When a central bank digital currency meets private money: effects of an e-krona on banks

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The introduction of a central bank digital currency (CBDC) is often perceived to have far-reaching implications for banks with adverse effects on financial and macroeconomic stability. We study the effects of CBDC on banks using the Swedish banking sector as an illustration. We find that, while a given outflow of retail deposits into e-krona reduces banks' liquidity portfolios and worsens their funding profiles, banks can normally control this outflow via deposit rates. Banks can also issue more market funding to restore their liquidity and funding profiles. An indicative calculation of the demand for e-krona in normal times shows that it would be below three per cent of nominal GDP and that the impact of an e-krona on bank funding costs would be up to 25 basis points under plausible assumptions. In times of distress, an e-krona may increase the number of banks experiencing a run. This will be the case if an e-krona has features that make it more attractive than existing run assets, such as deposits at the safest banks, tax accounts or cash. The exact features of an e-krona can, however, be controlled by the policy maker. In sum, we do not find any decisive argument against the issuance of an e-krona when studying financial stability effects on banks.

1 Introduction

The introduction of a central bank digital currency (CBDC) is being actively discussed both in academic and central bank circles. One of the most frequently raised issues is the impact of CBDC on banks.[1] How would banks fund their lending if deposits were converted into CBDC? What would CBDC mean for bank lending rates? And would not CBDC open up for large-scale bank runs? These are frequently asked questions in the context of CBDC. This article considers a specific CBDC in the form of an e-krona and studies the effects of an e-krona on the Swedish banking sector.

The article starts with a description of the assets and liabilities of the Swedish banking sector and the Riksbank. Next, the article considers a scenario where banks experience a given outflow of retail deposits into e-krona. The scenario is used to understand the effects of a given outflow of retail deposits into e-krona on banks and the Riksbank. The scenario is also used to illustrate what measures banks could take to compensate for a loss in liquidity and funding stability due to an outflow.

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1 See, for instance, Bank for International Settlements (BIS) (2018).

The article then moves on to discuss the potential demand for e-krona in normal non-stressed times. Using data on deposits and estimates on payment volumes via e-krona from Segendorf (2018), the article gives an indication of how large the demand for e-krona could be in normal times. The analysis of this demand is used to understand the implications of an e-krona for banks' funding costs and lending rates taking into account banks' own counterbalancing measures.

The article then discusses the demand for e-krona in stressed times when confidence in the banking sector is low. In particular, bank runs with and without an e-krona are discussed together with the measures that can be taken to mitigate the adverse effects of an e-krona on banks in times of distress.

The article concludes with a discussion of broader aspects of an e-krona. In particular, an e-krona as a medium of exchange as well as acting as a payment system is discussed together with costs and benefits stemming from the reduced role of deposits in banking and the increased role of central banks in financial markets.

2 The balance sheet of the Swedish banking sector and the Riksbank

To understand the effects of an e-krona on Swedish banks, it is useful to start with the description of their assets and liabilities. Swedish banks have a large portfolio of liquid assets, worth around 3 550 billion (see Table 1). Out of this liquidity portfolio, 450 billion is held at the Riksbank as reserves[2] and 3 100 billion is held in liquid securities and as reserves at foreign central banks. Banks fund their liquidity portfolio by issuing short-term securities, such as certificates, and other short-term liabilities, such as deposits from asset managers.

Table 1. Swedish banks' liquid assets, lending in Sweden and their sources of funding
SEK billion

Assets		Liabilities	
Reserves at the Riksbank	450	Short-term issuance	1 300
Other liquid assets	3 100	Other short-term liabilities	2 250
Lending to the real sector	6 100	Retail deposits	2 800
		Long-term issuance	3 300
Total	9 650	Total	9 650

Note. Data is as of April 2018. Reserves at the Riksbank refer to monetary policy deposits as well as certificates issued by the Riksbank. The real sector refers to Swedish households and non-financials. Retail deposits are taken to be equal with deposits from the real sector. Short and long-term issuance refers to market funding, such as certificates and bonds, issued in the domestic and foreign currencies. Some assets and liabilities, such as lending outside Sweden and derivatives, are excluded.
Sources: The Riksbank and the author's calculations

Swedish banks also have a lending portfolio to Swedish households and non-financial firms that is equal to approximately 6 100 billion. This is funded with a mix of retail[3] deposits from households and non-financial firms (approximately 2 800 billion) and long-term market funding (approximately 3 300 billion). Almost all retail deposits are on demand and can be used immediately for payments.

2 Banks' claims against the Riksbank come in the form of overnight deposits and certificates. For simplicity, the article refers to these claims as reserves.

3 Retail refers to small and medium-sized non-financial customers. The distinction between retail and non-retail is important since it is retail deposits that can be used to fund illiquid lending.

The Riksbank's balance sheet is currently around 900 billion. The Riksbank has no outstanding monetary policy lending to banks, but it has a security portfolio in domestic currency and a foreign currency reserve. The largest item on the liabilities side is the reserves held by banks.

