbank redistribution of liquidity within the euro area. Banks' price sensitivity to holding reserves may also come into play, i.e. banks that have relatively high thresholds for reserves holdings may contribute to a higher aggregate demand for reserves.

### 3.2.2 Fragmentation

Fragmentation in financial markets (e.g. money markets) is a sign of impairment in the transmission of monetary policy. The existence of fragmentation – defined here as a situation in which similar agents do not have access to similar financial services under similar conditions – can also explain the concentration of reserves in some crisis episodes, and therefore an increased demand. Over the years, financial fragmentation has fluctuated quite substantially due to specific events such as the subprime mortgage crisis and the collapse of Lehman Brothers in 2008, the sovereign debt crisis in 2010-2011, and the Brexit referendum in 2015. Pre-COVID-19, there were almost no signs of fragmentation in the euro area money market, particular in the secured money market and the FX swap market. Secured prices became almost totally homogeneous when banks from various jurisdictions used the same type of collateral. However, during the COVID-19 crisis in 2020 there were some signs of fragmentation in money markets (although less than in other financial market segments).<sup>48</sup> Hence, fragmentation might re-emerge as a key issue to address in periods of financial stress or with less ample liquidity. A renewed, fragmented euro area, spurred by the revival of a financial stress situation, could lead to an increased demand for reserves via two routes.

First, a flight to safety during episodes of fragmentation may incentivise banks based in more creditworthy countries to prefer holding reserves rather than domestic government bonds since reserves become more attractive from a risk/return perspective, thereby increasing concentration. As banks from other jurisdictions also need to meet their demand for reserves, the total demand may exceed the amount required in the system. Indeed, in earlier episodes of high fragmentation, for example, around the time of the collapse of Lehman Brothers and during the euro area sovereign debt crisis, EONIA seemed to converge more slowly with the DFR, which indicates fragmentation as a driver for reserves.

Second, and as discussed previously, fragmentation could lead to higher demand for reserves from banks with poor or unfavourable market access. Some banks may face relatively high interest rates in money markets due to perceived credit risk and/or other frictions. If for those banks, participation in central bank refinancing operations becomes cheaper (or the only possible option when it is impossible to find

<sup>47</sup> Stablecoins do not guarantee any fixed redemption value that is backstopped by the government (such as a deposit guarantee scheme). Therefore, they rely on the prudent business practices and legal structures of their private sector providers. If they have no access to the central bank, they can back stablecoins with reserves indirectly through a specialised bank, see Adrian and Griffoli (2019).

<sup>48</sup> ECB (2020b).



a counterparty) than entering into money market transactions, the shift from money market transactions to central bank operations may cause a demand-driven increase in reserves in the system.

## Box 1

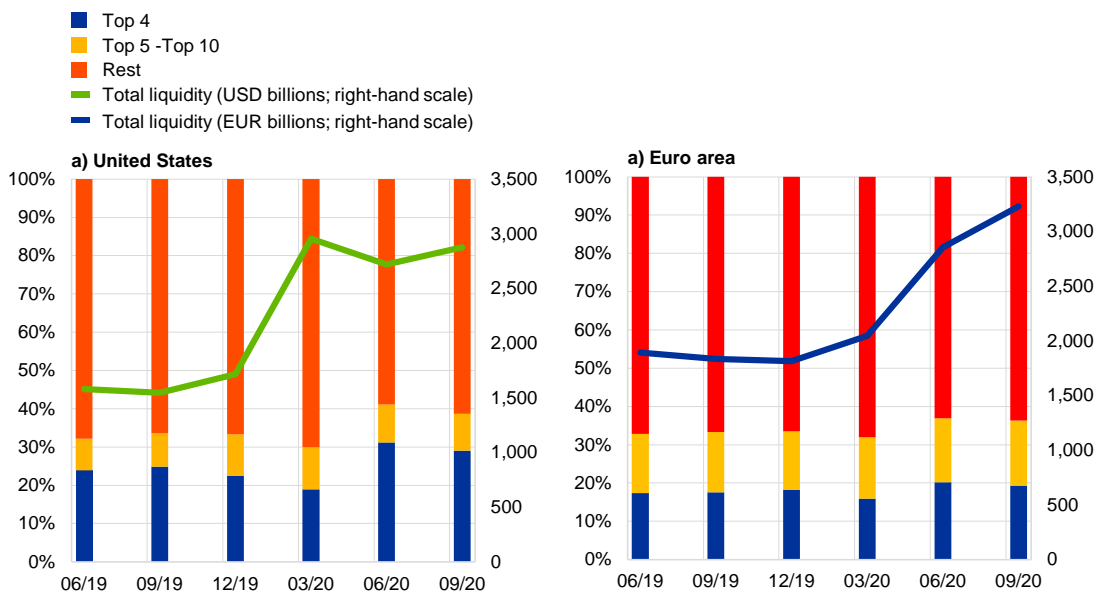
### Concentration of liquidity in the United States

