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Staff Discussion Paper/Document d'analyse du personnel—2022-13

Last updated: June 9, 2022

Settlement Balances Deconstructed

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DOI: https://doi.org/10.34989/sdp-2022-13 | **ISSN** 1914-0568

Acknowledgements

We thank Ron Allenby (Payments Canada), Jamie Armour, Toni Gravelle, Andrew Kidd, Stéphane Lavoie, Philippe Muller, Steve Thomas and Lorie Zorn for helpful comments and suggestions. We also thank Alison Arnot and Meredith Fraser-Ohman for their editorial help and Manon Dubois and Guylaine Letourneau for their assistance in translating some components of this paper. Any errors are our own.

An introduction to settlement balances

The concept of settlement balances is simple in its definition but complex when attempting to understand how they interplay between a central bank and the financial system. Settlement balances can be defined as interest-bearing deposits that belong to participants of Canada's payment system and that are an integral part of the high-value payment system (HVPS).[1] These balances, akin to excess reserves in other jurisdictions, are held overnight at the Bank of Canada, remunerated at the Bank's deposit rate and reflected as a liability on the Bank's balance sheet. The Bank's balance sheet also includes other liabilities such as deposits made by the Government of Canada as well as other deposits.[2]

A more detailed description of settlement balances is that they represent the excess of electronic funds flowing through the payment system that participants other than the Bank hold after all their payments have been settled. In other words, these balances are the net excess of any positive positions (overnight deposits) over any negative positions (overnight advances).[3] They are deposited back at the Bank of Canada at the close of the payment cycle each day, after all payments have settled—hence the name settlement balances.[4]

The objective of this paper is to deconstruct settlement balances by explaining how they come to be, how they flow through the financial system and how they are managed and deployed by the central bank. This paper presents both technical and non-technical discussions to help clarify and inform market specialists and the broader public.

Like other central banks, the Bank of Canada has the ability to provide unlimited domestic currency liquidity in the payment system through the creation of settlement balances. This is rooted in the Bank's powers under the *Bank of Canada Act* and has existed since the Bank first opened its doors in March 1935 (see Appendix A for additional details). At that time, financial institutions were required to maintain excess funds at the Bank as "reserve requirements," which are similar to settlement balances.

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[1] In Canada, the HVPS consisted of the Large Value Transfer System (LVTS), which was introduced in February 1999. In 2021, LVTS was replaced by Lynx. For further details on Lynx, see Bank of Canada and Payments Canada, "An Overview of Lynx, Canada's High-Value Payment System" (May 2022).

[2] Other deposits include deposits from financial market infrastructure institutions, other central banks, government institutions and foreign official institutions, as well as unclaimed balances.

[3] A participant's position is considered positive or "long" if the participant has excess funds (above $0). Likewise, a position is negative or "short" if the participant is deficient in funds (below $0).

[4] Settlement balances from each day are made available to payment system participants when the payment system opens the next day to support that day's payments. This transfer of balances occurs because, although settlement takes place on the Bank's books, Payments Canada is the operator of the HVPS, so the funds are moved to a sub-account within the payment system.

Settlement balances in the context of COVID-19

In response to the economic shock brought about by the COVID-19 pandemic, the Bank of Canada undertook a range of extraordinary policy actions to provide exceptional liquidity to support the economy and ensure a stable and efficient Canadian financial system. These policy actions resulted in a rapid expansion in the size of the Bank's asset holdings, which resulted in a corresponding increase in liabilities to fund those assets. Much of that liability expansion was in the form of settlement balances. Reflecting that rapid expansion, on March 23, 2020, the Bank made the unprecedented move of allowing settlement balances to grow unconstrained.[5] Settlement balances increased more than 1,500-fold—from $250 million before the pandemic (0.2% of the Bank's balance sheet) to a high of $403 billion (about 69.8% of the Bank's balance sheet)—in just under 12 months.[6]

The significant increase in settlement balances has piqued public interest; people want to better understand them. More specifically, people want to explore how settlement balances are created and the Bank's role in that process, and what effects elevated levels can have on the Bank's balance sheet and the financial system more broadly.

Settlement balances deconstructed

To appreciate the role of settlement balances within the financial system, it is important to consider two key elements that give the Bank the ability to create unlimited settlement balances:

- the closed nature of the HVPS and the financial system more broadly
- the Bank's role as banker for all direct participants within the HVPS

These elements are explained in more detail later in this paper, but this analogy may help: settlement balances can be likened to the law of conservation of energy. This law states that in a closed system, energy can be neither created nor destroyed, and therefore the total energy in that system is constant. Similarly, settlement balances can be neither created nor destroyed by participants of the payment system. As the ultimate provider of liquidity in the Canadian financial system, only the Bank adds or withdraws liquidity and therefore determines the total amount of liquidity for this closed system.[7] While the distribution of settlement balances can fluctuate among participants of the payment system based on their interactions with each other, the total amount of settlement balances for each day is

[5] The Bank increased the target for settlement balances to $1 billion on March 16, 2020, and to $2 billion on March 18, 2020.

[6] See Bank of Canada (2021d; 2021b) for more information.

[7] The Bank is the sole entity that can determine the amount of available liquidity by creating or removing settlement balances from the system. The amount of available liquidity is dependent on the Bank's policy objectives.

determined by the Bank and is always deposited back at the Bank at each day's end.[8] Note that because HVPS participants try to reduce their holdings of settlement balances but can only pass them amongst each other (the "hot potato" effect[9]), the amount of settlement balances that each HVPS participant holds tends to align with each participant's share of activity in the payment system.[10]

As noted earlier, settlement balances are interest-bearing deposits belonging to payment system participants that are held overnight at the Bank (and reflected as a liability on the Bank's balance sheet; see footnote 8 and Appendix B). However, this definition, while accurate, does not fully convey the details of how these balances come to be and how they relate to the payment system.

Four key constructs can help explain this and the role they play in the overall financial system:

1. The closed nature of the payment system, and how this allows the system to operate with zero net settlement balances
2. The Bank's role in the HVPS
3. How the Bank adjusts the level of settlement balances
4. How excess settlement balances can affect the financial system

Construct 1: The high-value payment system is a closed one

The Canadian payment system (**Figure 1**) is structured so that movements of nearly all electronic funds throughout the Canadian financial system during a particular day eventually aggregate and settle in the HVPS.[11] For example, while transactions occur in other payment and settlement systems, they are ultimately settled in the HVPS.[12] As well, non-participating members of the HVPS use it indirectly by having HVPS participants send and receive payments on their behalf. As such, these non-participants also have their payments settled through the HVPS. This simply means that on any given day, although electronic funds move from one participant to another, they eventually settle in the HVPS.

[8] On the Bank's balance sheet (discussed in Appendix B), settlement balances are net of advances (asset)/deposits (liability) to/from members of Payments Canada.

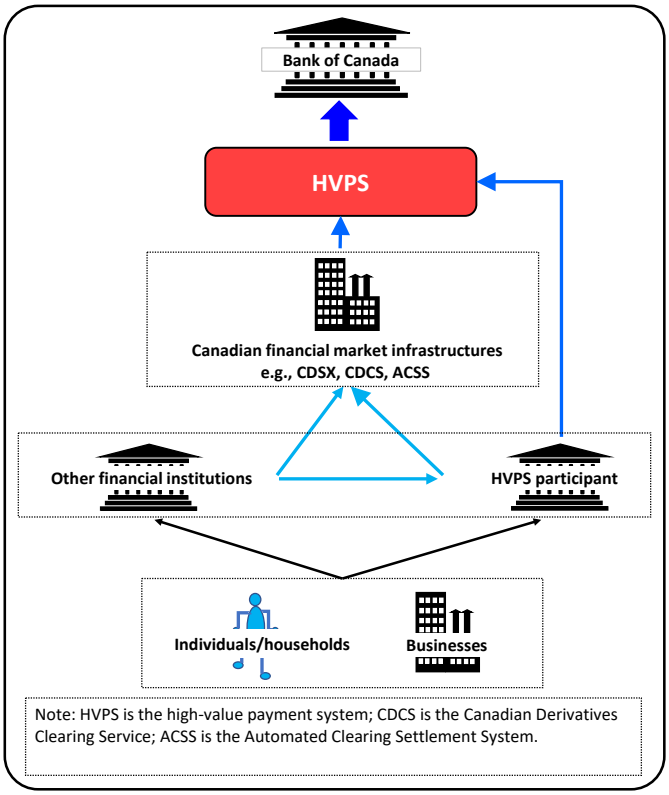
[9] US Federal Reserve Chairman Bernanke used this term when describing excess reserves in the US financial system. See Joint Economic Committee (2013)

[10] For more information on payment system activity during the COVID-19 pandemic, see Chaudry, Kosse and Sondergard (2021).

[11] For more information on the Canadian payment system landscape, see Miller and Olivares (2020).

[12] Most retail payments clear and settle in the Automated Clearing Settlement System (ACSS) but ultimately end up in the HVPS to settle participants' end-of-day positions by the next day at noon ET. Similarly, all fund transfers related to securities settlement in CDSX (the clearing and settlement system for debt and equity securities in Canada) are settled in the HVPS at 4 p.m. ET every day.

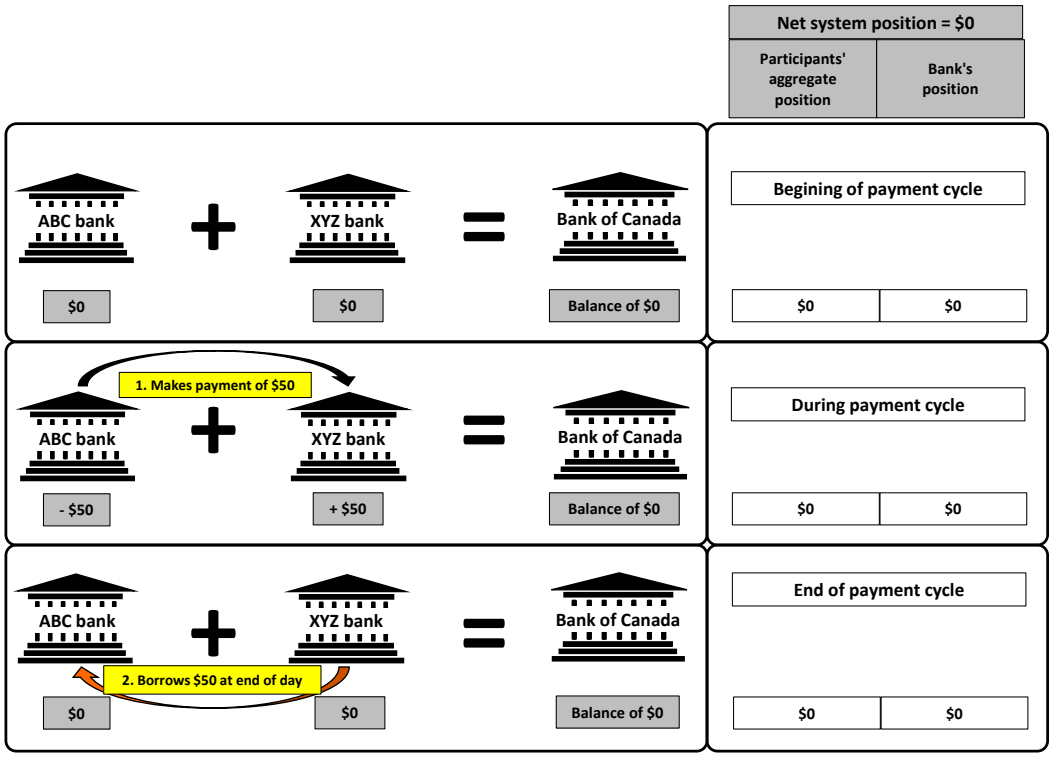
Figure 1: A simplified overview of the financial system



This design means that the payment system is a zero-sum game for all participants, including the Bank: for every participant in a surplus position, there must be at least one in a deficit position.

Figure 2 shows a fictional payment system with only two HVPS participants (ABC bank and XYZ bank) and the Bank of Canada. If ABC bank sends a $50 payment to XYZ bank (**Figure 2**, step 1), then ABC will be short and XYZ will be long. If these positions were to remain at the end of the payment cycle, XYZ bank could lend that money back to ABC bank overnight (**Figure 2**, step 2) and the system's position would be net zero because both participants' positions would be zero (i.e., ABC would not need to obtain an overnight advance from the Bank, which would require the payment of interest at the Bank rate). Note that in this example, the level of settlement balances would also be zero.

Figure 2: A simplified example of the payment system as a zero-sum game



Construct 2: The Bank's role in the high-value payment system

The Bank has several responsibilities within the HVPS.[13] These include:

- overseeing the system
- supplying settlement assets
- providing collateral services
- acting as lender of last resort to system participants

In addition to these activities, the Bank has two roles that are tied to the creation of settlement balances.

