INTERNATIONAL MONETARY FUND

The ECB's Future Monetary Policy Operational Framework

Corridor or Floor?

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WP/24/56

2024
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WORKING PAPER

 WP/24/56

IMF Working Paper
European Department

The ECB's Future Monetary Policy Operational Framework: Corridor or Floor?

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March 2024

ABSTRACT: This paper reviews the trade-offs involved in the choice of the ECB's monetary policy operational framework. As long as the ECB's supply of reserves remains well in excess of the banks' demand, the ECB will likely continue to employ a floor system for implementing the target interest rate in money markets. Once the supply of reserves declines and approaches the steep part of the reserves demand function, the ECB will face a choice between a corridor system and some variant of a floor system. There are distinct pros and cons associated with each option. A corridor would be consistent with a smaller ECB balance sheet size, encourage banks to manage their liquidity buffers more tightly, and facilitate greater activity in the interbank market. But it would require relatively more frequent market operations to ensure the money markets rate stays close to the policy rate and could leave the banking system vulnerable to intermittent liquidity shortages that may have financial stability implications and impair monetary transmission. The floor, on the other hand, would allow for more precise control of the overnight rate and a lower risk of liquidity shortages, but it would entail a somewhat larger ECB balance sheet, weaken the incentives for banks to manage their liquidity buffers, and discourage interbank market activity. The analysis of tradeoffs suggests that, on balance, in steady state, a hybrid system that combines the features of the "parsimonious floor" (with a minimal volume of reserves) with a lending facility or frequent short-term full-allotment lending operations priced at or very close to the deposit rate, making it a "zero (or near-zero) corridor", would be most conducive for achieving the ECB's monetary policy objective.

JEL Classification Numbers:	E42, E51, E58
Keywords:	Central bank operations; Monetary policy; The ECB
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* The author(s) would like to thank Nassira Abbas, Nazim Belhocine, Ashok Bhatia, Damien Capelle, Oya Celasun, Alfred Kammer, Malhar Nabar, Vina Nguyen, Jerôme Vandebussche, and Romain Veyrune for useful comments and discussions, Morgan Maneely, Kayla Qin, and Wei Zhao for excellent research assistance, and Zhuohui Chen for sharing data on money market rates and excess liquidity.

WORKING PAPERS

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Contents

Glossary

APP	Asset Purchase Program
DFR	Deposit Facility Rate
ECB	European Central Bank
ELB	Effective Lower Bound
ESTR	Euro Short-Term Rate
GFC	Global Financial Crisis
LCR	Liquidity Coverage Ratio
LTRO	Long-Term Lending Operations
MRO	Main Refinancing Operations
NFC	Nonfinancial Corporations
NSFR	Net Stable Funding Ratio
OMO	Open Market Operations
OMT	Outright Monetary Transactions
PEPP	Pandemic Emergency Purchase Program
QE	Quantitative Easing
QT	Quantitative Tightening
TLTRO	Targeted Long-Term Lending Operations
TPI	Transmission Protection Instrument

Executive Summary

Prior to the 2008-09 financial crisis, the European Central Bank (ECB) employed a corridor system for implementing monetary policy, engineering a structural shortage of bank reserves to a level where the target policy rate cleared the overnight money market. The corridor was followed, until January 2015, by an intermediate system that was still a corridor but with money market rates close to its floor. Subsequently, as the ECB lowered the policy interest rate to the effective lower bound (ELB) and expanded its balance sheet leading to an abundant supply of reserves, it employed a floor system with the overnight rate bounded from below using the deposit facility priced at the target interest rate level. At present, with the policy rate well above its ELB and balance sheet normalization under way, a key question is whether the ECB should return to a corridor system or maintain some variant of a floor.

This paper compares corridor and floor-based systems to assess which might be most suitable for the ECB in the short- and medium term. The key difference is that a corridor system comes with a reduced central bank balance sheet and encourages banks to manage their liquidity more tightly with greater reliance on interbank markets, whereas a floor system in which the supply of reserves systematically exceeds banks' demand enables more robust control over the policy interest rate and reduces the risk of unanticipated liquidity shortages that may impair the transmission of monetary policy. A corridor system would become a de facto floor system should excess reserves remain abundant, and thus is likely incompatible with large excess reserves induced by quantitative easing (QE), unsterilized use of the Transmission Protection Instrument (TPI) and Outright Monetary Transactions (OMT), or large-scale bank liquidity support interventions.

Given the presence of abundant reserves on its balance sheet, the ECB is likely to remain in a floor system for some time. As it proceeds with quantitative tightening (QT) that shrinks aggregate reserves, the ECB could transition toward a corridor or a variant of a floor system. Within the floor systems, the so-called "parsimonious floor" system is characterized by a minimal quantity of excess reserves that remains consistent with the floor system in principle but comes with the possibility of money market rates exceeding the deposit facility rate (DFR) if and when there is a liquidity shortage in the system. To firmly anchor the short-term interest rate at its target, as a precaution, the deposit facility in a parsimonious floor can be supplemented with a standing lending facility or frequent full-allotment lending operations priced at or very close to the DFR to provide a ceiling for money market interest rates, making it a hybrid system that can also be described as a zero (or near-zero) corridor. Such hybrid system can deliver robust control over the money market interest rate—which would sit at the DFR most of the time—while reducing the central bank's balance sheet size. The wider the corridor, the less the excess supply of reserves should be and the more banks would be encouraged to manage their liquidity buffers, supporting interbank activity. At the same time, allowing for a wider corridor in a hybrid system has a higher possibility of intermittent liquidity shortages that may impede monetary policy transmission. A corridor (or near corridor) system would function more robustly if coupled with faster progress toward completing the Banking Union that would help ensure such events do not precipitate wider, systemic banking distress. Learning-by-doing should remain a guiding principle as the ECB transitions to a steady state operational framework.

1. Introduction

To achieve the ultimate objectives of monetary policy—price and macroeconomic stability[1]—central banks employ one or more intermediate targets (e.g., an inflation forecast, if the central bank uses an inflation targeting strategy). To operationalize their intermediate targets, most modern central banks steer the money market overnight interest rate—the "operational target" of monetary policy (Bindseil 2014).

The "operational framework" refers to a set of mechanisms and instruments by which the central bank supplies reserves to implement a target short-term interest rate. Short-term interest rates are determined by supply and demand in money markets, where banks borrow and lend central bank reserves (defined as the balances that banks hold on central bank accounts) to cover their reserve requirements and liquidity and payments-related needs. Central banks control the aggregate supply of reserves through the use of monetary policy instruments—they provide and withdraw reserves through market operations and lending facilities and can "sterilize" reserves through remunerated deposit facilities, the issuance of central bank securities, or with minimum reserve requirements. By varying the supply of reserves, central banks steer the equilibrium short-term interest rate.

The choice of a central bank's operational monetary policy framework matters first and foremost because it may affect the effectiveness of monetary policy implementation. Although this effectiveness is ultimately measured by the strength and speed of the transmission of monetary policy to inflation and output, it is more immediately gauged by the central bank's ability to influence short-term money market interest rates and the pass-through of policy-induced movements in the latter to broader financial conditions. The degree of control over the overnight money market interest rate—and in the case of a currency union, the uniformity of this control across jurisdictions (Eisenschmidt et al., 2018)—as well as the ease with which the central bank can deploy some of its less conventional tools like quantitative easing (QE) when policy rates are close to the effective lower bound (ELB) under a given framework are important considerations to assess its effectiveness. Second, different operational frameworks may imply a different central bank footprint in financial markets (e.g., some frameworks rest on a well-functioning interbank market to meet banks' liquidity needs while others suppress its activity; some may entail more frequent market operations than others; and some may be associated with a larger central bank balance sheet size than others), may be more or less robust to financial market turbulence, liquidity shortages, and bank stress, may increase or reduce the amount of good collateral available to market operators, and, because they presuppose different sizes and composition for the central bank's balance sheet, will have different effects on its profit and loss statement. This means that the choice of the monetary policy framework will need to consider the pros and cons of each model.

[1] Central banks often have other ultimate goals like financial stability, financial development, or an efficient payments system, but these are not met with monetary policy. In particular for financial stability, whenever and wherever possible, central banks should follow a separation principle in which monetary policy pursues price stability and prudential policies target financial stability (see Gopinath, 2023).

Some of these considerations for the choice are of an operational framework are of general validity, while others may be especially important for currency unions, including the euro area. For example, euro area banks have boosted their liquidity and capital ratios thanks to a wide implementation of Basel III and have demonstrated their resilience throughout the pandemic shock and during the rapid tightening of monetary policy in 2022-23. However, long-standing structural differences across countries in the euro area (e.g., level of public debt and extent of sovereign risk priced in by markets) as well as the gaps in the financial architecture of the euro area (i.e., the lack of a full banking union and the consequent heterogeneity of its banks, and, given that the 2021 amendment to the ESM treaty has not been ratified yet, the still-incomplete bank backstop arrangements) may mean that liquidity squeezes in the money market—a tail risk scenario—may have disproportionate effects on the fragmentation of monetary policy transmission in the European monetary union. This heterogeneity implies a need to ensure stable liquidity conditions for the diverse European financial sector across the range of possible states of the world, with the purpose of fulfilling the ECB's monetary and financial stability objectives.

With these considerations in mind, this paper contrasts options for the ECB's monetary policy operational framework—falling in the spectrum of a corridor or a floor.[2] While QT proceeds, because of abundant reserves, the ECB is likely to remain in a floor system for some time. For the steady state (i.e., once QT has run its course), based on the analysis of the trade-offs, the paper argues that the preferred option is a hybrid system that combines the characteristics of a "parsimonious floor" with a "zero (or near-zero) corridor".[3]

Under this hybrid system, the central bank supplies reserves at the minimum (parsimonious) volume consistent with the floor system, and banks can deposit their excess reserves if needed in a remunerated deposit facility, as they currently do. Because banks' demand for liquidity is uncertain, there is some possibility that money market interest rates occasionally shift above the deposit facility rate. To avert excessive fluctuations in the money market rate, the hybrid system complements the deposit facility with a standing lending facility or frequent fixed-rate full-allotment lending operations

[2] Before the global financial crisis (GFCC), the ECB employed a corridor system for implementing monetary policy, which engineered a structural shortage of bank reserves to a level where the target policy rate cleared the overnight money market by equilibrating the supply and demand for bank reserves. The corridor system lasted until the GFC and was followed by an intermediate system until January 2015, in which there was a corridor, but money market rates were close to a floor given by the ECB's deposit facility rate (DFR). After that, the ECB has implemented a floor system in which an abundant level of excess reserves has set money market rates very close to the floor.