Central bank liquidity is also concentrated in the United States. Here, about 5,000 institutions hold reserves with the central bank, which is about twice as many as in the euro area. Data from the US Federal Deposit Insurance Corporation (FDIC) serve for comparison. The FDIC publishes reserve holdings of institutions that are members of its insurance scheme on a quarterly basis. These FDIC institutions hold about 60 to 70% of total liquidity, while other institutions, usually foreign banks, hold the remaining share.<sup>49</sup> As shown in Chart A, central bank liquidity is even more concentrated in the United States than in the euro area, when using the top-four banks as an indicator – they hold 29% in the US compared to 19% in the euro area. Both areas are similarly concentrated when taking the top-ten banks as an indicator (39% in the United States compared with 36% in the euro area).<sup>50</sup> The comparison emphasises that liquidity tends to be concentrated in large institutions, even when it is amply available on aggregate, and even without national borders that can otherwise reduce its redistribution.

### Chart A

#### Distribution of central bank liquidity in the US and euro area

(left-hand side: percentages; right-hand side: USD and EUR billions)



Sources: US Federal Deposit Insurance Corporation (FDIC), Federal Reserve System and Eurosystem.

Notes: Some of the reasons for higher and more concentrated central bank liquidity that are discussed in the United States, are similar to those discussed in the euro area, for example, the need for higher buffers because of new liquidity regulation or tighter internal control mechanisms. The Senior Financial Officer Survey in the United States is investigating the reasons why liquidity in the United States is highly concentrated. In February 2020, some banks identified

<sup>49</sup> For more details see, for example, Banegas and Tase (2016). The comparison between the US and the euro area is based on total liquidity (i.e. including minimum reserves), because the Federal Reserve set minimum reserves to 0% in March 2020 and no longer distinguishes between total and excess liquidity.

<sup>50</sup> Similar results can be found in Coeuré (2019).

meeting estimated stressed outflows determined by their firm over a longer time horizon as an important factor. This could hint at internal control mechanisms that foster liquidity hoarding. Measuring floor required excess liquidity and banks' sensitivity to the price of reserves

Floor required excess liquidity (FREL) is difficult to measure due to the uncertain demand for reserves and central banks' inexperience in scaling down a large balance sheet. The Federal Reserve experience of 2019<sup>51</sup> has shown that interest rate sensitivity in relation to outstanding reserves has increased compared with what previous empirical estimates and qualitative surveys suggested. This reflects both the difficulty in estimating the effective demand for reserves and the fact that scaling down a large balance sheet represents uncharted waters for central banks. In the Eurosystem, additional factors such as the concentration of reserves as well as structural differences in banking systems across countries are expected to play a role, therefore making any point estimation subject to high uncertainty. This notwithstanding, empirical estimations from aggregate Eurosystem data can shed some light on a range of FREL levels to enable monitoring from a monetary policy implementation perspective. Moreover, estimates of banks' sensitivity to the opportunity cost of holding reserves and market intelligence may help in better understanding the demand for reserves.

