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Romain Baeriswyl, Samuel Reynard, Alexandre Swoboda

SNB Working Papers

19/2021



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ISSN 1660-7716 (printed version)
ISSN 1660-7724 (online version)

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P.O. Box, CH-8022 Zurich

Retail CBDC Purposes and Risk Transfers to the Central Bank

Romain Baeriswyl

Swiss National Bank

Samuel Reynard

Swiss National Bank

Alexandre Swoboda

Graduate Institute Geneva

September 2021

Abstract

The issuance of retail central bank digital currency (CBDC) entails a transfer of risk from commercial banks to the central bank. While this paper does not provide an overall assessment on whether or not to issue a retail CBDC, it analyzes how different mechanisms to limit the risk transfer, such as an unattractive interest rate on retail CBDC, a quantity ceiling or preventing convertibility of cash and reserves into CBDC, have different effects on the ability of retail CBDC to fulfil its intended purposes. In particular, these mechanisms hinder the use of CBDC as a medium of exchange. Specific aspects of demand and challenges related to a potential retail CBDC in Switzerland, namely, a small open economy with a safe-haven currency and a low level of government debt, are discussed.

The authors would like to thank Andreas Fuster, Petra Gerlach, Christina Kessler, Nino Landerer, Carlos Lenz, Martin Schlegel and Oliver Sigrist for suggestions and comments.

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Authors' email addresses: romain.baeriswyl@snb.ch, samuel.reynard@snb.ch, alexandre.swoboda@graduateinstitute.ch

1. Introduction

National central banks and international financial institutions such as the Bank for International Settlements (BIS) and International Monetary Fund (IMF) have been exploring the pros and cons of central bank digital currency available to the public (retail CBDC, henceforth) over the last few years.¹ The idea of a central bank issuing digital currency available to the public is not new; it goes back to Tobin (1987), who claimed, “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.” While this proposal has not received much attention for over 30 years, the growing interest in retail CBDC has been driven by a combination of several factors.

First, the decline in the use of cash in several jurisdictions could suggest the need to provide the public with another form of legal tender money. Second, the growing dependence of the economy on electronic payment systems calls for improving their resilience, perhaps through the establishment of a backup system based on CBDC. Third, advances in new technologies, such as distributed ledger technology (DLT), big data or artificial intelligence, tend to foster concentration in payment systems. By providing a generally accessible alternative medium of exchange, CBDC would increase the diversity and national sovereignty of payment systems. Fourth, CBDC is also sometimes advocated to enhance monetary policy by accelerating the transmission of the policy rate to bank rates or by lowering the effective lower bound on nominal interest rates.

According to the BIS (2020) and several economists, such as Barrdear and Kumhof (2016), Bindseil (2020), Bordo and Levin (2017) and Goodfriend (2016), the issuance of retail CBDC could potentially provide a solution to these challenges. Others, by contrast – e.g., Agur et al. (2019), Bech and Garratt (2017), Jordan (2018) or Stevens (2017) – have expressed skepticism about a broadly available CBDC, highlighting the risks to the stability of the banking system posed by such a scheme. The concerns raised by these authors call into question the consistency of issuing a retail CBDC in a fractional or two-tier banking system. Since money is put into circulation in the form of deposits when commercial banks grant credit, the substitution of risk-free CBDC for risky bank deposits entails some risk transfer from commercial banks to the central bank, as explained in Section 3 of this paper.

To limit the demand for CBDC and the related transfer of risk, the literature proposes three mechanisms: the central bank could (i) apply an unattractive interest rate to CBDC, (ii) set an individual quantity ceiling for CBDC holdings, or (iii) decline to convert freely at par cash and reserves in CBDC, and issue CBDC only against a narrow basket of eligible collateral.

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

While this paper does not provide an overall assessment on whether or not to issue a retail CBDC, it analyzes how these three mechanisms are likely to affect the demand for CBDC as a medium of exchange and store of value and thus the achievement of the intended purposes for issuing retail CBDC. Our main results can be summarized as follows.

If the central bank applies an unattractive interest rate to retail CBDC to limit its demand, CBDC could fully play its role of legal tender money, as a deposit claim against a bank would be entirely redeemable in CBDC. However, CBDC would function less as a backup payment system because only a minority of people are likely to hold CBDC if it is unattractively remunerated. Moreover, as CBDC would be held primarily as a store of value rather than as a medium of exchange, it would not contribute to increasing the diversity of payment systems. Indeed, as CBDC – contrary to cash – does not offer a fundamentally different technology to its users than the current electronic banking payment system, those willing to hold an unattractively remunerated CBDC may do so for its absence of credit risk rather than for its specific technology. The absence of risk, however, is valuable for money hoarded, not for money spent in daily transactions. Furthermore, an unattractively remunerated CBDC will not accelerate the transmission of the policy rate to bank deposit rates or lower the effective lower bound on the nominal interest rate as long as cash coexists.

If the central bank limits the demand for CBDC by setting a maximum amount of retail CBDC that each person or firm can hold, then CBDC would not fully play its role of legal tender money, as a deposit claim against a bank would be redeemable in CBDC only up to the ceiling. CBDC would, however, establish an effective backup payment system because most people are likely to hold CBDC if it is not unattractively remunerated. Although a quantity ceiling would make CBDC suitable as a backup payment system (akin to cash hidden under the mattress), it will probably not contribute to increasing the diversity of payment systems for everyday transactions. Indeed, one may question why people would use CBDC rather than bank deposits to settle transactions in non-emergency situations. Since CBDC differs from traditional bank deposits in that it is free of credit risk, Gresham's law teaches 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. If, in addition, CBDC is attractively remunerated up to a ceiling, holding CBDC continuously until this ceiling is reached would maximize interest income. Furthermore, with a quantity ceiling, CBDC will not accelerate the transmission of the policy rate to bank rates and could even raise the effective lower bound on the nominal interest rate.

Finally, if the central bank does not freely convert at par cash and reserves in retail CBDC (but only issues CBDC against a narrow basket of eligible collateral), a deposit claim against a bank would not be payable in CBDC at all, undermining the role of CBDC as legal tender. Such a CBDC would also be an ineffective backup payment system, as most people would probably not hold any CBDC because of its excessively burdensome provisions. Moreover, an exchange rate between retail CBDC and cash

and reserves would emerge, further making CBDC more suitable as a store of value than as a medium of exchange. This would make the establishment of a CBDC-based payment system unlikely. Furthermore, a non-convertible CBDC will not accelerate the transmission of the policy rate to bank rates and could even raise the effective lower bound on the nominal interest rate.