The first is the role as banker, whereby the Bank provides all HVPS participants with a settlement account and access to the Bank's deposit facility and collateralized loan facility. Participants must have, at minimum, a zero HVPS position in their settlement account by the end of each HVPS cycle. Those with a long position will need to make an overnight deposit through the Bank's deposit facility, while those with a short position will need to borrow

[13] For more information on the various roles, see Bank of Canada (2021g).

funds overnight (in the form of a collateralized advance) from the Bank's Standing Liquidity Facility.

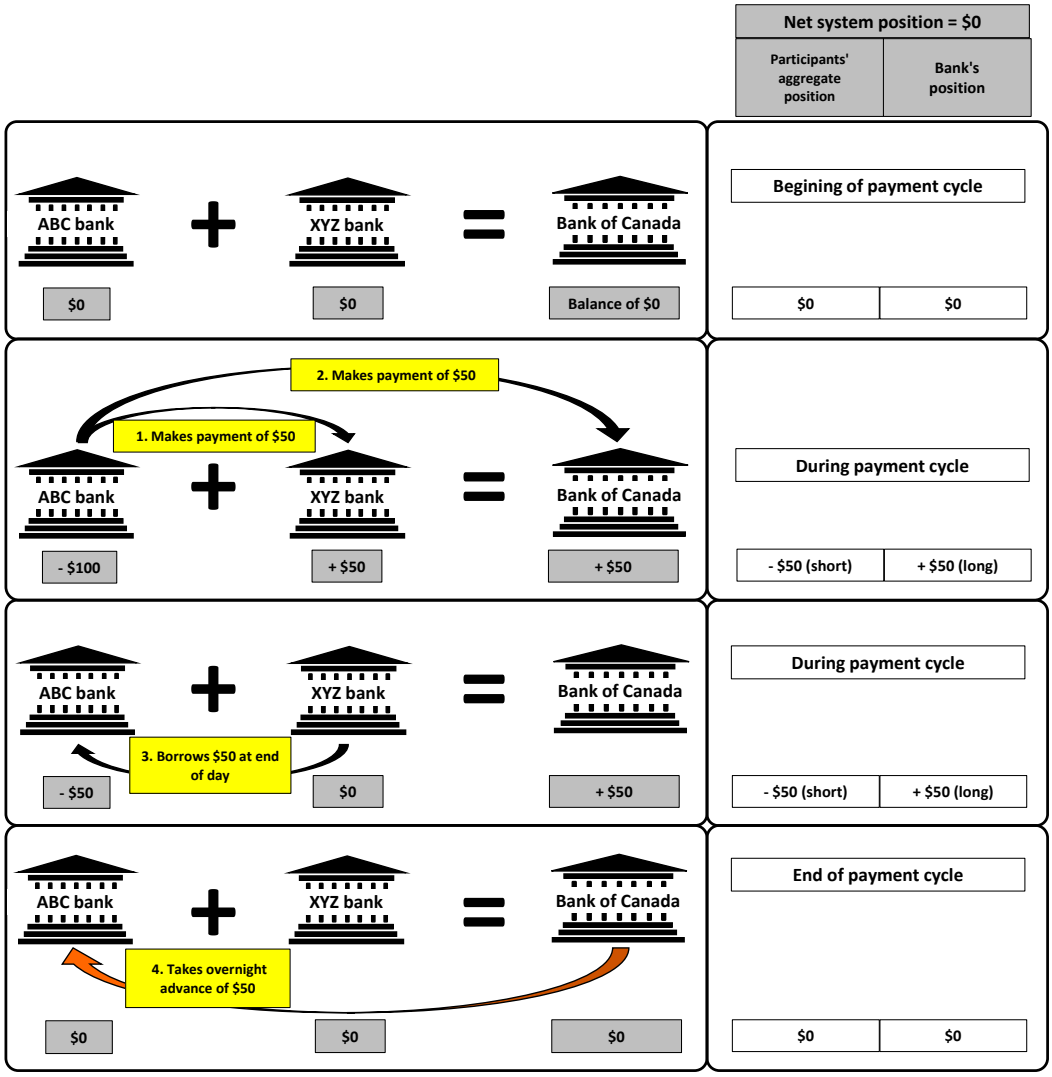
Because all electronic Canadian-dollar payment flows processed in Canada ultimately settle in the HVPS during the business day, and because every HVPS participant must have a settlement account with the Bank, the Bank ultimately plays the role of banker not only within the HVPS but ultimately to the entire Canadian financial system.

The second role of the Bank is as a participant in the HVPS. Every day, the Bank sends and receives payments in the HVPS either on its own behalf or that of its clients, including transactions it conducts as fiscal agent for the Government of Canada. Because of this, the payment flows to and from the Bank could result in the aggregate position of all other HVPS participants being positive or negative.

Consider the previous example with banks ABC and XYZ, but now assume that ABC bank sends a payment to XYZ and a payment to the Bank of Canada (**Figure 3**, step 1 and step 2). ABC can no longer find sufficient funds from XYZ to cover its short position overnight because the total amount that ABC sent out exceeds the total amount that XYZ received (**Figure 3**, step 3). In this instance, ABC will also need to borrow funds from the Bank of Canada (**Figure 3**, step 4).

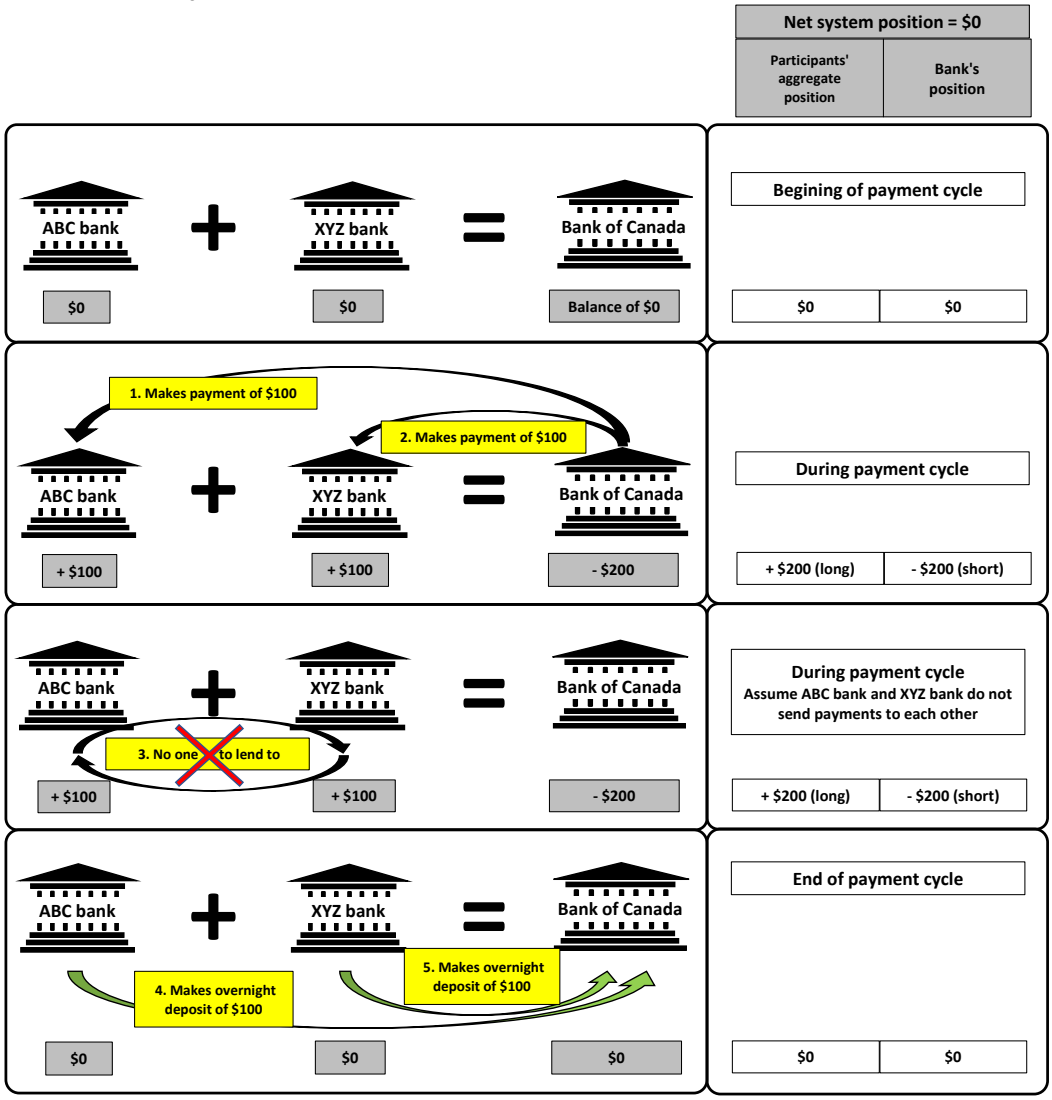
Consequently, the Bank needs to manage its own cash flows and net position in the HVPS daily to ensure that the other payment system participants have sufficient liquidity to fund their own payments without having to take a collateralized advance from the Bank. In practice, this means that every day, the Bank must adjust its balance sheet and payment flows so that it is always net short, which will leave the financial system net long. Note that when the Bank is targeting a near-zero level of settlement balances, such as it did before the COVID-19 pandemic, this net short position is very small. Conversely, as discussed below, when the Bank is operating in an environment of excess settlement balances, this net short position could be very large.

Figure 3: A simplified example of the payment system when the Bank of Canada is also a receiver of payments



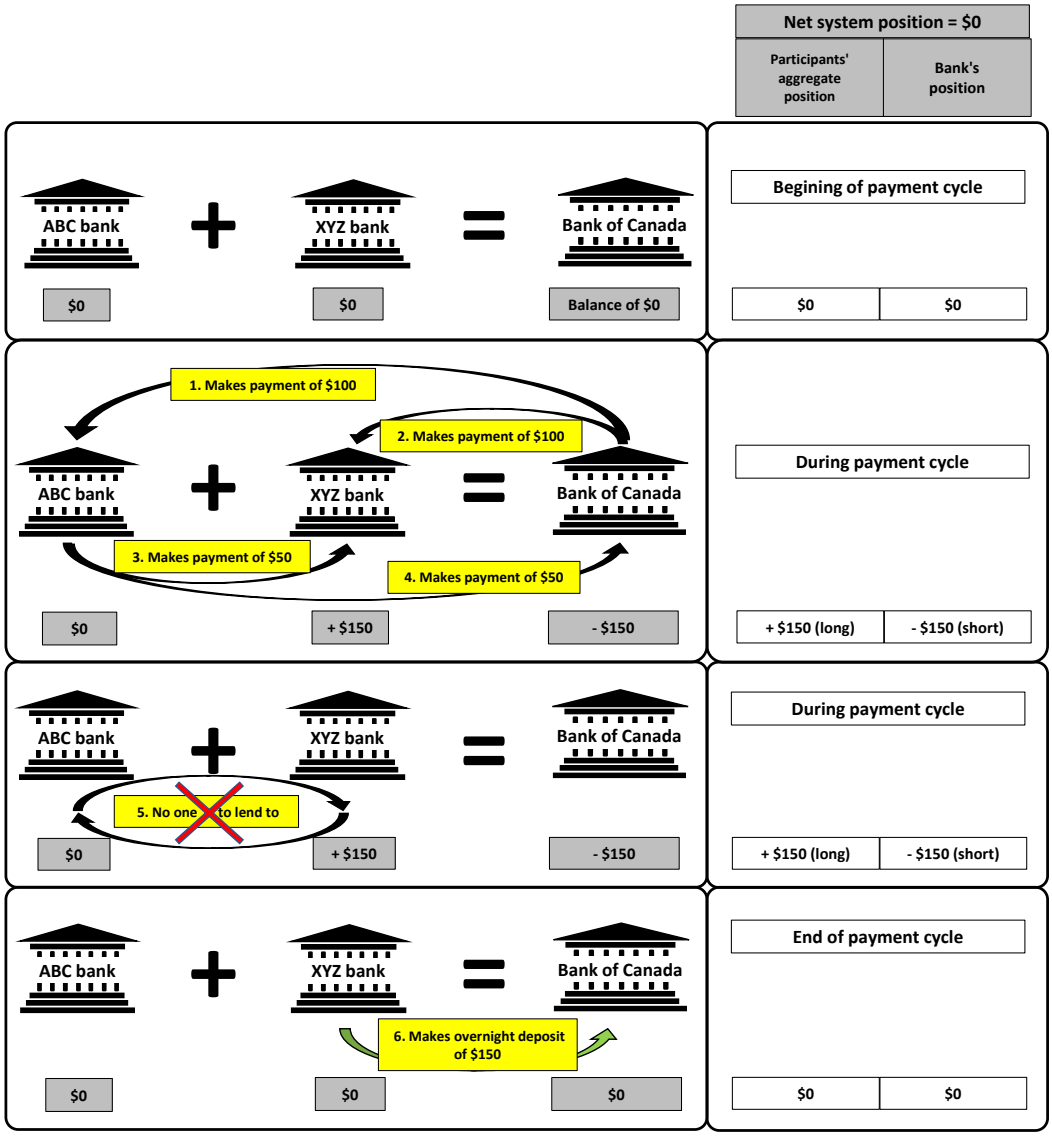
Now consider an alternative scenario where the Bank sends payments to ABC and XYZ (**Figure 4**, step 1 and step 2) that are large enough so that both ABC and XYZ have excess funds. In this case, at the end of the day the excess funds at ABC and XYZ will be automatically deposited back at the Bank to return ABC's and XYZ's HVPS positions to zero when the payment system closes, and the Bank will pay interest at the deposit rate overnight (**Figure 4**, step 4 and step 5).