Table 2. The Riksbank's balance sheet
SEK billion

Assets		Liabilities	
Lending to the banks	0	Reserves to the banks	450
Securities	370		
Foreign reserve, gold, other	530	Cash, other liabilities	450
Total	900	Total	900

Note. Data is as of April 2018.
Sources: The Riksbank and the author's calculations

3 An outflow of retail deposits into e-krona

In this section, we consider a scenario where banks experience a deposit outflow into e-krona. The goal of the scenario is to understand how a given deposit outflow into e-krona affects the asset composition and funding sources of banks and the Riksbank. The total outflow in the scenario is given and assumed to be 900 billion. The outflow itself takes place in two days in equal magnitudes, that is, 450 billion in deposits leaves the banking sector and moves to e-krona each day.[4]

The scenario focuses on retail deposits since it is these deposits that banks use to fund illiquid lending. The specific features of an e-krona are irrelevant for the scenario since the outflow is given and cannot be affected by banks. We do, however, assume that e-krona are supplied in exactly the same way as cash is supplied today: banks can buy e-krona from the Riksbank using reserves and the Riksbank takes measures to satisfy banks' aggregate need for reserves.[5]

3.1 Effects of an outflow on banks' balance sheets and the Riksbank

To begin with, banks have reserves at the Riksbank equal to 450 billion. Therefore, banks can use their existing reserves to manage the first outflow. Banks simply buy e-krona from the Riksbank using their reserves. These e-krona are then sold further to depositors who pay for them with their existing bank deposits.

After the first day, there are two changes in banks' balance sheets: on the asset side, reserves held at the Riksbank have been exhausted fully, since banks used these to buy e-krona, and on the liability side, retail deposits have gone down since depositors used these to pay for e-krona (see Panel A, Table 3). The Riksbank's asset side is the same, but the Riksbank now has a new liability of 450 billion in the form of e-krona towards the real sector while there is no liability towards banks (see Panel B, Table 3).

4 The reason why we consider 450 + 450 billion is because banks can meet the first outflow with existing reserves, while there are not enough existing reserves for the second outflow.
5 There are also other ways to issue an e-krona. See also Section 5.2.3.

Table 3. Changes in the balance sheets of Swedish banks and the Riksbank after the first outflow of 450 billion in retail deposits into e-krona
SEK billion

Panel A. Swedish banks			
Assets		**Liabilities**	
Reserves at the Riksbank	0	Short-term issuance	1 300
Other liquid assets	3 100	Other short-term liabilities	2 250
Lending to the real sector	6 100	Retail deposits	2 350
		Long-term issuance	3 300
Total	9 200	Total	9 200

Panel B. The Riksbank			
Assets		**Liabilities**	
Lending to the banks	0	Reserves to the banks	0
Securities	370	E-krona to the real sector	450
Foreign reserve, gold, other	530	Cash, other liabilities	450
Total	900	Total	900

Note. The changes have been marked in red.

At the beginning of the second day, banks have no reserves left. Banks must therefore first borrow reserves from the Riksbank to buy e-krona.[6] The Riksbank offers intraday credit to facilitate payments, so banks can use this facility to obtain reserves and buy e-krona to manage the outflow. However, the intraday credit must be paid back before the day ends. Therefore, banks also need an overnight loan from the Riksbank to be able to pay back their intraday credit. The Riksbank can use its regular monetary policy lending or any other facility to make the loan to banks. Irrespective of the facility, the Riksbank's lending will always be conducted against eligible collateral meaning that banks must encumber approximately 450 billion[7] of their liquidity portfolio to manage the second outflow (see Table 4).

Unlike the first day, the second day leaves the size of banks' balance sheets constant, while the Riksbank's balance sheet increases. Despite the constant size of banks' balance sheets, the outflow leads to changes in banks' asset and funding structure. On the asset side, some liquid securities become encumbered. On the liability side, retail deposits go down while borrowing from the central bank goes up.

The hypothetical scenario considered above leads to the following three general conclusions (see Figure 1 for a schematic view).

First, the outflow of retail deposits into e-krona reduces banks' liquidity portfolio. Banks' unencumbered liquidity portfolio goes down since they must either use their existing reserves or borrow new reserves by encumbering their securities to buy e-krona from the Riksbank. While the reduced amount of retail deposits also diminishes the need for banks' liquidity portfolio going forward, banks' liquidity situation can be said to have worsened after the outflow.[8]

6 Interbank borrowing or any other transaction between banks such as the sale of assets does not help here since there is an aggregate shortage of reserves in the banking sector.
7 Since the Riksbank also applies haircuts to different securities taken as collateral, banks need to pledge a bit more than 450 billion.
8 This effect is quantified in the next section.