As this discussion shows, the intended purposes behind CBDC issuance should guide the determination of the mechanism limiting the transfer of risk. The rest of this paper explores this issue in detail and is structured as follows. We begin Section 2 by reviewing the reasons why a central bank might want to issue retail CBDC. After presenting in Section 3 the process through which the demand for CBDC would lead to a risk transfer from commercial banks to the central bank, we discuss in Section 4 how mechanisms to limit this transfer may impede the intended purposes for issuing CBDC. Finally, in Section 5, we discuss specific aspects of introducing retail CBDC in Switzerland, a small open economy with a safe-haven currency and a low level of government debt.

2. Definition, purposes and characteristics of retail CBDC

Economic and financial writings encompass various monetary proposals under the label “CBDC”. As a starting point, we define the concept of retail CBDC and review the main purposes and characteristics proposed in the literature.

2.1. Definition

Broadly speaking, “CBDC, at the most basic level, is simply monetary value stored electronically (digitally, or as an electronic token) that represents a liability of the central bank and can be used to make payments.”² According to this broad definition, CBDC can take very different forms. One of them is as sight deposits currently held by commercial banks at the central bank, i.e., banks’ reserves. However, other forms of CBDC may differ from these reserves in a number of characteristics.

The main distinction to be made is between wholesale CBDC, which is accessible only to financial intermediaries, and retail CBDC, which is accessible to the public (see the prior reference to Tobin). In this paper, we focus on the economic consequences of issuing retail CBDC. Wholesale CBDC already exists in the form of sight deposits held by commercial banks at the central bank; issuing it in another form or through another technological medium would likely have only minor economic consequences. In contrast, issuing retail CBDC could potentially fundamentally change the monetary system. For the sake of simplicity, CBDC in this paper refers to retail CBDC.

The characteristics of CBDC could vary widely, depending on the purpose of its issuance. A specific CBDC will reflect design choices as to its legal tender status,

² See Engert and Fung (2017).

general or restricted access, interest rate, convertibility between various forms of central bank money, ceiling, and mode of distribution or anonymity, to mention a few.

CBDC does not require any particular technology and can be issued just as well with current technology (as proposed by Tobin in the 1980s) as it can with distributed ledger technology (DLT). Nevertheless, the belief that advances in IT and DLT provide the technology required for CBDC underlies many of the proposals for its issuance.

Depending on the desired functionalities of CBDC, one technology may be more efficient and attractive than another. We do not address the choice of technology in this paper and instead focus on the economic implications of CBDC.

2.2. Purposes for issuing retail CBDC

An array of arguments have been made for CBDC issuance.³ The main purposes can be regrouped under four headings: 1) providing the public with digital legal tender money as the use of cash is declining; 2) improving the resilience of payments by providing a backup system; 3) promoting diversity and sovereignty in payment systems; and 4) enhancing monetary policy.⁴

2.2.1. Providing the public with legal tender money

Ingves (2018) made the case for an e-Krona in Sweden as a way to provide the general public with legal tender money, as the use of the more traditional form of central bank money accessible to the public, i.e., cash, is in decline. Since a bank deposit is a claim on the bank redeemable in central bank money, public access to central bank money is a prerequisite for the enforcement of the deposit claim. Without public access to legal tender money, the bank's contractual obligation to redeem deposits in central bank money is impossible to fulfil. If central bank money was only available to banks 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. This would make the deposit contract meaningless. Thus, if the use of cash declines, CBDC could substitute in this role by providing public access to central bank money.

Moreover, providing people with access to CBDC is more efficient than cash for distributing money to remote or sparsely banked areas, as long as these areas are connected to the internet. Other arguments related to the disappearance of cash and its use in payments concern dwindling seigniorage. The issuance of CBDC may provide the central bank (and ultimately the state) with a substitute source of seigniorage.

³ See, for example, BIS (2020).

⁴ 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.

2.2.2. Improving the resilience of the payment system

The issuance of CBDC may improve the resilience of the payment system. CBDC could serve as a backup emergency medium of exchange in the event of a disruption to the current electronic banking system. Such a backup would be superior to cash in terms of speed, convenience and ease of emergency distribution.

2.2.3. Promoting diversity and sovereignty in payments

The diversity and sovereignty argument for CBDC relies on its potential to mitigate the anti-competitive effects of some financial innovations. The economies of scale and network effects that could arise with the adoption of new technologies (DLT, big data, and artificial intelligence among them) would tend to foster concentration and work against competitive provision of financial services and of payment systems in particular. As a result, payment systems today are highly concentrated in a few large (typically U.S.-based) companies that dominate electronic payment networks, and the importance of electronic payments will further grow with the rise of online commerce. By providing a generally accessible alternative medium of exchange, CBDC would make for increased contestability and diversity in payment systems.

Moreover, if an economy depends heavily on payment systems that are in the hands of foreign companies and regulated by foreign authorities, its sovereignty is at stake. A country without its own sovereign payment system is indeed at the mercy of foreign providers. Issued by the domestic central bank, CBDC would be a means of ensuring the sovereignty of at least one electronic payment system.

2.2.4. Enhancing monetary policy

A number of monetary policy arguments have been made for CBDC issuance. First, a remunerated CBDC could accelerate the transmission of the policy rate to bank rates. Today, deposit rates tend to respond slowly to the policy rate. If the policy rate is directly passed on to CBDC holders, banks may have an incentive to transmit policy rate changes quickly to their customers. Second, 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. It is, however, important to emphasize that most central banks – the SNB in particular – do not envisage phasing out of cash or high-denomination banknotes.⁵

2.3. Key CBDC characteristics

Given the wide range of purposes justifying the issuance of CBDC, it is not surprising that the issuance models proposed in the literature are very diverse.⁶ As we discuss in the next section, issuing CBDC can pose risks to monetary policy and financial stability. To limit these undesirable effects, it would be crucial that the central bank be

⁵ 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.

⁶ To get a taste of some of the many design choices that setting up a CBDC entail, see Table 1 in Engert and Fung (2017).

able to limit and control the amount of CBDC issued. To achieve this control, three characteristics of CBDC are particularly relevant: (1) whether it bears interest, (2) whether the maximal amount of CBDC per person is capped, and (3) whether it is freely convertible into other forms of central bank money. Various combinations of interest rate payments, ceilings and convertibilities define alternative models of CBDC issuance.

In the next section, we highlight the economic implications of CBDC when its supply is demand determined, that is, when it mimics cash as closely as possible by assuming that everybody can access it, yields no interest, has no ceiling, and the central bank converts it at par with other forms of central bank money. Then, Section 4 discusses how limiting the demand for CBDC or its supply affects the intended purposes of issuing it.

3. Implications for the conduct of monetary policy and the related risk transfer

Since the issuance of CBDC provides a new form of money available to the public, it would influence monetary policy. However, the potential impact of CBDC on the conduct of monetary policy depends largely on the issuance model and possible changes to the monetary system.