Figure 4: A simplified example of the payment system when the Bank of Canada is the sender of payments



In a slightly more complicated scenario that is closer to reality, the Bank is both a sender and receiver of payments (**Figure 5**). In this example, the Bank sends a larger amount of payments (**Figure 5**, step 1 and step 2) than it receives (**Figure 5**, step 4). The net effect of these flows results in a positive HVPS position at the end of the payment cycle. This means that on net, participants as a group will be long at the end of the payment cycle and the Bank will be short by the same amount. The liquidity that the Bank puts into the system to fund its policy actions (e.g., providing liquidity or acquiring assets) or to fund any other payments throughout the day plus the excess funds from payment system participant(s) will again be automatically deposited back to the Bank at the end of the payment cycle. In other words, while the liquidity the Bank creates circulates throughout the payment and financial system, it does come back to the Bank at the end of the day. (**Figure 5**, step 6).

Figure 5: A simplified example of the payment system when the Bank of Canada is both a sender and receiver of payments



Construct 3: Monetary policy implementation and how the Bank adjusts the level of settlement balances

Settlement balances and monetary policy implementation

The level of settlement balances in the payment system has a direct impact on how the Bank implements monetary policy.[14] The Bank can implement monetary policy through either a floor system, as is the case at the time of publication, or an interest rate corridor system, as it did before 2020. Under a corridor system, the Bank typically targets only a small amount of

[14] For more information on the Bank's framework for monetary policy, see Bank of Canada (2021e).

excess settlement balances in the system.[15] Conversely, in a floor system, the Bank does not closely target a specific level but provides a sufficiently large supply of settlement balances so that the overnight market rate consistently trades at (or close to) the Bank's deposit rate.

Under both systems, the Bank expects participants that are short to borrow funds in the overnight rate market—at or near the Bank's target for the overnight rate[16]—from participants that are long. In a corridor system, these funds borrowed by HVPS participants are largely used to close out their positions at the end of the payment cycle, so the Bank must be able to adjust the level of settlement balances in a precise and timely manner.

In a floor system, the level of settlement balances is sufficiently large to meet the demand of HVPS participants. Similar to what occurs on a simple demand curve with greater supply leading to lower prices, this should result in HVPS participants lending out their excess settlement balances at or near the Bank's deposit rate (target for the overnight rate).[17] Because of these excess settlement balances and the overnight rate being at or close to the Bank's deposit rate, the Bank sets the deposit rate equal to the target for the overnight rate (see **Figure 6**).[18]

[15] Occasionally, the Bank increases settlement balances while still operating in a corridor system. This happens when there is upward pressure on the overnight market rate relative to the target rate and the additional funds in the system put downward pressure on market rates. The Bank may also leave a nominal amount in the system to reduce frictions from the end-of-day processes and decrease the need for participants to take small, frequent advances from the Bank.

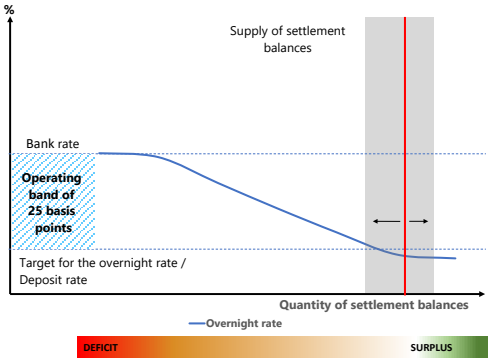
[16] The overnight rate is the rate at which major participants in the money market borrow and lend one-day (or overnight) funds on a collateralized basis amongst themselves.

[17] In actuality, the overnight rate may trade below the target rate (deposit rate). This is known as a leaky floor. It is due to some overnight market participants not having access to the Bank's deposit facility and, because of this, those that are short may end up borrowing at rates below the Bank's deposit rate. Another contributor to the leaky floor is the scarcity of safe assets due to the Bank's QE program. This results in these safe assets trading on "special" in the repo market—higher demand results in traders willing to lend at a lower-than-normal repo rate (i.e., below general collateral) in exchange for these safe assets. For more information, see Bank for International Settlements, "Large central bank balance sheets and market functioning" (October 2019).

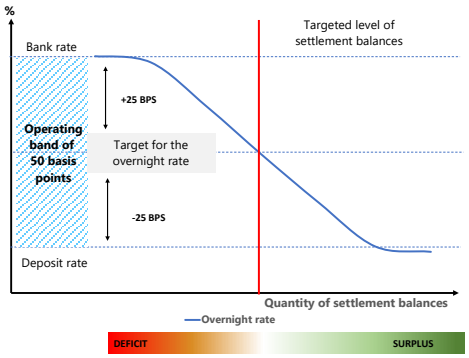
[18] For more information on the corridor and floor systems, see Bank of Canada (2021a).

Figure 6: The Bank of Canada's operating band in a floor system and a corridor system

a. Floor system—with abundant settlement balances



b. Corridor system—with scarce settlement balances



Adjusting settlement balances

As discussed in construct 2, payment flows to and from the Bank can result in the aggregate positions of payment system participants being short or long. This, in turn, must be reconciled so that all final positions, including the Bank's, net to zero at the end of the payment cycle.

Because of this, every day that the payment system is open, the Bank forecasts and tracks:

- payments it makes related to purchases or maturities of securities, loans and term repos
- payments and receipts on behalf of the Government of Canada
- other client deposits at the Bank
- net issuance of bank notes

In doing this, the Bank can monitor its net position within the payment system.

The net effect of these payments and receipts determines the amount of liquidity the Bank has supplied to the payment system, whether the Bank is net long or short, and whether further action to inject or withdraw liquidity is needed to achieve the desired level of settlement balances. For detailed examples of how the Bank manages its balance sheet in a system that is long, short or zero, see Appendix B.

The easiest way to determine if a certain action or financial market operation is adding or removing liquidity—and thus increasing or decreasing the level of settlement balances—is to identify the direction of the cash payment behind the transaction. If the Bank is sending a payment, it is injecting liquidity, hence raising settlement balances; if it is receiving a payment, it is removing liquidity from the payment system, thereby reducing settlement balances (for a list of liquidity flow examples, see Appendix C). Toward the end of each day around 4 p.m. ET, the Bank determines its position and if further action is required to inject

liquidity into the payment system.[19] If additional liquidity is needed, the Bank will auction off government funds that are in excess of the government's day-to-day operating needs and prudential liquidity plan through the Bank's Receiver General afternoon auction to HVPS participants. [20] This helps ensure the payment system has the necessary funds to allow participants to settle their payments without needing overnight advances from the Bank.

If the Bank is operating in a floor system, the excess settlement balances circulate throughout the system during the day. Payment system participants can use them to fund payments until they are redeposited back at the Bank at the end of each day when the payment system closes. The cumulative growth in settlement balances can be large enough that the odds of a participant being short are remote. Consequently, in a floor system, liquidity injection auctions at the end of the day are not needed.

Construct 4: The relationship between the Bank, settlement balances and the financial system

The creation of sizable excess settlement balances to support large-scale asset purchase programs (e.g., quantitative easing [QE]) and the reversal of this process (e.g., quantitative tightening [QT]) can have meaningful impacts on the financial system, including:

- significant deposit growth (or reduction) on HVPS participants' balance sheets
- a shifting distribution of high-quality liquid assets (HQLA) within the financial system between HVPS participants and non-participants

Ultimately, these impacts are contingent upon how much of the Government of Canada (GoC) bonds purchased by the Bank are from HVPS participants or non-participants during QE, and which of those two types of entities will finance the new government borrowing when the GoC bonds mature during QT.

This distinction between participant types is important because HVPS participants are the only entities allowed to have a settlement account at the Bank (non-participants must have an account with an HVPS participant).

[19] Note that the Bank cannot withdraw liquidity from the system at this point in the day; it can only reduce the amount of the Receiver General (RG) afternoon auction, cancel the auction or leave the system longer than intended, which leaves the Bank short. When the Bank is targeting a near-zero level of settlement balances, the level can unintentionally end up being negative. This can occur when the Bank conducts multiple overnight reverse repos and is unable to reinject liquidity later in the day when participants of the RG afternoon auction do not take the full amount offered (see Appendix B, Example B).

[20] In its 2011 Budget, the Government of Canada announced the prudential liquidity plan in Annex 2: Debt Management Strategy for 2011–12 and implemented it by the second half of 2013.

Quantitative easing—an illustrative example

To understand the importance of this distinction, consider two very different scenarios: one in which every GoC bond purchased by the Bank is owned by the household sector[21] (HVPS non-participants) and the other where these GoC bonds are owned by participants in the HVPS.

Scenario 1: Asset purchases with HVPS non-participant

In this example, every GoC bond purchased by the Bank comes from the non-bank sector (e.g., a household). As **Figure 7** illustrates, the flow of payments starts with the sale of GoC bonds by the household to a primary dealer.[22] After the sale, the household now has a long position and can:

- deposit the funds with its bank or an HVPS participant since the household does not have a settlement account with the Bank
- use the funds to purchase other assets or pay down liabilities, which spreads the funds through the financial system

Next, the primary dealer sells the newly acquired GoC bonds to the Bank and receives funds in return. In this scenario, the primary dealer acts as a conduit between the household and the Bank. As a result, the primary dealer's position (both cash and bonds) and the size of its balance sheet do not change because of this transaction. Similarly, the size of the household's balance sheet has not changed, although the composition of its assets has shifted to more cash holdings in exchange for the GoC bonds.

The HVPS participant's balance sheet does increase, however, because the participant received funds (an asset) and has a corresponding liability (a deposit from its client). Similar to the household, the HVPS participant can use the funds it has received to:

- fund other payments
- buy other assets
- make additional loans
- reduce its balance sheet by paying down liabilities

Regardless of the decision, the last HVPS participant in the transaction chain that is holding the funds at the end of the day must ultimately deposit the excess funds back with the Bank.

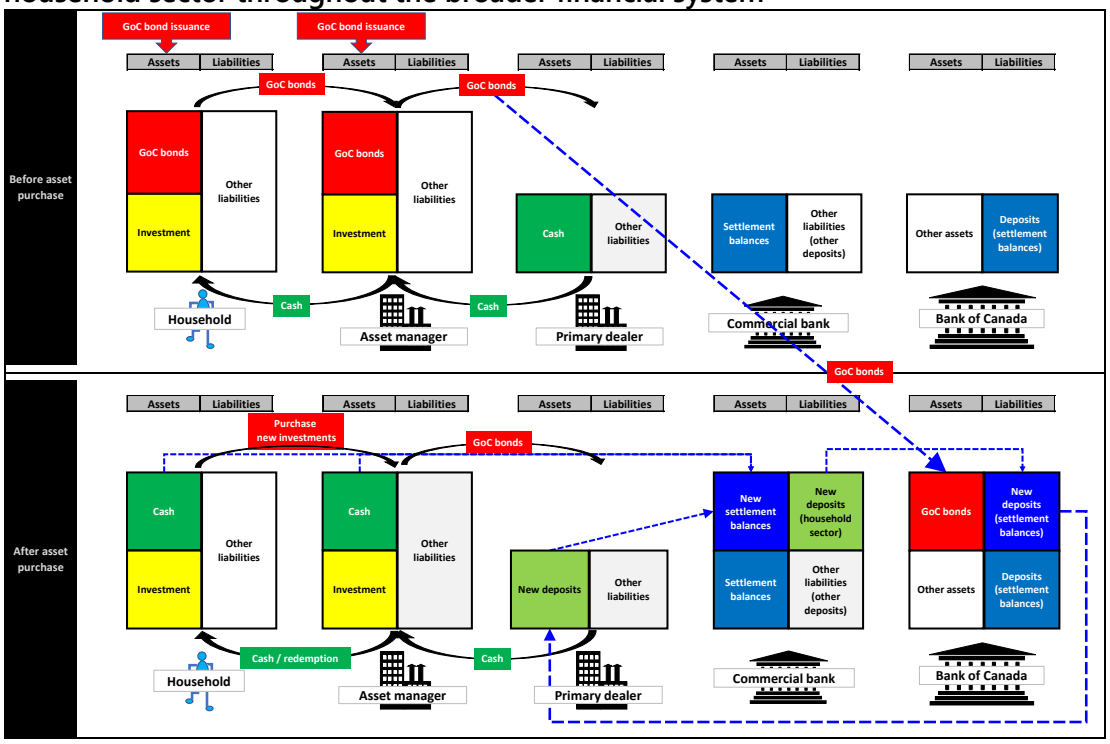
[21] For simplicity, in this example the household sector includes individuals, corporations and non-bank financial institutions—all non-HVPS participants.