Table 4. Changes in the balance sheets of Swedish banks and the Riksbank after the second outflow of 450 billion in retail deposits into e-krona
SEK billion

Panel A. Swedish banks			
Assets		**Liabilities**	
Reserves at the Riksbank	0	Short-term issuance	1 300
Other liquid assets	3 100	Other short-term liabilities	2 250
of which pledged to the Riksbank	450	Borrowing from the central bank	450
Lending to the real sector	6 100	Retail deposits	1 900
		Long-term issuance	3 300
Total	9 200	Total	9 200

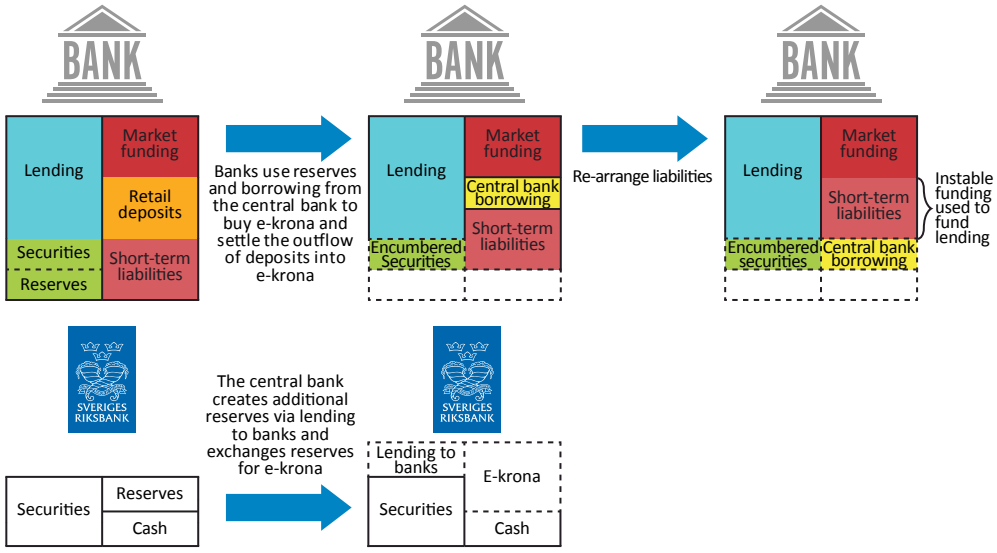
Panel B. The Riksbank			
Assets		**Liabilities**	
Lending to the banks	450	Reserves to the banks	0
Securities	370	E-krona to the real sector	900
Foreign reserve, gold, other	530	Cash, other liabilities	450
Total	1 350	Total	1 350

Note. Securities that are pledged stay on banks' balance sheets.

Secondly, if the demand for e-krona is larger than banks' initial holdings of central bank reserves, the outflow also means that the central bank has to create new reserves, for instance, by granting new loans to banks. For central banks, creating new reserves means increased balance sheets and for banks, it may mean increased usage of central bank funding.[9]

And finally, the outflow of retail deposits into e-krona has a negative impact on banks' funding stability, since a loss of retail deposits reduces the volume of stable funding available for banks. This means that there will be an imbalance between illiquid lending and stable funding.

Figure 1. A schematic illustration of the outflow of retail deposits into e-krona



Source: Author's own illustration

9 If reserves are created via buying assets, banks' use of central bank funding does not increase.

3.2 Potential measures to restore banks' liquidity and funding positions

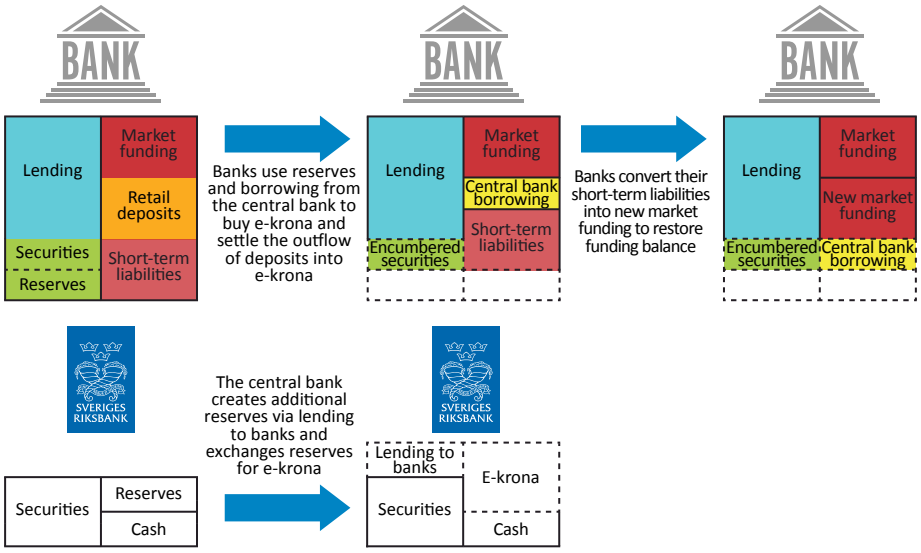
Banks can take measures to restore their liquidity and funding positions after a deposit outflow into e-krona. These measures are needed to restore banks' resilience against future unexpected outflows.

Consider again banks' balance sheets before and after an outflow of retail deposits into e-krona (see Table 5). We define *liquidity* as a difference between unencumbered liquidity portfolio and the sum of short-term issuance and other short-term liabilities.[10] The idea here is that short-term liabilities can generate an outflow that needs to be covered by the liquidity portfolio. According to this definition, banks' *liquidity* initially equals zero. Similarly, we define *funding stability* as the difference between real sector lending and the sum of retail deposits and long-term issuance. The idea here is that real sector lending is illiquid and needs to be funded with stable funding sources. According to this definition, banks' *funding stability* initially equals zero.