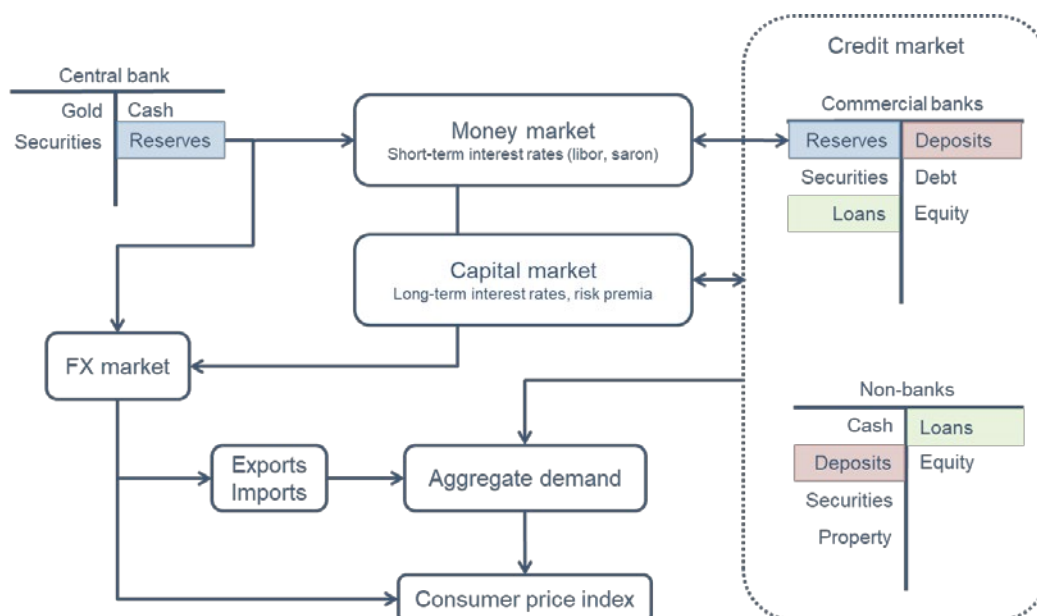
We assume in the following that the monetary and banking system remains unchanged, apart from the issuance of CBDC itself.⁷ Thus, commercial banks continue to operate under a fractional reserve system and to issue deposits when granting credit. Money held by non-bank entities therefore enters circulation first as deposits at commercial banks, which can then be converted into central bank money, i.e., cash or CBDC. Moreover, to fulfil its mandate of price stability, the central bank continues to influence the expansion of money and credit by steering a short-term interest rate through the issuance of reserves. Finally, we also assume that cash continues to exist.

3.1. The transmission mechanism of monetary policy

To analyze the effect of CBDC in the current monetary and banking system, it is useful to start by describing the transmission mechanism, as sketched in Figure 1. The central bank conducts monetary policy by carrying out operations on its balance sheet to steer short-term interest rates. This is achieved by controlling central bank money, which includes the stock of banknotes (cash) and sight deposits (reserves) that commercial banks hold at the central bank. The central bank controls the quantity of reserves with various types of operations, such as repos or direct purchases of domestic or foreign assets. By controlling the quantity and/or price of reserves, the

⁷ 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.

Figure 1: Transmission mechanism of monetary policy



central bank steers the short-term interest rate on the money market, which reflects the price of liquidity for banks and influences long-term interest rates and, thereby, the price of bank credit to non-banks. With excess reserves, as in the current situation, the central bank is able to control short-term interest rates directly by charging or paying interest on reserves to banks.

The credit-granting process by commercial banks plays a crucial role in the monetary policy transmission mechanism because the bulk of money used by non-banks in the economy consists of bank deposits, which are issued by commercial banks when they grant credit to non-banks. Several factors influence this process, such as the demand for credit by non-banks, the risk appetite of banks, the regulatory requirements with respect to liquidity and capital, and the price of liquidity. By steering short-term interest rates, the central bank influences the price of liquidity, credit provision by commercial banks, and thereby aggregate demand and consumer prices.

Monetary policy affects the aggregate demand and price levels through foreign exchange rates, long-term interest rates, the valuation of capital investments and the setting of expectations independent of the credit-expansion process of commercial banks. Our analysis focuses on the credit-expansion process because it is the channel that would be most affected by CBDC.

3.2. The CBDC issuance model

The effect of CBDC on the transmission mechanism of monetary policy depends crucially on the issuance model of CBDC. While some issuance models would have virtually no effect on the transmission and conduct of monetary policy,⁸ others would

⁸ For example, if CBDC were only available to financial intermediaries for wholesale transactions.

have important implications, particularly with respect to the transfer of risk from commercial banks to the central bank.

We examine the effect of CBDC when CBDC is a close substitute for cash, implicitly assuming that CBDC is issued to provide the public with a medium of exchange as convenient as deposits and as credit-risk free as cash. Referring to the characteristics of CBDC described in Section 2.3, we focus on cases where:

- CBDC is universally accessible and is accessible to financial intermediaries as well as resident and non-resident individuals and firms;
- CBDC does not bear interest, similar to cash;
- there is no ceiling on the amount of CBDC that each individual is allowed to hold; and
- the central bank guarantees par convertibility between cash, reserves and CBDC.

3.3. Two kinds of money and the risk transfer to the central bank

One of the challenges of issuing CBDC in the current monetary system stems from the transfer of credit risk from commercial banks to the central bank that it may cause. This risk transfer comes from the coexistence of two kinds of money, i.e., central bank money and bank deposits.

As its name suggests, central bank money is issued by the central bank and consists of cash (banknotes), sight deposits that commercial banks hold at the central bank (reserves), and potentially CBDC. Importantly, central bank money is an economic good free of credit risk, as it embodies no credit claim against anyone. It is unredeemable because the holder of central bank money can insist only on the redemption of a given amount of one form of central bank money into another form of the same central bank money. Of course, central bank money is not free of valuation risk with respect to domestic goods (i.e., through inflation) or foreign currencies (i.e., exchange rate depreciation).

In contrast, bank deposits are claims issued by commercial banks redeemable on demand in central bank money. Redemption can be made in cash, possibly in CBDC, or by transferring the funds to another bank. Because their redemption depends on the solvency of the issuing bank, deposits carry credit risk. They are, however, not (or less) subject to the risk of loss or theft and are more convenient to make payments than cash. Depositors accept deposits as a means of payment in place of central bank money only insofar as they are reasonably confident in the issuing bank's ability to fulfil its contractual obligation to redeem its risky deposits into risk-free central bank money.

Although the central bank may not be legally obliged to accommodate the demand for central bank money as a lender of last resort, it is induced to do so to fulfil its mandate of price stability. If the central bank does not meet rising demand for central bank

money, scarcity leads to an increase in money market rates, which slows down the credit-expansion process of banks and causes 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 tantamount to a contraction of broad money (because deposits at failing banks can no longer be used as a medium of exchange) and could lead to a debt-deflation spiral.⁹

When non-banks request redemption of their deposits in cash or in CBDC, the reserves held by banks with the central bank decrease, which affects money market conditions differently depending on whether excess reserves are small or large. The amount of reserves that banks hold in excess of what is legally required (minimum reserve requirement) or of what banks voluntarily demand for their liquidity management determines the impact of reserve fluctuations on the money market.¹⁰

3.4. Risk transfer mechanisms

This section explains and illustrates the risk transfer mechanisms when excess reserves are small or large.