[22] For a list of primary dealers in Canada, see Bank of Canada (2021f).

As a result, in this scenario the Bank's decision to purchase an asset funded by excess settlement balances increases the size of its own balance sheet. It also changes the composition and increases the overall size of HVPS participant's balance sheet.[23]

In addition to affecting the composition and size of HVPS participant's balance sheet, the distribution of HQLA within the financial system has undergone an important change. In general, the overall amount of HQLA within the system remains the same, because the GoC bonds that the Bank has purchased have been replaced by an increase in settlement balances (which themselves are also considered HQLA) held at the Bank. However, by purchasing GoC bonds from households, the HQLA has shifted from the non-bank sector to the banking sector. This involuntary shift in HQLA assets means that HVPS participants' liquidity ratios will initially increase because participants now own more HQLA assets than they would otherwise. (See Appendix D for additional details on how regulatory ratios were affected and managed by HVPS participants during the COVID-19 pandemic.)

Figure 7: Flow of transactions of the Bank of Canada's asset purchases from the household sector throughout the broader financial system



Note: GoC is Government of Canada.

[23] Recognizing the growth in deposits at deposit-taking institutions resulting from excess settlement balances, the Office of the Superintendent of Financial Institutions (OSFI) excluded settlement balances from the measure of leverage ratio exposure to support lending and financial intermediation activities. See OSFI's announcements from April 9, 2020 (OSFI 2020a) and November 5, 2020 (OSFI 2020b).

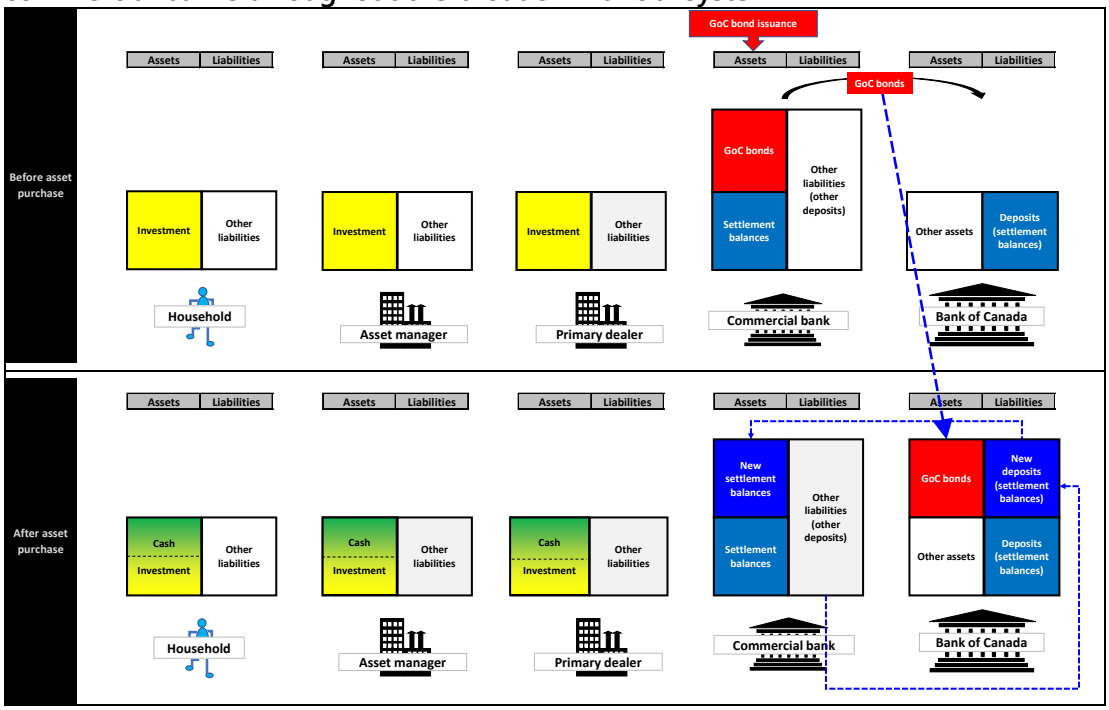
Scenario 2: Asset purchases with an HVPS participant

In a second example, every GoC bond purchased by the Bank is sourced from commercial banks that are HVPS participants. The transaction flow in this case is much simpler than in the household scenario. This is because it can be assumed that the Bank is transacting directly with the HVPS participant that already has an account with the Bank. [24] In this scenario, the Bank purchases the GoC bonds from the HVPS participant, which deposits the funds directly into its settlement account at the Bank. The asset side of the Bank's balance sheet increases by the amount of the GoC bonds that is funded by settlement balances, which in turn increases the liability side. The only change to balance sheet of the HVPS participant is the composition of its assets, which shows an increase in funds held at the Bank and a decrease in holdings of GoC bonds (see **Figure 8**).

The only effect of QE in this scenario is to shift the composition of HVPS participants' HQLA holdings from marketable government securities to deposits at the central bank. There is no impact on the HVPS participant's liabilities (no increase in its client's deposits) and no impact on either the government's or the household's balance sheets. In this instance, unlike in the first scenario when the purchases are made from the household sector, the HVPS participant's liquidity ratio is not affected because the participant has simply swapped one type of HQLA for another (see Appendix D).

[24] In general, the Bank conducts its asset purchase transactions through primary dealers, not HVPS participants. However, given that most primary dealers are closely linked to HVPS participants, it can be assumed that the Bank is dealing directly with the HVPS participant through its primary dealer. Because of this, the transaction flow in this scenario can be simplified.

Figure 8: Flow of transactions of the Bank of Canada's asset purchases from commercial banks throughout the broader financial system



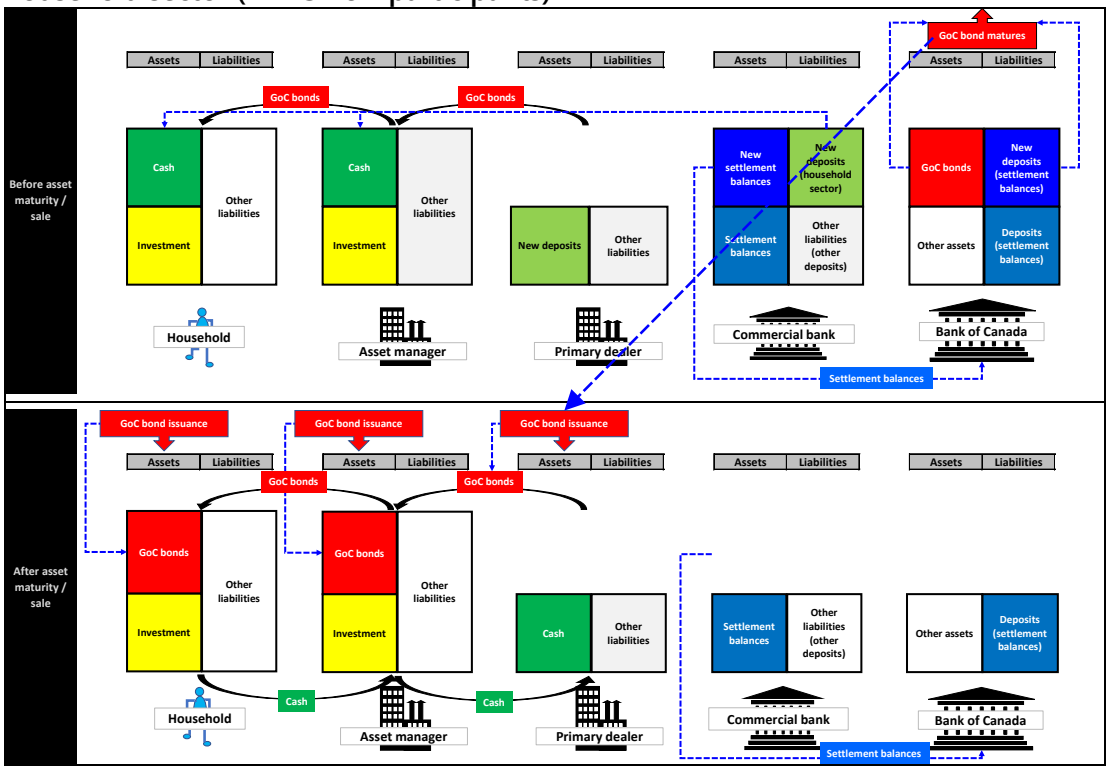
Note: GoC is Government of Canada.

Quantitative tightening—the same process but in reverse

Quantitative tightening reverses the above process. As the GoC bonds held by the Bank mature and the proceeds are not reinvested, the securities roll off the Bank's balance sheet, reducing settlement balances. If the government is not in surplus, it needs to issue new debt to refinance these maturing bonds. And because the Bank is no longer purchasing assets, these bonds need to be sold into the private sector. However, which entities—HVPS participants (banks) or non-participants (households)—purchase the new debt and fund the government's new debt remains an important factor in determining the impact on the financial system.

If households purchase most of the new debt (see **Figure 9**), HVPS participants will see deposits decrease as the households use those deposits to fund the purchase of the government debt. Similarly, the distribution of HQLA within the financial system will shift back toward the household sector because the decline in deposits (and subsequently in settlement balances) will result in less HQLA held by HVPS participants. Consequently, HVPS participants will see their liquidity ratios fall (see Appendix D).

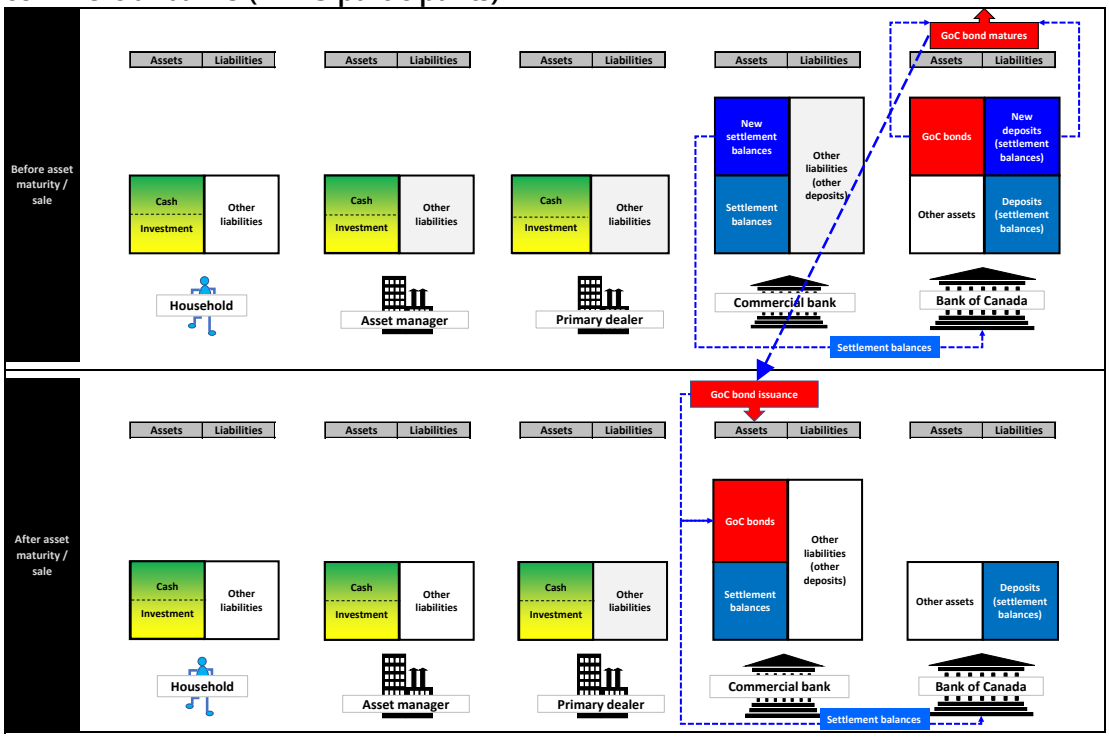
Figure 9: Flow of transactions in a natural normalization (roll-off) through the household sector (HVPS non-participants)



Note: GoC is Government of Canada.

In contrast, if HVPS participants purchase the new government issuances (see **Figure 10**), they will effectively swap settlement balances at the Bank for GoC bonds, leaving their HQLA holdings unchanged and having no impact on their deposits.

Figure 10: Flow of transactions in a natural normalization (roll-off) through commercial banks (HVPS participants)



Note: GoC is Government of Canada.

It is important to note that the two scenarios above are distinct and somewhat simplified examples that highlight the paths of the transactions and how they differ when HVPS participants or non-HVPS participants are involved. In reality, the impacts of QE and QT on the financial system are determined by the relative participation of these two types of market participants in the process.

Settlement balances and normalization

When the Bank no longer needs to expand its balance sheet (funded by increasing settlement balances), in the absence of any further policy actions by the Bank, settlement balances gradually decline over time through a natural normalization process. This happens because:

- existing assets on the Bank's balance sheet mature, and when they are not replaced, the level of settlement balances decreases
- bank notes in circulation continue to grow over time, which withdraws excess settlement balances from the financial system as banks send the Bank funds to pay for the increased demand in bank notes

Alternatively, if the Bank were to choose to accelerate this natural normalization, it could do so by selling some of its balance sheet assets back to the market.

