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Retail CBDC purposes and risk transfers to the central bank

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Abstract

The issuance of retail central bank digital currency (CBDC) involves a transfer of risk from commercial banks to the central bank. Mechanisms that limit the transfer of risk, such as an unattractive interest rate, a quantity ceiling or the non-convertibility of cash and reserves into CBDC, are likely to discourage the use of CBDC as a medium of exchange and thus defeat the purpose of issuing CBDC.

Keywords Central bank digital currency (CBDC), Fractional-reserve banking, Gresham's law, Medium of exchange

1 Introduction

Central banks and international institutions have been discussing the pros and cons of central bank digital currency (CBDC) over the past few years.¹ In the debate, the main distinction is between wholesale CBDC, which is available only to financial intermediaries, and retail CBDC, which is available to the public. Wholesale CBDC already exists in the form of sight deposits held by commercial banks at the central bank; issuing it in a different form or through a different technological medium would probably have little economic impact. In contrast, the issuance of retail CBDC would have significant economic implications. In this paper, we discuss the issuance of retail CBDC, which we refer to as CBDC for simplicity.

The idea of a central bank issuing a digital currency available to the public is not new; it goes back to Tobin (1987), who argued that “I think the government should make available to the public a medium with the convenience of deposits and the safety of currency, essentially

currency on deposit, transferable in any amount by check or other order.” A number of arguments for issuing CBDC have been put forward in recent years, for example by Ahnert et al. (2022), Barrdear and Kumhof (2016), Bindseil (2020), BIS (2020), Bordo and Levin (2017), ECB (2023), Goodfriend (2016). The main purposes of issuing CBDCs are (1) to provide central bank money to the public as the use of cash declines, (2) to improve the resilience of electronic payments by providing a back-up system, (3) to promote diversity and sovereignty in payment systems, and (4) to enhance monetary policy.²

There are significant challenges to achieving these purposes with a CBDC. The issuance of a CBDC in the current banking system can lead to a significant transfer of credit risk from commercial banks to the central bank. When depositors transfer their risky deposits to CBDC, the central bank responds to the demand to keep money-market rates and its monetary policy stance unchanged by taking on the banks' credit risk on its balance sheet. To limit this transfer of credit risk, it is highly desirable for the central bank to limit and control the amount of CBDC. However, limiting the demand for or supply of CBDC is likely to discourage the use of CBDC as a medium of exchange and encourage the holding of CBDC

¹ For information on central bank attitudes towards CBDC and pilot studies, see, for instance, Mancini-Griffoli et al. (2018), CPMI (2018), Barontini and Holden (2019) and the references therein.

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² Encouraging financial inclusion, improving cross-border payments and supporting public privacy are other motivations for issuing a CBDC mentioned in BIS (2020). We do not however address these purposes in this paper, as their achievement depends more on the technology implemented than on money being issued by the central bank.

as a store of value. If held as a store of value, CBDC may not achieve some of its intended purposes, such as the establishment of a sovereign electronic payment system. As long as the bulk of money in our monetary system is issued in the form of risky bank deposits, some purposes that CBDC is intended to serve would be better served by solutions based on bank deposits rather than central bank money.

2 Implications of CBDC for the conduct of monetary policy

What would happen if the central bank makes CBDC available to the public? The effects of CBDC on the conduct of monetary policy depends largely on the issuance model and any changes to the monetary system. In central banks and international institutions, the debate on the issuance of CBDC takes place in the context of the current fractional-reserve banking system. Central banks that discuss the possibility of issuing CBDC never do so with the aim of abolishing the fractional-reserve banking system, but rather with the aim of issuing CBDC within this system.³ We therefore assume that the monetary and banking system remains unchanged, apart from the issuance of CBDC itself.⁴ In order to fulfil its mandate of price stability, the central bank continues to influence the expansion of money and credit of commercial banks by steering money-market interest rates through the issuance of reserves and by setting the interest rate paid on these reserves.

2.1 CBDC in the fractional-reserve banking system

In their primary role, banks perform three interrelated functions. First, banks are intermediaries for non-bank money holdings. Non-banks deposit their money with their bank, which holds reserves at the central bank. This is the two-tier dimension of the system. Second, banks lend to non-banks and play an important role in the credit market. And third, banks issue deposits in order to grant credit and play a key role in the process of money creation. This is the fractional-reserve dimension of the system. Contrary to popular belief, banks do not collect deposits in order to lend (as pension funds do,

for example), but create the deposits they lend. Banks are therefore not credit intermediaries (because they create new deposits when they lend), but monetary intermediaries (because non-banks hold their money through banks).

The lending process by commercial banks is key to the monetary policy transmission mechanism, as it is when commercial banks lend that money first enters circulation in the form of customer deposits. This would remain the case if the central bank made CBDC available to the public. What would change, however, is that the public would be able to request the redemption of their bank deposits not only in cash but also in CBDC. That is not an insignificant detail, because the demand for CBDC could be considerably higher than the demand for cash. The redemption of deposits in cash is generally limited because cash is vulnerable to loss and theft and is less convenient than deposits for settling payments. However, the redemption of deposits into CBDC is likely to be on a much larger scale, as CBDC enjoys all the benefits of deposits without bearing credit risk. Thus, in normal times, the demand for CBDC is likely to be significantly higher than the demand for cash, especially when the opportunity cost of money holding, i.e. interest rates, is low. Moreover, the demand for CBDC is likely to increase further in times of crisis, as underlined by Agur et al. (2019), Bech and Garratt (2017), Jordan (2018) or Stevens (2017). Since it is much easier to transfer money from a bank deposit to a CBDC account (one click) than to withdraw cash at the counter, depositors will be much more likely to quickly convert their deposits into CBDC during periods of financial instability.

What are the implications for the banking system? The literature is often inaccurate in describing the impact of CBDC on the economy. As CBDC would substitute for bank deposits, banks would have fewer deposits on their balance sheets and it is often said that banks would consequently lend less. Fewer deposits, fewer loans, the argument goes. This view is misguided because in the fractional-reserve banking system banks do not need deposits to lend because they create the deposits they lend.

However, while banks do not need deposits to lend, they do need liquidity to fund the payment that usually follows the lending. As the CBDC would substitute for some of the bank deposits, banks would also have less liquidity on their balance sheets and this could hamper their lending as far as the money market is concerned. The money-market interest rate is the price that banks pay for borrowing liquidity. Therefore, the effect of CBDC on bank lending depends on the effect of CBDC on money-market rates.

³ For example, ECB (2023) stresses that “a digital euro would be designed to have no material impact on financial stability or the transmission of monetary policy” (p. 12), or that “a digital euro would seek to maintain the healthy equilibrium which has existed for decades between bank deposits and central bank money” (p. 33).

⁴ The issuance of CBDC under the current fractional-reserve banking system contrasts sharply with proposals to issue CBDC under a full reserve banking system, such as the Vollgeld proposal, which was rejected by 75% of the Swiss voting population in June 2018. These proposals aim not only to make CBDC available to the people but also to abolish the role of commercial banks as money issuers, so that all of the money in circulation would be central bank money (in the form of banknotes or CBDC). Of course, this would radically change the transmission mechanism of monetary policy.