3.4.1. Risk transfer if banks' excess reserves are small

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

Figure 2 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 of the central bank when excess reserves are small. Step 0 shows the balance sheet of the central bank, commercial banks and non-banks before issuing CBDC. We assume that banks are required by law to hold minimum reserves of 25% of their short-term liabilities, i.e., deposits. This induces a demand for reserves and a role for the money market. In step 1, depositors request the redemption of deposits worth 2 into CBDC, causing banks' reserves to fall below the required level.¹¹ As banks are pressed for reserves, money market rates rise. In step 2, to prevent an increase in money market rates and hence an undesired tightening of monetary conditions, the central bank expands reserves.

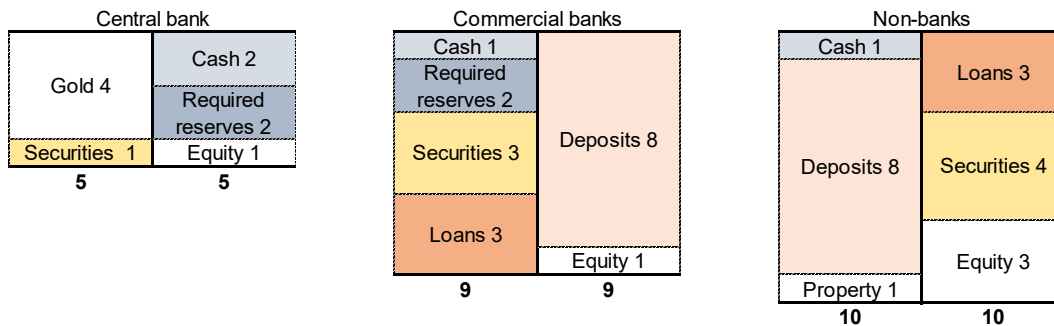
⁹ Böser and Gersbach (2020) and Gross and Schiller (2021) arrive at the same implication in their model; they show that the refusal by the central bank to accommodate the demand for reserves by banks would render banking nonviable and banks insolvent.

¹⁰ Thus, even in the absence of minimum reserve requirement (as in the UK), banks freely hold reserves to settle their payment obligations and, therefore, demand reserves on the money market. Minimum reserve requirements are just a simple and explicit way to account for the demand for reserves by banks.

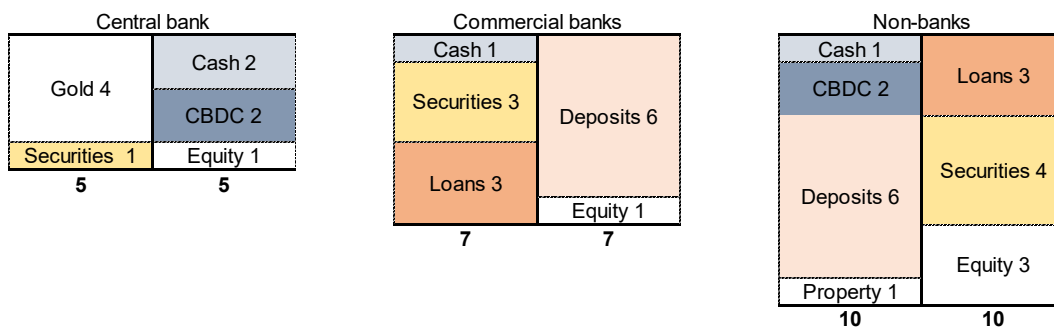
¹¹ Given the small amount of cash relative to deposits, we assume that the demand for CBDC is a substitute for deposits rather than cash.

Figure 2: Effect of an increase in the demand for CBDC with small excess reserves of banks

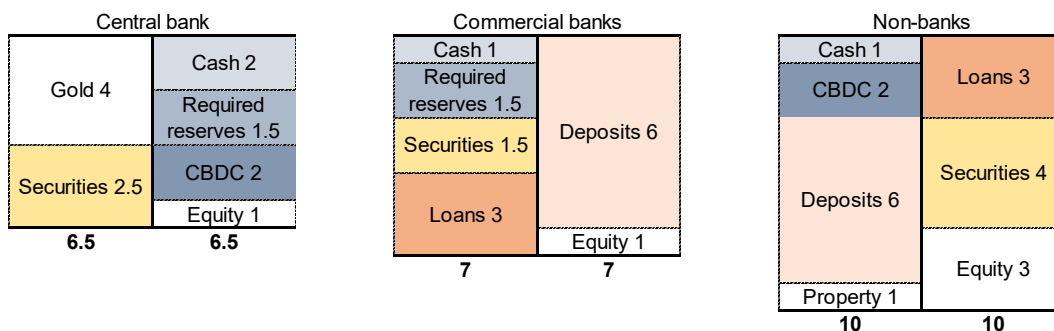
Step 0: initial situation



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



The central bank can expand reserves either by purchasing assets directly or by lending to commercial banks – through repo operations, for example. In both cases, the central bank's balance sheet increases 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 buying securities from commercial banks, but it could take over loans as an alternative.

Note that the described mechanism of risk transfer is already at work in the absence of CBDC, when the central bank accommodates non-banks' demand for cash. When depositors request redemption of deposits in cash, the decline in banks' reserves would

Figure 3: Demand for cash by non-banks

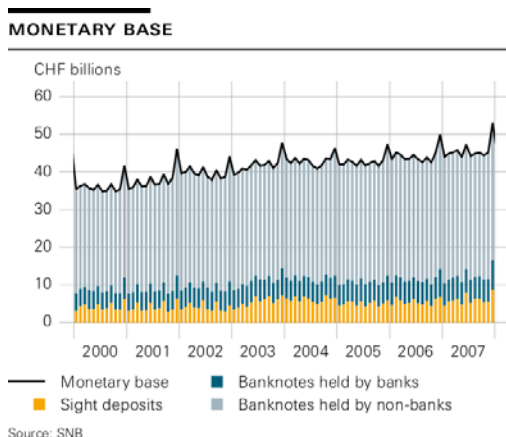
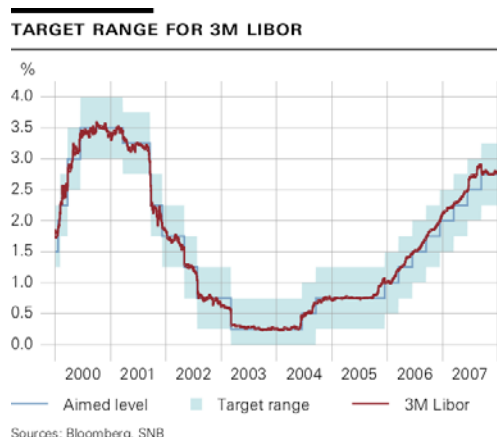


Figure 4: 3M Libor in CHF



lead to an increase in money market rates if the central bank failed to accommodate demand with a corresponding increase in reserves.