In addition, other factors and certain Bank policies and operations can be used to actively remove liquidity from the system, which can also impact the level of settlement balances (see Appendix C). For example:

- Growth of government deposits or other deposits on the Bank's balance sheet would reduce the level of settlement balances.
- The Bank can engage in operations, such as overnight or term reverse repo operations, that withdraw funds from the market and therefore reduce settlement balances.[25]

However, beyond the removal of liquidity from the system (as described above), once the size of the Bank's balance sheet has declined sufficiently, the Bank will resume making traditional bond purchases to manage its balance sheet to ensure the effective implementation of monetary policy. This is done to offset ongoing growth of notes in circulation (which would otherwise have the effect of lowering settlement balances over time, as noted above), to ensure the supply of settlement balances is sufficient to meet demand by financial participants, and to effectively implement monetary policy.

The level of settlement balances at which traditional bond purchases resume depends on several factors, including:

- Structural and implementation choices in the design of the new payment systems, and the interactions between these systems (such as between Lynx and Real-Time Rail) could require larger settlement balances (**Box 1**).
- The optimal amount of settlement balances will also depend on the liquidity preferences of payment system participants.
- Factors such as regulation and increased risk aversion may increase the amount of settlement balances required to meet participant demand.
- Other regulatory changes may require greater use of and access to central bank deposits.
- The potential issuance of central bank digital currencies (CBDCs) could have varying impacts on settlement balances and the implementation of monetary policy, depending on the characteristics chosen for CBDCs.[26]

[25] Through these operations, the Bank would temporarily sell Government of Canada securities with an agreement to repurchase them (typically the next day) at an agreed-upon price.

[26] For more details, see Bank for International Settlements (2018) and Bank for International Settlements (2020).

These factors all point to participants wanting to hold a higher level of settlement balances. Consequently, although the level of settlement balances was close to zero before the pandemic, the Bank will likely need to supply a much higher level to accommodate these structural factors going forward. As such, implementing monetary policy using a floor system that supplies ample settlement balances (as described in construct 3) is well suited for the factors mentioned above.

Box 1: Impact of the planned Real-Time Rail system on settlement balances

At the time of publication of this paper, Canada's payments modernization initiative is underway, with some components already completed. Payments Canada has replaced the Large Value Transfer System with Lynx and plans to introduce the new real-time payments system, Real-Time Rail (RTR), and further enhance the Automated Clearing Settlement System (ACSS). The goal of this activity is to modernize the payments system landscape in Canada so that it becomes fast, flexible and secure; promotes innovation; and strengthens Canada's competitive position (Kosse, Lu and Xerri 2020). For a timeline of these initiatives, see the *Modernization Delivery Roadmap* (Payments Canada 2020).

The planned design of the RTR payments system is such that it will be cash-funded, with participants holding RTR settlement accounts on the books of the Bank of Canada. Consequently, the Bank will need to supply these additional funds through higher settlement balances, which will be fungible with those of Lynx. Although RTR is meant for small-value payments, it will be a 24/7 real-time gross settlement system with broad access, with funding and defunding occurring only during Lynx operating hours. Because of these factors, the need for higher settlement balances will increase, especially around weekends and holidays because participants will want to hold a precautionary buffer when Lynx is closed. A larger level of settlement balances will ensure that participants of both Lynx and RTR have sufficient liquidity to enable payment flows within and between both systems without needing to borrow from the Bank overnight. The optimal level of required settlement balances will depend on participants' behaviour as they determine payment flows through the new system. It will also depend on the addition of new participants, given RTR's broader access.

Appendix A: A historical overview of settlement balances

Commercial banks have traditionally been required to hold reserves, where a specified fraction of commercial bank deposits is maintained at the central bank, serving as a lever to control money supply. By altering the reserve ratio—the amount of reserves a bank must retain—the central bank could change the supply of money in the economy. For example, reducing the proportion of reserves that banks maintain relative to their deposits increases the amount of available funds that banks have for lending in the economy, and vice versa. Globally, use of this approach has diminished over the years, largely because banks found ways to avoid reserve requirements since they were unremunerated and seen as a tax, which introduced an advantage for non-bank financial institutions (Clinton 1997).[27]

The Bank of Canada used reserve requirements for much of its history (from 1934 to the early 1990s, pursuant to the authority set out in the *Bank of Canada Act*). While the Bank has used different implementations of reserve ratios over the years, in February 1991, the Bank and the Minister of Finance announced the introduction of inflation-control targets. In June 1992, a new framework was revealed shortly after the proclamation of new legislation for financial institutions, which included the abolishment of reserve requirements. These changes ultimately transformed how the Bank implemented monetary policy, changing its focus from controlling money supply to influencing interest rates.[28]

Before the new legislation, the Bank required chartered banks to maintain a declining level of reserves in the form of vault cash or deposits with the Bank. In June 1994, the Bank began shifting its emphasis from the Bank rate (tied to the 90-day treasury bill rate[29]) to a new key monetary policy instrument—a target for the overnight rate. The Bank then set a 50-basis-point corridor (operating band) around the target for the overnight interest rate. It also ceased its open market operations in treasury bills and reinforced the target overnight interest rate through Special Purchase and Resale Agreements (SPRA) and Sale and Repurchase Agreements (SRA) operations. All these changes were made in preparation for

[27] According to Clinton (1997), deposits were recorded at non-bank subsidiaries within the corporate structure or moved offshore.

[28] Changes include (i) eliminating reserves to be able to supply and control the amount of settlement balances; (ii) remunerating deposits from banks to support the implementation of an operating band that the Bank could use to target the overnight rate (until then, the Bank did not remunerate for reserves on deposit); and (iii) introducing market operations (Special Purchase and Resale Agreements/Sale and Repurchase Agreements, now renamed overnight repos/overnight reverse repos) to inject or withdraw liquidity to reinforce the overnight target rate.

[29] From November 1, 1956, to June 24, 1962, and from March 13, 1980, to February 21, 1996, the Bank rate was set at 25 basis points above the 3-month treasury bill tender average. For more information on the history of monetary policy at the Bank, see Thiessen (2000).

the 1999 launch of Canada's high-value payment system (HVPS), the Large Value Transfer System (LVTS).

Under its current framework for the implementation of monetary policy, the Bank sets the target for the overnight interest rate (often referred to as the policy rate), which in turn influences interest rates at which banks and other selected agents can borrow and lend at the shortest end of the yield curve.[30] This framework is linked to the HVPS because system participants each have a settlement account with the Bank of Canada, where their final positions settle on the books of the Bank. The end-of-day positions are influenced by the Bank's operating band, which is supported by the Bank's standing deposit and lending facilities. These facilities incentivizes participants to conduct transactions at or near the target for the overnight rate.

Since the introduction of the LVTS in 1999, the targeted level of settlement balances in the system has been near zero, with two notable exceptions (described below). In a corridor system, the Bank targets a small positive amount of settlement balances, thus reducing frictions from the end-of-day process and the need for participants to take small, frequent advances from the Bank. In this system, the level of settlement balances can also be adjusted higher or lower based on conditions in the overnight market.

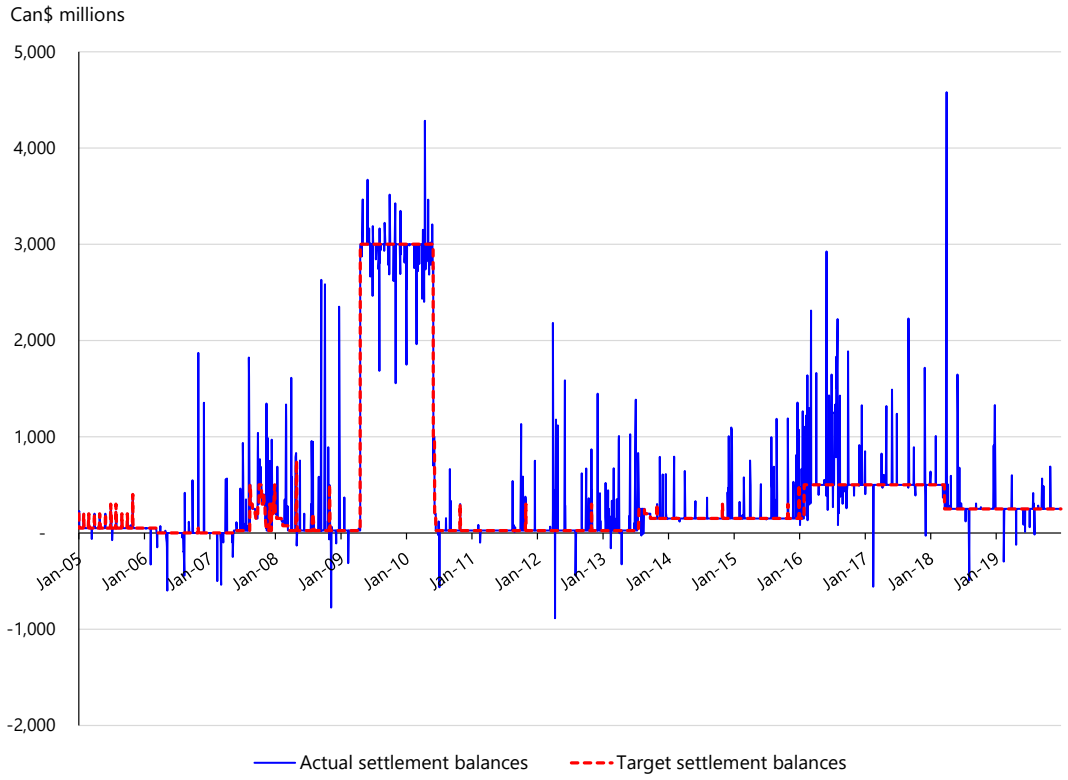
Two important observations can be made from **Chart A-1**. First, the Bank adjusted the target level for settlement balances at times due to temporary upward pressure on the overnight rate or because of anticipated seasonal needs, such as around quarter ends and the fiscal year-end for commercial banks. Second, it appears that the Bank frequently missed the target level of settlement balances. While the actual level certainly differed from the targeted amount, the Bank's intraday intervention to reinforce the target for the overnight rate through the use of overnight repos injected liquidity into the system and the Bank was unable to withdraw liquidity from the system at the end of the day. This resulted in the actual level of settlement balances being higher than the targeted amount.

As mentioned above, two noteworthy exceptions have occurred that involved adjustments to the level of settlement balances. These took place in periods of financial stress, during which the Bank shifted to the floor system. One was after the 2008–09 global financial crisis, when the Bank increased the target level of settlement balances to $3 billion—which at the time was the highest level of settlement balances since the inception of the LVTS (see **Chart A-1**).[31] The second was in 2020, in response to the COVID-19 pandemic. To support its monetary policy and financial stability objectives, the Bank made the unprecedented move of removing the target for settlement balances altogether and allowing settlement balances to grow unconstrained (**Chart A-2**).

[30] For more information on the target for the overnight rate, see Bank of Canada (2021h).

[31] For more information on the policy actions taken during the global financial crisis, see Bank of Canada (2009).

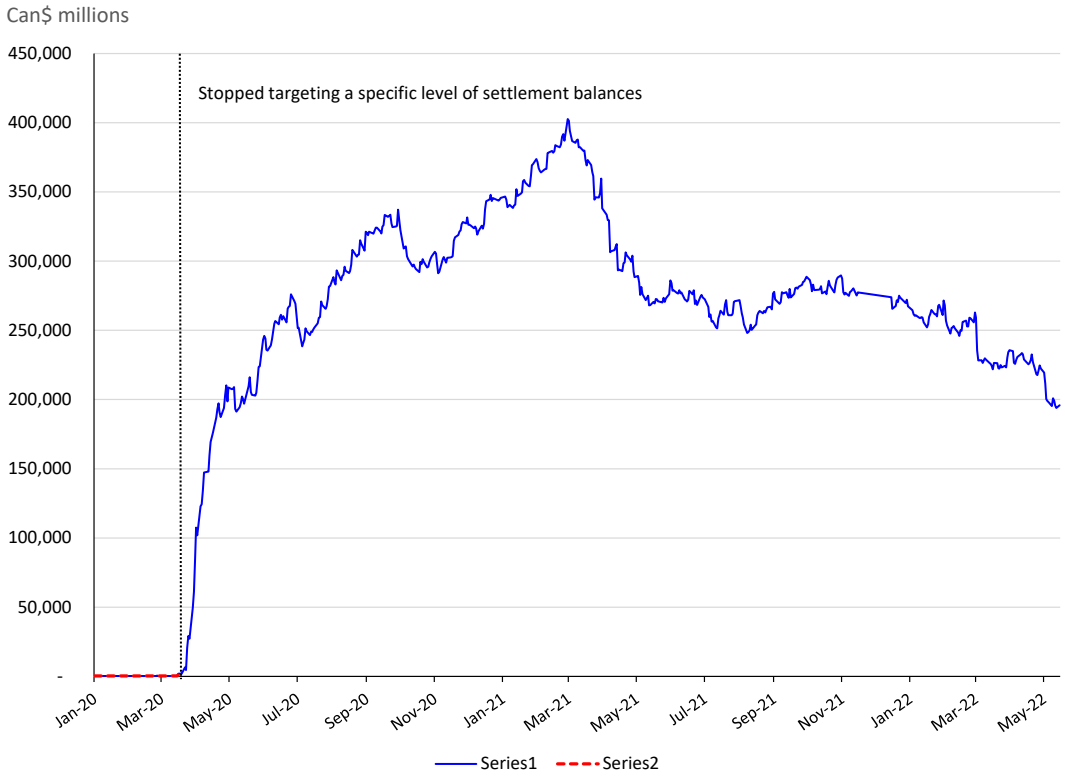
Chart A-1: Settlement balances before targeting ceased



Note: This chart shows actual settlement balances before the Bank of Canada stopped targeting a specific level of settlement balances on March 23, 2020. Data are from the Bank of Canada's Canadian Interest Rates and Monetary Policy Variables: 10-Year Lookup (2022).