### 3.3 Estimation of FREL

Historical data on money market rates and the amount of reserves in the system can be used to estimate the aggregate demand for reserves by banks and provide a proxy for the level of FREL. Since the GFC and the gradual move to a floor system, the Eurosystem has operated with different levels of excess liquidity: below €500 billion up until 2010 and above €3 trillion up to the end of 2020. During these periods money market rates (e.g. EONIA) traded at different spreads in comparison to policy rates (Chart 9). By mapping excess liquidity into a certain level of money market rates using historical data, it is possible to estimate the expected short-term rate for a certain level of excess liquidity and therefore obtain a proxy on the level of FREL. It should be noted that the estimation of historic levels of FREL might not entail potential factors which are relevant for future levels of FREL and should therefore be interpreted with caution.

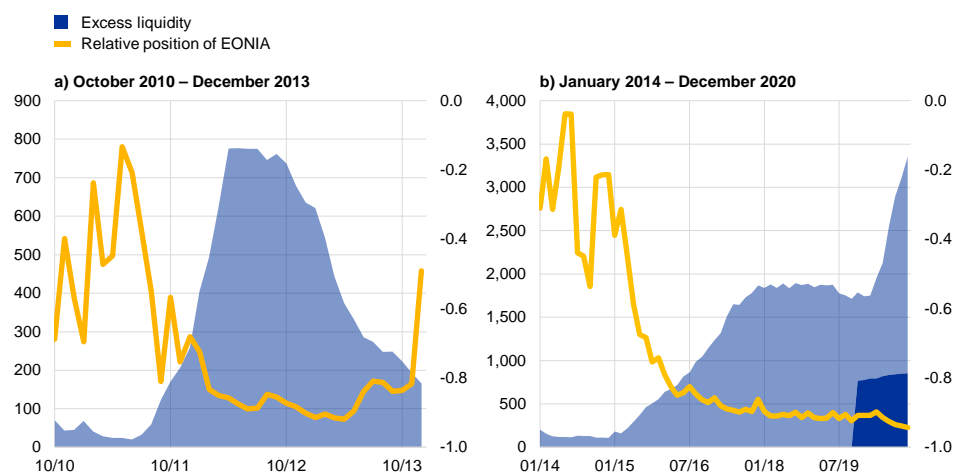
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<sup>51</sup> See e.g. Anbil et al. (2020).

## Chart 9

### Evolution of excess liquidity and normalised EONIA

(left-hand side: EUR billions; right-hand side: percentages)



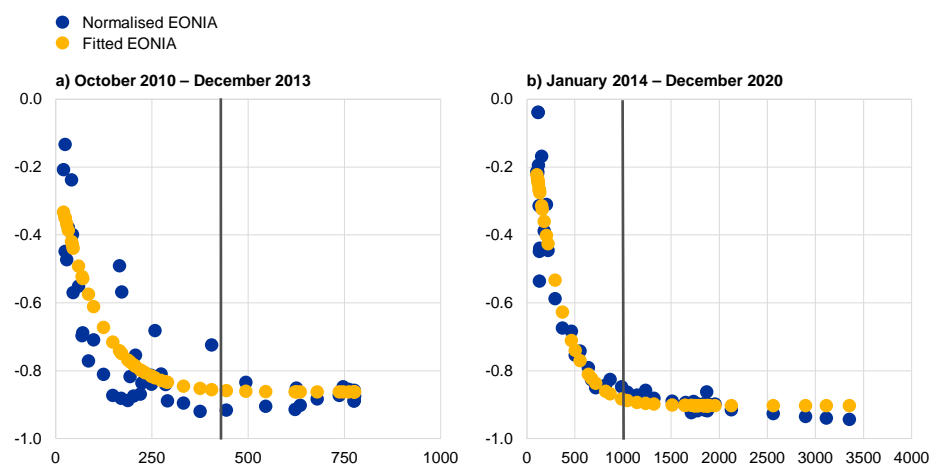
Sources: ECB and ECB calculations.

