BANK OF CANADA
BANQUE DU CANADA

Staff Discussion Paper/Document d'analyse du personnel—2023-10

Last updated: May 15, 2023

Reviewing Canada's Monetary Policy Implementation System: Does the Evolving Environment Support Maintaining a Floor System?

by Toni Gravelle,[1] Ron Morrow[2] and Jonathan Witmer[3]

[1] Deputy Governor
[2] Executive Director, Supervision
[3] Financial Markets Department
Bank of Canada
jwitmer@bank-banque-canada.ca

DOI: https://doi.org/10.34989/sdp-2023-10 | **ISSN** 1914-0568

Acknowledgements

We would like to thank Stéphane Lavoie, Philippe Muller, Ron Allenby, Scott Kinnear, Harri Vikstedt and Francisco Rivadeneyra for helpful comments and discussion. We would also like to thank Melissa Siqueira and Chinara Azizova for research assistance.

Abstract

At the onset of the pandemic, the Bank of Canada transitioned its framework for monetary policy implementation from a corridor system to a floor system, which it has since decided to maintain. This decision was informed by the analysis and assessment of the two frameworks in this paper. We provide a comprehensive analysis of both frameworks and assess their relative merits based on five key criteria that define a sound framework. Our evaluation includes a discussion of how these relative merits have changed since the pandemic began. Specifically, we examine the evolving regulatory landscape, changes in payment systems, and the Bank's quantitative easing program to understand their implications for the relative strengths of the two frameworks for monetary policy implementation.

Topics: Monetary policy implementation; Payment clearing and settlement systems; Market structure and pricing
JEL codes: D4, D47, E42, E5, E58

Résumé

Au début de la pandémie, la Banque du Canada a modifié son cadre de mise en œuvre de la politique monétaire, passant d'un système de fourchette de taux d'intérêt à un système de valeurs plancher – qu'elle a décidé de conserver. Ce choix a été éclairé par l'analyse et l'évaluation de ces deux cadres réalisées dans cette étude. Nous présentons une analyse approfondie de chacun d'eux et évaluons leurs atouts respectifs en fonction de cinq grands critères qui définissent un cadre solide. Aux fins de notre évaluation, nous examinons comment ces atouts ont changé depuis le début de la pandémie. Plus précisément, nous nous penchons sur l'évolution du contexte réglementaire, les changements au sein des systèmes de paiement, et le programme d'assouplissement quantitatif de la Banque afin de comprendre leurs répercussions sur les forces respectives des deux cadres dans l'optique de la mise en œuvre de la politique monétaire.

Sujets : Mise en œuvre de la politique monétaire; Systèmes de compensation et de règlement des paiements; Structure de marché et fixation des prix
Codes JEL : D4, D47, E42, E5, E58

1. The evolving Canadian financial system

Canada's financial system is changing. Some of its evolution—like the new online wealth management tools and other e-platforms—is driven by Canadians' changing needs for financial services. However, this note focuses on how the changing institutional and regulatory structure of the financial system, as well as the ongoing large size of the Bank of Canada's balance sheet, could require the Bank to adjust how it implements monetary policy.

Three core factors are driving the evolution of Canada's financial system:

- **Financial regulations have changed substantially since the global financial crisis (e.g., Basel III rules), and this has increased demand for safe assets.**
  New prudential regulations, such as the liquidity coverage ratio, have had notable impacts on how banks manage their liquidity. They have also had implications for collateral management across banks and other financial intermediaries, and on money market activity more generally. These changes, and adjustments in regulations for over-the-counter derivatives (leading to central clearing requirements and to margin requirements for uncleared derivatives) have also driven increased demand for high-quality collateral or so-called safe assets, which include central bank reserves (i.e., settlement balances). For example, stresses in the US repurchase agreement (repo) market in September 2019 were attributed to reserves declining below a minimum level desired by banks, motivated by tougher regulations and the banks' own heightened risk management activities after the global financial crisis.

- **Changes that have occurred or that are underway across the payment, settlement and clearing system landscape in Canada have contributed to increased demand for collateral and central bank reserves.**
  Since the global financial crisis, a more robust oversight framework has been put in place and designated systems have shifted to be compliant with the Principles for Financial Market Infrastructures (PFMI). This has led systems to improve their liquidity management and member-related risk containment features, such as through better participant-default rules and procedures, enhanced collateral holdings and management, and additional mitigations for banker risk. These improvements have not only increased the demand for safe assets within Canada but, as noted below, have also enhanced the amount and variability of the deposits these systems place at the Bank of Canada.[1] The increased variability of assets placed at the Bank, would, all other things being equal, make it more difficult for the Bank to successfully implement its fine-tuning operations (e.g., Receiver General [RG] afternoon auctions), which are important to the successful implementation of the Bank's traditional corridor system of monetary policy (see section 2 for more details on the corridor and floor systems).

  More importantly, the payment system modernization program led by Payments Canada that is currently underway will result in additional significant and likely far-reaching changes to the payment system landscape. Specifically, the planned introduction of an innovative new retail payments platform—known as the Real-Time Rail (RTR)—will cause the Bank to increase its supply

[1] The Bank of Canada provides deposit accounts to designated systems.

of settlement balances to provide RTR participants with overnight and weekend funds, since the RTR is a cash-upfront (or zero default) system. Demand from RTR members for settlement balances is based on overnight and weekend retail payment flows and is difficult to forecast. This, too, will make it harder for the Bank to successfully perform its daily fine-tuning operations. The RTR will also create challenges for the Bank to precisely target the level of central bank reserves (and hence the overnight rate) using a corridor system.

In addition, any provision of greater access to (and flexibility in using) Bank of Canada deposit accounts for financial market infrastructures (FMIs) and non-bank financial intermediaries (NBFIs) could add to the volatility of settlement balances. This could similarly impact the Bank's ability to precisely target both a specified level of settlement balances and the overnight rate in a corridor system.

- **The Bank has funded its quantitative easing (QE) purchases through an increase in settlement balances (i.e., reserves), and this directly impacts the framework for monetary policy implementation.**
  Since the global financial crisis, most central banks from mature economies have been operating in a low interest rate environment. Although many theories have been proposed to explain why this low rate environment exists and is likely to persist (e.g., secular stagnation), the fact is that central banks are more apt to leverage the use of unconventional tools such as QE in a low interest rate environment. The Bank's use of balance sheet tools like QE has resulted in a sharp increase in the Bank's asset holdings and, without an offsetting increase in government deposits at the Bank, a sharp increase in settlement balances (reserves).

  As we saw in 2009 and during the COVID-19 pandemic, resorting to QE involves switching the Bank's framework for monetary policy implementation from a corridor system to an ample reserve or floor system. Of note, several jurisdictions that embarked on QE during the global financial crisis decided to stay in the floor system rather than return to the corridor system (e.g., the United States and United Kingdom). These jurisdictions view the floor system as providing effective control in getting market rates near the policy or target rate in any rate environment.

2. Monetary policy implementation: The two core paradigms

Broadly speaking, central banks in advanced economies implement monetary policy by targeting the overnight interest rate using one of two approaches: a **corridor system** or a **floor system**.