Source: Bank of Canada Last observation: December 31, 2019

Chart A-2: Growth in settlement balances after no longer targeting a specific level



Note: This chart shows actual settlement balances after the Bank of Canada stopped targeting a specific level of settlement balances on March 23, 2020. Data are from the Bank of Canada's Canadian Interest Rates and Monetary Policy Variables: 10-Year Lookup (2022).

Source: Bank of Canada Last observation: May 16, 2022

Appendix B: Examples of payment and settlement system flows on the Bank of Canada's balance sheet

The following examples illustrate the various flows through the payment and settlement systems and the Bank's balance sheet when settlement balances are zero, negative and positive. While the actual flows are more complicated than these somewhat simplified examples, ultimately, once everything is aggregated and netted at the end of the day in the high-value payment system (HVPS), participants are either long or short and will look to cover their short position or deposit their excess funds at the Bank of Canada.

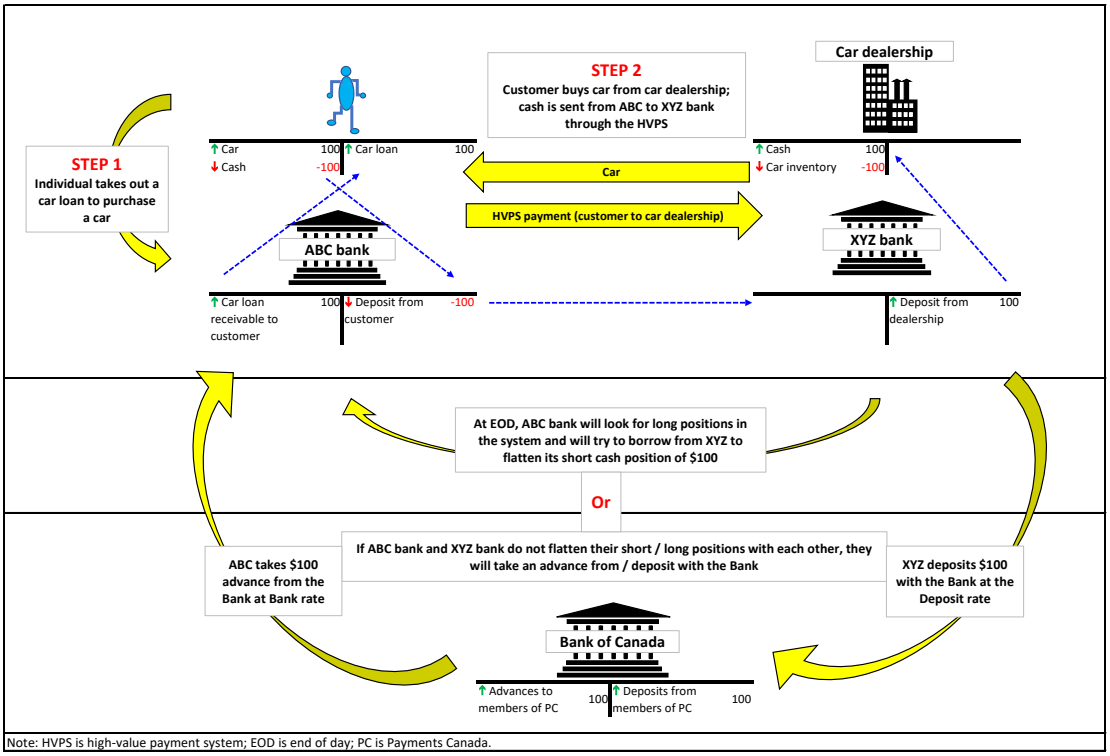
Example A: When settlement balances are small (near zero)

Before the COVID-19 pandemic, the Bank's framework for implementing monetary policy centred around an operating band of 50 basis points (bps) and the Bank targeted a specific level of settlement balances—near zero. To see the impact settlement balances have on the financial system under a corridor system, consider the interactions between a commercial bank (ABC bank) and its customers. In this simplified example of the flow of funds, a customer of ABC bank wishes to purchase a car and so takes a car loan from ABC. As ABC deposits the funds of the car loan into the customer's account, from ABC's perspective this transaction results in an asset (car loan receivable from the customer) and a liability (deposit in the customer's account). When the customer proceeds to purchase a car from the car dealership that also happens to be a customer of ABC, the impact on ABC is unchanged. This is because the funds used in the purchase of the car simply move from the customer's account to the car dealership's, and ABC still has an asset (car loan receivable from the customer) and a liability (deposit from the car dealership).

The situation becomes more complicated if, all else being equal, the car dealership banks with XYZ bank (see **Figure B-1**, step 1 and step 2). In this case, when the customer purchases the car from the dealership, the funds move by way of HVPS payment from ABC bank (which no longer has a deposit) to XYZ bank, which now has the funds (deposit from the car dealership). Recall that the HVPS is a closed system; therefore, ABC is now short cash (amount of the car loan) and XYZ is now long funds (amount of the car loan), but the payment system as a whole is still net zero. At the end of the day, ABC needs to fund its short position (or flatten its position) by finding another participant that is willing to trade its long position, and in this simple scenario it would likely be XYZ. Usually, with a 50 bps operating band (corridor system) and limited liquidity in the payment system, ABC and XYZ are incentivized to settle surplus and deficit positions with each other at the midpoint between the Bank rate and the deposit rate. Failing that, ABC would need to take an overnight advance from the Bank of Canada at the target rate plus 25 bps and XYZ would need to deposit its long position with the Bank overnight at the target rate less 25 bps. As shown in **Table B-1**, both the advance

and deposit are reflected on the Bank's balance sheet and the net of both flows results in settlement balances being zero. Note that if ABC and XYZ had been able to trade their short and long positions with each other, the net position of the payment system would be zero before and after trade, and they would not need to take an advance from or make a deposit with the Bank.

Figure B-1: Illustrative example of near-zero settlement balances (commercial bank deposits versus central bank deposits)



Note: HVPS is high-value payment system; EOD is end of day; PC is Payments Canada.

Table B-1: Impact on settlement balances when a customer makes a purchase in a zero-settlement-balances environment

Normal course	
Asset	**Liability**
100 ↑ Advance to PC	100 ↑ Deposit from PC

A	B	=B-A
Advance to PC (pay sys)	**Deposit from PC**	**Settlement balances**
100	100	0

Note: PC is Payments Canada; pay sys is payment system.

Example B: When settlement balances can miss the target and end up negative

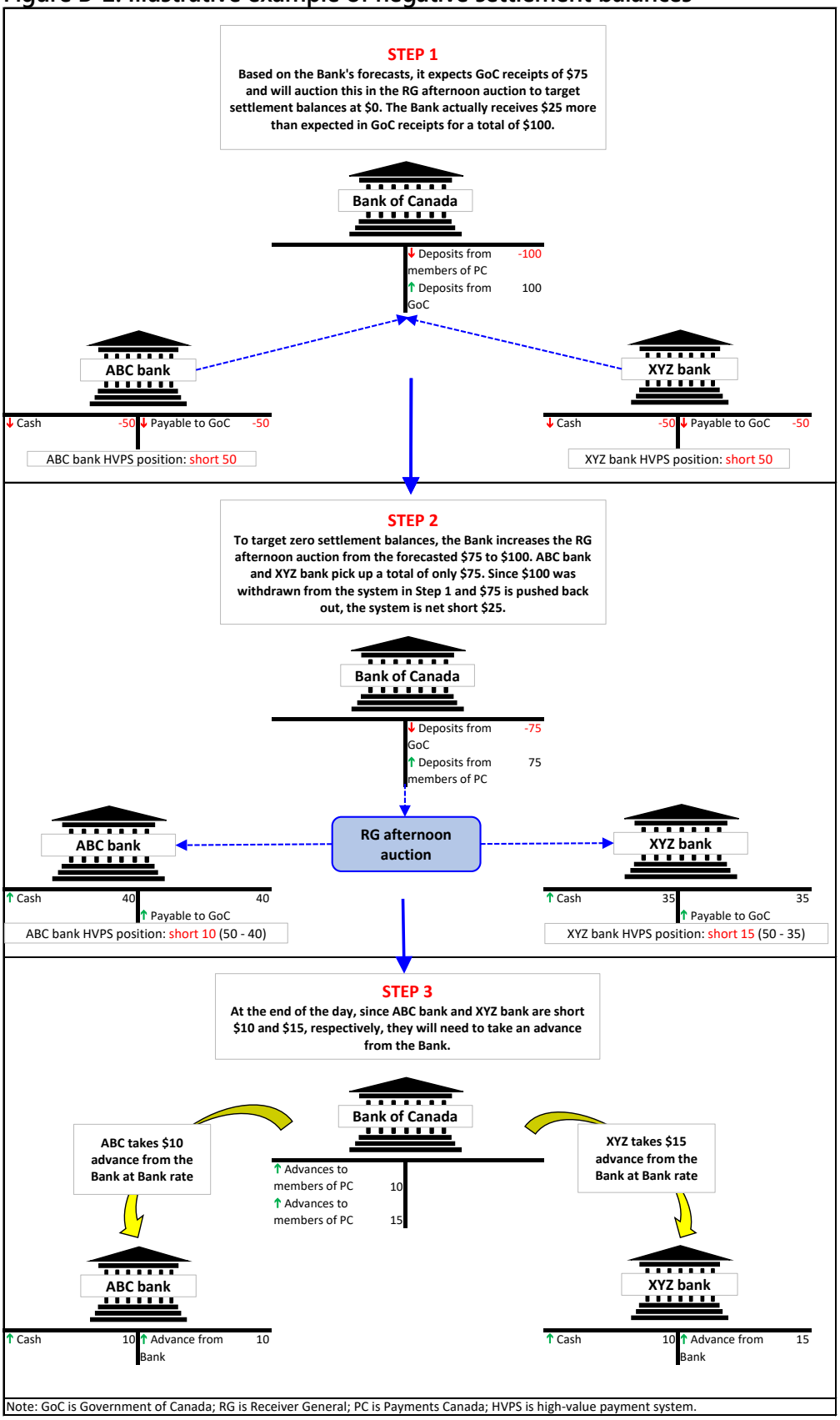
When the Bank is targeting a near-zero level of settlement balances (under a corridor system), it is possible that the level can end up being negative, when the aggregate net position of all participants is short and the Bank is long. This unanticipated situation could arise if Government of Canada receipts at the Bank are higher then expected (which drains liquidity from the system) and in response the Bank attempts to neutralize this by increasing the Receiver General (RG) afternoon auction to push liquidity back out to the system but is unsuccessful. In this scenario, because participants of the RG afternoon auction did not take the full amount offered, participants and the net payment system, excluding the Bank, will be left short. Negative settlement balances can also occur when the Bank conducts multiple overnight reverse repos (ORRs) (withdrawing liquidity from the market to support the target policy rate) and is similarly unable to reinject liquidity later in the day through the RG afternoon auction because participants do not bid for or take the full amount auctioned. In both instances, at the end of the day the net payment system would be left short (the Bank is long) and those participants that are short will need to take an overnight advance from the Bank.

Figure B-2 illustrates a scenario in which the Bank expects to receive a total of $75 from HVPS participants (ABC bank and XYZ bank) as payments to the Government of Canada. The Bank manages its forecasts and RG auction amounts ($75) to target settlement balances of zero at the end of the day. During the day, however, the Bank receives a total of $100 from ABC and XYZ (government receipts are $25 higher than forecast) and must now increase the RG afternoon auction to account for the additional $25 to reach the targeted level of settlement balances. Assume for simplicity that the Bank plans to auction $100 but ABC and XYZ take up only $40 and $35, respectively, for a total of $75. This leaves $25 uncovered.