Due to the outflow, *liquidity* and *funding stability* both fall by 900 billion, the magnitude of the total outflow. *Liquidity* worsens since banks use their liquidity portfolio to satisfy depositors' demand for e-krona. *Funding stability* goes down since retail deposits, which are a stable source of funding, fall. The new levels of both measures are equal to –900 billion, respectively.

Banks can restore their funding and liquidity situation by issuing new long-term funding. The issuance of new long-term funding means that banks roll-over their maturing short-term liabilities, such as deposits from asset managers, into new long-term market funding (see Panel C in Table 5 for balance sheet and Figure 2 for an illustration). By rolling over 900 billion in short-term liabilities into long-term market funding, banks restore both their *liquidity* and *funding stability*. *Liquidity* is restored since a reduction in liquidity portfolio due to an outflow of deposits into e-krona is compensated by a fall in short-term liabilities. *Funding stability* is restored since a loss of stable funding from an outflow of retail deposits is compensated by an increase in long-term market funding.

Figure 2. A schematic illustration of the outflow of retail deposits into e-krona with banks' measures to balance their funding



Source: Author's own illustration

10 We use a simplified version of Liquidity Coverage Ratio (LCR). We exclude retail deposits despite their short maturity as well as central bank borrowing. In practice, even these liabilities generate some outflow that may need to be covered by the liquidity portfolio. We also assume that the entire short-term issuance needs to be covered by the liquidity portfolio. In practice, only issuances that have remaining maturities below 30 days need to be covered by the liquidity portfolio. These simplifications make the analysis easier to follow, but do not affect the general conclusions of the analysis.

It is worthwhile to note that adjusting the liability side of banks is the only feasible strategy to restore *funding stability*. Banks could, of course, also cut their lending to the real sector. However, if they were to do this, the amount of retail deposits would also be affected.[11] Therefore, cutting lending would not lead to a better funding situation for the banking sector as a whole.

Table 5. The balance sheets of Swedish banks before and after the outflow of 900 billion in retail deposits into e-krona when banks restore their liquidity and funding profiles
SEK billion

Panel A. Swedish banks' balance sheet before the outflow of 900 billion in retail deposits			
Assets		**Liabilities**	
Reserves at the Riksbank	450	Short-term issuance	1 300
Other liquid assets	3 100	Other short-term liabilities	2 250
Lending to the real sector	6 100	Retail deposits	2 800
		Long-term issuance	3 300
Total	9 650	Total	9 650

Panel B. Swedish banks' balance sheet immediately after the outflow of 900 billion in retail deposits			
Assets		**Liabilities**	
Reserves at the Riksbank	0	Short-term issuance	1 300
Other liquid assets	3 100	Other short-term liabilities	2 250
of which pledged to the Riksbank	450	Borrowing from the central bank	450
Lending to the real sector	6 100	Retail deposits	1 900
		Long-term issuance	3 300
Total	9 200	Total	9 200

Panel C. Swedish banks' balance sheet after the outflow of retail deposits and banks' own compensatory measures			
Assets		**Liabilities**	
Reserves at the Riksbank	0	Short-term issuance	1 300
Other liquid assets	3 100	Other short-term liabilities	1 350
of which pledged to the Riksbank	450	Borrowing from the central bank	450
Lending to the real sector	6 100	Retail deposits	1 900
		Long-term issuance	4 200
Total	9 200	Total	9 200

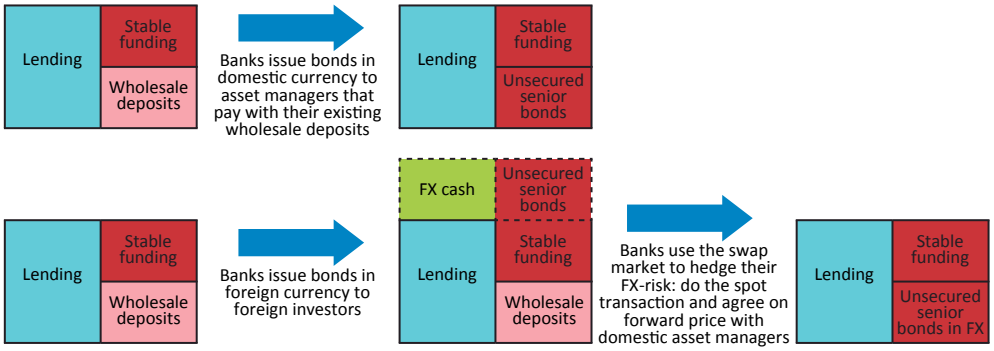
The issuance of new market funding to compensate for a loss of liquidity and funding stability also leads to the question of which debt is exactly issued and who are the investors. The major Swedish banks issue their current long-term funding either in the form of covered bonds that are secured by some specific assets, such as retail mortgages, or in the form of senior unsecured bonds. Since deposit funding is unsecured, it is reasonable that the lost retail deposits are replaced by senior unsecured bonds. These bonds are predominantly issued to foreign investors in foreign currencies, such as EUR and USD. So, banks can choose either to issue in domestic or foreign currency.