[3] A parsimonious floor is a floor framework with the smallest central bank balance sheet size—or structural liquidity surplus—required to operate it (Della Valle, King, and Veyrune, 2022), with both structural and fine-tuning operations required to offset autonomous factors and short-term fluctuations on the demand for liquidity (Mæhle and King, 2022). In a zero corridor, the central bank implements, through a standing lending facility, a price ceiling on reserves and could be implemented with any level of aggregate reserves as long as there is a deposit facility priced at the same rate as the lending facility.

priced at or slightly above the deposit facility rate, capping the money market interest rate from above and thereby making the framework a zero-width or near-zero-width corridor.[4]

Compared to the current floor system with abundant reserves and thus liquidity, a near-zero corridor would come with significantly less ample reserves and require banks to strengthen their liquidity management, improve their forecasts of reserve demand over the maintenance period, and rely more on the interbank market for meeting liquidity needs. This set up also opens the possibility of intermittent liquidity shortages and the prospect of self-fulfilling liquidity runs—which would call for faster progress toward completing the banking union for the euro area countries to ensure such events do not precipitate wider, systemic banking distress. A zero corridor would better stabilize liquidity conditions but weaken banks' incentives for liquidity management relative to a near-zero corridor and leave a smaller role for interbank markets. Having said that, the choice of operational framework should not be seen as policy tool that seeks to engender changes in bank behavior. Rather, appropriate liquidity management, risk management, and overall resilience of banks should be ensured by intensive supervision, adequate financial regulation, and structural measures to enhance resiliency such as the completion of the Banking Union and a stronger crisis management and deposit insurance system.

A hybrid parsimonious floor / zero or near-zero corridor system would allow the ECB to control the overnight money market rate more precisely (relative to a standard corridor system) and would be consistent with a total amount of euro area bank excess reserves of about 1.3 trillion euros or less, based on our estimates, compared with 3.5 trillion as of February 2024. Moreover, compared to a standard corridor system, it would also be more compatible with the use of balance sheet tools if policy rates were to near the effective lower bound (ELB) again. Finally, it would be more compatible with the activation of the ECB's anti-fragmentation tools like the Transmission Protection Instrument (TPI).

The rest of this paper proceeds as follows. Section 2 gives a brief overview of different types of operational frameworks. Section 3 discusses economic trade-offs that characterize the choice between corridor and floor systems. Section 4 explains why the ECB would likely need to maintain the current floor system until the size of the balance sheet is reduced further via QT and outlines the considerations for a potential transition to a hybrid parsimonious floor / zero or near-zero corridor system in a future steady state. Section 5 concludes.

[4] This would also bring the ECB's operational framework close to what is being envisaged by other large advanced-economy central banks like the United States Federal Reserve System and the Bank of England, who also have to deal with large and sophisticated financial systems.

2. A Short Primer on Monetary Policy Operational Frameworks

The operational framework of most central banks includes the modalities for open market operations (OMO; the purchase or sale of securities), standing facilities (lending or deposit), other types of central bank lending to banks, asset purchase programs, and minimum reserve requirements. The precise definition and use of these instruments varies by central bank.[5] Different frameworks rely on all or only some of these instruments to achieve a level of central bank liquidity consistent with a target level for a short-term interest rate and an admissible volatility around said target. Regarding the permissible level of interest rate variation, monetary policy operational frameworks come in three flavors: a ceiling, a corridor, and a floor.

In a ceiling system, central banks abstain from providing liquidity to the banking system through open market operations thereby ensuring that the system has a structural liquidity deficit. This deficit means that banks will systematically be short of central bank reserves to meet reserve requirements and their needs for reserves for liquidity and payments purposes. Such a deficit will be met by using the central bank lending or discount facilities priced at the policy interest rate. Since banks will need to borrow from the central bank at the policy rate and will never choose to borrow from other banks at a higher rate (absent stigma),[6] the overnight interbank market rate will be equal to the central bank's discount rate, which will therefore be an anchor for short-term interest rates. This operational framework was common before World War I (Bindseil and Jablecki, 2011).

In a corridor system, which was deployed by most advanced economy central banks before the Global Financial Crisis (GFC), central banks engineer a structural shortage of bank reserves to a level where the target short-term interest rate clears the money market by equilibrating the supply and demand for bank reserves.[7] To ensure that the money market interest rate hits its target, central banks must correctly anticipate aggregate demand for reserves as a function of the interest rate. A common mechanism, also used by the ECB pre-global financial crisis (GFC), involves setting target reserves based on demand schedules formulated by banks themselves ahead of each policy meeting, fulfilling this declared liquidity demand, and, in order to ensure that banks have incentives to forecast their liquidity demand correctly, penalizing banks whose average reserves over the

[5] A description of the ECB's instruments can be found here: https://www.ecb.europa.eu/mopo/implement/html/index.en.html.

[6] Stigma in the context of monetary policy operational frameworks refers to the reluctance that banks may have in borrowing from the central bank's standing lending or discount facility. In the case of stigma, banks prefer to borrow from the money market at a higher rate for fear of it signaling to markets that they exhausted their ability to borrow in the money market. See Armentier and others (2015) for an historical perspective of stigma associated with the United States Federal Reserve's discount window.

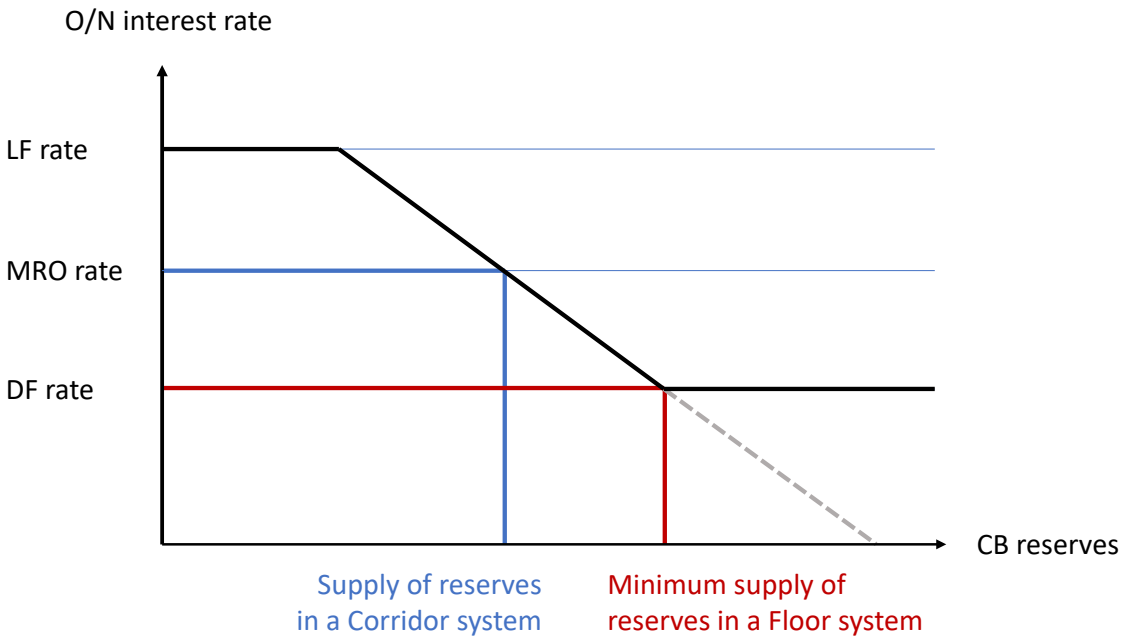
[7] Reserves are scarce in a corridor system in the sense that the central bank tightly controls the amount of reserves held by banks so that there is an opportunity cost for the latter to hold excess reserves (Borio, 2024) or too little reserves.

maintenance period (from one policy meeting to the next) deviate from the target in either direction.[8] Notwithstanding this mechanism, aggregate shocks in the demand for reserves during the maintenance period may cause the interest rate to deviate from its target. In this case, a central bank can adjust the supply of reserves with "fine-tuning" open market operations and/or use standing deposit and lending facilities priced at a margin around the target interest rate to provide upper and lower bounds for the money market rate (thus, the 'corridor' framework). Traditionally, the width of the corridor was +/- 100bps around the policy rate in major central banks, including for the ECB between 1999 and 2013, although some central banks employed narrower +/- 25bps corridors.

In a floor framework, which has been the norm for large, advanced economies since the GFC, central banks supply reserves in abundance through OMO, lending to banks, or asset purchase programs, and provide a floor for the price of reserves (interest rate) through a deposit facility. For example, the current ECB framework involves the supply of abundant reserves, in excess of reserve requirements and reasonable additional banks' reserves demand for liquidity and payments purposes. Then, the laissez-faire price of reserves (interest rate) could be very low, but the ECB bounds it from below using the deposit facility priced at the target interest rate level (Figure 1 summarizes the interest rate implementation mechanisms in the corridor and the floor frameworks). The expansion of bank reserves held at the ECB that took place between 2008 and 2022 was primarily driven by large scale asset purchases and targeted longer-term refinancing operations (TLTROs) and, during periods of acute market distress, refinancing operations and emergency asset purchase programs like the pandemic emergency longer-term refinancing operations (PELTROs) and the pandemic emergency purchase program (PEPP), respectively. Most of these programs are being wound down, which will lead to a smaller ECB balance sheet. Still, for the maintenance of a floor system, the ECB and other central banks will likely need to maintain a nontrivial amount of aggregate reserves backed by a structural bond portfolio (maintained through OMO) and/or structural longer-term refinancing operations (Lane, 2023c).

[8] In the context of the ECB's operational framework, the main penalty for banks failing to adequately forecast their liquidity needs to meet reserve requirements comes from having to borrow and the marginal lending facility rate (LFR), which is 100 bps above the DFR and 50 bps above the main refinancing operations (MRO) rate. The other penalty comes from not meeting reserve requirements, in which case a 250bps penalty applies. The purpose of averaging over the maintenance period is that requiring more stringent, daily compliance with target reserves would make money markets illiquid, as banks would be unwilling to lend or borrow reserves in response to high-frequency idiosyncratic demand shocks. Note that reserve targets, as a tool for forecasting the banks' demand for reserves, are distinct from reserve requirements that are used for liquidity management (sterilization) and financial stability purposes.

Figure 1. ECB Corridor and Floor Frameworks

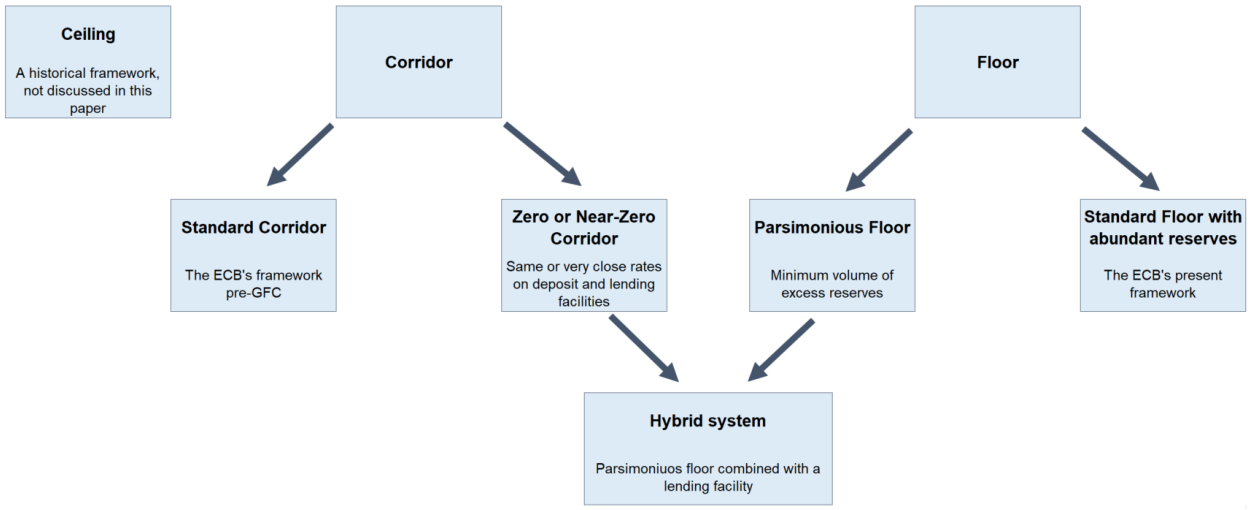


A variant of a floor framework is a "parsimonious floor", which is a floor system with a minimal supply of reserves that is just sufficient for the system to function as a floor system. This places the supply of reserves close to, but somewhat above, the level at which the money market rate starts being sensitive to the supply of reserves—the steep part of the reserves demand curve. However, the demand curve for reserves is difficult to estimate with precision, so the money market rate in a parsimonious floor may be unstable: bounded from below by the deposit facility rate but occasionally rising above. Hence, to ensure that the interest rate robustly remains at the deposit facility level even if the demand for reserves proves to be higher than anticipated, the central bank can supplement the parsimonious floor framework with a standing lending facility or frequent full-allotment lending operations priced at or slightly above the deposit rate, resulting in a hybrid system that also has the characteristics of a zero or near-zero corridor, respectively.