If there were no central bank, the outflow of liquidity from banks would dry up the money market and push up interest rates, making it more difficult for banks to lend. However, since the central bank conducts monetary policy by keeping money-market rates close to its policy rate, it would automatically conduct the necessary operations to neutralise the possible effects of CBDC on the money market. If the central bank did not offset these effects, the demand for CBDC would lead to an autonomous change in its monetary policy stance, which would be contrary to its objective of price stability. For example, if the central bank did not meet the rising demand for central bank money, the scarcity would lead to an undesirable rise in money-market rates, which would slow down the process of bank credit expansion and cause inflation to fall below target. In the worst case, the scarcity of central bank money could lead to the failure of some banks, which is equivalent to a contraction of broad money and could lead to a debt-deflation spiral.⁵ It is therefore realistic to assume that the central bank would keep money-market interest rates close to its policy rate, irrespective of the demand for CBDC.

Since money-market conditions would not be affected by CBDC due to the central bank's accommodation, banks' ability to lend and issue new deposits would also be unaffected, even if some of their previously issued deposits were substituted for CBDC. Andolfatto (2020) and Brunnermeier and Niepelt (2019) reach a similar conclusion, pointing out that a central bank committed to following an interest rate policy rule and acting as lender of last resort provides banks with the funds to substitute deposits.

Would CBDC lead to disintermediation of banks? To the extent that non-banks hold CBDC directly rather than bank deposits, the role of banks as monetary intermediaries would be reduced. However, to the extent that banks are not credit intermediaries, their ability to lend would not be affected as long as the central bank keeps money-market conditions unchanged. In order to fulfil its price stability mandate, the central bank would thus be induced to meet the demand for CBDC in order to keep money-market rates close to its policy rate. In doing so, it would be taking on the credit risk of commercial banks.

2.2 The transfer of credit risk from commercial banks to the central bank

By meeting the demand for CBDC in order to maintain its policy stance, the central bank lends to commercial banks, which results in a transfer of credit risk from

banks to its balance sheet. Let us now take a closer look at the mechanism of risk transfer when excess reserves are low or high.

2.2.1 Risk transfer when banks' excess reserves are low

When excess reserves are low, the decline in bank reserves following an increase in the public's demand for cash or CBDC leads to tighter money-market conditions and higher short-term interest rates. To prevent a tightening of monetary conditions, the central bank must accommodate this demand with a corresponding increase in bank reserves. This accommodation implies an expansion of the central bank's balance sheet and thus a transfer of risk to the central bank.

Figure 1 illustrates this risk transfer by describing the effect of an increase in the demand for CBDC by non-banks on the balance sheet of commercial banks and the central bank when excess reserves are low. Step 0 shows the balance sheet of the central bank, commercial banks and non-banks before the issuance of CBDC. We assume that banks are required by law to hold minimum reserves equal to 25% of their short-term liabilities, i.e. deposits. This creates a demand for reserves and a role for the money market. Alternatively, it can be assumed that banks wish to hold a fraction of their deposits as reserves in order to meet their payment obligations or to satisfy regulatory requirements, such as liquidity coverage ratios. In step 1, depositors demand the redemption of deposits worth 2 into CBDC, causing bank reserves to fall below the required or desired level.⁶ As banks are pressed for reserves, money-market rates rise. In step 2, to prevent a rise in money-market rates and hence an undesirable tightening of monetary conditions, the central bank expands reserves.

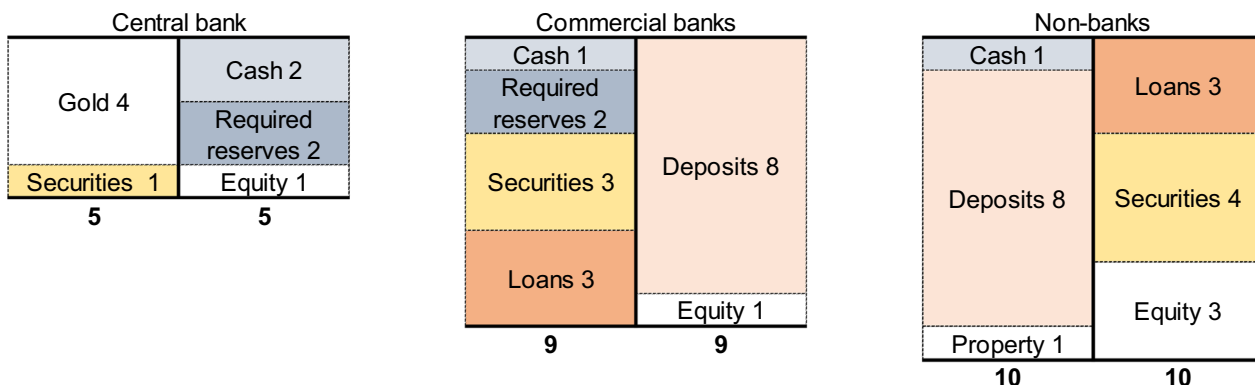
The central bank can increase reserves either by purchasing assets directly or by lending to commercial banks—for example, through repo operations. In either case, the central bank's balance sheet grows with the demand for CBDC. The assets taken over determine the risk transferred to the central bank. In this example, the central bank issues reserves by purchasing securities from commercial banks, but it could alternatively take over bank loans or lend to banks without collateral.

Note that this risk transfer mechanism was already at work in the absence of CBDC, when the central bank met non-bank demand for cash when reserves were scarce before the global financial crisis of 2008. When depositors demanded the redemption of deposits in cash, the decline in bank reserves would have led to an increase in money-market rates if the central bank had not met the demand with a corresponding increase in reserves.

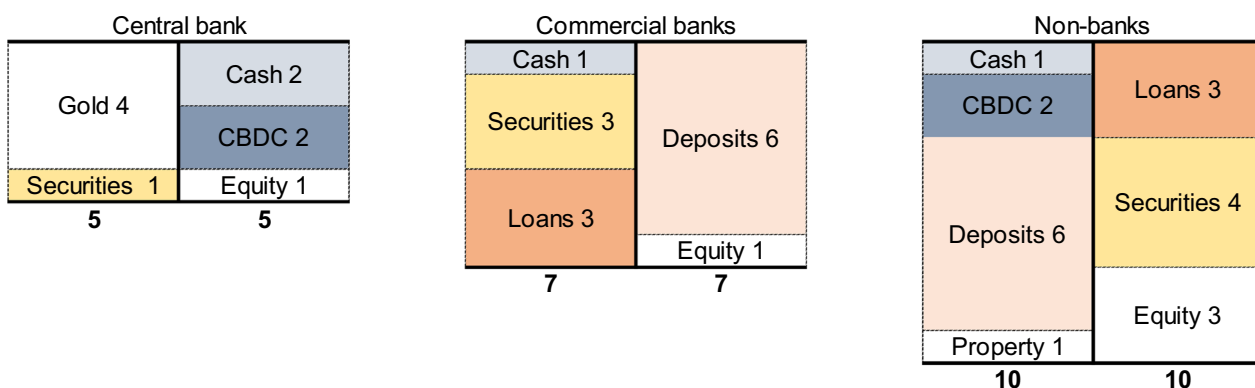
⁵ Böser and Gersbach (2020) and Gross and Schiller (2021) arrive at the same implication in their model; they show that the refusal by the central bank to accommodate the demand for reserves by banks would render banking non-viable and banks insolvent.

⁶ Given the small amount of banknotes relative to deposits, we assume that the demand for CBDC is a substitute for deposits rather than banknotes.