11 Whenever a loan is granted, new deposits are created. Whenever a loan is paid back, deposits are destroyed.

If bonds are issued in domestic currency, then the issuance means that domestic asset managers, such as pension and mutual funds, simply convert their existing short-term wholesale deposits into senior unsecured bonds denominated in domestic currency (see Figure 3).

If bonds are issued to foreign investors in foreign currency, then the issuance is more complicated since banks must hedge their resulting currency risk (see Figure 3). The new issuance of bonds in foreign currency would mean that banks first get an inflow of the foreign currency. This foreign currency would then be lent further via the so-called foreign currency swap market.[12] In the swap market, counterparties would first do a so-called spot transaction, exchanging currencies using the spot rate. At the time of the spot transaction, the counterparties would also agree on a forward rate that would be used when currencies are exchanged back at some pre-defined point in the future. The second part of the swap contract is needed to balance potential losses and profits that might stem from having assets and liabilities in different currencies.

Figure 3. A schematic illustration of the issuance of unsecured senior bonds in domestic and foreign currency



Note. The starting point here is the same as the end-point in Figure 1, but we have excluded central bank borrowing for simplification. Note that the forward contract would not be visible on the balance sheet, since it has a zero value at a time of origin.
Source: Author's own illustration

A natural counterparty to banks on the swap market would be a domestic asset manager interested in investing in foreign assets without taking an exchange rate risk. The asset manager would then buy the foreign currency from banks via the swap market and use this to buy foreign assets. The asset manager would pay for the foreign currency with its existing wholesale deposits in the domestic currency. At the end of the contract, the counterparties would either reverse the flows using the predefined forward rate or simply settle their remaining obligations depending on the actual realization of the exchange rate.

We can conclude this section by commenting on the generality of the analysis. The Swedish banking sector already relies on short- and long-term market funding. But would the results carry through to another country where banks exclusively rely on deposit funding because there is no existing market for domestic bonds? Banks in these countries could issue bonds in foreign markets and hedge their resulting foreign currency risks. To hedge currency risks, someone has to be willing to take the other side of the trade. This could be an export or import firm, or any asset manager exposed to foreign assets. This suggests that the results are fairly general and not necessarily specific to the Swedish context.

12 For an in-depth analysis of the foreign currency funding by Swedish banks, see Eklund et al. (2012).

4 The demand for e-krona in normal times and effects on banks' funding cost and lending rates

So far, we have taken the size of deposit outflows into e-krona as given and studied the resulting changes in balance sheets of banks and the Riksbank. We have also shown how banks could restore their funding and liquidity profiles by issuing additional market funding. In this section, we discuss the demand for e-krona together with the impact on banks' funding cost and lending rates. Our focus here is on normal times, that is, times when there is no significant stress in the banking sector.

4.1 Quantifying the demand for e-krona in normal times

To be able to discuss the demand for e-krona, we need to be clear about the assumed features of an e-krona. In this article we assume the following:

- an e-krona is a direct claim against the Riksbank denominated in SEK;
- e-krona can be used to make real-time payments in 24/7;
- e-krona has its own independent payment platform;
- e-krona can be held for saving purposes;
- there are no restrictions on who can hold e-krona and on how much they can hold;
- interest rate treatment of e-krona is consistent with monetary policy implementation.

All these features mean that e-krona is a close substitute for retail deposits. Both retail deposits and e-krona offer a similar level of credit risk protection and immediate availability. Retail deposits typically come from households and small and medium-sized companies which means that they would be fully covered by the deposit insurance guarantee.[13] There are also some real sector deposits, such as those from larger non-financial corporations, that are too large to be entirely covered by the deposit guarantee. However, the level of credit risk in these deposits can still be considered to be negligible in normal times since banks' creditworthiness is positively correlated with economic activity. Credit risk in these large deposits can also be mitigated by diversification and monitoring, that is, by spreading deposits across a number of different banks and tracking the creditworthiness of individual banks.

Due to small differences in credit risk between retail deposits and e-krona in normal times, it is the relative interest rate between the two that is an important driver behind the demand for e-krona in normal times. An e-krona will have an unattractive pricing in comparison to retail deposits for two reasons.

First, if an e-krona is to be consistent with the implementation of monetary policy, it must be consistent with the pricing of the deposit facility that is offered to monetary policy counterparties. In Sweden, the deposit facility is currently priced 75 basis points below the repo rate. This implies that an e-krona should be priced at least 75 basis points below the repo rate to avoid interference with the current stance of monetary policy.[14,15]

Second, banks can adjust their deposit rates to retain retail deposits.[16] Banks have strong economic incentives to increase deposit rates until the cost of deposits is equal to the cost of alternative funding in the form of long-term market funding. Historically, the cost of deposits

13 The current level of the deposit guarantee in Sweden is up to 950 000 SEK per client and bank, see the Swedish National Debt Office's website https://www.riksgalden.se/en/Deposit_insurance/About-deposit-insurance/.