Unlike in a standard corridor system, in the near-zero corridor, the central bank does not strictly target the mid-point of the corridor, but rather permits the money market rate to fluctuate between the deposit and lending facility rates depending on banks' liquidity demand. While targeting an interest rate range instead of a point implies less precise monetary policy implementation, when the spread between the deposit and lending facility rates is small enough (for example, 25 bps), interest rate volatility within this narrow range may be relatively inconsequential for financial conditions and macroeconomic outcomes. Moreover, given that the level of excess reserves will be close to where the demand for reserves become sensitive to the money market rate, this rate will be at the deposit facility rate most of the time. Thus, in what follows, when this paper speaks of a corridor system, that implies a *standard* corridor system (akin to what the ECB had in place prior to the GFC), whereas zero and near-zero corridors correspond to the implementation of the hybrid system that combines a

parsimonious floor with a standing lending facility and fixed-rate full allotment lending operations. Figure 2 summarizes the types of operational frameworks discussed so far.

Figure 2. Types of Operational Frameworks for Monetary Policy



Different operational frameworks are consistent with various levels of central bank excess reserves provided to the banking system (Figure 3). The corridor system relies on providing the volume of reserves matching the bank's demand for reserves. The floor system is implemented using abundant reserves. As the volume of reserves in the floor system declines, the floor system risks becoming unstable in case the supply of reserves suddenly becomes binding, inducing the money market rate to de-anchor from the deposit facility rate. The hybrid system based on zero or near-zero corridor can, in principle, be implemented with any level of excess reserves – but using the volume of excess reserves corresponding to the parsimonious floor allows using the minimal volume of reserves consistent with a policy rate anchored to the deposit facility rate, a framework which Afonso and others (2023b) call *ample* reserves.

Figure 3. Consistency of Excess Reserves with Operational Framework

	No excess reserves	Ample excess reserves (small positive amount of excess reserves)	Abundant excess reserves
Corridor			
Zero or near-zero corridor, including the hybrid parsimoiuous floor			
Floor			

Note: Green = feasible combinations. Red = infeasible combinations. Orange = an unstable combination.

3. Benefits and Costs of Corridor and Floor Systems

Conceptually, the choice of the operational framework is driven by the central bank's preferences regarding overnight interest rate volatility around the policy rate target, the effectiveness of monetary policy transmission, the size of the balance sheet, the size and frequency of open market operations, the scope to implement financial stability interventions, and, in the case of the ECB, the need to preserve unified transmission of monetary policy across different jurisdictions (i.e., to mitigate fragmentation risks that would impair monetary transmission). All else equal, central banks prefer low policy rate volatility, small and infrequent open market operations, and a small balance sheet—the latter reflecting both political economy considerations (Afonso and others, 2023b) and a preference to avoid a potentially distortionary footprint in financial markets.

These multiple central bank objectives involve trade-offs. For example, achieving lower policy rate volatility may require frequent and sizeable open market operations in a corridor framework or a large balance sheet that underlies a floor framework. Therefore, the choice of an operational framework would depend on the balance and the relative hierarchy of these objectives.

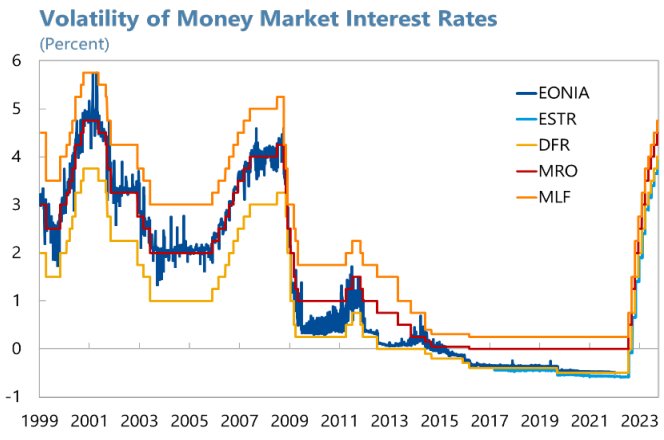
In what follows, we review the benefits and costs of the corridor and floor operating frameworks as they relate to monetary policy implementation and effectiveness, financial stability, and central bank finances.

Monetary Policy

Interest Rate Volatility and the Risk of Procyclicality and Divergence of Liquidity Conditions

In a corridor framework, the money market interest rate can fluctuate around its target, possibly substantially so in stressed periods. While such interest volatility encourages banks to manage their liquidity buffers more carefully, it may also make monetary policy implementation less precise.[9] Indeed, the implementation of a corridor framework, in which a central bank provides a quantity of reserves to hit a target price of reserves (interest rate), hinges on the accurate anticipation of the aggregate demand schedule for reserves (volume of demand as a function of the interest rate) by banks and the central bank alike. But the demand for reserves is volatile and hard to predict with high precision. Consequently, in corridor systems, the money market interest rate tends to fluctuate around its target, up to the bounds determined by the central bank's lending and deposit facilities – usually mildly so in normal times, but with potentially large deviations from the target rate during periods of stress. Figure 4, where the pure corridor system covers the period up to and including 2008, suggests that the corridor bounds were rarely approached before the GFC. However, in the aftermath of the GFC, rates approached the floor of the system as the ECB increased liquidity provision to banks through long-term lending operations (LTRO) with expanded collateral eligibility (Constancio, 2018; Hartmann and Smets, 2018) and remained volatile during the euro area sovereign debt crisis.

Figure 4. Volatility of Money Market Interest Rates



By contrast, in a floor framework with excess reserves, the central bank guides short-term interest rates by a price rather than a quantity mechanism, and target money market interest rates can be implemented more precisely during all market conditions. Indeed, Figure 4 shows a marked decline in the volatility of the money market interest rate once the ECB shifted to the floor system in 2015. In

[9] Potter (2016) argues that, with a corridor system, interest rate volatility in the interbank market is for the most part an artifact of reserve requirements and induced by the central bank.

fact, the floor system regime implemented after January 2015 had the lowest money market interest rate volatility since the inception of the Eurosystem.[10]

The volatility of the money market rate around its target has several implications. First, when the central bank is less able to hit the target interest rate, it may be more difficult to implement a desired monetary policy stance in a highly precise manner. Conceptually, this imperfection can be mitigated in systems with a narrower corridor.[11] But a corollary is that relative to a wide corridor, a narrow corridor system with no excess reserves may require the central bank to engage in more frequent fine-tuning open market operations. Moreover, banks may use the lending and deposit facilities more actively and trade less actively in the interbank market, implying a de-facto larger central bank presence in financial markets. These effects may be particularly pronounced for the ECB, as Europe's financial system is more diverse and complex than that of the jurisdictions that have used a narrower corridor, which could make the forecasting of the demand for reserves more difficult.[12]

Second, the volatility in money market rates could be procyclical. In anticipating their funding conditions, banks must account not only for the target interest rate, but also for the risks and risk premia associated with the fluctuation of the money market interest rate around its target. High risk premia imply de facto tighter funding conditions than those implied by the target interest rate alone. In stressed times, the precision with which a central bank can hit the target interest rate is lower, and thus money market risk premia are higher – implying a de-facto pro-cyclical tightening of money markets, up to the level implied by the corridor's upper bound. Additionally, as the deviations of money market rates from the target are a visible indication of money market stress, they may induce further, self-fulfilling money market tightening (e.g., Hughes, 2023, describes a recent self-fulfilling money market tightening episode in the United States). While in principle a central bank could offset such tightening by loosening the monetary policy stance or providing additional liquidity (reserves) to the banking system, the response time of such interventions may leave the financial system exposed to at least temporary and potentially self-fulfilling liquidity tightening episodes in practice.

Finally, while higher borrowing rates for weaker banks in a corridor framework may encourage them to improve their liquidity management, and ultimately their fundamentals, these banks could face stigma that could unduly amplify their financial stress. In the euro area context, this may also imply a divergence of liquidity conditions across countries, as had occurred in the euro area during the GFC and the European sovereign debt crisis (see Garcia-De-Andoain and others, 2014). When banks

[10] The ECB has had three regimes for the operational framework so far. The corridor system lasted until the GFC and was followed by an intermediate system until January 2015, in which there was a corridor, but money market rates were close to the floor. After that, the ECB has implemented a floor system. The estimated time-varying volatilities of the first difference of the EONIA/ESTR rate, according to a GARCH(1,1) process for each regime, are 0.0633, 0.0451, and 0.0067 for the corridor, intermediate, and floor regimes, respectively, and are all statistically different from each other at the 1 percent level.

[11] For example, pre-Covid, the Reserve Bank of Australia, the Bank of Canada, and the Reserve Bank of New Zealand used a +/- 25 bps width corridor.

[12] Furthermore, as the corridor narrows, it becomes increasingly akin to a zero-corridor implementation of the parsimonious floor system (Section 4). In these circumstances, a parsimonious floor might be preferrable, as it would have broadly similar properties but reduce the risk of a lending facility stigma.

avoid using the central banks' lending facility, a formally symmetric corridor may become de facto asymmetric (Lee, 2016). Then, the effective implementation of the interest rates would require the central bank to have information not only on the aggregate but also on bank-specific demand for reserves, a high informational bar (Bindseil, 2014). The corridor framework therefore requires that the supervisors closely monitor banks' financial conditions and liquidity management practices and induce corrective action where necessary.