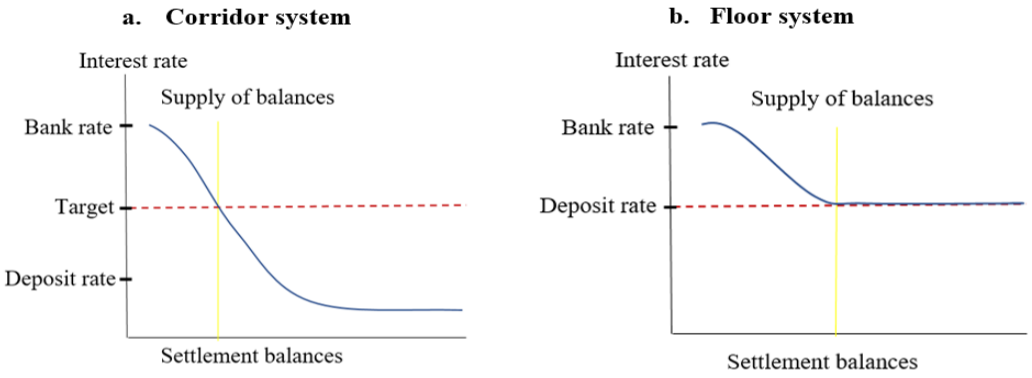
The differences between a corridor and a floor system for monetary policy implementation lie in:

- the demand for central bank reserves
- how this demand relates to the large-value payment system in operation
- the central bank's ability to precisely anticipate this demand and its capacity to supply reserves in a timely manner

Engert, Gravelle and Howard (2008) describe the corridor system used by the Bank.

In a **corridor system**, the central bank needs to carefully judge the amount reserves needed to incentivize trading near its target for the overnight interest rate. This can be seen in **Figure 1** (panel a), where the demand curve is inelastic around the target interest rate. That is, relatively small changes in the supply of reserves (or small shifts in the demand curve, holding supply constant) can cause a large change in the overnight market rate, given the steepness of the demand curve near the target interest rate. Because of this, the effective implementation of a corridor system (i.e., overnight rate trading near target) requires a central bank to have a good ability to forecast demand and the capacity to adjust the supply of reserves in a precise and timely way. The central bank adjusts the supply of reserves in a corridor system through its fine-tuning operations. In Canada, before the COVID-19 pandemic, the amount of settlement balances needed to keep the overnight market rate near the target rate was quite low, roughly $250 million.

Figure 1: Demand for central bank reserves in a corridor versus a floor system



In a **floor system**, the overnight market rate trades at or close to the central bank's deposit rate (the interest rate for deposited reserves at the central bank). This is because the supply of reserves is more than enough to satisfy financial institutions' demand for these reserves. **Figure 1** (panel b) illustrates how a sufficiently large supply of reserves will cross the lower, elastic part of the demand curve, causing the overnight market rate to be equal to the deposit rate. Financial institutions that participate in the wholesale payments system (i.e., they can earn the deposit rate on their excess reserves) lend out their excess reserves, which lowers the overnight market rate until it is at or near the deposit rate—the so-called floor of the corridor.[2] The simple demand curve above assumes that access to the central bank deposit facility is broad and that overnight trading is unsecured. We explain in section 4.1 how these factors may result in a leaky floor where the overnight market rate trades below the deposit rate.

Before the global financial crisis, central banks from several advanced economies, including the European Central Bank (ECB), the Federal Reserve System (the Fed) and the Bank of England, used a corridor system to implement monetary policy. Excluding the brief period in 2009–10 when it switched to a floor system, the Bank of Canada has also relied on a corridor system. The Bank's use of this system has been largely uninterrupted since the introduction of the Large Value Transfer System (LVTS) (see Engert, Gravelle and

[2] This assumes that few frictions to arbitrage exist in the market for overnight funding (i.e., markets are competitive and not segmented).

Howard 2008 for details on corridor system).[3] In Canada's corridor system, the deposit rate was set 25 basis points (bps) below the target for the overnight interest rate, and the Bank rate (the interest rate for funds borrowed from the Bank of Canada) was set 25 bps above it. The overnight interest rate was thus contained in a 50 bps "corridor" between these two rates. In most countries operating a corridor system, including Canada, the target for the overnight interest rate is typically set in the middle of this corridor (Keister 2012).

When several major central banks (notably the Fed, Bank of England and ECB) undertook QE in the wake of the global financial crisis, the level of reserves held in the banking system increased substantially, and these central banks moved to a floor system to implement monetary policy. As some jurisdictions (e.g., the United States and the United Kingdom) began to unwind QE and slowly normalize monetary policy, they retained their floor systems rather than reverting back to a corridor system (Logan 2019; Ramsden 2018). These central banks have noted several reasons for remaining in a floor system, but a common factor cited is the desire to have greater control over the overnight rate. These central banks have made the deliberate decision to remain in a floor system, despite having access to tools that would allow them to reduce excess reserves more rapidly than the predicted decline in central bank assets when QE is unwound.[4]

Many central banks, including the Bank of Canada, introduced QE and moved to a floor system during the pandemic. The Bank used a floor system with a much larger level of settlement balances during the pandemic (ranging from roughly $175 billion to $400 billion—more than 1,000 times the typical level of settlement balances in the pre-pandemic corridor system) than it did when it implemented a floor system during the global financial crisis (only $3 billion).[5] Because settlement balances increased so quickly, determining the minimum or appropriate level of settlement balances required to operate a floor system during the pandemic is difficult. Preliminary work by Bank staff suggests that the minimum could be much larger than the $3 billion that was sufficient during the global financial crisis.

3. Principles for evaluating operational frameworks for monetary policy

Bindseil (2016) and others have advanced several criteria for evaluating different operational frameworks for monetary policy. Drawing on this work, we believe the following criteria capture the key characteristics that are desirable in an operational framework:

[3] Several central banks (including the Bank of England and the Fed) used a reserve averaging system. Most of these central banks had standing lending and deposit facilities with a much wider range between the lending and deposit rates. The Fed did not have an interest-paying deposit facility before the crisis, so excess reserves were not compensated, and the range of the Fed's corridor varied. As a result, the target for the federal funds rate did not always correspond to a specific point in the corridor, such as the midpoint.

[4] These and other central banks could revert to a corridor system once their balance sheets and, in turn, the amount of reserves supplied decline to a level consistent with the corridor system depicted in **Figure 1** (panel a). Alternatively, they could move more quickly to a corridor system, if desired, by increasing the level of required reserves or the size of non-reserve liabilities (outside of currency in circulation). This would reduce the supply of reserves more rapidly (e.g., through the issuance of central bank treasury bills).

[5] When the Bank implemented a floor system during the global financial crisis, it provided $3 billion in settlement balances, which effectively maintained the overnight rate at the target rate (the Bank's deposit rate). Zhang (2012) estimates that about $2.4 billion would have been sufficient to effectively keep the overnight rate at the target rate.

- **Effective control of the target interest rate**—The framework should achieve the target interest rate for monetary policy with a high degree of certainty and limited variability. To this end, systematic deviations of the overnight rate from the target should be within the desired tolerance level.
- **Operational simplicity**—Implementation of the framework should require a small number of simple tools. In addition, simplicity means that operations should rely primarily on rules rather than on discretion. The framework should function effectively with a high degree of operational transparency and be easily understood by market participants.
- **Robustness across different operating environments**—The framework should function effectively regardless of whether the central bank is implementing conventional or unconventional monetary policy measures. Further, the framework should operate effectively when the central bank is taking policy actions to support financial stability (e.g., exceptional market-wide liquidity operations or emergency lending assistance).
- **Resilience to the evolution of market infrastructure**—The framework should be able to accommodate new payment, clearing and settlement systems as well as changes to existing systems that settle in central bank money and that can affect the central bank's balance sheet.
- **Minimal distortion of market functioning and relative prices**—The framework should minimize the extent to which it distorts markets (e.g., creating disincentives for trading or price discovery) or relative prices.