In this instance, the system is short by $25—the amount not taken by HVPS participants and that remains in the government's account with the Bank. **Table B-2** shows both the $25 uncovered from the auction and the system being short by $25 as an advance to members of Payments Canada and a Government of Canada deposit on the Bank's balance sheet. Since there is no deposit from members of Payments Canada, the net of advance to / deposit from members of Payments Canada results in settlement balances being negative $25. The ORR is similar to this scenario, in that the ORR operation withdraws liquidity from the market much like a larger-than-expected receipt for the government would.[32]

[32] Overnight repo and overnight reverse repo operations cannot be forecast because they are conducted in response to prevailing market conditions. For more information, see Bank of Canada (2021e).

Figure B-2: Illustrative example of negative settlement balances



Note: GoC is Government of Canada; RG is Receiver General; PC is Payments Canada; HVPS is high-value payment system.

Table B-2: Impact on the level of settlement balances when government receipts are higher than expected and the Bank is unable to neutralize

Normal course	
Asset	**Liability**
25 ↑ Advance to PC	25 ↑ Deposit from GoC
	0 Deposit from PC

A	B	=B-A
Advance to PC (pay sys)	**Deposit from PC**	**Settlement balances**
25	0	-25

Note: PC is Payments Canada; pay sys is payment system.

Conversely, differences can also occur because either the net government receipts are lower than expected or the net impact of the Bank's intervention actions (overnight repos [ORs] to reinforce the overnight rate) exceed the amount of maturing RG deposits.[33] In this situation (see **Table B-3**), assume for simplicity that the increase in the Special Purchase and Resale Agreement (SPRA) line item is in the amount of the OR operation. This results in a corresponding increase in deposits from members of Payments Canada, assuming that all participants were able to flatten their positions and no advances were made. Since the system is already long, and this liquidity that was injected by the Bank's operation cannot be withdrawn from the system, the RG afternoon auction will be cancelled. Note, in exceptional circumstances, if the Bank is unable to offset the provision of liquidity through its expanded, or extended, term repo operations or Contingent Term Repo Facility, the impact will affect the Bank's balance sheet and the level of settlement balances in the same way as the OR operation. This is captured in the same SPRA line item as the OR operation.

Table B-3: Impact on the level of settlement balances when the Bank has intervened through overnight repo operations and is unable to neutralize

Normal course with OR	
Asset	**Liability**
1,000 ↑ SPRA	1,000 ↑ Deposit from PC

A	B	=B-A
Advance to PC (pay sys)	**Deposit from PC**	**Settlement balances**
0	1,000	1,000

Note: PC is Payments Canada; OR is Overnight Repo operations; pay sys is payment system; SPRA is Special Purchase and Resale Agreements.

Example C: Operating with abundant settlement balances

When the Bank buys an asset through either the asset purchase program or term repos, it receives securities in exchange for funds and sends a payment like it does in the payment system. At the end of the CDSX cycle, this transaction and those of other participants settle through the HVPS. From the seller's (e.g., primary dealer's) perspective, there is no change in the size of its balance sheet, since the amount of securities sold is replaced by the funds it received from the sale—which it can turn around and use to purchase new securities. Because the proceeds of the sale of securities will flow through the seller's commercial bank (an HVPS participant), from the commercial bank's perspective this results in a grossed up balance

[33] To manage a targeted level of settlement balances, normally the Bank transfers net payments and receipts of the public sector, itself and those of its clients to and from the deposits by the Government of Canada on its balance sheet through RG auctions.

sheet (see **Figure 7**), with an asset (settlement balances received from the purchase of securities on behalf of the bank's client) and a liability (deposit in the seller's deposit account).

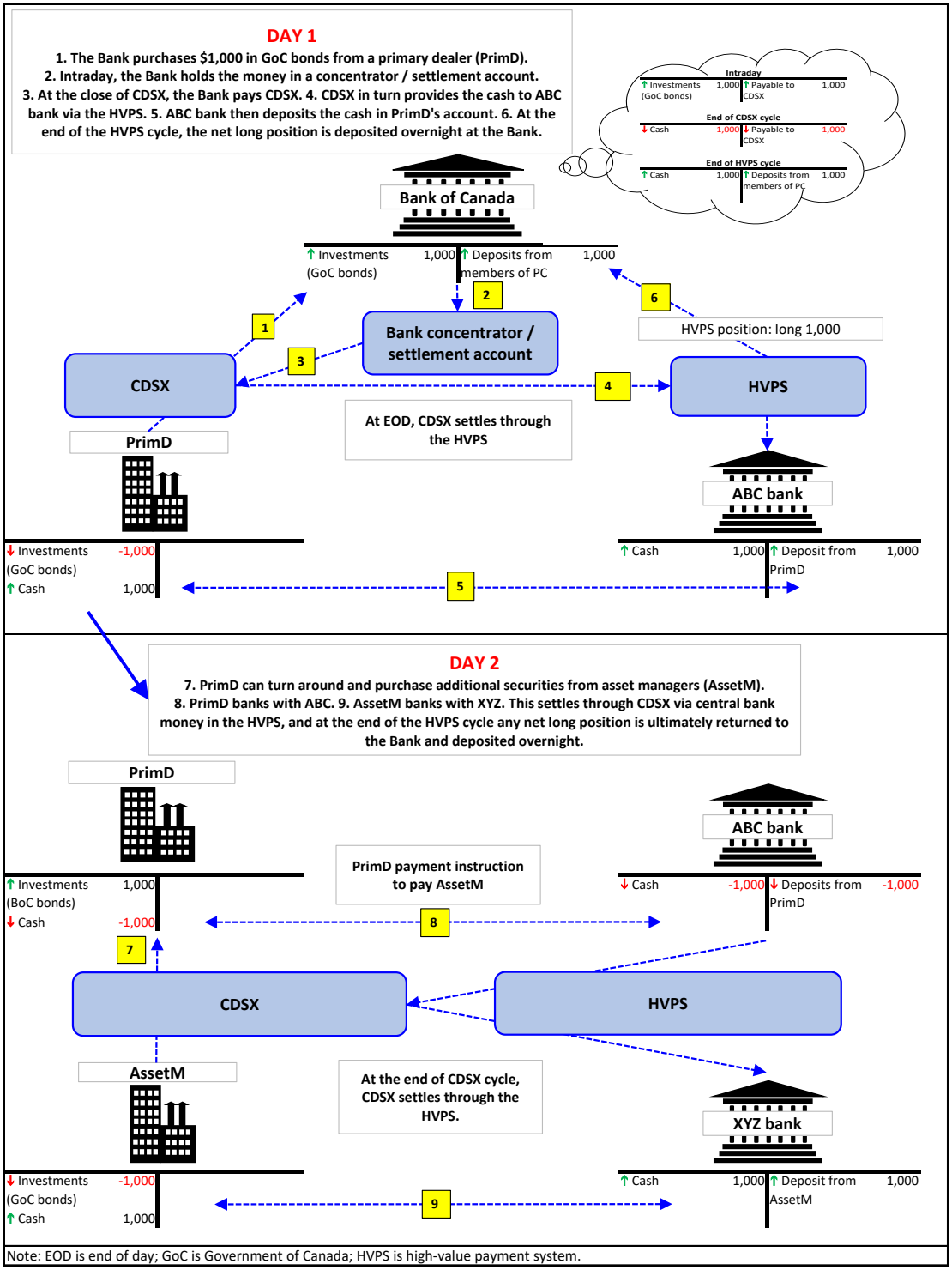
To illustrate this example (see **Figure B-3** for a comprehensive overview), consider that the Bank purchases $1,000 in securities for its asset purchase program from the counterparty PrimD in CDSX. PrimD is a direct participant in CDSX but is not an HVPS participant, and therefore it banks with ABC bank. When the Bank purchases these securities, it increases its securities assets and has a payment obligation to PrimD in CDSX that is settled in CDSX at the end of the day.[34] As such, the Bank has injected liquidity into the financial system. As for PrimD, it sees a decrease in investments by $1,000 when it sells the securities, but it has also received $1,000, which is deposited with ABC bank. Following the transactions, ABC bank now has a deposit liability to PrimD of $1,000 and at the end of the HVPS cycle (notwithstanding all other transactions) it will be long $1,000, which it will deposit at the Bank overnight, assuming all other HVPS participants are flat. This results in a net position (net deposits) of $1,000. As a result:

- the Bank has increased its investments by $1,000 (asset purchase program)
- the Bank has funded this through an increase in net deposits held by HVPS participants (settlement balances)
- ABC bank has a claim or receivable with the Bank that earns the deposit rate
- ABC bank has a deposit from its client PrimD, which in turn has the funds to purchase additional securities the next day (Day 2 of **Figure B-3**)

The increase in investments and the related increase in deposits from members of Payments Canada are reflected on the Bank's balance sheet, as shown in **Table B-4**.

[34] PrimD can use these funds intraday to purchase other securities, but this example assumes it does not purchase additional securities with these funds on Day 1.

Figure B-3: Illustrative example of extraordinary circumstances when settlement balances are abundant



Note: EOD is end of day; GoC is Government of Canada; HVPS is high-value payment system.

Table B-4: The impact on the level of settlement balances when the Bank undertakes asset purchase programs

Severe market-wide stress	
Asset	**Liability**
1,000 ↑ Investment	1,000 ↑ Deposit from PC

Note: PC is Payments Canada; pay sys is payment system.

A	B	=B-A
Advance to PC (pay sys)	**Deposit from PC**	**Settlement balances**
0	1,000	1,000

Appendix C: Liquidity flows at the Bank of Canada

Table C-1: Liquidity injections (withdrawals) from the Bank's operations, regardless of policy objectives, generally increase (decrease) the level of settlement balances[35]

Bank market operations	Normal course	Exceptional
Overnight repo	Injects liquidity	
Overnight reverse repo	Withdraws liquidity	
Securities lending	Near neutral (security for security)	
Securities repo operations[36]	Withdraws liquidity	
Advances to members of Payments Canada (SLF, STLF and ELA)	Provides liquidity	
Term Repo Program for balance sheet management	Provides liquidity (maturity withdraws liquidity)	N/A
Market-wide facilities (expanded, or extended term repo and CTRF)	N/A	Provides liquidity (maturity withdraws liquidity)
Asset purchase programs	N/A	Provides liquidity (maturity withdraws liquidity)
Morning/afternoon Receiver General auction	Injects liquidity (maturity withdraws liquidity)	

Note: SLF is Standing Liquidity Facility; STLF is Standing Term Liquidity Facility; ELA is Emergency Lending Assistance; CTRF is Contingent Term Repo Facility.

[35] The purpose of the Bank's operations varies and can include managing the Bank's balance sheet; lending specific securities that are in high demand in the market; providing extraordinary liquidity to individual financial institutions and on a market-wide basis; acting as fiscal agent to the Government of Canada; and targeting a specific level of settlement balances.

[36] In line with its objectives to support core funding markets and to foster the efficient functioning of the Government of Canada securities market, the Bank announced the introduction of its securities repo operations in July 2020. See Bank of Canada (2020).

Table C-2: Examples of other payments that the Bank accounts for when determining settlement balances

Exogenous factors	Example	General impact on the payment system
Government payments	Social benefit payment	Adds liquidity
Government receipts	Taxes	Removes liquidity
Government debt issuance	New treasury bill issuance	Removes liquidity
Government debt maturity	Bond maturity	Adds liquidity
New bank notes in circulation	Commercial bank needs more bank notes for ATMs	Removes liquidity
Bank notes removed from circulation	Commercial bank returns excess bank notes	Adds liquidity
Client flows	Other central bank deposits	Removes liquidity

Note: ATM is automated teller machine.

Appendix D: Regulatory impacts of quantitative easing on HVPS participants during COVID-19

As mentioned in construct 4, quantitative easing (QE) (and quantitative tightening [QT]) funded by settlement balances can have significant impacts on high-value payment system (HVPS) participants' balance sheets and liquidity ratios if the process or transaction flows involve non-HVPS participants.

While assets and liabilities increase (and decrease) in tandem during QE (and QT) for HVPS participants, the effect on the balance sheet is not neutral because of liquidity coverage ratio (LCR) constraints.[37] QE has resulted in an increase in high-quality liquid assets (HQLA) that is fully funded by an increase in deposits, resulting in an immediate rise in the aggregate LCR. To return the banking system's LCR ratios to a desired steady state, commercial banks will need to shift out of low-yielding HQLA assets into higher-yielding, less-liquid assets until the LCR returns to the desired steady state.

Consider the following example. A commercial bank has a simple balance sheet composed of two types of assets (HQLA and other assets), deposit liabilities and equity (**Table D-1**). Assume the deposit liabilities are subject to a 10% run-off rate assumption under LCR rules. The initial position of this commercial bank is shown in the account balances below. The commercial bank holds $120 in HQLA against deposits of $1,000 that have a 10% run-off rate. The result is an LCR of 120%—the desired steady state. The remaining balances are invested in other assets.

Table D-1: Calculation of liquidity coverage ratio for a commercial bank's simple balance sheet

Asset		Liability and equity	
120	HQLA (A)	1,000	Deposits (B)
980	Other assets	100	Equity
1,100		**1,100**	

LCR calculation	
Run-off rate (C)	10%
30-day run-off (D = B x C)	100
LCR (A / D)	**120%**

The Bank of Canada then conducts a QE operation, buying $100 of Government of Canada bonds from the household sector, which deposits the proceeds of the sale with the commercial bank. The commercial bank in turn deposits the proceeds with the Bank of Canada (which take the form of settlement balances). Now the commercial bank has $220 in HQLA against deposits of $1,100 (**Table D-2**).