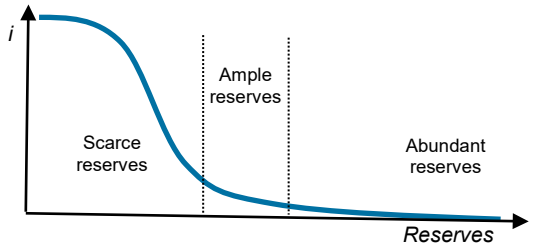
Still, unlike for the U.S. Federal Reserve's discount window, the evidence of stigma when it comes to euro area banks accessing the marginal lending facility is somewhat inconclusive. On the one hand, euro money market rates have never surpassed the ECB's marginal lending facility rate (i.e., euro area banks have never chosen to avoid borrowing from the ECB and borrow instead from the interbank market at a higher rate). Although the reasons for a lack of stigma are not totally clear, the way the ECB communicates about its marginal lending facility (as being just another overnight facility that banks can tap into instead of only a lender of last resort facility) may have played a role (Lee and Sarkar, 2018). On the other hand, there is evidence of stigma in the access to ECB dollar swap lines by euro area banks—made clear by widening deviations from the covered interest parity—during the 2010-2012 European debt crisis which lessened their effectiveness in dealing with stress in the dollar funding market (Allen and Moessner, 2012).

The volatility of the money market rate also relates in part to the uncertainty surrounding banks' demand for reserves. Aggregate demand for reserves may be more uncertain at present than in the past, and data from the pre-GFC corridor framework period may not reflect well the regularities that apply today (Aberg and others, 2021; Schnabel, 2023). A key reason is that the regulatory changes enacted since the GFC now require banks to hold substantial amounts of high-quality liquid assets (HQLA) to manage liquidity risk. Being subject to liquidity requirements and, more generally, having more rigorous liquidity risk management has made banks more resilient to liquidity runs compared to pre-GFC and GFC periods, but has likely substantially increased their demand for reserves and made it more difficult to predict (Aberg and others, 2021). Relatedly, in assessing the demand for reserves, banks and the ECB must consider the effects of financial innovation, including the larger role of nonbanks in the financial system and their liquidity and payments needs, the effects of a more digital and effective payments system, and the potential implications for the demand for reserves of the introduction of the CBDC.[13] These changes may have made liquidity forecasting potentially less certain and more costly in terms of central bank analytical resources (Box 1).

[13] Note that, depending on the design of the CBDC, its introduction will likely affect the demand for reserves in a regime of scarce reserves, but not necessarily in a regime of abundant reserves. When a household transfers funds from a bank deposit account to a CBDC account, as it would happen with a request for cash, bank reserves are destroyed (either by a reduction in vault cash or a drawdown of the commercial banks' deposits with the central bank). Under scarce reserves, the central bank will likely need to create additional reserves to satisfy the household's demand and the commercial bank's demand for liquidity. By contrast, when the same happens in a regime of ample reserves, a commercial bank can settle this transaction by transferring own excess reserves to the central bank to credit against the household's CBDC account, without requiring the central bank to issue more reserves. Moreover, Abad and others (2024) show that depending on the take-up of the CBDC, a central bank could follow a floor (low take-up), or need to follow a corridor (medium take-up) or a ceiling (high take-up) operational framework.

Box 1. Factors Affecting the Demand for Reserves

The state-of-the-art knowledge on the demand for reserves is that the demand curve is nonlinear and unstable (see Afonso and others, 2023a, for evidence for the United States and a conceptual framework). The nonlinearity comes from a kinked demand curve around the satiation level of reserves. The instability comes from horizontal and vertical shifts to demand.



Horizontal shifts to the demand are driven by factors that shift the demand for reserves at every price (interest rate) level. These include changes in bank liquidity regulation (e.g., the LCR requirements) and structural changes in money market liquidity (e.g., liquidity hoarding by banks as the perceived risk sharing benefits of interbank market activity decreases). Horizontal shifts in bank reserves can shift threshold points for the transition between the regimes of abundant reserves (where the demand curve is flat), ample reserves (where the demand curve is gently downward sloping), or scarce reserves, making exact thresholds uncertain. While these factors may be slow moving, they may complicate the transitions from the floor to the corridor framework.

Vertical shifts in the demand for reserves reflect factors that affect banks' ability to arbitrage the differences between policy interest rates (e.g., the DFR for the ECB) and interbank or money market rates (e.g., the Euro Short-Term Rate (ESTR) for the euro area). These factors include changes to banks' balance sheet costs which constrain their balance sheet space (i.e., the ability to expand their balance sheets), including those caused by regulations like limits to the leverage ratio (a lower cap on the leverage ratio would shift down the demand for reserves). The practical implication of these vertical shifts is that spreads between policy rates and overnight money market rates may be imprecise or inconsistent over time indicators of the ampleness of reserves.

Balance Sheet Tools

In a floor system, the size of the balance sheet and the overnight interest rate are disconnected (Reichlin and others 2021). In a corridor system, however, the short-term interest rate responds to changes in the size of the central bank's balance sheet. Thus, a corridor framework is likely inconsistent with the use of central bank balance sheet tools to ease financial conditions, because tapping these tools leads to a sizable increase in reserves, effectively lowering the money market rate to the floor. Since the GFC, central banks have used balance sheet tools to overcome the zero lower bound, support financial stability, and mitigate the risk of divergent responses to monetary policy across the euro area. Since the GFC, the ECB implemented QE through instruments such as APP, LTRO/TLTRO, and PEPP,[14] which are now being rolled back as part of QT. Also, the ECB has created important contingency instruments—TPI and OMT—to limit the risk of fragmentation of financial conditions in the euro area. Consequently, should the ECB shift to a corridor system, any future use of balance sheet tools would likely require a de-facto shift back to a floor system.

[14] Full PEPP principal reinvestment is expected to continue until mid-2024, after which the ECB plans to reduce this portfolio by 7.5 billion euros per month, on average (ECB 2023).

The potential complexity and signaling costs of the repeated transition to a floor framework,[15] ceteris paribus, could make the ECB's use of contingency tools—TPI/OMT—less credible in the eyes of the market participants, potentially compromising the stability of the euro area financial markets in times of stress. Theoretically, the additional reserves created by TPI/OMT operations could be sterilized if the ECB simultaneously sold sovereign bonds of counties not affected by financial fragmentation. However, as such sterilization would likely require selling bonds of countries that are not targeted by TPI/OMT, it may: risk unintended market impact due to the market's potentially limited absorption capacity especially as the activation of TPI/OMF would likely occur during stressed conditions; be operationally complex (as relates to dealing with the absorption capacity risks and the potential capital key constraints), and potentially be politically charged given that the sale of assets involved in the sterilization would create explicit "winners and losers" from TPI/OMT as relates to sovereign debt markets. Therefore, it cannot be ruled out that hinging the use of TPI/OMT on a simultaneous sterilization of the created reserves may negatively impact the credibility of the future use of these instruments.

Monetary Policy Transmission

From a conceptual perspective, the effects of the corridor and floor frameworks on monetary policy transmission are mixed (Table 1). On the one hand, because the floor system (or its variations, the zero- or near-zero corridor systems) can implement target interest rates more precisely at any point in time, the longer-term interest rates will more precisely reflect the expected path of the target short-term rates, possibly achieving better pass-through of policy interest rates along the yield curve under the expectations hypothesis of the term structure of interest rates. Similarly, as the floor system is more consistent with the potential for future QE, central banks can better control long-term rates near the effective lower bound and ensure more consistent monetary policy transmission across the euro area (by providing abundant liquidity, if needed, to all banks in the system), thanks to either actual QE or central bank communication about potential QE. Relatedly, the floor framework, by allowing the use of central bank balance sheet tools such as TLTRO, allows a more direct impact on bank liquidity conditions and incentives to lend, which may strengthen monetary policy transmission over the business cycle.

On the other hand, the corridor framework avoids conditions where banks have access to de-facto unlimited liquidity in the form of central bank reserves, and some literature suggests that bank deposits and lending may respond to policy interest rates more forcefully when banks are less liquid (Kashyap and Stein, 2000).[16] However, more recent studies suggest that the transmission of monetary policy to interbank and lending rates, as well as to lending volumes, may be stronger under a floor system with abundant reserves than under a corridor system with a lean balance sheet

[15] However, there remains disagreement concerning how cumbersome it would be to revert to a floor system from a corridor every time the central bank needs to deploy unconventional monetary policy with Borio (2023, 2024), for example, arguing it would not be very much so.

[16] The reason is that monetary policy transmits to banks also through funding liquidity conditions, and changes in funding liquidity affect the lending capacity of less liquid banks more.

if interbank markets are not very efficient and interbank rates include a significant liquidity premium when reserves are scarce (Bianchi and Bigio, 2022).[17]

Table 1. Conceptual Considerations on Transmission in Floor vs. Corridor

	Floor with abundant reserves	Parsimonious floor		Corridor
		Zero-corridor	Near-zero corridor	
Footprint in money markets	Large with very limited interbank market activity.	Large with very limited interbank market activity.	Large with limited interbank market activity.	Limited, depending on width of corridor. With a narrow corridor, footprint increases with frequency and size of OMO.
Footprint in (other) financial markets	Large given large central bank bond holdings. Large excess reserves.	Medium with moderate sized excess reserves and/or direct lending to banks.	Medium with moderate sized excess reserves and/or direct lending to banks.	Limited, in normal times. With increased money market volatility, central bank lending to banks may increase. Reliance on interbank market may add financial fragility and make LOLR more frequent.
Volatility of policy rate	Zero with possibly better transmission along yield curve.	Zero with possibly better transmission along yield curve.	Zero or limited, with possibly better transmission along yield curve.	Could be high, which adds to lending rates through higher liquidity premium (but not clear how big an issue in normal times).
Transmission to deposit rates	Low for overnight and demand deposits, some transmission to longer term deposits.	Possibly higher than under floor with abundante reserves but lower than under a corridor.	Possibly higher than under floor with abundante reserves but lower than under a corridor.	Higher than under any floor system.
Transmission to lending rates	Strong transmission to interbank and bank loan rates.	Strong transmission to interbank and bank loan rates.	Strong transmission to interbank and bank loan rates.	Somewhat weaker transmission if interbank market is not very efficient and liquidty premium is high.
Transmission to bank credit	Strong, especially if capital requirements are strict.	Strong, especially if capital requirements are strict.	Strong, especially if capital requirements are strict.	Weaker than under floor and possibly in the wrong direction if capital requirements are lax and reserves low.
P&L cycle	Amplified, with strong earnings in easing phase and high losses in tightening phase.	Variable depending on how far is the aggregate supply of reserves to the right of the point of satiation of demand for reserves.	Variable depending on how far is the aggregate supply of reserves to the right of the point of satiation of demand for reserves.	Very limited, especially with wide corridor.

Recent analysis in Breyer and others (2024) shows that bank liquidity mattered in the euro area for transmission of policy rates to bank deposit rates but not to the loan rates during the ECB's 2022-23 tightening cycle (Box 2). While there is evidence that the transmission of policy interest rates to bank deposit rates (i.e., pass-through) is weaker when banks' liquidity positions—as captured by LCR and NSFR—are stronger, excess reserves by themselves (a characteristic of a floor system) do not correlate with pass-through to deposit rates based on cross country data for all euro area countries in 2022. The latter finding might reflect the fact that reserves are but one component of overall bank liquid asset holdings.[18] Importantly, and more directly related to the transmission of monetary policy

[17] The argument relies on the interaction between liquidity and capital requirements, and the existence of frictions in interbank markets. Such frictions generate a liquidity premium when reserves are scarce, but not when they are past the point in which banks' reserves are no longer sensitive to the interest rate. Increasing the deposit facility rate when reserves are scarce can lead to an expansion in deposit creation (now cheaper) and lending, and an incomplete pass-through to interest rates (because the liquidity premium is shrinking). However, when reserves are abundant, interest rates move one-to-one with the deposit facility rate (strong pass-through) and, because capital requirements will always bind with abundant reserves, lending will unambiguously fall.