14 Note that this can be achieved both with an interest-bearing and interest-free e-krona. If an e-krona is designed to be interest-free, then it will be the level of the repo rate that dictates the attractiveness of an e-krona. In normal times, the repo rate will be positive which means that an e-krona will have an interest rate that is below the repo rate. If an e-krona is actively priced as a spread to the repo rate, similarly to the Riksbank's deposit facility, then it is this spread that will make an e-krona less attractive in relation to the repo rate.

15 See also Nessén et al. (2018).

16 For a similar argument, see also Meaning et al. (2018).

has been under the repo rate, while the cost of long-term market funding has been over the repo rate (see Figure 4). This means that banks have room to adjust their deposit rates to make the interest on deposits higher than the interest on e-krona.

E-krona can be viewed as a deposit facility offered to the public by the Riksbank, similar to the current deposit facility offered to monetary policy counterparties. Actual use of the current deposit facility is rare and has historically taken place in significant volumes only in extreme cases of distress.[17] This limited use is due to the unattractive pricing of the facility: in normal times, the existing market solutions offer better ways to deal with short-term liquid savings than using the safe deposit facility offered by the Riksbank. In the same way, since an e-krona would have an unattractive pricing vis-à-vis market solutions, its actual use could be expected to be limited in normal times.

E-krona can also be held for reasons that are not directly related to credit risk or return. For instance, there may be some groups that don't wish to use commercial banks. E-krona could offer these clients a solution, since e-krona could be used to carry out services that are currently available only via bank deposits. E-krona could also be held to improve resilience against technical risks. Having some liquidity in e-krona could increase technical resilience, since e-krona could be used as a back-up payment system in situations when other forms of payments do not work due to idiosyncratic shocks. In addition, e-krona could also be demanded for pure payment purposes.[18] If an e-krona offered payment solutions that were easier and cheaper than existing market solutions, the demand for e-krona could also come from payments.

All the factors mentioned above could play some role in determining the demand for e-krona in normal times. To get some sense of the magnitudes involved, we have carried out a back-of-the-envelope calculation under the following assumptions:

- 10 per cent of non-guaranteed real sector deposits are substituted for e-krona to enhance risk-management and lower credit risks;
- 2 per cent of household deposits are substituted for e-krona to satisfy the demand from clients who wish to be bank-free;
- 10 per cent of all payments are carried out via an e-krona system.[19]

Under these assumptions and using 2017 data, the demand for e-krona would be up to 120 billion, which is less than 3 per cent of nominal GDP. This magnitude can be compared with the absolute demand for cash that peaked at about 100 billion and with the relative demand for cash that peaked at about 10 per cent of nominal GDP.

4.2 The effects of an e-krona on the cost of funding and lending rates

Banks' funding costs would be affected if banks met the demand for an e-krona by replacing cheap retail deposits with more expansive market funding. Their funding costs would also be affected if they increased deposit rates to disincentivize depositors to move their deposits into an e-krona. In this section, we quantify these effects on the cost of funding and discuss the implication for lending rates and macroeconomic activity.

4.2.1 The impact on the cost of funding when retail deposits are replaced by market funding

As shown by Figure 4, the cost of deposit funding has been below the repo rate, aside from the most recent period with the negative repo rate, and the cost of relevant long-term market funding has been above the repo rate. The data also show that banks have not

17 See data on the Riksbank's balance sheet.

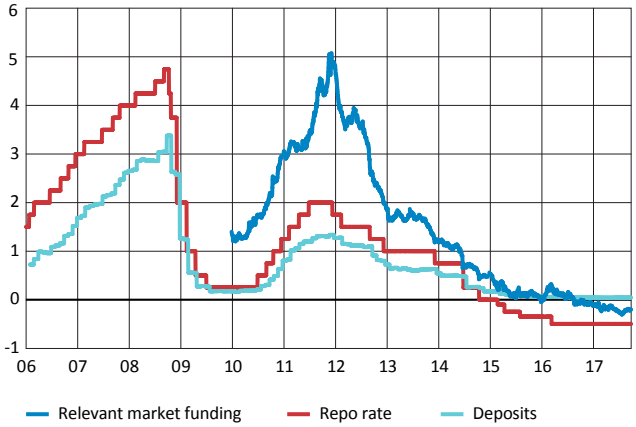
18 See Segendorf (2018) for a discussion of the demand for e-krona from payments.

19 Segendorf (2018) finds that the transaction demand for e-krona would stay below 45 billion if e-krona has 10 per cent of the payment market.

fully passed on increases in the repo rate to their deposit rates. Instead, as the repo rate has increased, the so-called deposit margin, defined as the gap between the repo rate and the deposit rate, has tended to increase.[20] Even the cost of market funding has fluctuated significantly over time in relation to the repo rate. However, if one focuses on stable financial and economic times, the cost of market funding is rather stable in relation to the repo rate.