Notes: Based on average data during maintenance periods. To consider changing interest rate corridors, fitted values are calculated by using the relative positions of EONIA in the interest rate corridor, whereby MLF rate = 1, DFR = -1 and MRO rate = 0 always applies.

## Chart 10

### Estimation of the relationship between normalised EONIA and EL

(x-axis: EUR billions; y-axis: percentages)



Sources: ECB and ECB calculations.

Notes: Based on average data during maintenance periods. To consider changing interest rate corridors, fitted values are calculated by using the relative positions of EONIA in the interest rate corridor, whereby MLF rate = 1, DFR = -1 and MRO rate = 0 always applies.

Our empirical estimation confirms high uncertainty regarding the level of FREL in the euro area. By using a clearly defined methodology, as provided in Veyrune et al. (2018)<sup>52</sup>, the relationship between short-term money market rates and excess

<sup>52</sup> The relationship between excess liquidity and short-term interest rates is empirically estimated for the euro area using a non-linear regression model, as presented by Veyrune et al. (2018), formula (5), p.13. The logistic function makes it possible to have positive and negative values of the explanatory variable (between -1 and 1), an asymptotic convergence and a mid-rate outcome when explanatory variable reaches zero.

liquidity can be used to estimate the level of FREL. The results of these analyses are shown in Chart 10. Given the uncertainties in estimating the demand function and the presence of regime shifts in the relationships between excess liquidity and the short-term rate, the estimates would fall within a wide range as suggested by comparing the two periods in Chart 10. One factor that plays a role in the estimations are the rates of other liquid, money-like assets (such as government bonds), which were higher during the first sub-period compared to the second, resulting in reserves being comparatively less attractive. The first graph shows that with relatively lower levels of excess liquidity, EONIA started to increase at around €400 billion. When excess liquidity increased with the start of the APP, FREL shifted to around €1 trillion.<sup>53</sup> While these estimations do not provide information on the drivers behind the level of FREL, it seems to be at a relatively low level when the Eurosystem provided liquidity in refinancing operations and at rates close to other funding conditions. FREL seems to become much higher during periods in which the Eurosystem increased excess liquidity via the APP and in which the DFR becomes attractive to other liquid assets. A possible explanation could therefore be that the use of refinancing operations results in a demand-driven supply of reserves – whereas the supply of reserves by asset purchases is supply driven. Yet, understanding the reasons behind this development may require further in-depth analysis.<sup>54</sup>

### 3.4 Analysis of banks' sensitivity to the price of reserves

Banks' sensitivity to the price of reserves may help in understanding the demand for reserves. Money market transaction data can provide an indication on banks' sensitivity to the price of reserves and therefore help in modelling a demand function for reserves. Using MMSR data<sup>55</sup>, we analyse banks' sensitivity to the price of reserves in an environment of ample reserves by focusing on banks with scarce reserves<sup>56</sup> as a case study. Although the APP and the PEPP have forced excess liquidity on the aggregate banking system in the euro area, at the micro level there may be banks holding only limited excess liquidity (as discussed in Section 3). Under the hypothesis of a structural demand for reserves, these "reserve-scarce"<sup>57</sup> banks are expected to be willing to borrow reserves against relatively higher prices compared with the DFR and the cost of holding other HQLA. In addition, banks are expected to only lend at rates significantly above the DFR when their reserve

<sup>53</sup> The results do not change if only non-exempted reserves are considered.

<sup>54</sup> On estimating the required level of excess liquidity in the corridor system (CREL). It has been difficult so far to re-estimate the (at that time existing) CREL level from pre-crisis data. During the pre-crisis period, in which the Eurosystem steered short-term money market rates close to the MRO rate in the middle of the corridor, data observations are clustered closely around this rate. The fact that the Eurosystem was very successful in achieving its operational target, i.e. keeping short-term money market rates close to the MRO rate, makes it difficult however to re-estimate CREL econometrically.