Step 0: initial situation



Step 1: non-banks request redemption of deposits in CBDC, banks' reserves fall below required level



Step 2: to keep policy rate unchanged, the central bank expands reserves by taking securities as collateral

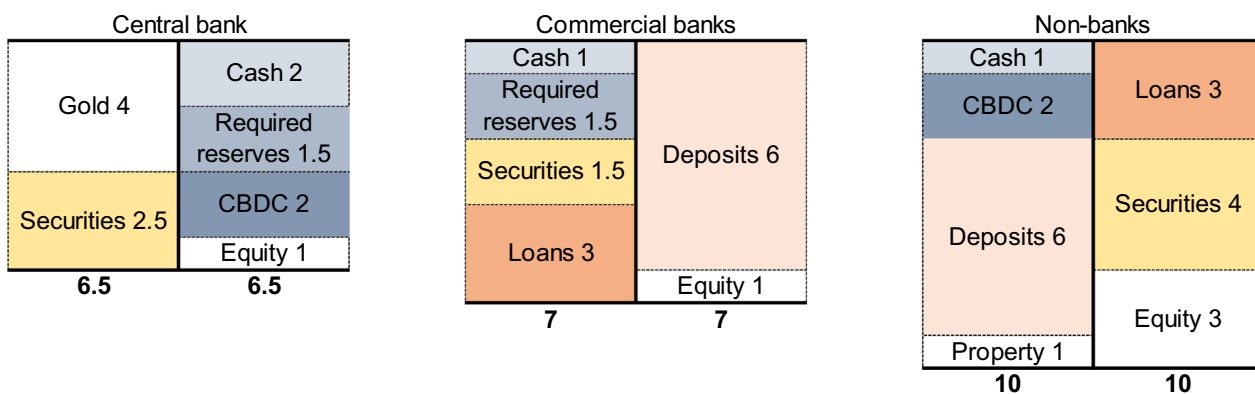
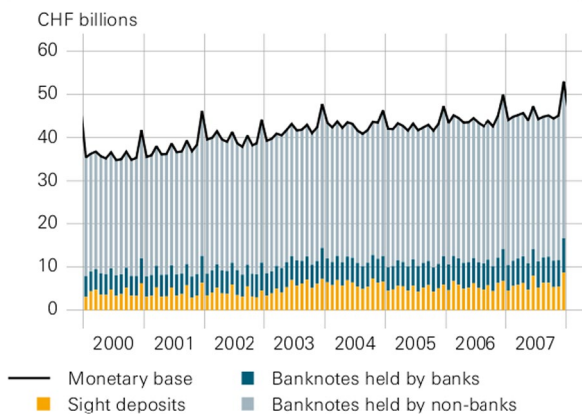


Fig. 1 Effect of an increase in the demand for CBDC with low excess reserves of banks

As an example of the above mechanism, it is well known that the demand for cash by non-banks in Switzerland increases significantly at the end of the calendar year. Figures 2 and 3 show that the increase in demand for cash did not lead to spikes in the three-month Libor in

Swiss francs. This indicates that the SNB accommodated demand in order to keep the Libor close to its aimed level. The sample starts in 2000, when the SNB started to steer short-term money-market rates rather than monetary aggregates, and ends in 2007, before bank excess

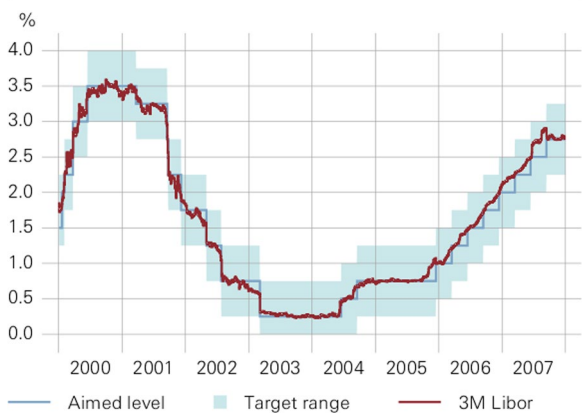
MONETARY BASE



Source: SNB

Fig. 2 Demand for cash and reserves

TARGET RANGE FOR 3M LIBOR



Sources: Bloomberg, SNB

Fig. 3 3M Libor in CHF

reserves became large due to unconventional monetary policy measures during the global financial crisis.

2.2.2 Risk transfer when banks' excess reserves are high

When excess reserves are high, the decline in bank reserves does not immediately lead to tighter money-market conditions and higher short-term interest rates. Thus, the central bank does not need to accommodate non-bank demand for cash or CBDC in order to maintain its monetary policy stance. However, as bank excess reserves decline, the central bank loses the ability to reduce its balance sheet and the risk associated

with it in the future. High excess reserves are the result of previous increases in the central bank's balance sheet. By reducing excess reserves, the redemption of deposits into cash or CBDC "locks in" the risk on the central bank's balance sheet.

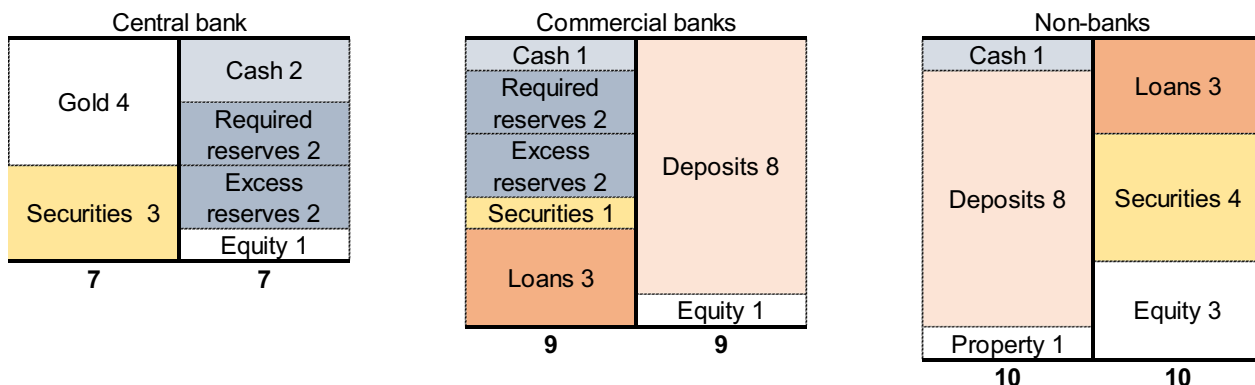
Figure 4 illustrates the effect of an increase in the demand for CBDC by non-banks on the balance sheet of commercial banks and the central bank when excess reserves are high. Step 0 shows the balance sheet of the central bank, commercial banks and non-banks before the issuance of CBDC. In step 1, depositors demand the redemption of deposits worth 2 in CBDC, which causes bank reserves to fall. However, as reserves remain above the required or desired level, the demand for CBDC does not lead to a significant increase in money-market rates. Although the central bank's balance sheet does not increase in response to the demand for CBDC, the central bank loses the ability to reduce its balance sheet to the extent that it could before. Before issuing CBDC, the central bank can reduce its balance sheet by 2, the amount of excess reserves, without significantly affecting money-market rates. After issuing CBDC, the central bank can only reduce its balance sheet by 0.5 without affecting money-market rates.