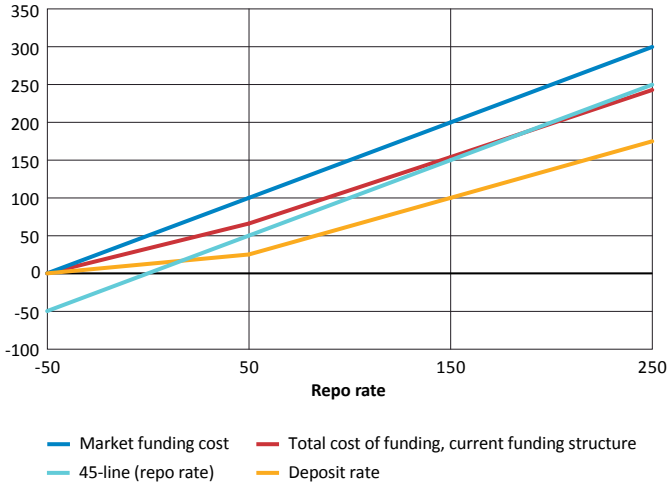
The historical cost of market funding and deposit rates suggests that an outflow of cheap retail deposits increases banks' funding costs if an outflow of retail deposits is compensated by an increased issuance of market funding. We can quantify this effect for different levels of repo rates. The assumptions we use are presented in Figure 5 and the total cost of funding with and without an outflow of deposits into an e-krona is presented in Figure 6.

Figure 4. The historical cost of market funding and deposits
Per cent



Note. Relevant market funding refers to the cost of senior unsecured bonds with a two-year maturity and floating coupons. The cost is derived using the major Swedish banks' CDS spreads for unsecured debt issued in EUR, which is then swapped into SEK.
Sources: Bloomberg, Statistics Sweden and the author's calculations

Figure 5. The assumed cost of market funding and deposits as a function of the repo rate
Basis points

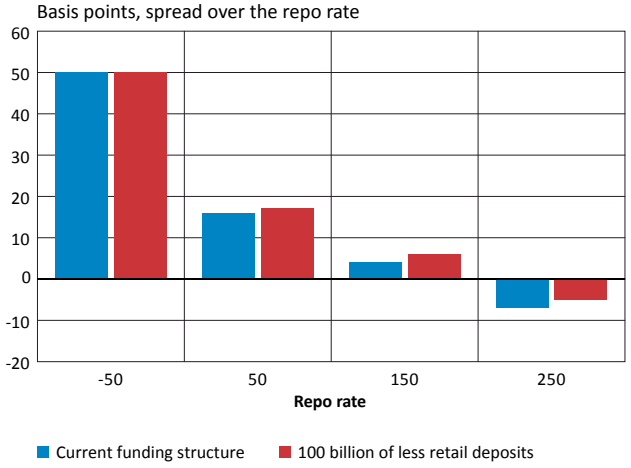


Note. Based on historical data, we assume the following deposit margins: -50, 25, 50 and 75 basis points for the level of repo rate -50, 50, 150 and 250 basis points, respectively. The cost of market funding is taken to be 50 basis points above the repo rate, which is in line with the historical cost in recent non-stressed times. The current funding structure is based on data presented in Table 1: lending to the real sector is equal to 6 100 billion and is funded by retail deposits of 2 800 billion and market funding of 3 300 billion.
Source: Author's own calculations

20 For an in-depth description of deposit margins, see Gibas et al. (2015).

To begin with, note that the total cost of bank funding, measured as a spread over the repo rate, will fall as the repo rate increases (see blue or red bars in Figure 6). The magnitude of this fall depends on the share of deposits in banks' funding as well as on the assumed deposit margins for any given level of the repo rate. Under current funding structure, banks' funding costs would fall from 50 basis points above the repo rate to about 10 basis points below the repo rate if the repo rate increased from −50 to 250 basis points (see blue bars in Figure 6). An e-krona that leads to an outflow of deposits reduces the share of deposits in banks' funding structures. As a consequence, banks' cost of funding would still fall as the repo rate increases, but to a smaller extent (see the red bars in Figure 6). An exact increase in banks' funding costs due to e-krona depends on the level of the repo rate at the time of an outflow. For every 100 billion of deposits that are converted into e-krona, banks' funding costs would increase between 0 to 2 basis points depending on the level of the repo rate at the time of the outflow (see the difference between blue and red bars in Figure 6).

Figure 6. Banks' funding costs with and without an outflow of deposits into an e-krona for a given level of the repo rate
Basis points, spread over the repo rate



Note. The current funding structure is based on data presented in Table 1: lending to the real sector is equal to 6 100 billion and is funded by retail deposits of 2 800 billion and market funding of 3 300 billion.
Source: Author's own calculations

The analysis above is conservative in the sense that it assumes that the historical deposit margins will be valid even going forward. This may be a rather strong assumption since competition for retail deposits is likely to intensify due to fintech. Specialized fintech companies can target retail deposits and help retail clients allocate deposits to those banks that offer the best rates. This is likely to limit banks' ability to have deposit rates that are significantly below the repo rate in the future. Lower deposit margins would reduce the impact of an e-krona on banks' funding costs since the difference between the cost of deposits and market funding would be lower.