[18] Moreover, low transmission of policy rates to deposit rates may imply stronger monetary policy transmission to bank lending as it may, ceteris paribus, reduce the volume of bank deposits and hence bank lending (Drechsler, Savov, and Schnabl, 2017).

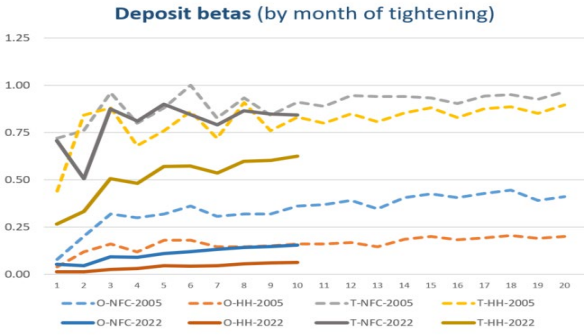
to the real economy, neither the banking system's liquidity nor the level of excess reserves are correlated with the transmission of policy rates to nonfinancial corporations (NFCs) or household loan rates. Relatedly, Lane, 2023b indicates that the changes in credit volumes in the euro area appear stronger during the ongoing tightening cycle than during the previous tightening cycles, alleviating concerns that such transmission may be impeded by high bank liquidity.

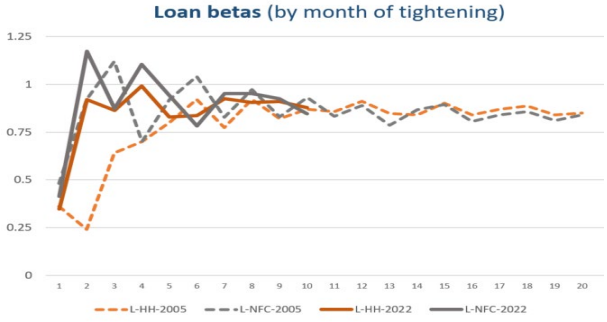
Box 2. The (Non-)Impact of Bank Liquidity on Monetary Policy Transmission

Monetary policy transmits to the real economy primarily through its impact on the interest rates relevant for economic agents (such as bank deposit and loan rates). Those interest rates effect the real economy via several economic channels, such as the standard neoclassical interest rate channel, the income channel, the balance sheet channel, and the banking channel (see Beyer and others, 2024 for a description of the channels and Mishkin, 1996, Boivin and others, 2010, and references therein for a more detailed discussion).

The tightening cycle that the ECB initiated in 2022 represents a real-life case of monetary policy tightening under high bank liquidity and excess reserves. One can therefore assess whether this environment was associated with impeded transmission, by comparing the transmission of monetary policy to interest rates during this cycle to that during the previous (2005) tightening cycle and by examining cross-country evidence on the association between bank liquidity and excess reserves vs. the strength of the transmission.

For bank rates, the transmission to deposits rates, particularly for household and corporate overnight deposits (O-HH and O-NFC, respectively) and term household deposits (T-HH), seems weaker this cycle. However, the monetary policy transmission to variable-rate loan rates, which may be more directly related to the effects of monetary policy on the real economy, appears as strong this cycle as in the previous one.

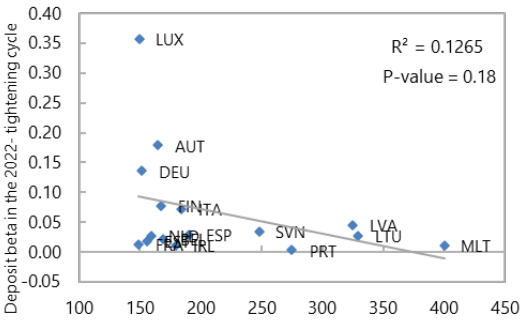




Using cross-country data for this tightening cycle, we explore the determinants of deposit and loan betas (Box Figure 2.1), defined as a ratio of the increase in the bank interest rates to the increase in the policy rate, both measured cumulatively from the beginning of the tightening cycle to the most recent observations at the time of writing (October 2023). The analysis confirms that high bank liquidity (as measured by the LCR) may have contributed to low deposit betas but had no effect on loan betas. Interestingly, even for the effect of bank liquidity on the deposit rates, banks' excess reserves per se are insignificant, indicating that excess reserves are but a part of banks' overall liquidity.

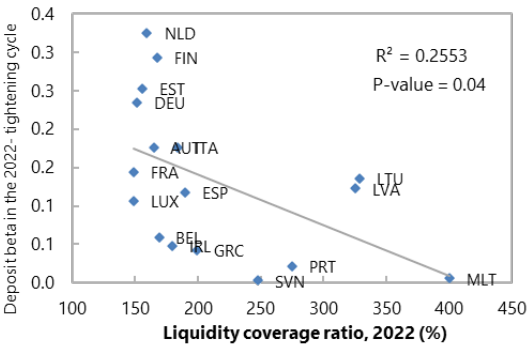
Box Figure 2.1. Deposit and Loan Rate Betas and Banking System Liquidity Characteristics

Euro Area: HH O/N Betas and Liquidity Coverage Ratio



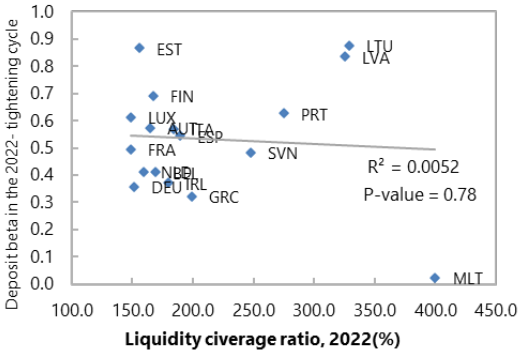
Sources: Haver Analytics; and IMF staff calculations.

Euro Area: NFC O/N Deposit Betas and Liquidity Coverage Ratio



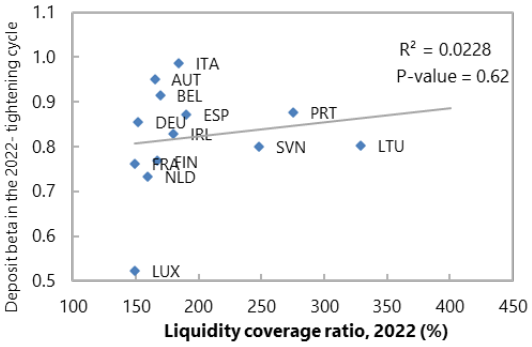
Sources: Haver Analytics; and IMF staff calculations.

Euro Area: HH Loan Betas and Liquidity Coverage Ratio



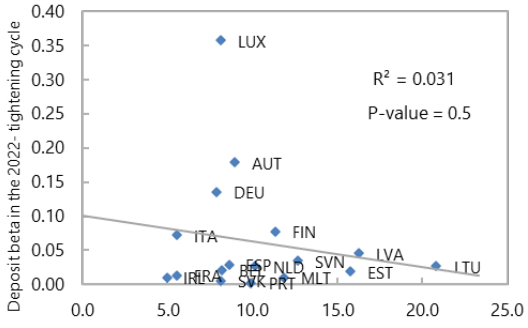
Sources: Haver Analytics; and IMF staff calculations.

Euro Area: NFC Loan Betas and Liquidity Coverage Ratio



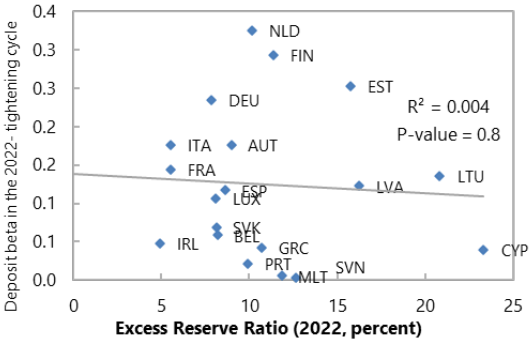
Sources: Haver Analytics; and IMF staff calculations.

Euro Area: HH O/N Betas and Excess Reserve Ratios



Sources: Haver Analytics; and IMF staff calculations.

Euro Area: NFC O/N Betas and Excess Reserve Ratios



Sources: Haver Analytics; and IMF staff calculations.

Note: Bank deposit and loan betas are defined as a ratio of a change in bank interest rate to a change in the policy rate since the beginning of this tightening cycle to the most recent observation (Oct 2023). Lower betas indicate weaker transmission of policy rates to bank rates.

Financial Sector Footprint, Market Discipline, and Financial Stability

The corridor system, thanks to a smaller supply of reserves than in a floor system, is associated with a smaller central bank balance sheet, which may encourage interbank market activity, enhance market discipline, and support price discovery. In the corridor framework, the central bank supplies reserves and banks lend and borrow these reserves between themselves to manage their daily idiosyncratic liquidity needs. Traditionally, such interbank lending was seen as supporting market discipline by encouraging banks to monitor each other's conditions (and banks are considered superior in monitoring each other as they operate in the same industry with similar business models, Rochet and Tirole, 1996).[19] Additionally, decentralized markets enabled "price discovery": bank-specific interbank rates contained price signals on the borrowers' financial health, while average interest rates provided policymakers with information on the banking systems' overall liquidity conditions.

While the corridor system could engender improved liquidity management practices and interbank activity, several recent developments and findings may mean that market discipline and price discovery in interbank markets could be less effective than previously thought.

First, both before and especially after the GFC, much of the interbank market has moved from unsecured lending with rates that are sensitive to borrower conditions to secured (repo) lending where rates depend mostly on the quality of collateral (Lane, 2023a). Moreover, the money market expanded to include many nonbanks. Part of these moves were related to changes in bank regulation that impose higher capital charges on unsecured than on secured interbank exposures and are unlikely to be reversed. The move to secured lending undermines lender banks' incentives to provide market discipline and focuses price discovery on collateral availability and quality rather than on reputation or perceived balance sheet strength of borrower banks. Still, even in secured lending, lending counterparts may exercise a degree of market discipline when they do not wish to be reputationally connected to a failing borrower even when their financial exposure is protected by collateral or risk costly failures-to-deliver in subsequent trades.[20]

Second, even though interbank markets may provide some warning ahead of impending stress, creditor-based market discipline is often overly discrete. Lenders may exhibit complacency in good times but withdraw funding rapidly during stress in a run-like manner in response to rising

[19] At the conceptual level, a key ingredient of the market discipline hypothesis of money markets is asymmetric information (see Hoerova and Monnet, 2016). The interaction between banks with liquidity deficits and banks with excess liquidity in unsecured or secured money markets leads to lower risk taking by the former either through borrowing limits or collateral requirements. However, market discipline fails in the presence of aggregate liquidity risk and the provision of liquidity by the central bank can improve outcomes.