As an example to illustrate the mechanism above, it is well known that the demand for cash by non-banks in Switzerland rises significantly at the end of calendar years. Figures 3 and 4 show that the rise in the demand for cash did not lead to the spikes in 3M Libor. This indicates that the SNB was accommodating demand to maintain its policy rate. The sample starts in 2000, when the SNB began to steer short-term money market rates rather than monetary aggregates, and ends in 2007, before banks' excess reserves became large due to unconventional monetary policy measures during the great financial crisis.

The provision of CBDC would, however, exacerbate this risk transfer mechanism because the demand for CBDC by non-banks is likely to be significantly higher than that for cash. CBDC is safer than cash because it is less exposed to the risk of loss and theft, and it is more convenient as it can be transferred electronically to settle payments. Thus, in normal times, the demand for CBDC is likely to be significantly larger than the demand for cash, particularly when the opportunity costs of money holding, i.e., interest rates, are low. The demand for CBDC presumably increases further in times of crisis. Since it is much easier (“by a mouse click”) to transfer money from a bank deposit to a CBDC account than to withdraw cash at the counter, depositors will be much more likely to convert their deposits into CBDC quickly during periods of financial instability.¹²

Deposits would thus become a much less stable source of funding for commercial banks than they are today, which can have a dual effect on bank financing. On the one hand, this could encourage banks to be more cautious and issue more long-term debt securities to sustain their funding, which would drive up credit interest rates and lower

¹² As discussed in Jordan (2018).

Figure 5: Effect of an increase in the demand for CBDC with large excess reserves of banks

Step 0: initial situation

Central bank		Commercial banks		Non-banks		
Gold 4	Cash 2	Cash 1	Deposits 8	Cash 1	Loans 3	
Securities 3	Required reserves 2	Required reserves 2		Equity 1	Deposits 8	Securities 4
	Excess reserves 2	Excess reserves 2				Equity 3
	Equity 1	Securities 1		Loans 3		Property 1
7	7	9		9	10	10

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

Central bank		Commercial banks		Non-banks		
Gold 4	Cash 2	Cash 1	Deposits 6	Cash 1	Loans 3	
Securities 3	Required reserves 1.5	Required reserves 1.5		Equity 1	CBDC 2	Securities 4
	Exc. res. 0.5	Exc. res. 0.5			Equity 3	
	Equity 1	Securities 1		Loans 3	Property 1	
7	7	7		7	10	10

investment and growth. On the other hand, the central bank would more often have to act as lender of last resort.

3.4.2. Risk transfer if banks' excess reserves are large

When excess reserves are large, the decline in banks' reserves does not immediately lead to tighter money market conditions and higher short-term interest rates. Thus, the central bank does not have to accommodate the demand for cash or CBDC by non-banks to maintain its monetary policy stance. However, because banks' excess reserves decline, the central bank loses its ability to reduce its balance sheet and the risk associated with it in case this becomes necessary. Large 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. This risk transfer is discussed in Section 5 in the case of Switzerland for the current SNB balance sheet situation.

Figure 5 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 large. Step 0 shows the balance sheet of the central bank, commercial banks and non-banks before issuing CBDC. In step 1, depositors request the redemption of deposits worth 2 into CBDC, causing banks' reserves to fall. However, as reserves remain in

excess of the required 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 demand for CBDC, the central bank loses its ability to reduce its balance sheet to the degree 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 reduce its balance sheet by only 0.5 without affecting money market rates.

4. Does limiting risk transfer hinder the achievement of CBDC purposes?

The previous section has shown that the issuance of CBDC leads to a transfer of risk from commercial banks to the central bank. As the bank deposit carries credit risk, its conversion into CBDC means that the central bank takes over that risk. All other things being equal, it seems natural that a depositor would prefer to hold a risk-free CBDC over a risky deposit with a commercial bank. Thus, if there was no limit to the issuance of CBDC – and assuming that the central bank keeps its monetary policy stance unchanged and fully assumes its role of lender of last resort – then a substantial part of the bank lending risk could end up on the central bank's balance sheet.

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

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

First, the choice of the portfolio of eligible collateral by the central bank shapes the allocation of bank lending in the economy. In turn, the central bank would be indirectly involved in the credit allocation process. For example, if the portfolio of eligible collateral consists of government bonds only, banks will have to lend to the government – rather than to households or companies – to obtain the collateral needed to meet CBDC demand. If the portfolio of eligible collateral includes mortgages to households but not loans to businesses, banks will lend more to households and less to businesses. Second, the application of haircuts to collateral assets does not fully eliminate their risk, particularly if the central bank lends massively to commercial banks, leaving the challenge of risk transfer fundamentally unsolved. Moreover, increasing the required haircut increases the volume of eligible collateral needed to meet CBDC demand and thus amplifies the undesirable effect on lending allocation described above.

It is technically possible to leave the supply of CBDC unlimited and to mitigate the materialization of risk for the central bank with conservative collateral requirements

and haircuts, as Brunnermeier and Niepelt (2019) point out. The banking system could then gradually slide – de facto if not de jure – toward a 100%-reserve (i.e., full reserve or sovereign) monetary system. Nevertheless, most authors, such as Bindseil (2020), Kumhof and Noone (2018) or Panetta (2018), believe that it is necessary to additionally contain the amount of CBDC to remain in a two-tier monetary system and avoid sliding toward a 100%-reserve monetary system.

4.1. Mechanisms limiting the demand for CBDC

At least three mechanisms can be imagined to limit the amount of CBDC demanded by the public and issued by the central bank: (i) unattractive interest rates, (ii) a quantity ceiling, and (iii) no convertibility at par.

Before analyzing how these mechanisms affect the achievement of the four purposes of issuing CBDC discussed in Section 2.2, it is worth recalling that retail CBDC is by definition accessible to the general public. Therefore, restricting access is not an applicable mechanism to limit risk transfer, as it would mean abandoning the idea of issuing retail CBDC and issuing only wholesale CBDC. It would still be possible to grant access to retail CBDC only to residents and exclude non-residents.¹³

Nevertheless, even if the CBDC was only available to residents, a substantial portion of the banks' credit risk could still be transferred to the central bank when they substitute their deposits for CBDC.

4.1.1. Unattractive interest rates

The transfer of risk can be limited by charging interest on CBDC holdings, much like negative interest rates have been applied in recent years to bank reserves in Switzerland and other economies. Digital money is more convenient than cash because of the lower risk of loss or theft and ease of payment; making CBDC more expensive to hold than cash would limit its demand. In normal times, a moderately negative interest rate might limit the demand for CBDC and, thereby, the risk transfer. During crises, interest in CBDC would probably need to be lowered sharply, which would yield uncertain results because even a very negative annual interest entails only small costs over a short period. For example, an interest rate even as negative as –20% per annum would only result in a cost of 0.85% over a two-week period. One can imagine that many may be willing to pay this price to get their money out of a risky bank in due time.