3 Limiting the transfer of credit risk

The previous section has shown that the issuance of CBDC leads to a transfer of risk from commercial banks to the central bank. Thus, if there were no limit to the issuance of CBDC—and assuming that the central bank offsets the effects of the demand for CBDC on the money market and fully assumes its role as lender of last resort—a substantial part of the banks' credit risk could end up on the central bank's balance sheet. Technically, there is no limit to the credit risk that can be transferred to the central bank because there is no limit to the amount of central bank money that can be issued. However, the prevailing view is that the current system, based on private banks bearing their own credit risk, should be maintained and that credit allocation should be the responsibility of commercial banks, not the central bank. For example, the ECB (2023, p. 33) states that "a digital euro would seek to maintain the healthy equilibrium which has existed for decades between bank deposits and central bank money." The transfer of credit risk from commercial banks to the central bank should thus be limited.

The risk transferred depends on the quality of the assets held by the central bank or taken as collateral in lending operations and on the quantity of CBDC issued, i.e. the size of the central bank's balance sheet.

Step 0: initial situation



Step 1: non-banks request redemption of deposits in CBDC, banks' excess reserves decrease

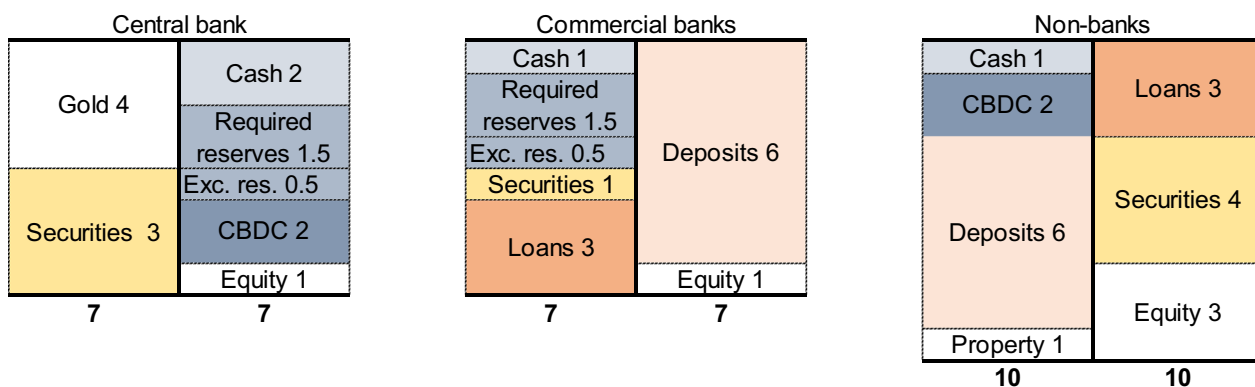


Fig. 4 Effect of an increase in the demand for CBDC with high excess reserves of banks

3.1 Maintaining the quality of assets held by the central bank

One way to limit the transfer of risk is to define a conservative portfolio of eligible collateral and to apply significant haircuts to collateral assets. While these measures mitigate the materialisation of risk for the central bank, they raise at least two issues, that are particularly acute when the demand for CBDC is large and fully satisfied.

First, the central bank’s choice of eligible collateral affects the allocation of bank credit in the economy. In turn, the central bank would become involved in the credit allocation process. For example, if the portfolio of eligible collateral consists only of government bonds, banks will have to lend to the government—rather than to households or firms—in order to obtain the collateral needed to meet the demand for CBDC. If the portfolio of eligible collateral includes mortgages to households but not loans to firms, banks will lend more to households

and less to firms. On the other hand, if the central bank were to refinance banks without collateral, it would not influence bank lending, as Brunnermeier and Niepelt (2019) point out, but it would bear significant bank risk. Second, applying haircuts to collateral does not fully eliminate its risk, especially if the central bank lends massively to commercial banks, leaving the risk transfer challenge fundamentally unresolved. In addition, increasing the required haircut increases the volume of eligible collateral needed to meet CBDC demand, thereby reinforcing the undesirable credit allocation effect described above.

Although conservative collateral requirements and haircuts can mitigate the materialisation of risk for the central bank, the drawbacks outlined above lead most authors, such as Bindseil (2020), ECB (2023), Kumhof and Noone (2018) or Panetta (2018), to prefer to limit the issuance of CBDC in order to control the transfer of risk to the central bank.

3.2 Mechanisms limiting the demand for CBDC

At least four mechanisms have been suggested in the literature to limit the amount of CBDC demanded by the public and issued by the central bank.

First, the demand for CBDC can be limited by applying an unattractive interest rate relative to bank deposits. Since CBDC is safer than deposits, making it more expensive to hold than deposits would limit the demand for it and hence the transfer of risk. In normal times, a slightly unattractive interest rate may be sufficient to limit the demand for CBDC. In a crisis, the interest rate on CBDC would probably have to be cut sharply and go negative, similar to the negative interest rates on bank reserves in Switzerland and other economies in recent years. However, this would lead to uncertain results, as even a very negative annual interest rate would have only a small cost over a short period of time. For example, an interest rate as negative as -20% per annum would only cost 0.85% over a two-week period. One can imagine that many bank customers would be willing to pay this price to get their money out of a risky bank in time.

Second, another way to limit the demand for CBDC is to set a maximum amount that each person or firm can hold. A quantity ceiling can be strictly enforced (hard ceiling), so that any surplus above an individual threshold is automatically transferred to another account at a commercial bank (related to the CBDC account). This is the mechanism envisaged by the ECB (2023) in its recent report outlining its digital euro project.

Third, a soft ceiling can be implemented in a more flexible way by applying an unattractive interest rate to any excess over a certain ceiling. This would induce holders to rapidly reduce their CBDC holdings above the ceiling.⁷ For example, Bindseil (2020) suggests a tiered remuneration of CBDC by applying an attractive interest rate up to a ceiling and an unattractive rate on the amount above the ceiling to encourage the use of CBDC as a medium of exchange but not as a store of value.

Fourth, another mechanism to limit its demand is to issue CBDC only against a narrow set of eligible securities and not against other forms of central bank money. For example, Barrdear and Kumhof (2016) or Kumhof and Noone (2018) propose a mechanism whereby the central bank issues CBDC only against government bonds. A depositor wishing to convert his bank deposit into CBDC would first have to purchase government bonds with his deposit, which he would then exchange with the central bank for CBDC. Deposits would not leave the banking system as a whole because they would simply be transferred to the seller of the bonds and the banks would not need to refinance themselves with the central bank. The central bank would only be taking government bonds

onto its balance sheet, not the credit risk of the banks. However, this means that the central bank would not convert cash or reserves into CBDC. If cash and reserves were not freely convertible into CBDC at the central bank, the demand for CBDC could be constrained by inelastic supply, and an exchange rate between CBDC on the one hand and cash and reserves on the other could arise. The factors determining the supply of CBDC (such as the amount of government bonds available) may not compensate for the factors determining the demand (such as the remuneration of CBDC). With an exchange rate between its different forms, central bank money would not form a uniform unit of account.

4 Would CBDC achieve its intended purposes?

The previous section showed that four mechanisms could limit the demand for CBDC and the transfer of credit risk. We now assess the implications of these mechanisms from the point of view of achieving the various purposes put forward for the issuance of retail CBDC. The chances of achieving the various objectives of CBDC depend on the mechanism used to limit the supply of and demand for CBDC. We discuss each objective in turn and assess whether a limitation mechanism is favourable or unfavourable to its achievement. Table 1 provides an overview.