[20] A "failure to deliver" or simply "fail" is a situation in repo or securities lending when the counterparty responsible to deliver the security at the end of the transaction fails to do so. It is common for financial intermediaries to commit to deliver in subsequent trades the securities that they have temporarily pledged in repos, a phenomenon known as rehypothecation. Secured lending connections to a failing bank may render a bank unable to retrieve the pledged securities, raising a cascade of contractual and liquidity issues in the system.

counterparty risk or due to liquidity hoarding.[21] Creditor runs on an individual bank can be contagious and precipitate broader interbank market freezes and liquidity squeezes (Liu, 2016). Consequently, signals which arise from money markets, although useful, may come too late for corrective action by supervisors and, therefore, should not substitute for timely, intensive supervision and adequate regulation.

Third, the conditions in other markets, notably for bank's equity and subordinated debt may provide policymakers with information broadly comparable to that which they could elicit from interbank market rates (Gorton and Santomero, 1990; Ashcraft, 2008).[22] Moreover, the use of interbank market as a monitoring tool of the policymaker requires the existence of stigma in the access to standing lending facilities or discount windows, which reduces the ability of the operational framework to manage bank liquidity (Anbil and Vossmeyer, 2019).

Finally, information revealed in interbank lending may not be very high and interbank markets can be marked by risk-shifting, segmentation, and a build-up of systemic risk (Upper and Worms, 2004 and Elliot and others, 2021).[23] For instance, under a corridor system like that of the ECB before 2008, interbank markets tended to be surprisingly segmented with credit limits and reputation considerations that induced banks with liquidity shortfalls to prefer private settlement of their accounts instead of openly borrowing in the interbank market so as to not reveal potentially compromising information (Gaspar and others, 2008).

Importantly, floor and corridor systems may have different implications for financial stability. On the one hand, a corridor system may not be very robust to financial market stress. As shown by Bindseil and Jablecki (2011), under a conventional corridor and for given transaction costs in the interbank market, the wider the corridor, the greater the interbank market turnover (as it becomes less likely that a bank hits either the upper or lower bound of the corridor after a liquidity shock), the smaller the size of the balance sheet, and the greater the volatility of short-term interest rates. The choice of the optimal width of the corridor ultimately depends, in their framework, on central banker preferences. However, with increasing transaction costs, as to be expected in a crisis, either the width of the

[21] Lender complacency in good times that can give way to abrupt "run"-like behavior in periods of stress was analyzed, for example, in Ratnovski (2013). The phenomenon of liquidity hoarding for precautionary motives during financial stress periods is well documented. For example, Acharya and Merrouche (2013), Ashcraft and others (2011), and Berrospide (2021) find evidence of hoarding in interbank markets during the GFC and Tran and others (2023) for the Covid crisis. Liquidity hoarding can happen because of counterparty risk (Heider and others, 2015), rollover risk (Acharya and Skeie, 2011), or asset price volatility (Gale and Yorulmazer, 2013). Counterparty risk can increase in crisis periods because of adverse selection or because of higher credit risk which increases banks cost of capital (Afonso, Kovner, and Schoar, 2011). Adverse selection in interbank market occurs interbank market participants cannot differential weak banks from the rest and lenders require higher rates to participate in that market. From a theoretical point of view, there is reasonable consensus that the ample provision of reserves by the central bank, by substituting the private provision of liquidity, solves these problems (e.g., Gale and Yorulmazer, 2013, and Heider and others, 2015).

[22] Market discipline and price discovery that occur in markets other than the short-term funding markets are beneficial in that they less likely to lead to disorderly bank failures. As a flip side, however, it may allow weak banks ("zombies") to persist in the financial system for longer. In general, this calls for more active regulatory policy intervention to deal with weak banks and overbanking (ESRB, 2014).

[23] Risk-shifting occurs when bank shareholders maximize their returns in states of the world in which their bank and that to which it lends have high profits, while they see their losses capped at the value of their equity when both banks fail.

corridor widens (and the allowed interest rate volatility increases, possibly with different implications for the stability of the financial system as a whole and possibly weakened monetary policy transmission) or the interbank market volume plumets (with a corresponding increase in the take-up of the central bank's standing facilities).

Moreover, the implementation of an operational framework with lean reserves such as a traditional corridor or ceiling could increase the potential for liquidity squeezes in other short-term funding markets such as repo and foreign exchange swap markets (Afonso and others, 2022). This is because, at least for U.S. banks, there is evidence of strategic complementarities in banks' behavior when settling interbank payments: even when reserves are abundant, banks tend to wait for incoming payments before settling outgoing payments. This is a sign that the level of excess reserves observed at a given point in time may not be a strong indication of abundant liquidity as banks still hoard intraday liquidity. Although there could be many reasons for such behavior, including liquidity regulation, the use of reserves for repo lending and FX swaps is a likely candidate (see Afonso and others, 2022, and sources therein). Hence, the reduction of the total amount of excess reserves could increase the chances of those markets becoming impaired.

On the other hand, although a large supply of reserves in a floor system reduces the risk of liquidity stress in banks, it may also induce collateral shortages that can be destabilizing for nonbank financial intermediaries (NBFIs). By allowing banks to meet HQLA needs with reserves, a floor system reduces the risk of bank liquidity shortages and asset fire sales during periods of financial stress, which could happen should banks need to sell illiquid assets to meet their liquidity needs (see Afonso and others, 2023b and references therein). This reduces the need for the activation of emergency liquidity facilities by the central bank, which may carry stigma. Relatedly, the intermediation of liquidity via the central bank rather than by interbank markets leads to less financial interconnectedness between commercial banks, which reduces the scope for potentially unpredictable contagion in the case of bank stress and failures (Allen and Gale, 2000; Nier and others, 2007). At the same time, the central bank bond purchases that underlie the creation of ample reserves may result in collateral shortages in the repo markets, resulting in liquidity pressures in the NBFIs, which typically have no direct access to central bank facilities and rely on sourcing liquidity from commercial banks via secured (repo) money markets. The monitoring of collateral shortage risks may be complicated by the relative opacity of the NBFI sector, including as relates to its liquidity needs. A broad enough collateral framework can permit the central bank to tailor asset purchases in a way that minimizes the effects of reserves creation on collateral availability, as well as increases the price stability of a broader range of assets by making them eligible central bank collateral.[24]

Finally, given the diversity of the European banking system, with weak banks concentrated in some jurisdictions, a system that relies on an active interbank market to address idiosyncratic liquidity shocks (i.e., a corridor system with a structural liquidity shortage) may deliver very different bank

[24] An eventual scarcity of collateral could also be remedied if the ECB were to start selling its own bills, as many other central banks currently do (e.g., Central Bank of Chile and Swiss National Bank).

liquidity conditions across euro area counties even outside of crisis periods. This is because the demand for bank reserves can be different from country to country even with uniform liquidity regulations and similar fundamentals because, among other factors, the level of trust that exists among participating banks varies across countries. In particular, in countries with a past of frequent bank failures and stress, a lower level of trust among banks ensues, which decreases the participation in interbank markets and increases the reliance on central bank liquidity (Allen and others, 2022). Hence, the return to a corridor framework may exacerbate the unequal distribution of bank reserves across the euro area and raise the risk of liquidity shortages that could be amplified via self-fulfilling runs into broader systemic distress. Though a floor system would mitigate these concerns, these fragmentation risks nevertheless underscore the need to make faster progress toward the banking union as the ECB's balance sheet winds down with QT and the transition to the steady state operational framework proceeds. Still, from a financial stability perspective, the choice between retaining the current floor system (or moving to a parsimonious floor with less abundant reserves) or moving to a corridor framework with lean reserves should also consider the benefits of reducing the risks of liquidity runs and of potential fragmentation of financial conditions across jurisdictions against the cost of, through moral hazard, contributing to structural bank fragilities.

The Eurosystem's Finances

The choice of the operational framework may have implication for the financial position of a central bank. Notably, the size of the central bank's balance sheet, which is partly endogenous to the choice of the framework, will likely affect the variance of its profit over the monetary policy cycle. The reason for the cyclicality of a central bank's profit is that central bank balance sheets exhibit duration mismatch. Most central bank assets are long term and have a fixed interest rate (e.g., government bonds and other securities), while the liabilities are short term and have variable interest rates (predominantly, reserves). Consequently, central banks experience valuation and income losses when interest rates increase and gains when interest rates decline. When a central bank's balance sheet is smaller, the central bank's losses and gains over the monetary policy cycle would be smaller in absolute terms, all else equal.

In principle, a central bank's profitability should be subordinate to its primary objectives of achieving monetary and financial stability (Belhocine and others, 2023). Nevertheless, in reality, there is a risk that central bank losses, even temporary ones, may lead to undesirable political interference or diminish public confidence in the central bank. Indeed, Schwartz (2014) cautions that "the financial weakness of a central bank can, in extremis, affect the effectiveness of monetary policy decisions, since policy measures can expose central banks to the risk of substantial losses." Furthermore, empirically, central banks tend to exhibit a preference for making non-negative profits (Goncharov and others, 2023), suggesting concerns about the potential impact of balance sheet losses on central bank policies and operations.

The corridor system operates under a smaller central bank balance sheet size compared to the floor system with abundant reserves, and therefore makes central bank profit less affected by fluctuations

of the monetary policy stance. Similarly, a floor framework with a smaller volume of excess reserves (and especially the "parsimonious floor" framework with the minimum volume of excess reserves consistent with the floor system) would also serve to reduce the volatility of central bank profit compared to a floor system with more abundant reserves. These considerations could be taken into account in determining the desired steady state size of the central bank balance sheet where the risk of political inference is high and cannot be mitigated.

4. Path Forward: From the Floor to a Hybrid System

Near-Term Issues

Until QT advances further and excess reserves have been removed from the system, the ECB will most likely have to maintain the current floor framework, because a corridor system is not consistent with excess reserves (see the discussion of balance sheet tools in Section 3). Based on the current QT pace, the volume of reserves may become binding for the interest rate around 2028-2030 (see slide 3 in Schnabel, 2023), although it may start to affect bank and bond market liquidity conditions as early as 2026 (Altavilla and others, 2023). The corollary of the long lead time is that the economic conditions that inform the analysis of the trade-offs involved in choosing an ECB operational framework for the steady state may change by then.

As QT proceeds, there would be benefits from augmenting the floor framework with a "demand-driven" lending facility or full allotment open market operations priced at or close to the deposit facility rate,[25] to ensure robust and consistent transmission of monetary policy. Notwithstanding the estimates by Schnabel (2023) and Altavilla and others (2023), the exact point where the demand for reserves becomes binding for interest rates may be highly uncertain as past regularities in the demand for reserves may not hold. A demand-driven lending facility would ensure that when the supply of reserves during QT under a floor system becomes binding, banks can start tapping the facility, which would anchor the money market rate at the policy rate and ensure robust transmission of target policy rates (Box 4). Additionally, given the uneven distribution of excess reserves across European banks and potential frictions in interbank markets, a demand-driven facility would also ensure consistent transmission of monetary policy across the euro area during QT. Note that the introduction of a demand-driven facility effectively transforms a floor system into a hybrid system that also has the characteristics of a zero corridor or near-zero corridor, depending on whether the lending facility is priced at or near the DFR.