4.1.2. Quantity ceiling

Another way to limit the risk transfer is to set a maximum amount of CBDC that each person or firm can hold. A quantity ceiling can be strictly enforced so that any surplus above an individual threshold is automatically transferred into another account at a commercial bank (related to the CBDC account). Alternatively, it can be implemented

¹³ This would, however, be a form of capital controls.

in a more flexible way by applying an unattractive interest rate to any surplus above an specific threshold, which would induce the holders to rapidly reduce their CBDC holdings.¹⁴ Bindseil (2020) suggests, for example, applying an attractive interest rate up to a ceiling and an unattractive rate on the amount above that ceiling to encourage the use of CBDC as a medium of exchange but not as a store of value.

4.1.3. No convertibility at par

Another mechanism to limit the transfer of risk 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) propose a mechanism by which the central bank issues CBDC only against government bonds.¹⁵ As they state, “a private-sector agent that wishes to switch his bank deposit to CBDC must first acquire government bonds in order to offer these to the central bank. In making this acquisition, the deposits do not leave the banking system as a whole – they are simply transferred to the seller of the bonds – thus, funding cannot, in aggregate, be lost. The key to this result is that the central bank declines to fund commercial banks directly, thus forcing agents to first exchange their deposits for assets that are not bank liabilities.”

While the choice of a narrow basket of eligible collateral could limit the quantity and quality of risk transfer, it means that the central bank would not convert cash or reserves in CBDC. If cash and reserves were not freely convertible into CBDC at the central bank, an exchange rate between CBDC, on the one hand, and cash and reserves, on the other hand, would emerge. This is highly undesirable, as the different types of central bank money would not establish a uniform unit of account.

4.2. The achievement of CBDC purposes

When the issuance of CBDC is not limited, a significant part of the credit risk of commercial banks would be transferred to the central bank. The previous section showed that three mechanisms could limit the demand for retail CBDC and the transfer of risk. We now assess the implications of these mechanisms for achieving the various purposes put forward for issuing a retail CBDC. Table 1 provides an overview.

One criterion for evaluating a CBDC’s fitness to purpose is to ask whether it is the only and best means for achieving the desired purpose. Moreover, the CBDC design that is fit for one purpose may have unwanted side effects on another of the listed purposes.

4.2.1. Providing the public with legal tender money

The disappearance of cash is not a universal phenomenon. With the possible exception of some Scandinavian countries, cash continues to be widely demanded across the

¹⁴ This corresponds typically to the way banks apply a negative interest rate to their customers when their deposits exceed a certain threshold.

¹⁵ See also Kumhof and Noone (2018).

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

	Unattractive interest rate	Quantity ceiling	No convertibility at par
Providing legal tender money	Effective legal tender function of CBDC since deposit claims against banks would be fully payable in CBDC	Impeded legal tender function of CBDC since deposit claims against banks would be payable in CBDC only up to the ceiling	Impeded legal tender function of CBDC since deposit claims against banks would not be payable in CBDC
Improving resilience of payment system	Ineffective backup system as most people would not hold CBDC	Effective backup system as most people would hold CBDC	Ineffective backup system as most people would not hold CBDC
Promoting payment diversity and sovereignty	Impeded use of CBDC as medium of exchange since paying with unattractive CBDC does not benefit the payer	Impeded use of CBDC as medium of exchange since it would be hoarded as a store of value (Gresham's law)	Impeded use of CBDC as medium of exchange because of value fluctuations against cash
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	No acceleration of transmission if CBDC is not remunerated
	No effect of remunerated CBDC on the ELB as long as cash coexists	Unremunerated CBDC may raise the ELB on interest	Unremunerated CBDC may raise the ELB on interest

world.¹⁶ Even in countries where the use of cash to settle transactions is declining, such as Switzerland¹⁷, the demand for cash as a store of value is increasing, driving up the amount of cash in circulation per capita. As long as the public has access to cash, the issuance of CBDC does not seem necessary to provide it with legal tender money.

Nevertheless, if a central bank plans to abolish cash, providing the public with legal tender money in the form of CBDC is a prerequisite, as explained in Section 2.2.1.

The mechanisms to limit the demand for CBDC have differentiated effects on the role of CBDC as legal tender money. First, if the central bank applies an unattractive interest rate to CBDC, CBDC will be an effective provision of legal tender money because the deposit claim against the bank will be fully payable in CBDC (as well as in cash). Although the demand for redemption of deposits in CBDC may be low due to unattractive remuneration, such a CBDC would enable the bank to fulfil its legal obligation to the depositor. Second, if the central bank applies a quantity ceiling to CBDC holdings, the deposit claim against the bank will be payable in CBDC only up to the ceiling. This naturally hampers the legal tender role that CBDC would be intended to play. Third, if the central bank does not guarantee par convertibility

¹⁶ See Sveriges Riksbank (2018) for the second progress report on the possible introduction of an E-Krona.

¹⁷ See SNB (2018).

between CBDC and cash or reserves (but only issues CBDC against a narrow basket of eligible collateral), the deposit claim against the bank will only be payable in cash. CBDC would thus be a poor provision of legal tender money since it would not allow the depositor to enforce his claim against the bank in CBDC.

In summary, if the purpose for issuing CBDC is to provide the public with legal tender money, then applying an unattractive interest rate to CBDC is the most appropriate way to limit its demand.

4.2.2. Improving the resilience of the payment system

The mechanisms to limit the demand for CBDC also have differentiated effects on the achievement of a CBDC-based backup payment system. To be effective, a backup payment system must be usable by 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, then most people will probably not hold CBDC permanently, thereby making a CBDC-based payment system ineffective as a backup. Second, if the central bank applies a quantity ceiling to CBDC holdings, then most people will probably 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 does not guarantee par convertibility between CBDC and cash or reserves, most people will probably not hold CBDC because acquiring it would be burdensome. CBDC could therefore not serve as an effective backup system.

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

4.2.3. Promoting diversity and sovereignty in payments

Mechanisms to limit the issuance of CBDC greatly reduce the chances of widespread use of a CBDC-based payment system for everyday transactions. First, if CBDC earns an unattractive interest rate, one wonders why anyone would make a payment in such a CBDC in the first place. The comparison with cash is useful because it pays no interest, which is, in normal times, unattractive compared to the interest rate on bank deposits. However, cash has the advantages of being free of credit risk and of offering a different technology from the electronic banking payment system, which guarantees anonymity. Those who value the absence of credit risk demand cash typically 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 a fundamentally different technology to its users than the current electronic banking payment system. Therefore, the main reason why people would hold CBDC with an unattractive interest rate is the absence of credit risk (and not because its technology is different from the current electronic technology). This raises the question of why anyone would hold an unattractively remunerated CBDC if they were to spend it at the first opportunity.