4.1 Providing the public with central bank money

CBDC can provide the public with a new form of central bank money at a time when the use of cash is declining in several jurisdictions. The proper functioning of the current monetary system requires public access to central bank money. A bank deposit is a claim on the bank that can be redeemed for central bank money. Depositors accept deposits as a means of payment in lieu of central bank money only to the extent that they have reasonable confidence in the bank's ability to honour its contractual obligation to redeem their deposits for central bank money. Without central bank money available to the public, the deposit contract would be unenforceable and therefore meaningless. If central bank money were only available to banks (and not to the public) in the form of reserves, depositors would only be able to move their deposits from one bank to another, but not to withdraw their deposits in central bank money as provided for in the terms of the deposit contract. Thus, if the use of cash were to decline, CBDC could play the role of a monetary anchor by providing the public with access to central bank money.⁸

⁷ This corresponds typically to the way banks applied a negative interest rate to their customers when their deposits exceeded a certain threshold.

⁸ For example, Ingves (2018) and Sveriges Riksbank (2018) made the case for an e-Krona in Sweden as a way to provide the public with central bank money, as the use of cash is in decline. Moreover, providing people with access to CBDC is more efficient than cash for distributing central bank money to remote or sparsely banked areas.

Table 1 Effects of mechanisms limiting the demand for CBDC on the achievement of CBDC purposes

	Unattractive interest rate (compared to deposits)	Quantity ceiling (hard ceiling)	Unattractive interest rate above ceiling (soft ceiling, tiered remuneration)	No convertibility at par
Providing central bank money	Effective provision of central bank money, as deposit claims on banks would be fully payable in CBDC	Impeded provision of central bank money, as deposit claims on banks would only be payable in CBDC up to the ceiling	Effective provision of central bank money, as deposit claims on banks would be fully payable in CBDC	Impeded provision of central bank money, as deposit claims on banks would not be payable in CBDC
Improving resilience of payment system	Ineffective back-up system, as most people would not hold CBDC	Effective back-up system, as most people would hold CBDC	Effective back-up system, as most people would hold CBDC	Ineffective back-up system, as most people would not hold CBDC
Promoting payment diversity and sovereignty	Discourage the use of CBDC as medium of exchange, as payment with unattractively remunerated CBDC does not benefit the payer	Discourage the use of CBDC as medium of exchange, as it would be hoarded as a store of value (Gresham's law)	Discourage the use of CBDC as medium of exchange, as it would be hoarded as a store of value and payment with unattractively remunerated CBDC does not benefit the payer	Discourage the use of CBDC as medium of exchange due to fluctuations in value against cash and reserves
Enhancing monetary policy	Impeded acceleration of transmission, as interest on CBDC would be lower than deposit rate	No acceleration of transmission if CBDC is not remunerated	Impeded acceleration of transmission, as interest on CBDC would be higher than deposit rate only up to the ceiling	No acceleration of transmission if CBDC is not remunerated
	No effect of remunerated CBDC on the ELB as long as cash coexists	Non-negatively remunerated CBDC may raise the ELB on interest	No effect of remunerated CBDC on the ELB as long as cash coexists	Non-negatively remunerated CBDC may raise the ELB on interest

The mechanisms for limiting the demand for CBDC have different effects on the achievement of this objective.

First, if the central bank applies an unattractive interest rate on CBDC relative to bank deposits, the deposit claim on the bank will be fully payable in CBDC. The CBDC will thus be an effective provision of central bank money. Although the demand for redemption of deposits in CBDC may be low due to an unattractive remuneration, such a CBDC would enable the bank to meet its legal obligation to the depositor.

Second, if the central bank applies a quantity ceiling to CBDC holdings, the deposit claim on the bank will only be payable in CBDC up to the ceiling. This, of course, hampers the monetary anchor role that CBDC would be intended to play because the deposit contract could only be incompletely enforced.

Third, if the central bank applies a combination of an unattractive interest rate and a quantity ceiling in the form of a soft ceiling or a tiered remuneration, the deposit claim on the bank will be fully payable in CBDC, which is an effective provision of central bank money.

Fourth, if the central bank does not guarantee par value convertibility between CBDC and cash or reserves (but only issues CBDC against a narrow basket of eligible collateral), the deposit claim on the bank will only be payable in cash. CBDC would thus be a poor provision of central bank money, as it would not allow the depositor to enforce his claim on the bank in CBDC.

In sum, if the purpose of issuing CBDC is to provide the public with central bank money, then applying an unattractive interest rate or a soft ceiling to CBDC is the most appropriate way to limit their demand.

4.2 Improving the resilience of the payment system

CBDC can improve the resilience of the payment system. The growing reliance of the economy on electronic payment systems calls for their resilience to be improved and CBDC could serve as a back-up emergency medium of exchange in the event of a disruption to the current electronic banking system. Such a back-up would be superior to cash in terms of speed, convenience and ease of emergency distribution.

The four mechanisms for limiting the demand for CBDC also have different effects on the implementation of a CBDC-based back-up payment system. To be effective, a back-up payment system must be available to a large part of the population at all times. This requires that the vast majority of people permanently hold a certain amount of CBDC.

First, if the central bank charges an unattractive interest rate on CBDC relative to bank deposits, then most people are unlikely to hold CBDC permanently, making a

CBDC-based payment system ineffective as a back-up in an emergency.

Second, if the central bank applies a quantity ceiling to CBDC holdings, then most people are likely to hold CBDC permanently, provided that no unattractive interest rate is charged on those deposits. In this way, CBDC could be used as a means of payment if the current electronic system fails.

Third, if the central bank applies a soft ceiling or a tiered remuneration of CBDC, most people are likely to hold some CBDC permanently (up to the soft ceiling) and CBDC could be used as a means of payment if the current electronic system fails.

Fourth, if the central bank does not guarantee par value convertibility between CBDC and cash or reserves, most people are unlikely to hold CBDC because it would be cumbersome to acquire, requiring first the purchase of collateral to exchange for CBDC at the central bank, and its value could fluctuate relative to cash or reserves. CBDC could therefore not serve as an effective back-up system.

In sum, if the purpose of issuing CBDC is to improve the resilience of the payment system, then applying a hard or soft ceiling to CBDC is the most appropriate way to limit its demand.

4.3 Promoting diversity and sovereignty in payments

CBDC can promote the diversity and sovereignty of payment systems and mitigate the anti-competitive effects of some financial innovations. The economies of scale and network effects that could arise from the adoption of new technologies (including DLT, big data, and artificial intelligence) would tend to promote concentration and work against the competitive provision of financial services and, in particular, payment systems. Payment systems today are highly concentrated in a few large (typically US-based) companies that dominate electronic payment networks, and the importance of electronic payments will continue to grow with the rise of online commerce. CBDC would increase the contestability and diversity of payment systems. By providing diversity, a CBDC could lead to lower transaction fees. Moreover, when an economy is heavily dependent on payment systems that are in the hands of foreign companies and regulated by foreign authorities, its sovereignty is at stake. CBDC would be a means of ensuring the sovereignty of at least one electronic payment system.