In the next section, we evaluate the current and future effectiveness of the floor and corridor systems for the Bank based on each of these criteria.

4. Evaluation of the corridor and floor systems

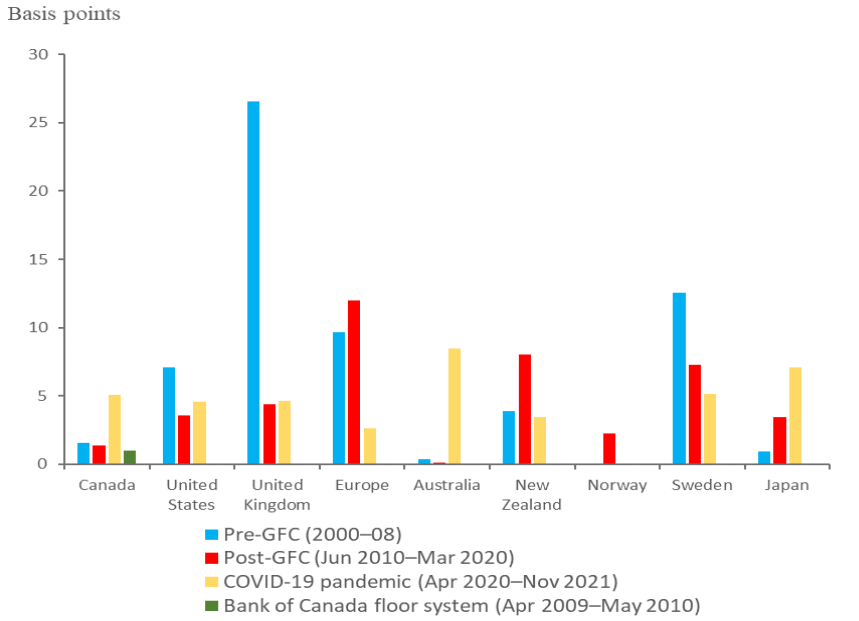
4.1 Effective control of the target interest rate

One measure of the effectiveness of monetary policy implementation is the size of and variability in the difference between the overnight market rate and the target rate (known as rate deviations). The importance of this criterion depends on the tolerance for rate deviations. That is, if the Bank's Governing Council has a high tolerance for rate deviations, this criterion may be less important in evaluating the two systems.

Some tolerance for small rate deviations should exist, since eliminating rate deviations entirely can be infeasible or costly. For example, while the Bank could eliminate rate deviations by providing standing lending and deposit facilities at the same rate to all participants, this would also eliminate trading in the market and induce large fluctuations in the Bank's balance sheet, among other things. The level of tolerance is thus a matter of preference and a function of the trade-offs with the other criteria evaluated here. This tolerance could be asymmetric—for instance, deviations below target could be tolerated more than deviations above, perhaps due to the strong and variable demand for high-quality collateral that can, at times, drive down the overnight repo rate. This tolerance could also distinguish between transitory and persistent deviations.

The Bank's corridor system had been highly effective at achieving the target interest rate. Canada's corridor system was introduced in February 1999, coinciding with the introduction of the LVTS. As noted earlier, the corridor system remained in place until the COVID-19 pandemic, with the exception of a brief period from 2009–10 during the global financial crisis. At that time, the Bank temporarily adopted a floor system to maintain the overnight rate at the effective lower bound of 25 bps. Canada's experience with the corridor system compared quite favourably with that of other jurisdictions both before and after the global financial crisis (**Chart 1**).

Chart 1: Mean absolute deviation of the overnight rate from the target rate



Note: GFC is global financial crisis. The European Central Bank (ECB) does not have a singular target rate. The midpoint of the ECB deposit facility and the ECB marginal lending facility was used as the target rate until late 2008. The ECB deposit facility was used as the target rate from 2009 onward.
Sources: Bloomberg Finance L.P., central bank websites and Bank of Canada calculations
Last observation: November 2021

Corridor systems can provide precise control over the overnight rate when the central bank has good control of the aggregate supply of settlement balances. The Bank of Canada, for example, had tight control of the target rate in its corridor system because it could precisely set the aggregate supply of settlement balances to be equal to its target level of settlement balances through its fine-tuning operations, namely the RG afternoon auction. It also used overnight repos (ORs) and overnight reverse repos (ORRs) to reinforce the target rate intraday by intervening directly in the overnight market. The Bank's success with the corridor system was largely due to some of the key characteristics of Canada's wholesale payment system—notably the relatively small number of participants in the system and the dominant role played by major banks. It was also due to, more importantly and quite uniquely, the high degree of precision in forecasting government payment flows, which made it easier to fine-tune the level of settlement balances.

In comparison, corridor systems that did not have firm control over the supply of settlement balances were not as successful in tightly controlling the overnight market rate (**Chart 1**). Thus, precise control over

reserve supply is essential for tight control of the overnight market rate, since a corridor operates on the vertical part of the demand curve (**Figure 1**), where small changes in reserve supply can lead to large changes in the overnight rate.

Would the Bank be able to exert the same degree of tight control of the overnight market rate if it returned to a corridor system after unwinding QE? The advent of the RTR will increase the variability of desired settlement balances in the system (i.e., the vertical part of the demand curve in **Figure 1** will shift more to the left and right) and diminish the Bank's capacity to precisely supply the needed settlement balances and, in turn, to control the overnight rate in a corridor system. Similarly, the fact that more FMIs have deposit accounts with the Bank, and that the Bank grants those FMIs more flexibility than before to move funds in and out on short notice, also diminishes the Bank's capacity to precisely supply the desired level of settlement balances.

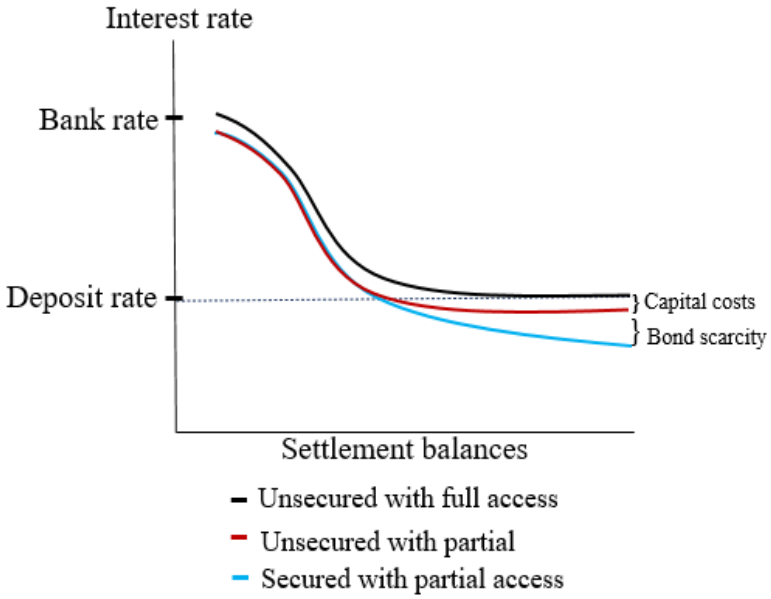
With floor systems, some jurisdictions have substantially more control of the overnight market rate than they previously achieved through their corridor system. **Chart 1** shows, for example, that control of the overnight market rate improved in the United States, Sweden and the United Kingdom in the post-crisis period when a floor system was in place.[6] This stems from the fact that floor systems operate on the flatter part of the demand curve (**Figure 1**), where changes in reserve supply have limited impact on the overnight rate.