[37] LCR = (HQLA + eligible non-operational demand and overnight deposits) / total net cash outflows over the next 30 calendar days. For more information, see OSFI (2019).

Table D-2: Calculation of liquidity coverage ratio when the Bank conducts quantitative easing from the household sector

Asset		Liability and equity	
220	HQLA (+100)	1,100	Deposits (+100)
980	Other assets	100	Equity
1,200		**1,200**	

LCR calculation	
Run-off rate	10%
30-day run-off	110
LCR	**200%**

The fact that the entire asset expansion was in HQLA (settlement balances) and the incremental deposit has an assumed run-off rate of 10% leads to a material increase in the LCR to 200% in this example. This is well above the commercial bank's desired state, so it shifts its assets from HQLA into other, higher-yielding assets (**Table D-3**).

Table D-3: Calculation of liquidity coverage ratio after the commercial bank changes the composition of its assets

Asset		Liability and equity	
132	HQLA (-88)	1,100	Deposits
1,068	Other assets (+88)	100	Equity
1,200		**1,200**	

LCR calculation	
Run-off rate	10%
30-day run-off	110
LCR	**120%**

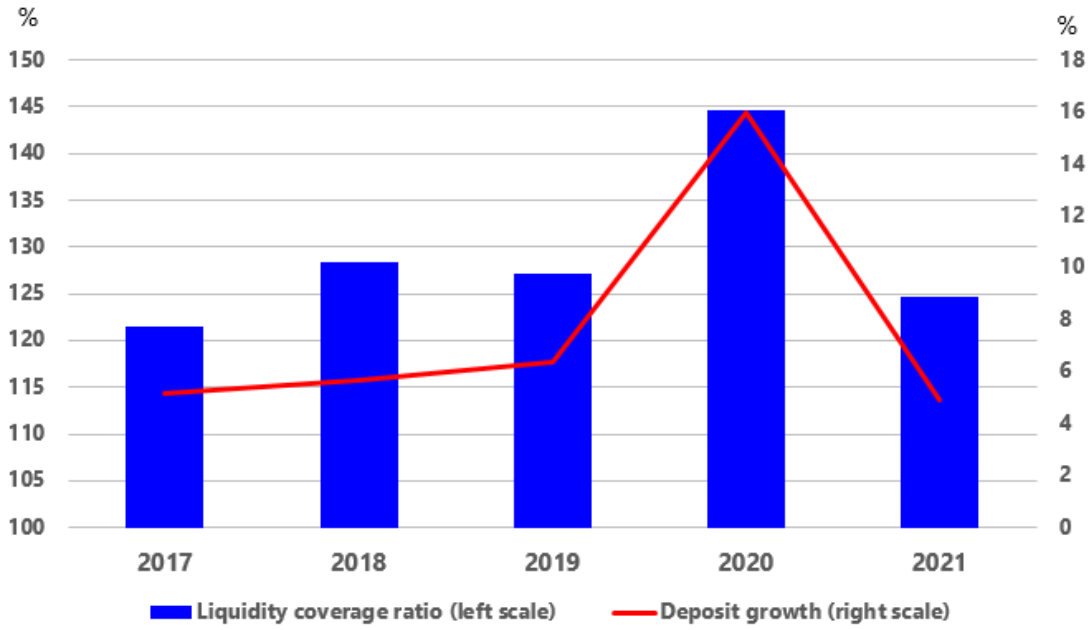
In this scenario, the commercial bank has sold $88 of HQLA and bought other assets. These other assets may be commercial loans, mortgages or other marketable securities (that do not count as HQLA). This returns the LCR to the desired target of 120%.

This simplified example appears to represent what occurred after QE was implemented in Canada in 2020. **Chart D-1** shows the median LCR[38] of Canada's five largest banks (Bank of Montreal, Bank of Nova Scotia, Canadian Imperial Bank of Commerce, Royal Bank of Canada and Toronto-Dominion Bank), with 125% appearing to be the desired target. Following the Bank's QE, the median LCR jumped to about 145% as the banks became flush with HQLA. This declined over 2021 to return the aggregate LCR to its desired level. When comparing the LCR over the five-year time horizon, note the corresponding spike in deposit growth. This suggests that a significant portion of QE purchases were sourced from outside of the banking system and were transformed into commercial bank deposits.

[38] The median three-month weighted average of Canada's five largest banks as at October 31 of each year, as reported in the management discussion and analysis section of each bank's annual report from 2017–21.

Chart D-1: Five-year median liquidity coverage ratio and total deposit growth at Canada's five largest banks

Median three-month weighted average as at October 31 of each year shown



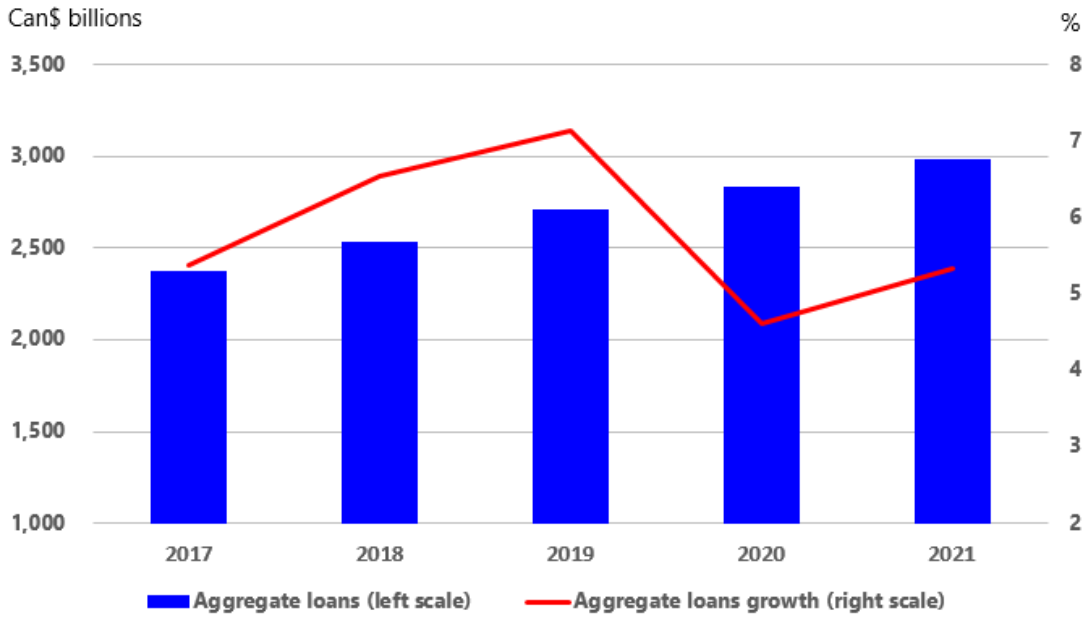
Sources: Bank of Montreal, Bank of Nova Scotia, Canadian Imperial Bank of Commerce, Royal Bank of Canada and Toronto-Dominion Bank

Last observation: October 2021

This raises the question of where the banks deployed their HQLA. What other assets did they invest in as they ran down their HQLA and returned to the preferred range of around 125%? The answer does not appear to be loans, either commercial or consumer (see **Chart D-2**). While aggregate loans have grown, the percentage growth over the QE period was actually below the growth level of the previous three years. This is consistent with the relatively low level of demand for loans observed during the COVID-19 pandemic.

Chart D-2: Value and growth of five-year total aggregate loans at Canada's five largest banks

As at October 31 of each year shown



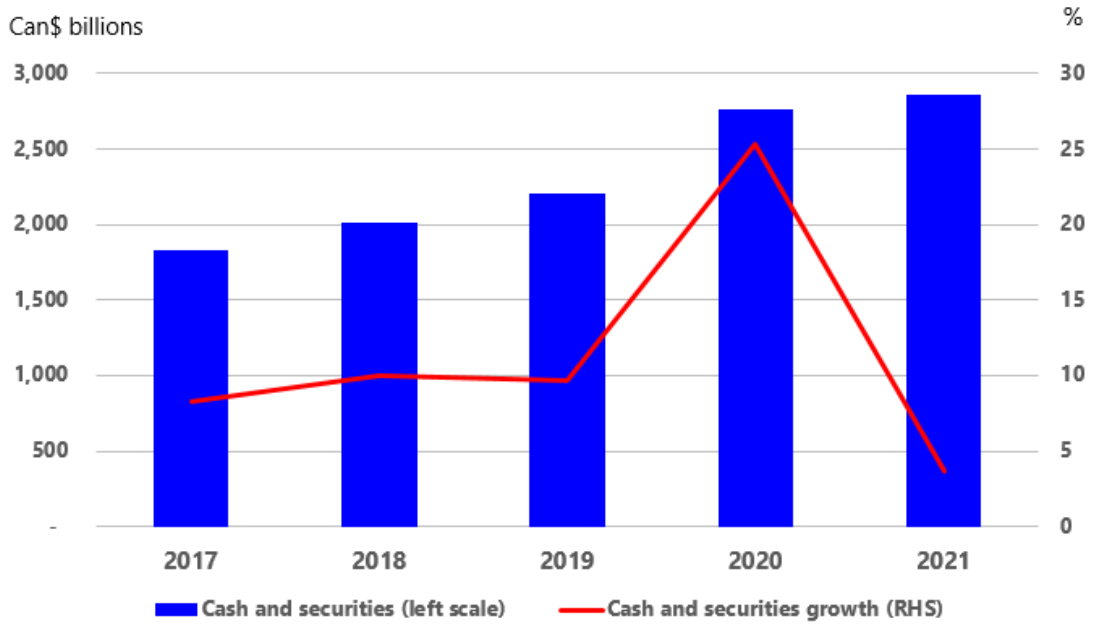
Sources: Bank of Montreal, Bank of Nova Scotia, Canadian Imperial Bank of Commerce, Royal Bank of Canada and Toronto-Dominion Bank

Last observation: October 2021

Conversely, the most rapid growth in assets was in cash and securities, which saw growth spike from about 10% per year before QE to 25% in 2020. It appears that the banks (in aggregate) returned their LCR ratios to their internal target mostly by shifting away from HQLA assets and toward other non-HQLA securities (see **Chart D-3**).

Chart D-3: Value and growth of five-year total cash and securities at Canada's five largest banks

As at October 31 of each year shown



Sources: Bank of Montreal, Bank of Nova Scotia, Canadian Imperial Bank of Commerce, Royal Bank of Canada and Toronto-Dominion Bank

Last observation: October 2021

QT will, of course, have the reverse impact. As bonds mature and the Bank allows settlement balances to run down, the system will see a reduction in deposits and the associated HQLA. This is due to the household sector drawing down its bank deposits to purchase the newly issued Government of Canada bonds. The impact on a commercial bank's balance sheet is shown in **Table D-4**.

Table D-4: Calculation of liquidity coverage ratio at the commercial bank with quantitative tightening through the household sector

Asset		Liability and equity	
32	HQLA (-100)	1,000	Deposits (-100)
1,068	Other assets	100	Equity
1,100		**1,100**	

LCR calculation	
Run-off rate	10%
30-day run-off	100
LCR	**32%**

In this scenario, the $100 decrease in deposits and the associated HQLA has resulted in the LCR falling well below the regulatory minimum. The commercial bank now must either rebalance its asset holdings (moving from other assets into HQLA) or raise some term funding. This reverses the shift away from HQLA that the banks had done after QE. Shifting from other assets to HQLA restores the LCR ratio to the desired level (**Table D-5**). Note that the value of assets shifted is lower than the value of settlement balances that were withdrawn.

Table D-5: Asset rebalancing at the commercial bank to restore the liquidity coverage ratio

Asset		Liability and equity	
120	HQLA (+88)	1,000	Deposits
980	Other assets (-88)	100	Equity
1,100		**1,100**	

LCR calculation	
Run-off rate	10%
30-day run-off	100
LCR	**120%**

Alternatively, if the commercial bank wishes to maintain its holdings of other assets at the same level, rather than shifting from other assets to HQLA, it would have to acquire additional HQLA by either competing for more deposits (pulling money out of non-bank financial institutions [NBFIs]) or issuing term debt (**Table D-6**). This incremental deposit would be used to fund purchases of HQLA. The impact on the commercial bank's balance sheet is shown below.

Table D-6: Issuance of term debt at the commercial bank to restore the liquidity coverage ratio

Asset		Liability and equity	
120	HQLA (+88)	1,000	Deposits
1,068	Other assets	88	Term funding (+88)
		100	Equity
1,188		**1,188**	

LCR calculation	
Run-off rate	10%
30-day run-off	100
LCR	**120%**

In both cases (asset rebalancing or term funding), the aggregate size of the commercial bank's balance sheet has shrunk. This is a function of QT. Just as QE moved money out of the NBFI sector and into the banking sector, QT reverses this.

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