<sup>55</sup> The Eurosystem collects daily transaction data in the money market of the 50 largest banks in the euro area, known as Money Market Statistical Reporting (MMSR).

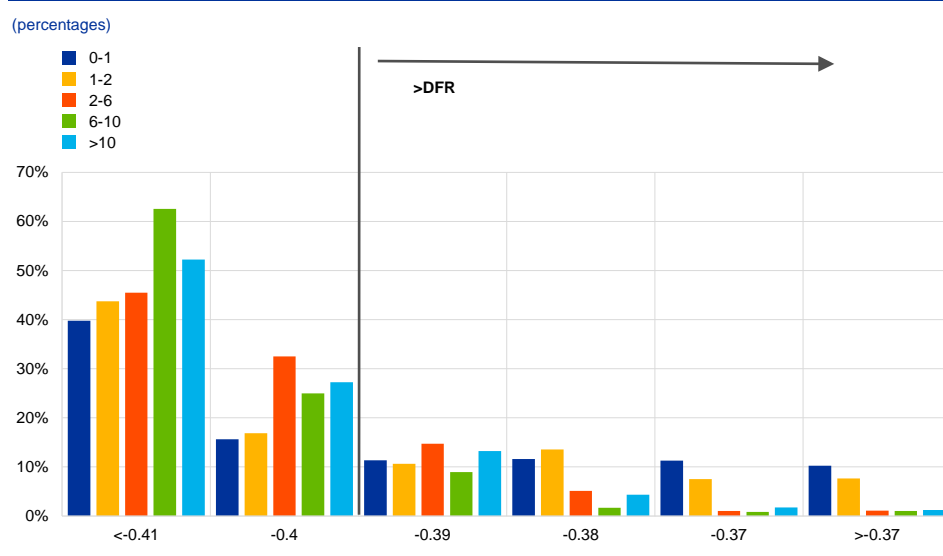
<sup>56</sup> The focus on banks with scarcer reserves, defined as banks that have between 0-2 times their MRR as reserve holdings on a daily basis, is justified, as the behaviour of banks with more ample reserves in the money market does not necessarily indicate their position towards a "demand for excess liquidity", given they already have ample reserves.

<sup>57</sup> In the paper "reserve scarce banks" are banks with excess liquidity less than six times their reserve requirement.

holdings marginally exceed their MRR. Only a significant premium compared to the DFR might encourage these banks to lend their reserves in the money market.

However, in our case study, even reserve-scarce banks seem to be sensitive to opportunity costs. Therefore, a clear preference for holding excess liquidity does not emerge in the sample. However, the findings cannot really be extrapolated to the banking system as a whole, since they may be conditional on the monetary environment and subject to selection bias.<sup>58</sup>

**Chart 11**  
Distribution of borrowing volumes over reserve bucket



Sources: MMSR and ECB calculations.  
Notes: Sample period between July 2016 and July 2019. The MMSR banks' daily reserve holdings are computed as multiple of their MRR. These observations are put into buckets of [0-1], [1-2], [2-6], [6-10] and [>10]. Values above 1 imply that excess liquidity are held. Values below 1 are possible daily, as banks only must fulfil the MRR on average throughout a maintenance period. Observations in buckets [0-1] and [1-2] are defined as reserve-scarce banks. The observations in the buckets are matched with the respective banks' money market transactions daily. The percentage shows the share of transactions per rate for each bucket. Bin-size is 1 bps i.e. -0.4 represents transactions conducted at rates between -0.40 and -0.41 (including -0.40) and -0.39 represents transactions conducted at rates between -0.39 and -0.40 (excluding -0.40). For example, around 25% of the transactions of banks in the group 6-10 takes place against a rate between -0.40 and -0.41 (see the green bar at the rate of -0.4 in Chart 10). Consequently, 75% of the transactions of this group is conducted against other rates.