However, in reality, demand curves for central bank reserves are not perfectly flat, and overnight rates have traded persistently below the target in several floor systems. A floor system can be leaky (i.e., rates trading below the floor) if counterparties that are large players in overnight funding markets do not have access to the central bank deposit facility. It could also be leaky in a secured overnight market if participants place additional value on the collateral they receive in the repo transaction, when they view that collateral as being scarce. In essence, the demand curve in **Figure 1** is no longer bounded from below by the deposit rate.

Figure 2 illustrates these two effects. First, when some major participants do not have access to the central bank deposit facility and banks are net borrowers from these particular participants, the demand curve shifts to account for banks' capital costs when they borrow from these participants (note: these regulatory capital costs would be zero when government bonds and central bank reserves are exempt from the leverage ratio). Second, a further change occurs in the demand curve in a secured overnight market because participants value the collateral they receive in the lending transaction. Further, this change is not a parallel shift. All else being equal, as settlement balances increase, in most cases more government bonds are removed from the market, which increases their collateral value. Hence, the demand curve is no longer flat when settlement balances are large; instead, the demand curve has a slightly negative slope.

[6] The Reserve Bank of New Zealand decided to move to a tiered hybrid system and does not actively target total reserves (+/- NZD 500 million). The deviations from target for the ECB may not be comparable to those for other jurisdictions since the ECB does not have a singular policy target rate.

Figure 2: Demand for settlement balances in a secured overnight market



In the United States, access to the deposit facility was an issue for the Federal Reserve when the federal funds rate traded consistently below interest on excess reserves (IOER, the deposit facility rate). This was because some participants, such as government-sponsored enterprises, did not have access to IOER. Because this has the potential to create conditions where capital costs lead to below-target rates as described above (and illustrated by the red line in **Figure 2**), the Federal Reserve set a range below IOER as its operating target for the federal funds rate. As well, it implemented a new facility open to a broader range of participants to overcome the issue of constrained access. This also addresses the second issue related to collateral shortage by providing scarce assets (the Overnight Reverse Repo Facility or ON RRP) to provide a subfloor to its IOER floor (Federal Reserve Bank of St. Louis 2016).[7] The ON RRP has proven quite effective at enforcing the subfloor, with the overnight repo rate rarely deviating below the ON RRP rate by more than 2–3 bps. In principle, the Fed could set the ON RRP rate to be equal to its IOER rate and have tighter control over the target rate. Nonetheless, given that the Fed targets the federal funds rate (an uncollateralized rate) while the ON RRP seeks to reinforce the overnight repo rate (a collateralized rate), market segmentation concerns are the likely drivers of the Fed's continued use of a target range for the policy rate rather than a specific level.

The Bank of Japan and the ECB, in contrast, target a rate that corresponds to the rate between participants with access to central bank facilities. In both cases, leakage has not been an issue—their policy rates remained close to or above their target rates (Bowman, Gagnon and Leahy 2010).

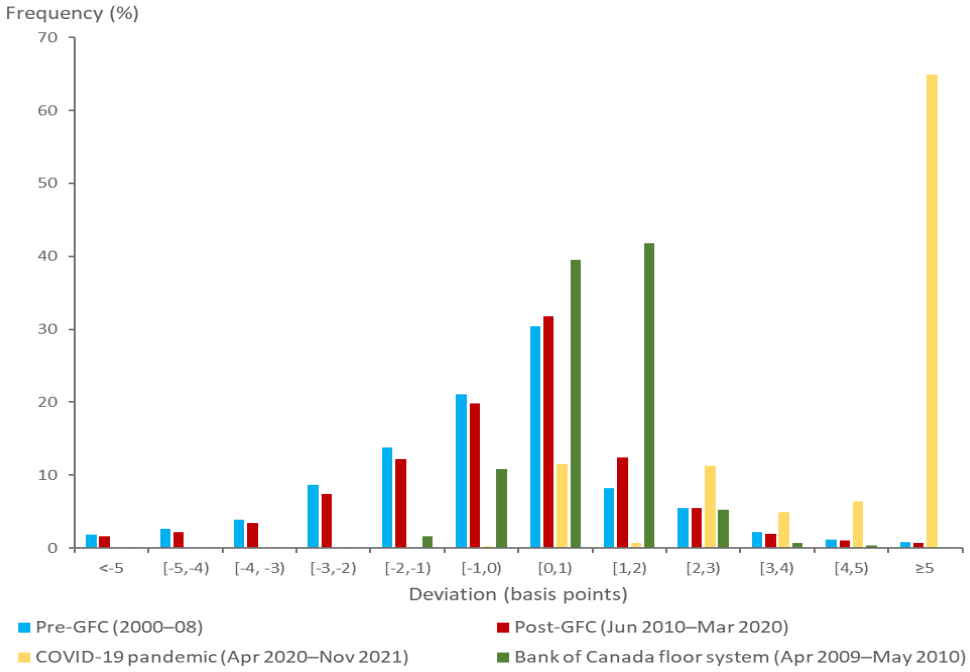
In Canada's experience with the floor system during the pandemic, the Canadian Overnight Repo Rate Average (CORRA, the benchmark for the secured overnight rate in Canada) has also consistently traded

[7] However, in September 2019, the federal funds rate traded above the floor implied by IOER. Several factors contributed to this, including quarterly corporate tax payments and the settlement of Treasury auctions, but the higher federal funds rate was mainly derived from a reduction in excess reserves (see, for example, Williams 2019). Like in a corridor system, in a floor system the Bank of Canada could increase settlement balances or conduct overnight repos if rates traded above target.

below the target overnight rate (**Chart 2**). Part of this leakiness is due to some overnight market participants not having access to the Bank's deposit facility. However, it is also due to the scarcity of bonds created by QE and the increased demand for safe assets. CORRA is a blend of two types of repo rates:

- a general collateral repo rate, which trades closer to the deposit rate (in a general collateral repo trade, participants are indifferent to the specific bond used for collateral)
- lower, "special" repo rates that use scarce bonds as collateral, reflecting demand for those specific bonds; as more bonds become scarce (or "on special" in the repo market), CORRA is dragged lower, reflecting the increased proportion of special repo transactions in the overnight market

Chart 2: Difference between the Bank of Canada target for the overnight rate and the realized Canadian Overnight Repo Rate Average



Note: GFC is global financial crisis.
Sources: Bloomberg Finance L.P. and Bank of Canada calculations
Last observation: November 2021

Central banks can help address the issue related to scarce government securities by putting in place securities lending facilities, in which the central bank provides the market with securities that are in short supply. These securities lending operations do not drain liquidity from the financial system because central banks lend out only securities that are in short supply, and in exchange receive non-scarce debt securities. Central banks can also carry out overnight reverse repo operations that do drain liquidity (settlement balances) out of the system (e.g., the Bank's ORRs and the Fed's ON RRP), while at the same time supplying securities—many of which could be scarce—from their balance sheet as collateral for these operations.[8]

[8] Another tool central banks can use to drain liquidity is the issuance of central bank bills. The issuance of these short-term debt securities implies that market participants are lending to the central bank and, in effect, reducing the level of settlement balances. The Bank of Canada is legislatively precluded from issuing debt securities.