The four mechanisms that limit the issuance of CBDC greatly reduce the chances of widespread use of a CBDC-based payment system for everyday transactions.

First, if CBDC pays an unattractive interest rate relative to bank deposits, one wonders why anyone would make

a payment in such a CBDC at all. The comparison with cash is useful because it pays no interest, which in normal times is unattractive relative to the interest rate on bank deposits. However, cash has the advantages of being free of credit risk and of being based on a different technology from electronic banking, which, among other things, guarantees anonymity. Those who value the absence of credit risk typically demand cash as a store of value, while those who value cash technology demand cash as a medium of exchange. In contrast, a CBDC-based payment system does not offer its users a fundamentally different technology from the current electronic banking payment system. Therefore, the main reason why people would hold a CBDC with an unattractive interest rate is the absence of credit risk (and not because the technology is different from current electronic technology). This raises the question of why anyone would hold an unattractively remunerated CBDC if they were going to spend it at the first opportunity. Indeed, making a payment with an unattractively remunerated—but risk-free—CBDC gives no advantage to the payer. However, holding an unattractively remunerated CBDC as a store of value provides security to the holder. Thus, an unattractive interest rate cannot limit CBDC holdings without undermining the widespread use of CBDC as a medium of exchange.

Second, if there is a quantity ceiling on CBDC, one might ask why people would use CBDC rather than bank deposits to settle transactions. Since CBDC is free of credit risk, Gresham's law tells us that people will hoard CBDC (i.e. the "good" money) as a store of value and get rid of bank deposits (i.e. the "bad" money) by making payments with them. A hard quantity ceiling would therefore undermine the widespread use of CBDC as a medium of exchange.

Third, if the central bank applies a soft ceiling or a tiered remuneration to CBDC holdings, the conclusion remains the same. If CBDC earns an attractive interest rate (compared to bank deposits) up to the ceiling, people would maximise their profits by continuously keeping their CBDC holdings at the ceiling. This would encourage them to hold CBDC as a store of value and not to cause account fluctuations by making payments with it. On the other hand, if CBDC were to earn an unattractive interest rate up to the ceiling, we are back to the considerations discussed above. People would hold CBDC with an unattractive interest rate to the extent that they value its safety, which is important for a store of value, not for a medium of exchange. The combination of an interest rate and a quantity ceiling does not favour the widespread use of CBDC as a medium of exchange.

Fourth, if the central bank does not convert cash or reserves into CBDC at par (because it would issue CBDC only against a narrow basket of eligible collateral), the value of a payment in CBDC could fluctuate over time

relative to cash and reserves. This is clearly an inappropriate characteristic for a medium of exchange, as CBDC would not fulfil the function of a unit of account.

In sum, all four mechanisms for limiting issuance make it unlikely that CBDC will increase the diversity and sovereignty of payment systems because it will not be widely used as a medium of exchange.

4.4 Enhancing monetary policy

CBDC may enhance monetary policy by speeding up the transmission of the policy rate to bank rates or by lowering the effective lower bound on nominal interest rates. In the current system, deposit rates tend to react slowly to the policy rate. If the policy rate is passed on directly to CBDC holders, banks may have an incentive to pass on changes in the policy rate quickly to their customers. A remunerated CBDC would help to accelerate the rise in bank deposit rates, as depositors would otherwise significantly transfer their (poorly remunerated) deposits into (highly remunerated) CBDC. Moreover, to the extent that CBDC can support a negative interest rate, the effective lower bound (ELB) on interest rates could be lowered, provided that cash is phased out or at least made more expensive to hold (e.g. Smets, 2016).⁹

The arguments in favour of CBDC to enhance monetary policy also need to be assessed in the light of the mechanisms that limit the demand for CBDC. Let us first consider the argument that CBDC can speed up the transmission of the policy rate to bank rates.

First, if CBDC earns an interest rate, it could accelerate the transmission of the policy rate to bank rates to the extent that CBDC holdings are an attractive alternative to bank deposits. Banks would have an incentive to pay higher interest rates on deposits if the CBDC were generating significant liquidity outflows, which can only happen if the CBDC is sufficiently attractive relative to deposits. Thus, if the central bank chooses to limit the risk transfer by making CBDC unattractive, it is difficult to see how this CBDC could at the same time encourage banks to pay more for their deposits. Applying an unattractive rate to CBDC to limit this transfer would also limit the potential accelerating effect on its transmission to bank rates.

Second, if the central bank applies a quantity ceiling to CBDC holdings—as long as CBDC is not remunerated—the issuance of CBDC is unlikely to accelerate the transmission of the policy rate to bank rates.

Third, if the central bank applies a soft ceiling or a tiered remuneration to CBDC holdings, the transmission

⁹ Furthermore, CBDC may prove an efficient vehicle to transfer money directly to the public, should the authorities have to resort to "helicopter drops" or other fiscal payments to citizens, such as COVID stimulus checks issued in the US.

of the policy rate to bank rates can be strengthened to the extent that CBDC is an attractive alternative to deposits and if the amount of attractively remunerated CBDC is significant relative to deposits. This would again result in a significant transfer of risk to the central bank. Conversely, if, to limit the transfer of credit risk, the central bank applies an attractive interest rate up to a low ceiling and an unattractive interest rate above the ceiling, CBDC will not accelerate the transmission because it will not really be an attractive alternative to deposits.

Fourth, if the central bank issues CBDC only against a narrow basket of eligible collateral, it will not accelerate the transmission of the policy rate to bank rates. The incentives for banks to remunerate deposits will remain unchanged because CBDC will not lead to an outflow of liquidity and funding from banks.

Thus, it appears that the purpose of accelerating the transmission of the policy rate to the deposit rate can only be achieved with a significant transfer of credit risk from commercial banks to the central bank, and that the mechanisms limiting the demand for CBDC reduce the hope that CBDC would strengthen the transmission of the policy rate to bank rates.

CBDC has also been considered to help monetary policy to further stabilise the economy. For example, Assenmacher et al. (2023) present a mechanism to elastically supply CBDC deposits while adjusting their yield to influence their relative attractiveness. Although the economic responses to standard monetary policy shocks would not be significantly affected, the ability to adjust the supply of CBDC and influence the interest rate differential between CBDC and bank deposits could dampen the response of output and inflation to financial shocks. However, if the risk transfer to the central bank is to be avoided, as discussed above, the additional interest rate instrument would end up being used mainly to limit the amount of CBDC. Thus, the interest rate paid on CBDC would be used to avoid a problem created by the introduction of CBDC itself, i.e. the additional instrument would be needed to solve a new problem. The money supply could alternatively be influenced by quantitative easing or quantitative tightening without the need for CBDC.

Let us now turn to the argument that CBDC can reduce the ELB on interest rates. The ELB on interest rates results from the existence of cash on which no interest rate can be charged. Therefore, the issuance of CBDC subject to a negative interest rate does not remove the ELB on interest rates as long as cash coexists. Moreover, if the central bank does not remunerate CBDC, the issuance of CBDC could increase rather than decrease the ELB on interest rates. Since CBDC would be a more convenient store of value than cash for most people, CBDC would raise, not lower, the effective lower bound on interest rates relative to that imposed by cash. However,

mechanisms to limit the issuance of CBDC would also limit this effect on the ELB.

In sum, our findings corroborate the analysis of the monetary policy implications of digital currencies by Assenmacher (2020), who concludes that there is no convincing monetary policy motivation for issuing a retail CBDC at this stage.