[25] Relative to other allotment procedures in central bank auctions, a fixed-rate full-allotment auction makes it easier for banks to know beforehand how much of their net demand for reserves will be met by the central bank (i.e., it makes the supply of reserves more predictable, thereby removing noise from the money market; see Bindseil 2016). The ECB has been using fixed-rate full allotment tenders since 2008.

A demand-driven facility would also have financial stability benefits. The reduction in central bank balance sheet during QT may have difficult-to-predict effects on the financial system once liquidity conditions tighten. For example banks that have extended credit or have committed to credit line increases during central bank balance sheet expansion may be unable to easily unwind such exposures during balance sheet drawdowns, potentially limiting the banks' ability to extend new loans (Acharya and others, 2022). Another challenge is that withdrawing from banks an important liquid asset—de-facto unlimited central bank reserves—requires adjustments throughout banks' balance sheets. Banks may need to accumulate other liquid assets and/or switch to more stable sources of funding, which may be costly and cause market uncertainty. Also, money market desks in banks may have limited experience in operating under scarce liquidity, raising the risk of liquidity planning mistakes (cf. Bouwman and Malmendier, 2015). These challenges can be further complicated by the fact that the European banking system is large and heterogeneous, and that QT coincides with other adjustment needs in European banks, including those to higher interest rates and to a possible increase in NPLs. Moreover, despite a substantial strengthening of capital and liquidity buffers of European banks thanks to a wide implementation of Basel III and intensified supervision, the risk of fragmentation of financial conditions across jurisdictions, imperfect backstops, and the tail risk of sovereign-bank spillovers—all amplified by an incomplete Banking Union—are likely to remain in place for some time. In these circumstances, a demand-driven facility could provide an automatic and low-stigma backstop to the risk of liquidity shortages in European banks and give banks time to adjust to structural changes.

Box 4. The Bank of England's "Demand-Driven Floor" System

The Bank of England (BOE) has in August 2023 introduced a short-term repo facility (STR) to mitigate the risk of shortages in reserves supply during QT. The stated rationale for the facility is that although reserves scarcity is probably several years away, banks' overall demand for reserves is uncertain and will evolve over time. In this context, according to the BOE's Market Operations Guide, "it is possible that reserves scarcity could arise much sooner than expected." The STR allows the BOE counterpart bank to borrow an unlimited quantity of reserves at the policy rate, which is equal to the deposit facility rate. At the point where the supply of reserves reaches the level that may become binding for the price (interest rate) during QT, banks will be able to meet their demand for reserves at the policy rate price through use of the STR. This would ensure that the control of short-term interest rates in the context of the floor framework is maintained—the interest rate will remain anchored at the deposit facility rate—when reserves scarcity is reached. Once banks start tapping the STR facility, the volume of reserves will effectively be determined by banks' demand, rather than purely by the central banks' discretionary reserves supply decisions, hence the "demand-driven" floor.

A Steady-State Framework

Once reserves decline to levels close to the steep segment of the demand curve, the ECB would face a choice between continuing to maintain a floor system—which with the minimum volume of exchange reserves would become a "parsimonious floor"—or shifting to a corridor. The trade-offs

discussed in this paper indicate that the choice of a steady-state central bank operational framework is not clear cut. There are distinct benefits and costs associated with either option.

A corridor would anchor a smaller central bank balance sheet size, encourage banks to manage their liquidity tightly, and facilitate greater activity in the interbank market. But it could require relatively more frequent market operations to ensure the overnight rate stays close to the policy rate and leave the banking system vulnerable to intermittent liquidity shortages that may have financial stability implications and impair monetary policy transmission.

The parsimonious floor, on the other hand, would allow for more precise control of the overnight rate and lower the risk of liquidity shortages. But it may open the door to a larger ECB balance sheet size and could suppress interbank activity. It would also provide fewer incentives for banks to manage their liquidity and for banks with persistent liquidity shortages to strengthen their balance sheets.

The analysis of tradeoffs suggests that, on balance, in steady state a hybrid system that combines a parsimonious floor with a lending facility or frequent full-allotment operations priced at or very close to the deposit rate, corresponding to a zero or near-zero corridor, would be most conducive for achieving the ECB's monetary policy objective.

Specifically, the discussion in Section 2 suggests that maintaining such a hybrid system would combine many of the favorable attributes of the two polar frameworks with likely limited costs. First, the hybrid system that combines the parsimonious floor with a zero or near-zero corridor would allow for more robust control over the money market rate in an environment where accurately forecasting the demand for reserves (as required under a standard corridor) is challenging. Moreover, implementing the parsimonious floor with a broad-based structured portfolio, complemented by a broad collateral pool for structural lending operations can expand the pool of safe assets, without inducing scarcity in the market for highest quality bonds.

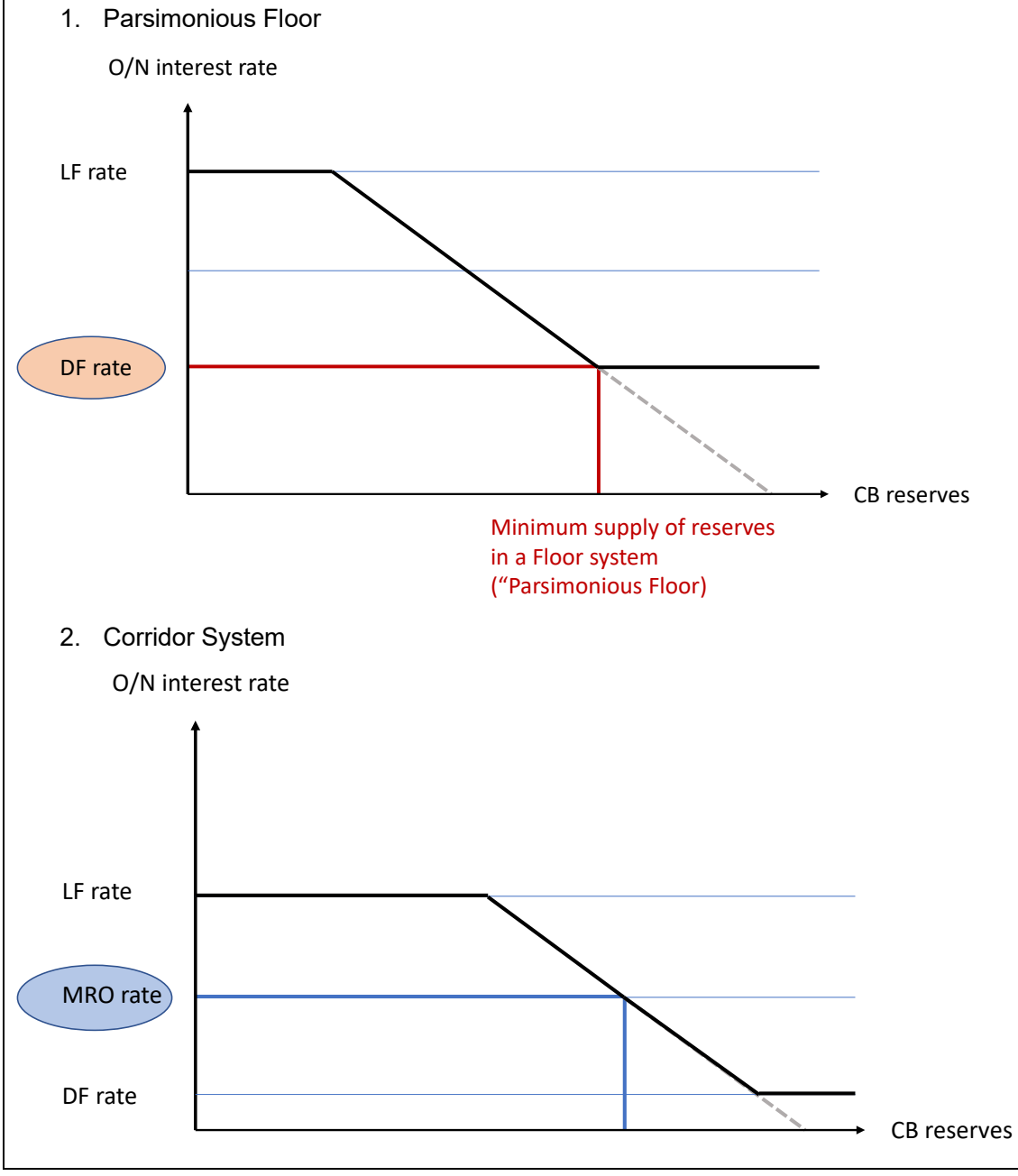
The volume of excess reserves in a parsimonious floor is expected to be considerably smaller than the current level, assuaging potential concerns that excess reserves would impede monetary transmission (however, as discussed, even under the current floor system, there is no evidence so far that the excess central bank reserves have interfered with transmission). The lower volume of reserves would also imply lessened volatility of the Eurosystem's finances over the monetary policy cycle—which, in any case, should remain orthogonal to monetary policy decision-making (Belhocine and others, 2023)—relative to a standard floor system. Moreover, while associated with a smaller steady state balance sheet than under the current floor, this hybrid system would still be compatible with the use of central bank balance sheet tools when the policy rate is close to the ELB—which may enhance the ECB's credibility in dealing with adverse demand shocks.

In fact, a hybrid system with a parsimonious floor (both the zero and the near-zero corridors) would enable maintaining the central bank balance sheet size at a level that is *identical or very close* to that of a corridor system. To see this, consider Figure 5, which is a variation of Figure 1. The two panels of the Figure depict an identical schedule of banks' demand for reserves and compare the

implementation of the same target interest rate under the two frameworks. In the parsimonious floor, the target rate is implemented by setting the lending rate at the same level as the deposit rate. Once the central banks' discretionary supply of reserves falls short of the demand for reserves at that rate, banks will tap the short-term lending facility up to a point where their demand for reserves at the target rate is satisfied. That point is given by the intersection of the policy rate and the demand schedule. Now, consider the implementation by the ECB of the same target rate in a corridor framework, in which the same target rate would be implemented as the main refinancing operations (MRO) rate. The central bank would aim to supply the volume of reserves given by the intersection of the same target interest rate (even though it is now the MRO rate not the DFR) with the banks' reserves demand schedule, that is, the same volume of reserves.

To summarize, the parsimonious floor and the corridor systems may in equilibrium operate with the volume of reserves given by the intersection of the target rate and the banks' reserves demand schedule. Deviations between the volumes of reserves may arise if, in a parsimonious floor, banks would opportunistically borrow at the short-term lending facility more reserves than they need to satisfy their liquidity demand. As this would result in excess reserves, banks would allocate them immediately to the deposit facility. However, the incentives of banks to "hoard" liquidity in this manner should be low if any, as long as the lending facility is always available. Moreover, since the lending facility is priced at the same or slightly higher rate than the deposit facility, the effects of such liquidity hoarding on the central bank's profits-and-losses should be minimal, if any. Maintaining a near-zero corridor rather than a zero-corridor variant of a parsimonious floor hybrid system would further reduce such liquidity hoarding incentives (although, as discussed below, might somewhat increase systemic liquidity risks).