Since the start of its QE efforts, the Bank has sought to address this scarcity effect by introducing its securities repo operations (SROs), in which it lends specific, scarce government bonds back to the market. The SROs are structured as ORRs (securities lent against settlement balances), not as securities lending operations (scarce securities lent against non-scarce securities). This implies that ORRs and SROs provide largely the same economic services, except that dealers can specify which securities they are seeking in SROs, whereas for ORRs the Bank decides which securities to deliver and generally seeks to provide a basket of non-scarce government securities.

Although they have different objectives, these SRO and ORR operations do overlap in their economic impacts on the overnight repo market. The objective of ORRs is to drain liquidity by offering to borrow cash at the Bank's target for the overnight rate (which would be above the market rate at the time, otherwise there would be no need to undertake the ORR operation). Nonetheless, ORRs lend (in effect supply) large amounts of the Bank's government bond holdings to the market. While the objective of SROs is to lend specific securities, SROs nonetheless drain liquidity, given that dealers supply cash at below-market rates in return for their desired (and hard-to-find) government bonds.

Ideally, the Bank could alleviate the leaky floor issues by carrying out sufficiently large ORR operations at the target rate to counteract downward pressure on the overnight market rate coming from excess liquidity (e.g., excess settlement balances) and use traditional securities lending operations to provide the market with scarce securities.

Moreover, as the Bank's balance sheet has decreased, the leakiness caused by a scarcity of bonds has subsided and the overnight rate has traded closer to target. This suggests that the overnight rate may remain close to target, while settlement balances are within a very wide range of values, provided that no large scarcity premium exists.

4.2 Operational simplicity

In their steady states, both a floor system and a corridor system are transparent and easy to communicate. In Canada, most of the major participants generally understand how both systems operate. As noted above, a number of central banks from advanced economies have opted for a floor system. The Bank of England (2018) is keeping its floor system because that system provides operational continuity and simplicity, among other reasons. The Federal Reserve also feels a floor system is operationally efficient and easy to communicate.

The Bank of Canada's corridor system was operationally simple but did require both daily fine-tuning operations to successfully achieve the Bank's target and occasional market operations to reinforce it.[9] The main operations required for the Bank's corridor system included:

- end-of-day fine-tuning transfers of government balances to payment system participants to achieve the targeted level of reserves (RG afternoon auctions)
- discretionary overnight lending and borrowing facilities to relieve intraday upward or downward deviation of the overnight rate from its target (ORs and ORRs)

[9] These end-of-day lending and deposit facilities had a high degree of automaticity. Furthermore, operational guidelines were in place that effectively steer and constrain discretion around intraday lending operations.

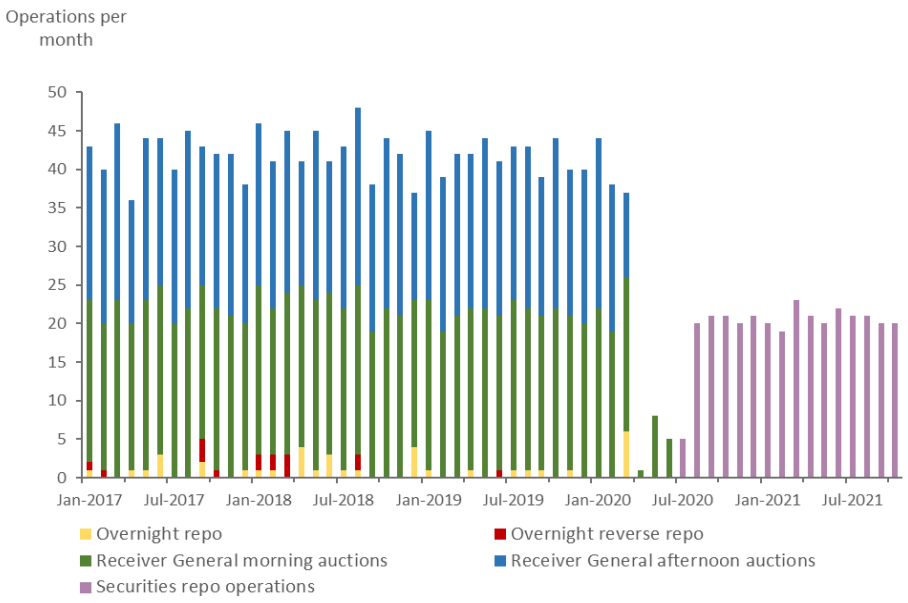
- management of the target level of settlement balances to deal with seasonal or structural changes in the demand for balances (i.e., reserves)

The **Bank of Canada's floor system** is also operationally simple and, moreover, does not require as much precision over the aggregate supply of reserves as a corridor system does (i.e., fewer fine-tuning operations).

This can be seen in the experience with the floor system during the pandemic, when the Bank did not need to intervene because of day-to-day fluctuations in the level of reserves caused by flows on the government's or Bank of Canada's balance sheet. This eased the operational burden of fine-tuning settlement balances, with no need for RG auctions.

Nonetheless, the Bank has conducted SROs daily, beginning a few months after the transition to a floor system (**Chart 3**). These SROs are more operationally complex than both RG auctions and ORs and ORRs, especially when volumes are large.[10] Therefore, a floor system can have some operational complexity in cases where reserves are extremely large if government bonds are scarce. Even though SRO operations (and large-scale ORRs and term reverse repo operations) would be needed if settlement balances were sufficiently large, this should not be a critique of a floor system, as it would be infeasible to operate a corridor system when the Bank's balance sheet and hence settlement balances need to be large.[11]

Chart 3: Number of monthly operations



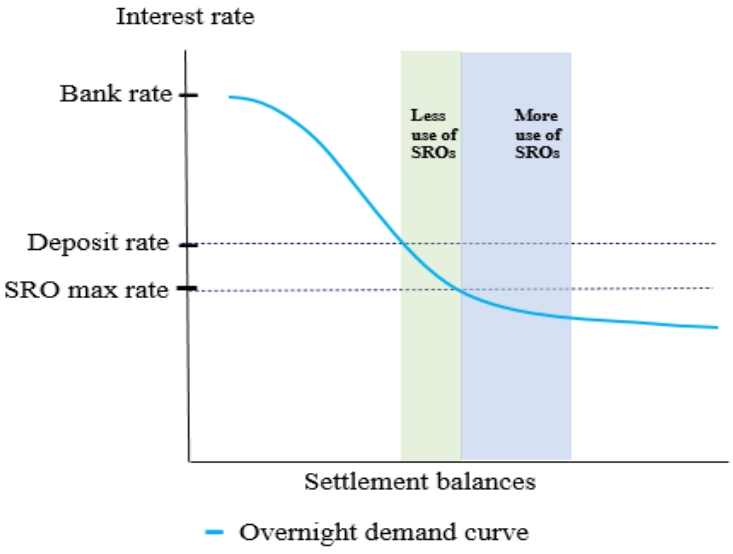
Source: Bank of Canada calculations
Last observation: October 2021

[10] The complexity of SROs increases with size, but not necessarily proportionally. Larger SRO volumes may result in more fails at the end of the day, which are manual operations.

[11] Before the pandemic, Sveriges Riksbank used one-week Riksbank certificates to drain liquidity from its system and had a +/- 75 bps corridor around its target rate (the repo rate). It issued about SEK 300–400 billion worth of one-week certificates each week compared with about SEK 200–400 million in its deposit facility.