5 The Swiss case

The consequences of issuing a CBDC would vary from country to country, depending, for example, on the structure of the banking sector, the availability of safe assets, and the role of the domestic currency in the international monetary system. This section illustrates these influences in the Swiss case.

A special feature of the Swiss franc is that it is an attractive store of value for many, especially in times of crisis. Thus, compared to the general discussion above, the arguments relating to CBDC as a store of value carry particular weight in the Swiss case. Moreover, the supply of government bond is relatively small, and most of the assets on commercial banks' balance sheets are mortgages, so the assets that the banking system would provide to the central bank in exchange for CBDC would mostly be mortgages.

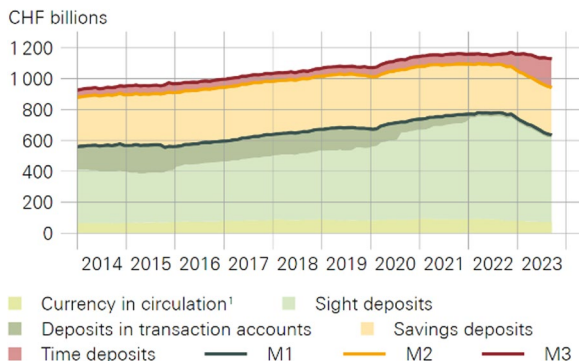
5.1 Potential demand for CBDC

In quantitative terms, as shown in Fig. 5, there are around CHF 75 bn of currency in circulation (i.e. central bank money held by non-banks) and almost CHF 870 bn of customer sight deposits and transaction and savings deposits redeemable on demand at par. These deposits, which are included in the monetary aggregates, are held by Swiss non-bank residents.

As banks incur costs in facilitating transactions and payments, these accounts usually pay a lower interest rate than money-market rates. Savings deposit rates have been below 1% since 2003. Given the low yield on these accounts and the safety properties of CBDC, this domestic money demand already represents a potential demand for CBDC of almost CHF 1,000 bn.

As the reserves of domestic and foreign commercial banks at the SNB amount to around CHF 470 bn (see Fig. 6 and the orange area "CHF liquidity" in Fig. 7 for Swiss banks), the SNB would not have to immediately increase its balance sheet if a CBDC were introduced. Excess reserves at the SNB would be exchanged for CBDC by the amount that households and firms decide to substitute from existing deposits. However, as discussed in Sect. 2.2, this would still result in a transfer of risk. The counterpart of CBDC would be existing foreign exchange assets already on the SNB's balance sheet. This means that the SNB would not be able to reduce its balance sheet by the corresponding amount of CBDC.

MONETARY AGGREGATES

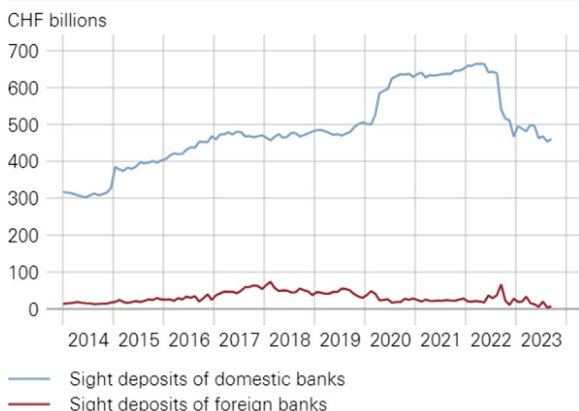


1 This also includes sight deposits of insurance companies and public administration (excl. Swiss Confederation) at the SNB.

Source: SNB

Fig. 5 Monetary aggregates

GIRO DEPOSITS



Source: SNB

Fig. 6 Bank reserves at the SNB

In principle, the SNB could change the composition of its asset holdings and adjust its risk exposure. However, since the supply of Swiss government bonds is only approximately CHF 100 bn and the volume of Swiss franc securities held by commercial banks is relatively small (see Fig. 7), the SNB would only have the choice of maintaining its foreign exchange risk or replacing it with domestic credit risk. In the latter case, the SNB would sell foreign exchange assets and buy mortgages or mortgage-backed securities (cf. Sect. 5.2), which are the main assets of the commercial banks (CHF 1330 bn of loans in Fig. 7) and which would then be transferred to the SNB’s balance sheet. Alternatively, the SNB could sell foreign exchange assets and lend Swiss francs to banks. It would then hold claims on the banks on its balance sheet. Thus, although the risk transfer could take different forms, it would still

take place when the demand for CBDC exceeds the current demand for cash.

In the longer term, the demand for CBDC could be so large that excess reserves would disappear. This, or a situation in which the SNB reduces its balance sheet and sells assets above a certain level, would lead to a situation of low reserves as described in Sect. 2.2.1. In this case, the banks would have to acquire reserves on the money market when their customers convert funds from their accounts into CBDC. In order to keep the monetary policy stance constant and thus the money-market rate stable, the SNB has to provide additional reserves, thus increasing its balance sheet and taking on more risk.

In addition to the above-mentioned CHF 870 bn deposits held by Swiss residents, there are CHF 60 bn of non-resident deposits in Swiss banks, which also represent a potential demand for CBDC. Moreover, the Swiss franc is a safe-haven currency with a limited supply of investable assets, in particular due to the low level of government debt. Issuing a CBDC would mean creating a new form of Swiss franc money that is safer than deposits with commercial banks. If foreigners see a Swiss CBDC as an attractive reserve asset or a safe haven in times of crisis, this would increase the demand for it and thus for the Swiss franc. Today, international investors are happy to hold Swiss franc bank deposits; a Swiss franc-denominated CBDC would be even more attractive. This would lead to an appreciation of the Swiss franc, while at the same time increasing the SNB’s balance sheet and its risk profile. To try countering this risk, it would be possible to allow only Swiss residents to hold CBDC, although arbitrage opportunities would arise.

5.2 Limiting the risk transfer

Section 3 presented mechanisms for limiting the risk transfer and their implications for the purposes of the CBDC, which also apply to the Swiss case. We only mention here those features that would be specific to Switzerland.

From the point of view of the quality of the assets taken by the SNB in exchange for CBDC, a particular asset in the Swiss case would be covered bonds, or “Pfandbriefe”, which are perceived as a particularly safe investment because of their design.¹⁰ However, covered bonds are

¹⁰ (i) Mortgages pledged to guarantee covered bonds stay on the issuers’ balance sheets. Hence, mortgage-issuing banks are in the first-loss position. (ii) The framework features a dynamic replenishment duty, i.e. mortgage-issuing banks must replenish losses on non-performing mortgages and ensure that the interest-rate payments by the pledged mortgages cover the interest rates of the loans. (iii) The mortgagor is also liable for the loan at all times to the full extent of its assets and future income. (iv) Covered bonds require stringent rules such as a minimum loan-to-value ratio, mandatory minimum overcollateralisation and minimum collateral requirements. (v) Due to their membership structure, “Pfandbrief” institutions provide a countrywide diversification effect and run neither a maturity nor a currency mismatch.