Figure 5. Comparison of the Supply of Reserves in a "Parsimonious Floor" and in a Corridor System



The implementation of the parsimonious floor may require a judgement on whether the discretionary supply of reserves should be above or below the parsimonious point, as well as on the mix of asset purchases and OMO in the discretionary supply of reserves. When the discretionary supply of reserves is above the parsimonious point, banks would mostly be using the deposit facility, and when it is below that point, the lending facility. This choice may have implications for financial conditions, as discretionary reserves obtained by banks via asset purchases represent long-term

liquidity obtained at a fixed interest rate, while reserves obtained via OMO or a lending facility carry a short-term interest rate. Since bank loans are also long-term, the use of a lending facility may involve higher interest rate risk for banks. Consequently, higher bank reliance on the OMO or the lending facility may result in less credit provision and be non-neutral from a monetary policy stance perspective (Altavilla and others, 2023).

Another consideration for the provision of reserves above the parsimonious point may be that the central bank has better control over the types of assets that it chooses to acquire in asset purchases than over the types of assets that banks choose to pledge as collateral in the lending facility. This may potentially offer benefits from the perspective of central bank balance sheet risk management, while making collateral availability in the market more predictable, potentially reducing or helping to monitor the risk of collateral shortages.

This paper estimates the volume of excess reserves required to implement a parsimonious floor at about 15 percent of total overnight deposits at euro area banks, or 1.3 trillion euros (Figure 5). This number comes from a nonparametric estimation of the demand for excess reserves as a function of the difference between the money market rate and the main policy rate, and is pinned down by the slope of the demand curve becoming very close to zero.[26] This estimate is only somewhat higher than this paper's estimate of the level of excess reserves for which their convenience value is zero (i.e., such that the money market rate equates the interest rate on reserves),[27] about 12 percent of total overnight deposits or 1 trillion euros.[28] It is also very close to the Altavilla and others (2023) estimate of the level of excess liquidity consistent with the Friedman rule for reserves,[29] roughly 1.5 trillion euros.

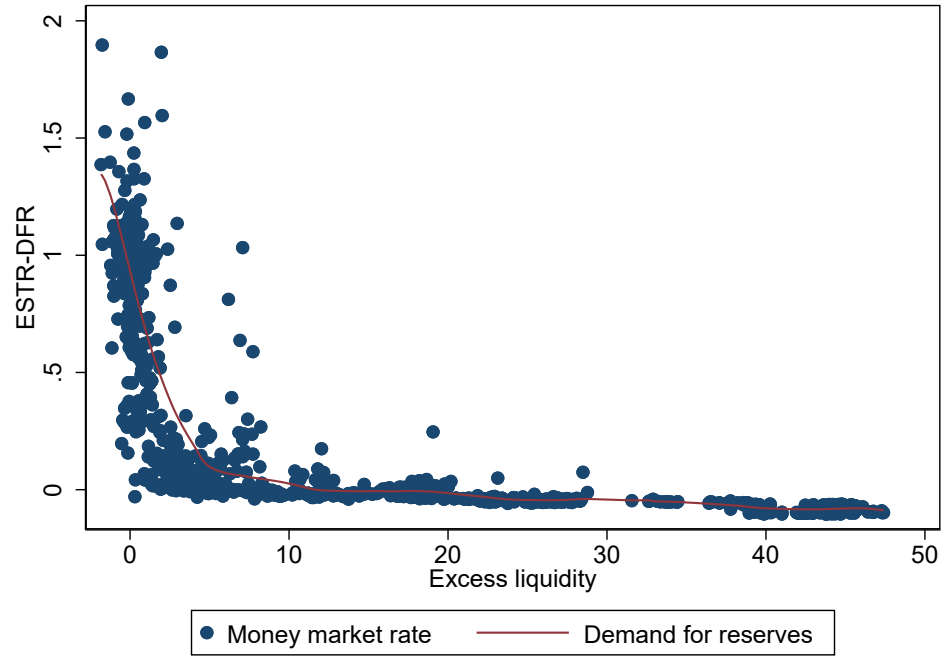
[26] The approach used here follows Chen and others (2023) who use parametric and nonparametric methods to estimate the demand for reserves for the U.S. Federal Reserve System and the Eurosystem. See Annex I for details.

[27] The convenience yield on reserves is measured by the difference between the money market rate and the interest rate on reserves, plus some balance sheet cost of holding reserves, possibly driven by regulation which constrains banks' balance sheet space (Vissing-Jørgensen, 2023).

[28] For comparison, Vissing-Jørgensen (2023) estimates the convenience yield-minimizing level of Eurosystem reserves at 1.25 trillion euros, provided the ECB's monetary portfolio is made only of "inconvenient" assets (i.e., assets which do not carry a convenience yield like ultra-safe sovereign bonds). If the ECB were to hold only government bonds according to the capital key, this estimate would be cut by about half.

[29] The Friedman rule for reserves implies a supply of reserves to a point in which they are no longer scarce, that is, to a point in which their convenience yield is zero (Vissing-Jørgensen, 2023).

Figure 6. Demand for reserves in the Eurosystem



Source: ECB and authors' estimates. Note: The chart shows the difference between the representative money market rate for the euro area (EONIA until October 2019 and €STR after that) and the ECB's main policy rate (the MRO until 2015 and the DFR after that) plotted against the level of excess reserves (in percent of total sight deposits at euro area banks) held at the Eurosystem from January 7, 1999 to August 10, 2023 at the weekly frequency. Excess reserves are calculated as deposit facility – marginal lending facility – average reserve requirement + current account. The red line is a fitted demand curve using nonparametric local-linear kernel regression.

Zero corridor versus near-zero corridor in a hybrid parsimonious floor system

Once having settled on a parsimonious floor hybrid system, the choice of zero corridor vs. a near-zero corridor involves trade-offs for the central bank. A potential benefit of a near-zero corridor is that it provides banks with incentives to better forecast their own liquidity demand to minimize the volume of borrowed reserves, so as to avoid allocating them to the deposit facility at the cost of a spread between the central bank's lending and deposit facilities.[30] A near-zero corridor may also permit more space for interbank markets, as the presence of a spread between the central banks' deposit and lending facilities would induce banks with idiosyncratic liquidity shocks to manage their liquidity in interbank markets (i.e., borrow and lend at market interest rates rather than depositing borrowed reserves with the central bank). But, as mentioned in Section 3, the additional informational content on borrowers (and resulting market discipline) may be limited in practice as activity in short-term money markets is now mostly secured with collateral, while other markets (for

[30] Borrowed reserves are funds borrowed by banks from the central bank to meet minimum reserves. Poor liquidity forecasts by banks may cause them to borrow above their liquidity needs.

example, for bank equity and subordinated debt) may provide comparable or more effective market discipline (Gorton and Santomero, 1990; Ashcraft, 2008).

However, a near-zero corridor may also exacerbate certain frictions compared to a zero-corridor. For example, the higher spread of the central banks' lending facility over the deposit facility, the higher the potential risk of stigma associated with the use of the lending facility even during tranquil times (see Altavilla and others, 2023). Moreover, intermittent liquidity shortages could materialize under a near-zero corridor, raising the prospect of self-fulfilling liquidity runs (especially when stigma is present)—which argues for making faster progress toward completing the banking union to ensure such events don't precipitate wider, systemic banking distress.

5. Conclusion

This paper has reviewed the trade-offs involved in the choice of the ECB's monetary policy operational framework. In the near-term, until the size of the ECB's balance sheet is reduced to a level which is closer to the one implied by the banks' demand for reserves to meet reserve requirements, payments settlement needs, and to appropriately self-insure against liquidity shocks, the ECB will likely continue to employ the floor system for implementing the target interest rate in money markets. Once the supply of reserves declines and approaches the steep part of the reserves demand function, the ECB will face a choice between a corridor system and a parsimonious (with minimal volume of reserves) implementation of the floor system. The analysis of the trade-offs indicates that the parsimonious floor has distinct benefits and likely limited costs compared to a corridor system. The implementation of the parsimonious floor involves a lending facility or frequent full-allotment short-term lending operations priced at or very close to the deposit rate. The choice between the zero-corridor or the very narrow corridor implementations of the parsimonious floor also involves trade-offs. While European banks are now financially strong, the fragmented nature of the European financial system will need to be taken into account in the choice of the ECB's operational framework until the Banking Union is fully completed. Still, the operational framework should not contribute, through moral hazard, to build further financial sector fragilities, which stresses the importance of intrusive bank supervision and of adequate regulation in line with a full implementation of Basel III.

Some of the core questions relating to the choice of the medium-term framework may not need to be settled up-front (Altavilla and others, 2023, Lane, 2023c). A cautious approach focused on delivering fail-safe management of transition risks relating to the reduction of aggregate reserves is of primary importance. Learning-by-doing should remain a guiding principle as the ECB transitions to a steady state operational framework as it provides flexibility to change course should circumstances justify it. Close monitoring of the evolution of bank funding patterns would help inform the shape and form of the future steady state balance sheet, including the feasible set of operational frameworks and the composition of the structural bond portfolio.

Annex I. Nonparametric estimation of the demand for bank reserves in the euro area

This annex explains how the estimates for the demand curve for aggregate bank reserves for the euro area were obtained. The demand curve is estimated using a nonparametric method because there is little to no guidance concerning its functional form, except that it is important to condition on the level of bank deposits (Lopez-Salido and Vissing-Jorgensen, 2023). In this setting, the use of nonparametric regression is ideal (Henderson and Parmeter, 2015). The results shown in Annex Table A.1 are produced by a nonparametric local-linear kernel estimator of the following general specification:

$$r_t = m\left(\frac{xres_t}{dep_t}\right) + \varepsilon_t,$$

in which r_t is the difference between the euro money market overnight interest rate and the ECB's main monetary policy rate at week t, $xres_t$ is the total excess reserves of euro area banks deposited with the Eurosystem, dep_t is total overnight deposits held at euro area banks, $m(.)$ is an everywhere differential regression function, and ε_t is an error term.

The nonparametric regression estimator uses an Epanechnikov smoothing kernel function, with inference being performed with a paired bootstrap with 399 replications. The kernel bandwidth parameters for the mean and derivative of $m(.)$ are set to 1.97, which is optimal in the root-mean squared error for the derivative estimator but imposes more smoothing than optimal for the mean estimator, which is needed to avoid some local nonmonotonicity in the fitted demand curve.

Annex Table A.1. Nonparametric estimation of euro area demand for bank reserves

	Average estimate	95 percent confidence bands
Mean	0.4196 ***	[0.393 0.444]
	(0.013)	
Derivative	-0.1390 ***	[-0.150 -0.128]
	(0.005)	
R2	0.86	
Observations	1,280	

Note: The table shows estimates of the mean and average slope of the difference between the euro area money market rate as a function of total bank excess reserves normalized by total bank deposits. Standard errors (in parenthesis) are calculated using a paired bootstrap. Confidence bands come the percentile bootstrap using 399 replications. *, **, *** mean that estimates are statistically significant at the 10, 5, and 1 percent levels, respectively. Data are from the ECB data warehouse and are at the weekly frequency, except for total euro area bank deposits for which they are at the monthly frequency and converted to weekly through linear interpolation.

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The ECB's Future Monetary Policy Operational Framework: Corridor or Floor?
Working Paper No. WP/2024/056