We believe that daily SROs would likely not be needed in the steady state when the floor operates within a range of settlement balances that is not so large as to contribute to bond scarcity (such as in the first few months after the transition to a floor).[12] This is illustrated in **Figure 3**, which shows conceptually how SROs or, preferably, securities lending operations fit into the supply-demand framework described earlier. When settlement balances are low enough that the secured overnight demand curve is well above the maximum rate in the SRO or securities lending operations, participants would demonstrate less demand to borrow securities from the Bank, so we would expect fewer or smaller securities lending operations. The Bank could allow settlement balances to fluctuate within a range ("less use of SROs" in the chart) where the overnight rate trades at or slightly below the deposit rate and securities lending operations would be used by participants only to address security-specific scarcities rather than broad-based scarcities. Therefore, a floor should be operationally simple as long as the size of the buffer range for settlement balances is large enough to accommodate fluctuations of flows into and out of settlement balances, while keeping settlement balances above a certain minimum level. (A corridor system would have to offset these fluctuations daily, whereas a floor would need to offset fluctuations only when settlement balances approach the boundaries of this range.)

Figure 3: Operations and overnight demand curve



Note: SROs are securities repo operations.

4.3 Robustness across different operating environments

While a corridor system can work well with a small balance sheet, it cannot, by definition, function when settlement balances are large (without other operational changes as discussed above). This would be the case when the Bank conducts large-scale asset purchases (QE), which naturally results in an increase in central bank reserves. That is, QE increases the asset side of the central bank's balance sheet and, without the ability or desire of the central bank to issue debt or some other liability, also increases the reserves on

[12] Broad-based collateral scarcity on an ongoing basis would not be expected in the steady state when settlement balances are not too large. However, a securities lending program would likely continue to be needed to address occasional or idiosyncratic scarcities, particularly Government of Canada securities.

the liability side of the balance sheet.[13] Due to the nature of the floor system, the central bank can supply reserves to the system (i.e., to fund QE) with little to no effect on the overnight rate and thus separate monetary policy from the quantity of central bank balances (Keister, Martin and McAndrews 2008). In contrast, an increase in central bank reserves from QE would put downward pressure on the overnight rate in a corridor system.

If QE was rare and of small scale and duration, switching from a corridor to a floor system would not be as much of an issue. The Bank can transition quickly from a corridor to a floor system and back, as it did during the global financial crisis. However, experience suggests that QE may be slow to unwind, suggesting the Bank will spend long periods of time in a floor system. Given this, switching back and forth between a corridor and a floor is not really feasible or desirable. Generally, simply remaining in a floor system may be easier.

The activation of the Bank's lender of last resort (LOLR) facilities and market-wide lending facilities, if provided on extremely short notice (and thus largely unplanned), would generally lead to a sharp jump in settlement balances. Moreover, if either the LOLR or market-wide lending were significant, it would take time to reduce the settlement balances by using offsetting sales of assets or increasing other liabilities. In the past, in a corridor system, it would typically take several days or weeks to increase the government deposits held at the Bank to offset the increase in settlement balances. While ORRs or term reverse repos could be used to offset the increase in settlement balances, these operations are obviously precluded when the system is being hit by a market-wide liquidity stress event. Another highly effective way to offset the LOLR or market-wide liquidity injections would be to issue central bank bills, but the Bank of Canada is not legally able to do so. Overall, given the above considerations, a floor system is the preferred approach from a robustness perspective.

4.4 Resilience to the evolution of market infrastructure

Payments Canada is modernizing its payment system infrastructure, introducing a retail payment system that operates 24 hours a day, 7 days a week (the RTR). At the same time, the Bank of Canada, like the central banks of some other economies, is analyzing the pros and cons of issuing a central bank digital currency (CBDC). The emergence of new payment and settlement systems and participants could effectively segregate and immobilize some amount of settlement balances to facilitate final settlement of the new systems.

All these innovations could increase the demand for settlement balances (and the volatility of this demand). A corridor system is less robust to changing demands for reserves or settlement balances on a day-to-day basis because of the inherent challenge in forecasting these changes to determine the appropriate level of aggregate reserves to incentivize trading at the midpoint of the corridor. In contrast, to steer the overnight rate to its target in a floor system, all that is required is that reserve balances be set well above the demand for settlement balances.

For instance, due to the 24-7 nature of the RTR, participants will have an extra, precautionary demand for

[13] A central bank may not have a desire to issue other liabilities because this may not be consistent with its monetary policy and financial stability objectives at the time. For example, the Bank of Canada could issue ORRs but might not choose to do so during QE when it is aiming to increase liquidity and lower yields in the financial system.

reserve balances since they do not have access to central bank lending facilities overnight. This means that RTR participants must always maintain positive RTR settlement balances and cannot process payment flows on behalf of others if processing that payment flow would cause their balance to become negative. RTR participants would hold additional balances to avoid such a situation. The amount of additional balances they would want to hold would depend not only on their risk tolerance but also on the degree of uncertainty regarding their overnight payment flows. This uncertainty would be larger, for example, on weekends or over statutory holidays (similar to the seasonal increase in the demand for bank notes at year-end) when there is a longer period of time without access to central bank lending facilities.

While initially this demand will be low (and not significant to overall demand) given the small volume of retail payments, it has the potential to be larger should the RTR system gain traction. Further, this precautionary demand will change over time (e.g., ahead of weekends), which makes it harder to forecast the balances needed in a corridor system and could make it more difficult to fine-tune balances to achieve the target rate (Witmer 2020). Over time, the Bank and RTR participants may get better at forecasting the seasonal component of these flows (potentially with better forecasting models). Although this will alleviate some of the forecasting challenges, precautionary demand also depends on other factors—such as risk aversion of participants—which are time-varying and challenging to estimate.

In addition, PFMI-driven regulatory changes are increasing demand from FMIs to be able to more flexibly manage cash margins posted by participants. Since FMI cash collateral is generally held in an account at the central bank (to eliminate banker risk), swings in FMI cash balances will affect the central bank's balance sheet and the level of settlement balances. Depending on how large those swings are, central banks could face challenges in implementing a corridor system but could possibly be manage these challenges through new or existing fine-tuning tools. In a floor system, these swings would not necessarily require offsetting intervention to manage their impact on the Bank's balance sheet, as long as the swings do not lower settlement balances below the amount required to incentivize trading at the floor rate.

Given the low variability in the overnight rate in a corridor system relative to the variability of the overnight rate in other jurisdictions, capacity exists to absorb some additional variability in the overnight rate with minimal impacts. With a floor system, however, the level of settlement balances could be set at a level sufficient to insulate the overnight rate from the variability in FMI cash balances held at the Bank.

4.5 Minimal distortion of market functioning and asset prices

4.5.1 Settlement liquidity and collateral

The academic literature presents arguments for having either a small or a large quantity of reserves. For example, Sims (2013) argues for a smaller quantity of reserves, because larger reserves can lead to a greater maturity mismatch, which can create risks for a central bank's net worth and monetary policy independence. A smaller quantity of reserves can also help reduce bank balance sheet costs, although welfare can still be improved by broadening access to the central bank through a reverse repo facility (Williamson 2019). In contrast, Greenwood, Hanson and Stein (2016) argue for a larger central bank balance sheet. A larger central bank balance sheet can help with financial stability by crowding out the creation of money-like assets by banks. Gagnon and Sack (2014) argue for a monetary policy framework with abundant reserves (and broader access through ON RRP) to integrate financial markets and improve

the efficiency of liquidity management, among other reasons. In the middle of these two extremes, Martin et al. (2019) find that a moderate quantity of reserves is optimal (more than a corridor, less than a floor), where the ideal supply of reserves trades off the liquidity benefits of reserves against the balance sheet costs of holding reserves.