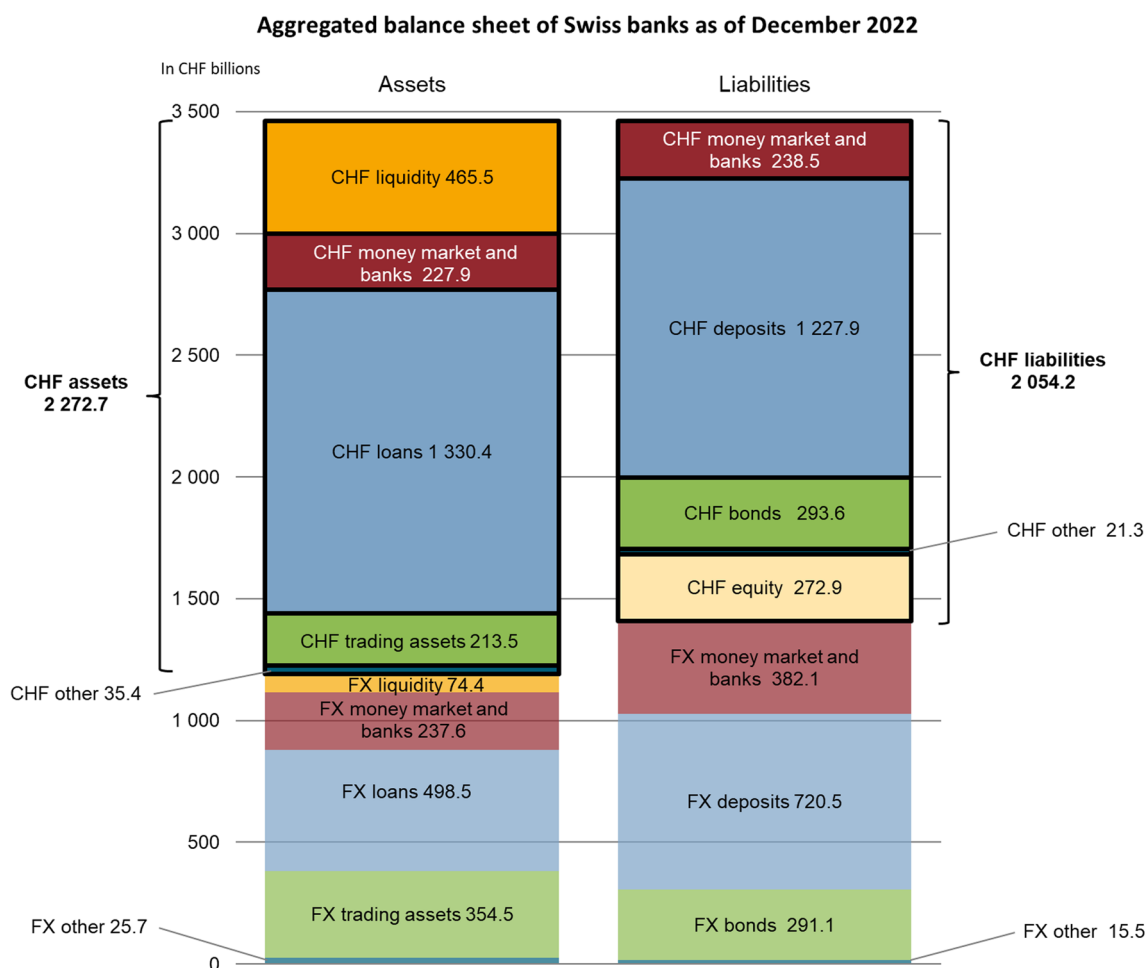


Fig. 7 Swiss banks' balance sheet

not risk-free. In the event of a severe crisis in the real estate market, the SNB would likely suffer losses.

From the perspective of limiting the quantity by not allowing convertibility at par, the SNB could issue CBDC against eligible collateral such as Swiss government bonds or Pfandbriefe. Apart from the problem that the parity between different forms of money (i.e. CBDC and cash/bank deposits) would be broken, as discussed in Sect. 3, the availability of collateral, i.e. Swiss government bonds, is low. This could significantly distort their yields, thereby affecting bond prices and thus long-term interest rates.

5.3 Does Switzerland need a CBDC?

The four main purposes for issuing CBDC were analysed in Sect. 4. This section discusses whether these objectives are relevant for Switzerland.

Providing the public with central bank money: Despite the fact that the shift from cash to cashless payment methods is continuing, there is a widespread desire

among the Swiss population for cash to continue to be available as a means of payment (cf. SNB, 2023). Banknotes are in high demand and there is no intention to abolish them. Switzerland therefore does not need CBDC to provide the public with central bank money.

Improving the resilience of the payment system: As discussed in Sect. 4, there is little chance that CBDC will be widely used as a medium of exchange. It would be very costly to implement a new system based on CBDC for back-up purposes only.

Promoting diversity and sovereignty in payments: This seems a reasonable objective for any sovereign country, including Switzerland. But CBDC will not achieve this objective because it is unlikely to be widely used as a medium of exchange. As long as the bulk of money in our monetary system is issued in the form of risky bank deposits, improving the diversity or sovereignty of payment systems would be better served by relying on this type of money rather than central bank money. One example is the Twint system, developed and operated

by a consortium of Swiss banks, which allows money to be transferred from one commercial bank account to another, from one individual or company to another, using a smartphone or the internet. While the application promotes diversity and sovereignty of payment systems, it does not suffer from the disadvantages that CBDC would bring. Tokenised bank deposits would be an alternative solution to promote new payment systems. Moreover, contestability in payments may be better achieved by other policy measures than the introduction of CBDC, such as antitrust measures to avoid the anti-competitive consequences of network effects.

Enhancing monetary policy: As discussed in Sect. 4, limiting the supply of and demand for CBDC limits the potential impact on the transmission of monetary policy. The alleged additional instrument provided by CBDC, i.e. the interest on CBDC, would have to be used mainly to limit the attractiveness of CBDC in the event of safe-haven flows into the Swiss franc. It would therefore not succeed in enhancing the transmission of monetary policy. Moreover, the SNB has been able to fulfil its mandate with the instruments at its disposal. There is thus no economic reason that would currently justify the introduction of CBDC in Switzerland.

6 Conclusion

In the coming years, CBDC will continue to be of great interest to the central banking community. The fear of missing the digital train is prompting reflection on the adoption of new technologies in the monetary sphere and the entry of central bank money into the digital age.

However, the challenge of issuing a CBDC is not technological but economic. The current banking system developed because of the convenience that bank deposits have provided to holders of gold coins and banknotes. The difference in form between currency and deposits is the *raison d'être* of commercial banks and the basis of the fractional-reserve banking system. If the monetary base were to take the same form and become as convenient as bank deposits, people would no longer use commercial banks as monetary intermediaries and the banking system would lose its internal coherence. Issuing CBDC while maintaining the fractional-reserve banking system is like squaring the circle.

Our analysis suggests that mechanisms to limit the transfer of risk to the central bank make the use of CBDC as a medium of exchange unlikely. Thus, there is a trade-off between limiting risk transfers to central banks and achieving specific CBDC purposes. CBDC should therefore be designed according to its intended purpose. Moreover, some purposes, such as the establishment of an electronic payment system, may be better served by solutions based on commercial bank money (e.g. Waller 2021).

Abbreviations

BIS	Bank for International Settlements
CBDC	Central bank digital currency
ELB	Effective lower bound
SNB	Swiss National Bank

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Declarations

Competing interests

The authors declare that they have no competing interests.

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