Most borrowing transactions take place at rates just around or below the DFR (Chart 11). Although reserve-scarce banks are also paying mild mark-ups above the DFR, they do not use these transactions to source a substantial amount of reserves. As in terms of their MRR, these banks only borrowed marginally in net terms. This suggests that as soon as banks are confronted with opportunity costs in the money market, they do no longer source a substantial amount of excess liquidity.

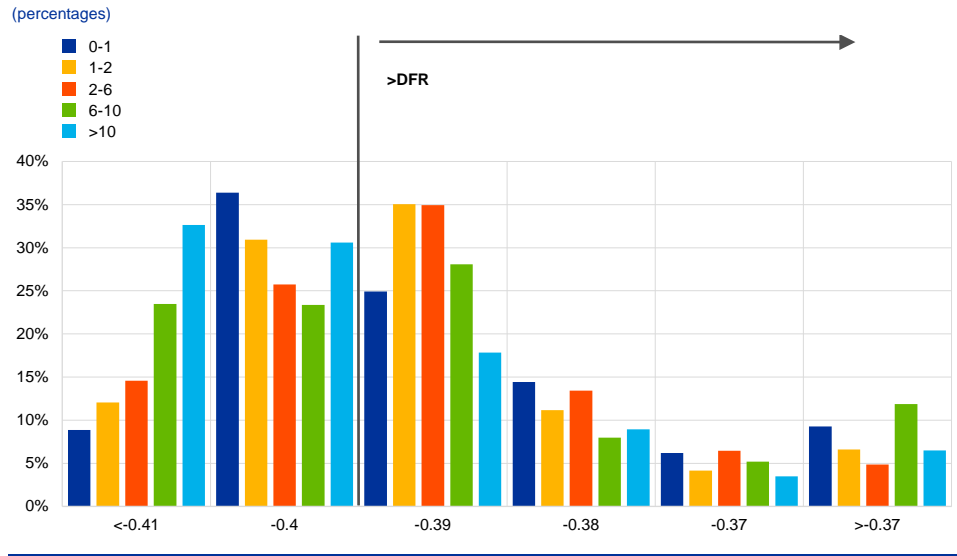
Moreover, reserve-scarce banks also lend relatively large amounts of reserves against small profits instead of holding them as excess liquidity (Chart 12)<sup>59</sup>. Overall,

<sup>58</sup> Banks with scarcer reserves may be less concerned about the market liquidity under stressed conditions if they know other banks have ample reserves. In addition, the FRFA policy provides reserve-scarce banks a backstop facility in case the market liquidity for non-reserve HQLA were to disappoint. Moreover, the MMSR sample may not be representative for all banks. Finally, there may be a possible selection bias, as the preference for reserves vis-à-vis other HQLA might differ between reserve-scarce and reserve-rich banks.

<sup>59</sup> Banks are willing to lend at rates just above (as little as 0.5 basis points) the DFR.

banks thus still seem to be sensitive to opportunity costs in their determination whether to hold reserves or not.

**Chart 12**  
Distribution of lending volumes over reserve bucket



Sources: MMSR and ECB calculations.  
Note: Sample period between July 2016 and July 2019, when the DFR was flat at -0.40%.