Overall, reserves are a form of liquidity transformation by the central bank—a normal part of a central bank's business. Put simply, central banks transform less-liquid assets (e.g., longer-term government bonds) into liquid assets (e.g., cash or reserves). So the critical question is about the best composition of the central bank balance sheet. That is, is it still optimal to have the near-zero level of reserves associated with the corridor system that has served the Bank of Canada so well in the past? Some practical arguments could suggest that a near-zero level of reserves is no longer optimal:

- First, higher reserves associated with a floor system can help improve settlement liquidity because they reduce the incentive for participants to delay payments until later in the day in a large-value payment system. For example, after reserve balances at the Federal Reserve increased substantially in 2008, settlement of payments occurred earlier in the day (Bech, Martin and McAndrews 2012). Likewise, when Canada implemented a floor system during the global financial crisis, LVTS payments also settled earlier in the day (Zhang 2015). In essence, excess settlement balances can act as a substitute for daylight credit (i.e., intraday credit from the central bank): as long as the central bank supplies settlement balances in excess of the maximum potential daylight credit usage, it need not worry about setting the amount of balances too precisely (Lacker 2006). Specifically, a floor system could free up collateral being used to provide bilateral credit lines in the payment system (and demand for this could increase with real-time gross settlement).
- Second, the higher reserves associated with a floor system could help provide banks with a high-quality liquid asset. The benefits of abundant reserves in a floor system depend on what asset the central bank purchases to increase the reserves. If the central bank purchases a less-liquid asset (or lends to banks while holding less-liquid collateral), then a floor system could be beneficial in satisfying a perceived or actual shortage of safe assets.[14] Banks may, for example, have a desire to hold reserves, which are an intraday ($t + 0$) cash asset rather than a $t + 1$ asset like treasury bills. Conversely, if the central bank is purchasing a liquid asset to create the reserves, a floor system could require more collateral than a corridor system (Bernhardsen and Kloster 2010), and this could be problematic for some systems that face a shortage of high-quality assets (e.g., Debelle 2013).[15]
- Third, any broadening of access to central bank deposits may benefit from a higher level of reserves in a floor system. This broadened access may evolve regardless as part of payment

[14] Some have argued that QE and associated excess reserves could crowd out private lending (e.g., Beckworth 2018). Others argue that excess reserves and QE promote lending (Kandrac and Schlusche 2017).

[15] Norges Bank (2014) found that in its system, the required level of balances needed to keep the overnight rate at the floor increased over time as banks' incentive to lend decreased as they adjusted to higher reserve levels (most of this increase in reserves happened around the global financial crisis, so other factors may also explain why they needed more reserves). Norges Bank adopted a hybrid (tiered compensation) floor system to address this concern and to incentivize trading in the overnight market. In this system, individual banks receive the (target) deposit rate on balances up to a certain quota amount, and reserves in excess of this quota are remunerated at a lower rate (called the reserve rate). The Reserve Bank of New Zealand uses a similar system.

system modernization or as part of the review of potential tools to provide liquidity access to NBFIs to reduce the risk of liquidity stresses that were experienced during the COVID-19 pandemic.

4.5.2 Trading volumes

Some concerns exist that a floor system could cause money markets to atrophy. Bech and Monnet (2016) show theoretically that volume in the overnight uncollateralized interbank money market decreases as central bank reserves increase. Indeed, Norges Bank modified its floor system to a quota-based system[16] (reducing the compensation that banks receive on deposits in excess of their quota) to provide a stronger incentive for banks to redistribute liquidity in the uncollateralized interbank market. However, Norway is the exception, as other jurisdictions that have adopted a floor system have not seen the need for similar actions.

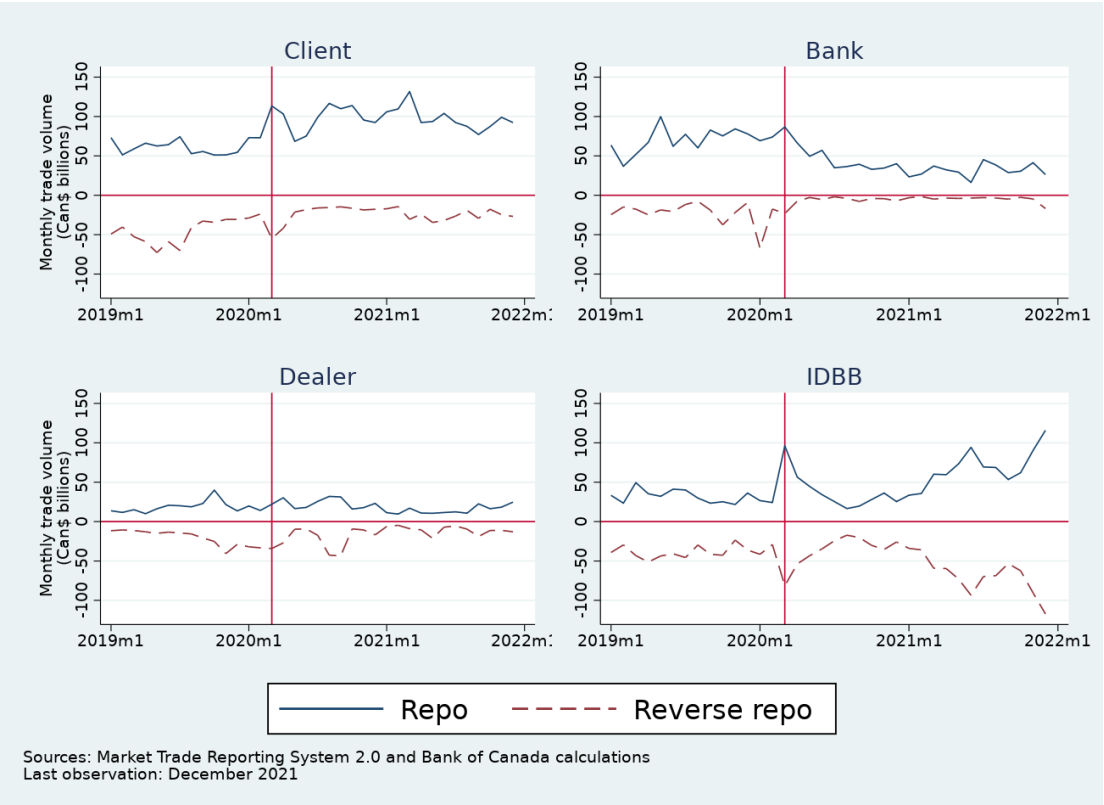
Volume in unsecured overnight trading declined in the US, UK and euro-area markets around the transition to a floor system (Bech and Monnet 2013). Some of this reduced trading in unsecured overnight markets could be explained by regulatory changes (liquidity coverage ratio, high-quality liquid assets, leverage ratio), which have reduced incentives for a lot of short-term financing (securities inventory and for the balance sheet more broadly). In addition, after witnessing that large, regulated counterparties can fail (e.g., Lehman Brothers), banks may have reduced their appetite for uncollateralized lending and may have generally shifted away from wholesale market funding such as short-term repo markets.