Indeed, making a payment with an unattractively remunerated – but risk-free – CBDC does not bring any advantage to the payer. However, holding an unattractively remunerated – but risk-free – CBDC as a store of value provides security to the holder. An unattractive interest rate thus cannot limit CBDC holdings without undermining the CBDC’s widespread use as a medium of exchange.

Second, if a quantity ceiling applies to CBDC, one may question why people would use CBDC rather than bank deposits to settle transactions.¹⁸ Since CBDC is, unlike bank deposits, free of credit risk, Gresham’s law teaches 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. This is true regardless of the interest rate applied up to the CBDC ceiling (tier one, as per Bindseil 2020). If CBDC earns an attractive interest rate (compared to bank deposits) up to the ceiling, people would maximize 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. In contrast, if CBDC earns an unattractive interest rate (compared to bank deposits) up to the ceiling, we are back to the considerations made in the previous subsection. People would hold CBDC with an unattractive interest rate to the extent that they value its security, which matters for a store of value, not for a medium of exchange.

Third, if the central bank does not convert cash or reserves in CBDC at par (because it would issue CBDC only against a narrow basket of eligible collateral), the value of a payment in CBDC would fluctuate against cash and reserves over time. This is clearly an unsuitable property for a medium of exchange, as CBDC would not fulfil the function of a unit of account.

In summary, all three mechanisms to limit its issuance will make CBDC unlikely to increase the diversity and sovereignty of payment systems because it will not be used widely as a medium of exchange. As long as the bulk of money is issued mainly in the form of risky bank deposits in our monetary system, improving the diversity or sovereignty of payment systems would be better served by relying on this type of money rather than on central bank money. Contestability in payments may be better achieved by policies other than the introduction of CBDC – for example, anti-trust measures to avoid the anti-competitive consequences of network effects.

4.2.4. Enhancing monetary policy

The arguments raised in favor of CBDC to enhance monetary policy must also be assessed in light of the mechanisms limiting the demand for CBDC. Let us first consider the argument that CBDC can accelerate the transmission of the policy rate to bank rates. If CBDC is not remunerated – while the central bank applies a quantity ceiling or issues CBDC only against a narrow basket of eligible collateral – the

¹⁸ As discussed in Section 4.2.2, they would, however, use CBDC to settle transactions as a backup, if the current electronic system were to fail.

issuance of CBDC is not expected to accelerate the transmission of the policy rate to bank rates. In contrast, if CBDC earns an interest rate, it could potentially accelerate the transmission to the extent that CBDC holdings represent an attractive alternative to bank deposits. A remunerated CBDC would contribute to accelerating the rise of bank deposit rates as depositors significantly transfer their (lowly remunerated) deposits into (highly remunerated) CBDC. This would, however, cause a substantial transfer of risk to the central bank. Applying an unattractive rate to CBDC to limit this transfer would also limit the potential acceleration effect on its transmission to bank rates.

Let us now turn to the argument that CBDC can lower the ELB on interest rates. The ELB on interest rates results from the existence of cash, on which no interest rate can be charged. Issuing CBDC subject to a negative interest rate will therefore not remove the ELB on interest rates. Furthermore, 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. Mechanisms limiting the issuance of CBDC would, however, limit this effect on the ELB.

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

5. The Swiss case

We now turn to the specific case of Switzerland. This section assesses the implications of issuing a CBDC for the SNB given specific features of the Swiss economy, in the current situation and in the future. A special characteristic of the CHF is that it is for many an attractive store of value, especially in crisis times. Thus, in comparison to the general discussion above, the arguments that relate to CBDC as a store of value carry particular weight in the Swiss case.

5.1. Potential demand for CBDC

The potential domestic demand for CBDC is large. The non-banking sector needs assets that can be directly or indirectly (via transfers) used to buy goods or services without risk of loss. This includes banknotes and coins, customer sight deposits, and transaction and savings accounts. A CBDC would be a very close substitute for those assets.

Quantitatively, as seen in Figure 6, there is approximately CHF 94 bn of currency in circulation (i.e., central bank money held by non-banks) and almost CHF 1,000 bn in customer sight deposits and transaction and savings accounts that are redeemable at par on demand. These deposits included in monetary aggregates are held by Swiss non-bank residents only.

Figure 6: Monetary aggregates

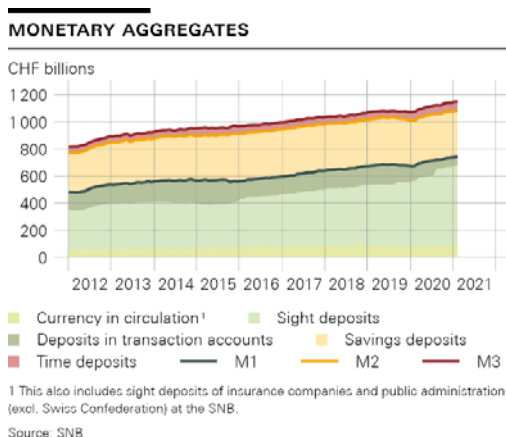
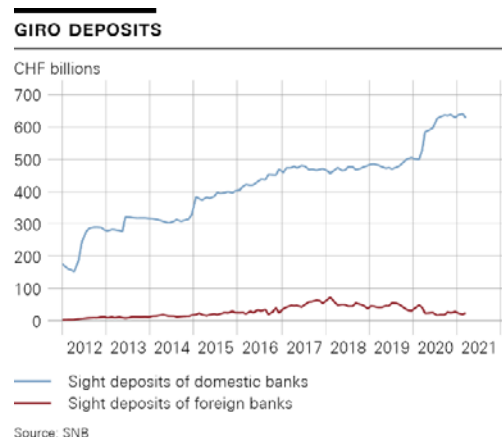


Figure 7: Banks' reserves at the SNB



As banks incur costs in facilitating transactions and payments, those accounts usually yield a relatively low interest rate. This is the case especially in the current economic environment following the great financial crisis but was also the case in prior economic environments. Savings deposit interest rates have been below 1% since 2003. Given the low yield on those accounts and the safety properties of CBDC, this domestic money demand thus already corresponds to potential demand for CBDC of over CHF 1,000 bn.

As reserves of domestic and foreign commercial banks at the SNB amount to over CHF 650 bn (see Figure 7), the SNB might not have to immediately increase its balance sheet if a CBDC were to be introduced. Commercial banks would exchange part of their excess reserves at the SNB for CBDC by the amount households and firms decide to substitute from existing deposits. However, as discussed in Section 3.4.2, this would still in fact lead to a risk transfer. The counterpart of CBDC would be existing FX assets already on the SNB balance sheet. This means that the SNB would be unable to reduce its balance sheet by the corresponding amount of CBDC if and when it will choose to do so at some point in the future.