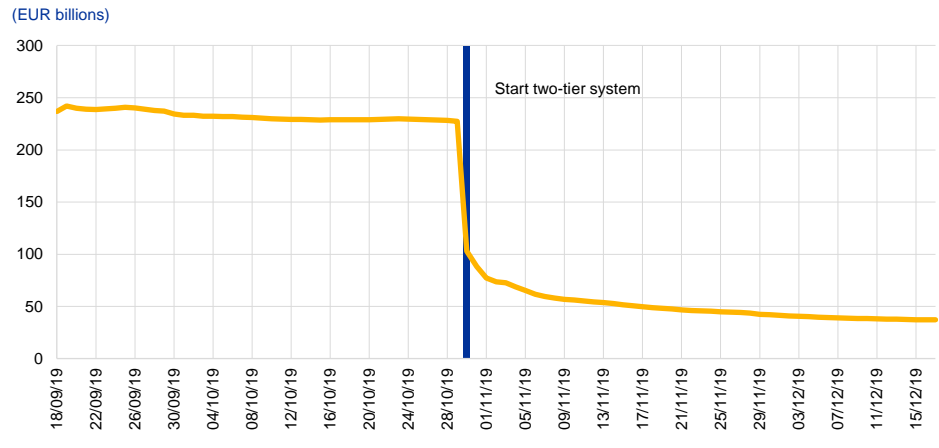
The introduction of the two-tier system in the Eurosystem, also shows that banks are still sensitive to opportunity costs. Banks that had lower reserves than their exempt tier<sup>60</sup> were incentivised to attract additional reserves to “earn” a rate of 0% at the Eurosystem. Banks with (“theoretical”) unused exemptions before the introduction of the two-tier system filled most of these exemptions when the two-tier system started (Chart 13). In other words, banks that are relatively low in reserves (typically with unused exemptions) were still sensitive to opportunity costs.<sup>61</sup>

<sup>60</sup> Set at six times the bank’s MRR.

<sup>61</sup> See Deutsche Bundesbank (2021).

**Chart 13**

(“Theoretical”) unused exempt tier before and after the introduction of the two-tier system



Sources: ECB and ECB calculations.

Note: The “unused exempt tier” shows how much of the aggregate exempt tier at euro area level is left unused by banks.

## 4 Conclusions

This paper draws lessons on how the demand for central bank reserves interacts with the monetary policy implementation framework of the Eurosystem.

First, the demand for reserves is shown to be – at least partially – endogenous to the calibration of the implementation framework. A floor system facilitates a broad range of motivations to hold central bank reserves. Banks will be incentivised to hold larger amounts of precautionary buffers, while for some banks holdings reserves can even be relatively attractive from a risk/return investment perspective. Potentially combined with unconventional monetary policy measures, this leads to a higher demand for reserves in comparison to a corridor system.

Second, a prolonged period of ample reserves may increase the demand for them if a sort of “hysteresis effect” comes into play. The negative impact of ample reserves on money market activity may become more persistent, resulting in a higher demand for excess liquidity that, if not met by the central bank, could impair the implementation of its monetary policy. This could in particular be the case for the lower activity of banks in the unsecured money market and general collateral repo market. A long-lasting implementation of the floor system with ample liquidity could hence lead to an endogenous increase of the demand for excess liquidity.

Third, additional structural factors such as regulation and liquidity concentration complicate estimation of the demand for reserves. While the LCR neither prescribes thresholds for minimum reserve holding within the HQLA buffer, nor has a preferential treatment of reserves versus other HQLA, nor discourages short-term lending, it has certainly added an additional factor for holding excess liquidity. This factor can become more attractive with a higher rate of return in comparison to other HQLA, though banks might even be willing to incur larger opportunity costs in comparison to the pre-GFC period in order to hold reserves for additional structural purposes.

These new dynamics could complicate a transition towards lower levels of reserves, since the absorption of reserves risks generating unwarranted volatility on the money markets if the demand is not appropriately estimated. Although we have illustrated that banks are still sensitive to opportunity costs, our analysis shows that the relationship between short-term money market rates and the level of excess liquidity in the banking system – and therefore the level of FREL – strongly depends on the choice of the sample periods as well as the instruments to achieve a certain level of liquidity. Moreover, well-functioning money markets are important in order to keep rates close to the DFR in this situation. Revitalising interbank money markets, for those banks that usually do not borrow liquidity in a floor system but suddenly face liquidity shortages, may be difficult.

Finally, the analytical framework and macro and micro estimations discussed in this paper could be complemented by regular collection of feedback from market participants to foster central banks understanding of the demand for reserves. The



collection of market intelligence is already ongoing through different channels, but it could also be further enhanced through, for example, a qualitative and limited quantitative survey to market participants.

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