In Canada, trading volumes in the unsecured overnight funding market are much more modest, with market participants relying significantly more on the secured market for overnight funding. Moreover, aggregate trading volumes in the repo market remained relatively stable following the transition to a floor system and have even increased slightly as the Bank's balance sheet expanded. However, trading volumes in the repo market between some counterparties decreased following the transition to a floor system in March 2020 (**Chart 4**).[17] In particular, reverse repos between dealers and banks (and between dealers and clients) declined after March 2020. Meanwhile, interdealer trading volume (and volume through interdealer brokers) was largely unaffected or even increased. The volumes in secured markets were largely unaffected, likely because many participants (such as hedge and pension funds) did not have access to settlement balances and participants' demand for the collateral received by the other side in a repo remained the same or even increased in the transition to a floor system.

[16] See Norges Bank (2011).

[17] Little data exist on what happened in the Canadian repo market when the Bank transitioned to a floor in 2009–10, but anecdotal evidence suggests that the repo market functioned normally.

Chart 4: Overnight repo and reverse repo monthly trading volume



Sources: Market Trade Reporting System 2.0 and Bank of Canada calculations
Last observation: December 2021

5. Conclusion

In light of the changing environment, our analysis reveals that a floor system, operating with reduced settlement balances relative to present levels, outperforms a corridor system when evaluated across five criteria:

- While both systems have demonstrated the ability to tightly control the overnight rate, the floor system is better at maintaining the overnight rate near target when volatility in the supply of settlement balances is high.
- Both systems should be operationally simple to operate in a steady state.
- A corridor system is infeasible when the balance sheet has expanded due to QE and cannot be implemented until the balance sheet shrinks sufficiently to operate a corridor system. In a floor system, in contrast, switching implementation frameworks due to QE is not needed.
- A floor system is more resilient to further evolution of market infrastructure. This evolution could cause more fluctuations in settlement balances, and a floor system is more capable of accommodating these fluctuations while having a lower impact on the overnight rate.
- The relative advantage of either system for market functioning is not clear and depends on several factors, including the availability of high-quality collateral. In a floor system with reduced settlement

balances relative to present levels, the difference between the two systems from a market functioning perspective may be minimal.

After discussing the relative merits of a floor system and a corridor system, the Bank announced in April 2022 that "**...the floor system will remain in place even after quantitative tightening has run its course...**" It further indicated that the "**longer-run level of settlement balances is yet to be determined, but it is far lower than the current level**" (Bank of Canada 2022).

5. References

Bank of Canada. 2022. "Bank of Canada provides operational details for quantitative tightening and announces that it will continue to implement monetary policy using a floor system." Market notice, April 13.

Bank of England. 2018. "The Bank of England's Future Balance Sheet and Framework for Controlling Interest Rates." Discussion Paper.

Bank for International Settlements. 2019. "MC Compendium: Monetary Policy Frameworks and Central Bank Market Operations." Markets Committee (October).

Bindseil, U. 2016. "Evaluating Monetary Policy Operational Frameworks." Proceedings of the Economic Policy Symposium, August 25–27. Jackson Hole, Wyoming: Federal Reserve Bank of Kansas City.

Bech, M. L., A. Martin and J. McAndrews. 2012. "Settlement Liquidity and Monetary Policy Implementation – Lessons from the Financial Crisis." Federal Reserve Bank of New York *Economic Policy Review* 18 (1) (March).

Bech, M. and C. Monnet. 2013. "The Impact of Unconventional Monetary Policy on the Overnight Interbank Market." In *RBA Annual Conference Volume (Discontinued)*. Reserve Bank of Australia.

Bech, M. and C. Monnet. 2016. "A Search-Based Model of the Interbank Money Market and Monetary Policy Implementation." *Journal of Economic Theory* 164 (C): 32–67.

Beckworth, D. 2018. "The Great Divorce: The Federal Reserve's Move to a Floor System and the Implications for Bank Portfolios." Mercatus Research.

Bernhardsen, T. and A. Kloster. 2010. "Liquidity Management System: Floor or Corridor?" Norges Bank Staff Memo No. 4.

Bowman, D., E. Gagnon and M. Leahy. 2010. "Interest on Excess Reserves as a Monetary Policy Instrument: The Experience of Foreign Central Banks." Board of Governors of the Federal Reserve System, International Finance Discussion Papers No. 996.

Debelle, G. 2013. "The Impact of Payments System and Prudential Reforms on the RBA's Provision of Liquidity." Address to the Australian Financial Markets Association and Reserve Bank of Australia Briefing, Sydney, Australia, August 16.

Engert, W., T. Gravelle and D. Howard. 2008. "The Implementation of Monetary Policy in Canada." Bank of Canada Staff Discussion Paper No. 2008-9.

Federal Reserve Bank of St. Louis. 2016. "The Fed and Interest Rates: A Floor with a Subfloor." *On the Economy Blog* (July 5).

Gagnon, J. E. and B. Sack. 2014. "Monetary Policy with Abundant Liquidity: A New Operating Framework for the Federal Reserve." Peterson Institute for International Economics, Policy Briefs 14-4.

Greenwood, R., S. Hanson and J. Stein. 2016. "The Federal Reserve's Balance Sheet as a Financial-Stability Tool." Proceedings of the Economic Policy Symposium, August 25–27. Jackson Hole, Wyoming: Federal Reserve Bank of Kansas City.

Kandrac, J. and B. Schlusche. 2017. "Quantitative Easing and Bank Risk-Taking: Evidence from Lending." Federal Reserve Board, Finance and Economics Discussion Series 2017-125.

Keister, T. 2012. "Corridors and Floors in Monetary Policy." *Liberty Street Economics,* Federal Reserve Bank of New York (April 4).

Keister, T., A. Martin and J. McAndrews. 2008. "Divorcing Money from Monetary Policy." *Federal Reserve Bank of New York Economic Policy Review* (September): 41–56.

Lacker, J. M. 2006. "Central Bank Credit in the Theory of Money and Payments." Remarks presented at The Economics of Payments II Conference, Federal Reserve Bank of New York, New York City, March 29.

Logan, L.K. 2019. "Observations on Implementing Monetary Policy in an Ample-Reserves Regime." Remarks to the Money Marketeers of New York University, New York City, April 17.

Martin, A., J. McAndrews, A. Palida and D. R. Skeie. 2019. "Federal Reserve Tools for Managing Rates and Reserves." Working paper.

Norges Bank. 2011. "Background for the System for Managing Bank Reserves in Norway system."

Norges Bank. 2014. "Banks' Assessment of Norges Bank's Liquidity Management System." Norges Bank Papers No. 4/2014.

Ramsden, D. 2018. "Finding the Right Balance." Remarks at the Society of Professional Economists Annual Conference, London, United Kingdom, September 28.

Sims, C. A. 2013. "Paper Money." *American Economic Review* 103 (2): 563–584.

Williams, J. C. 2019. "LIBOR: The Clock Is Ticking." Remarks at the 2019 U.S. Treasury Market Conference, Federal Reserve Bank of New York, New York City, September 23.

Williamson, S. D. 2019. "Interest on Reserves, Interbank Lending, and Monetary Policy." *Journal of Monetary Economics* 101: 14–30.

Witmer, J. 2020. "Monetary Policy Implementation and Payment System Modernization." Bank of Canada Staff Working Paper No. 2020-26.

Zhang, N. 2012. "Estimating the Demand for Settlement Balances in the Canadian Large Value Transfer System." Bank of Canada Staff Working Paper No. 2012-15.

Zhang, N. 2015. "Changes in Payment Timing in Canada's Large Value Transfer System." Bank of Canada Staff Working Paper No. 2015-20.