In principle, the SNB could change the composition of its asset holdings and adjust its risk exposure. However, as the Swiss government bond supply represents only approximately CHF 100 bn and as the volume of securities held by commercial banks is relatively low, the only choice the SNB would have is whether to maintain its FX risk or to replace it with credit risk. In the latter case, the SNB would sell FX assets against mortgages or securities backed by mortgages, which represent commercial banks' major assets and which would then be transferred to the balance sheet of the SNB. Alternatively, the SNB could sell FX assets and lend to banks. It would then hold claims against banks on its balance sheet. Thus, although risk transfer could take different forms, it would still take place if the demand for CBDC exceeds the current demand for cash.

In the longer term, CBDC demand could be so large that excess reserves would disappear. This, or a situation in which the SNB decides to reduce its balance sheet

and sell assets, would lead to a situation as described in Section 3.4.1, when reserves are small. In this case, when banks' customers want to convert funds from their accounts into CBDC, banks must acquire reserves on the interbank market. To keep the monetary policy stance constant and thus the interbank rate stable, the SNB has to provide additional reserves and thus increase its balance sheet and take on more risk.

In addition to the CHF 1,000 bn deposits mentioned above held by Swiss residents, CHF deposits held by non-residents with Swiss banks amount to CHF 100 bn, which also represents a potential demand for CBDC. Moreover, the CHF is a safe-haven currency with a limited supply of investable assets, especially because of low government debt. Issuing a CBDC would mean creating a new form of CHF money that is safer than deposits at commercial banks. If foreigners see a Swiss CBDC as an attractive reserve asset or as a safe haven in times of crisis, this would raise the demand for it and thereby for CHF. Today, people are happy to hold CHF bank deposits; in theory, a CHF-denominated CBDC would be even more attractive. This would lead it to appreciate and at the same time increase the SNB's balance sheet and its risk profile.

5.2. Limiting the risk transfer

Section 4 presents mechanisms of limiting the risk transfer and their effects on the CBDC's intended purposes, which also apply to the Swiss case. We mention here only 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 to be a particularly safe investment due to their design.¹⁹

However, covered bonds are not risk-free. Should a severe crisis occur in the real estate market, the SNB would probably suffer losses.

From the perspective of limiting the quantity through no convertibility at par, the SNB could issue CBDC against eligible collateral such as Swiss government bonds or Pfandbriefe. Apart from the problem that parity between different forms of money (i.e., CBDC and cash/bank deposits) would break down, as discussed in Section 4, the availability of collateral supply, i.e., Swiss government bonds, is low. This could substantially distort their yields, affecting bond prices and thus long-term interest rates.

¹⁹ (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 nonperforming 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 overcollateralization 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.

6. Conclusions

This paper started by outlining the various purposes often cited to justify the issuance of a retail CBDC. We have highlighted the risk transfers from commercial banks to the central bank arising from the issuance of a retail CBDC and then analyzed the specific Swiss case.

The main contribution of our analysis is to have pointed out that mechanisms to limit the risk transfers make the use of CBDC as a medium of exchange unlikely. There is thus a trade-off between limiting the risk transfers to central banks and achieving certain CBDC purposes.

If CBDC is to provide the public with legal tender money, its holding should not be subject to quantity ceilings and deposit claims against banks should be fully redeemable in CBDC. Applying an unattractive interest rate to CBDC may then contain its demand in normal times; an unattractive interest rate, however, is likely to contain demand much less in times of financial crisis because even a very negative annual interest entails only small costs over a short period.

If CBDC is to improve the resilience of the payment system as a backup, the vast majority of people need to hold a certain amount of CBDC at all times. This requires CBDC to be unremunerated or perhaps positively remunerated up to a certain quantity ceiling. By applying an attractive interest rate up to a ceiling and an unattractive interest rate above that ceiling, CBDC would be able to fulfil its roles as legal tender money and as a backup payment system but may facilitate massive runs in times of financial crisis.

If CBDC is to increase the diversity and sovereignty of payment systems, people should actively use CBDC to settle their daily transactions. However, as Gresham's law teaches us, mechanisms limiting the demand for CBDC will undermine its widespread use as a medium of exchange for everyday transactions because people will hoard their credit risk-free CBDC and spend their risky bank deposits instead. A CBDC-based payment system is therefore unlikely to promote the diversity and sovereignty of payment systems. This purpose would be more easily achieved with a system based on bank deposits rather than on central bank money.

Overall, the implications of issuing a retail CBDC would thus depend on its design. Failure to limit the demand would entail risk transfers, actual or potential, to the issuing central bank. Limiting the demand, however, could hamper the prospect of achieving some intended purposes of its issuance.

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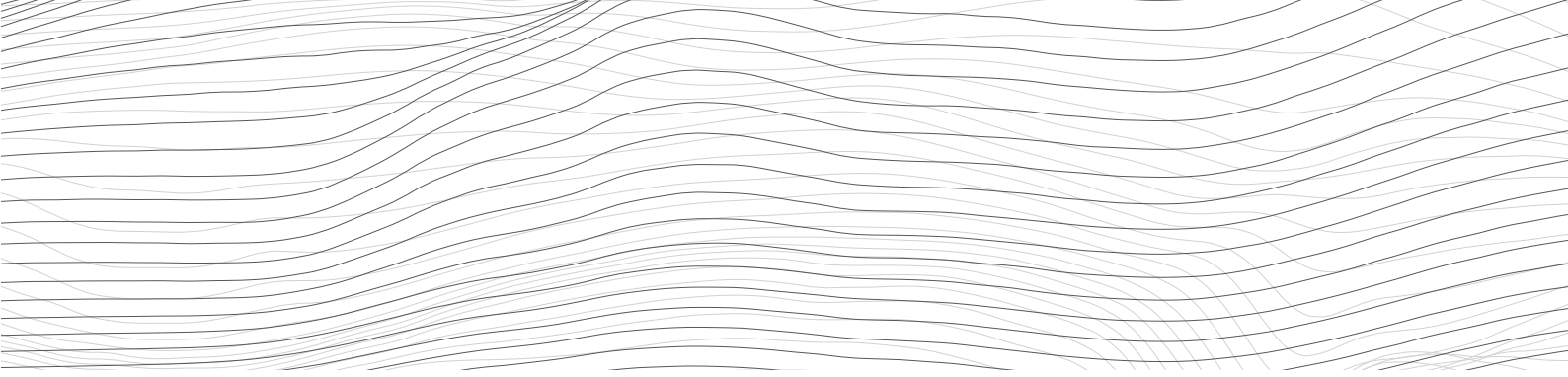
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- 2020-24 Basil Guggenheim, Sébastien Kraenzlin, Christoph Meyer:
(In)Efficiencies of current financial market infrastructures – a call for DLT?



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