4.2.2 Banks' incentives to retain their retail deposits

The analysis so far has quantified the effect of an e-krona on the cost of bank funding when an outflow of bank deposits into e-krona actually takes place and banks choose to issue market funding to restore their funding profile. But as argued before, an e-krona can also trigger a situation where banks increase their deposit rates to disincentivize the outflow of deposits into e-krona. If this were to happen, banks' cost of funding might be affected even if no outflows of retail deposits into e-krona actually took place.

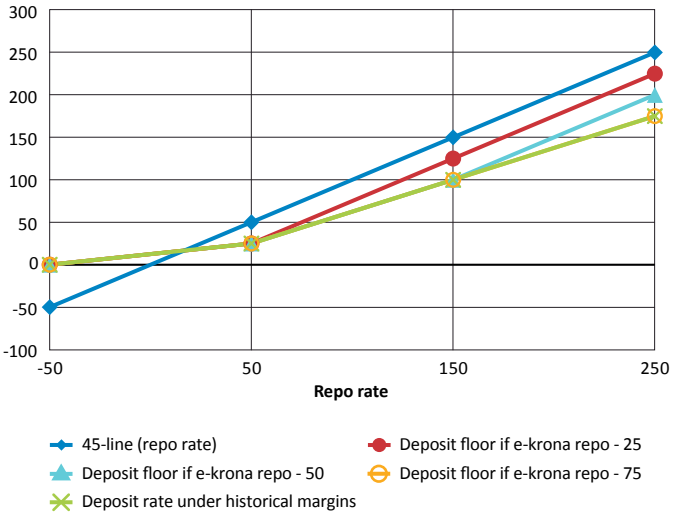
The need to raise deposit rates is economically relevant in circumstances where the interest rate on e-krona would be high enough to act as a binding floor for deposit rates.

Therefore, this effect depends on the exact pricing of e-krona as well as on deposit margins (see Figure 7).

To illustrate this, suppose the interest rate on e-krona was closely tied to the repo rate, say 25 basis points below. In this case, the interest rate on e-krona would act as a binding floor to deposit rates when the repo rate is larger than 50 basis points. For instance, at times when the repo rate is equal to 150 basis points, banks can no longer have their historical deposit margin equal to 50 basis points and pay 100 basis points for their deposits. Instead, banks must offer deposits rates that are at least equal to 125 basis points, the interest rate on e-krona.

As can be seen in Figure 7, the largest increase in deposit rates takes place when the repo rate is 250 basis points and the pricing of e-krona is 25 basis points below the repo rate. An e-krona would in this case lead to an increase of 50 basis points in deposit rates which translates into an increase of 22 basis points in total funding cost with the current funding structure.

Figure 7. Deposit rates with different pricing of e-krona
Basis points



Note. The same assumptions as in Figure 5: historical deposit margins are -50, 25, 50 and 75 basis points for the level of repo rate -50, 50, 150 and 250 basis points, respectively.
Source: Author's own calculations

Finally, note that even this analysis is conservative in the sense that it uses banks' historical deposit margins as estimates for future deposit margins. However, as we argued before, specialized fintech firms can intensify competition for retail deposits and push deposit rates closer to the repo rate going forward. If this were to happen, then the exact pricing of e-krona would have little or no effect on banks' deposit rates.

4.3 The impact of the changed cost of funding on lending rates and macroeconomic activity

A potentially higher cost of funding due to an e-krona raises the issue of who bears it: would it be banks, in the form of lower profitability, or their customers? There are some good reasons to believe that the increased cost of funding due to a lower share of retail deposits will be at least partially absorbed by banks, and not entirely by the customers.

There are natural limits on how much banks can increase their lending rates to compensate for lost retail deposits. These limits are set by banks that use little or no deposit funding as well as other non-bank sources of funding that compete with deposit-taking banks. For instance, the corporate bond market as well as direct lending by institutional and retail investors can partially act as a substitute for bank lending to companies and

households. This type of non-bank lending has become increasingly important in Sweden, especially after the financial crisis.[21]

In addition, the cost of deposits is not in practice used to determine the internal cost of funding for different lending products; instead the benefits that are obtained from cheap retail deposits are typically allocated to business units that have collected these deposits.[22] Even from a normative perspective, it is not clear why banks should lower their lending rates simply because they receive a subsidized source of funding; after all, lending rates should reflect riskiness of lending and not the cost of funding that is guaranteed by the deposit guarantee system.

Another important question is how potentially higher lending rates due to an e-krona would affect macroeconomic activity.[23] Recall that an e-krona may affect lending rates by increasing funding costs in relation to the repo rate (see Figure 6). It is therefore possible to offset an increase in absolute lending rates via a more expansionary monetary policy, if deemed necessary. An e-krona may also have a positive effect on long-term economic growth. An outflow of retail deposits into an e-krona reduces the use of guaranteed funding in banking. In this way, an e-krona contributes to lower distortions created by these guarantees, facilitating a more sustainable long-term growth (see also Section 6).

5 The demand for e-krona in times of distress

One of the main arguments against the introduction of an e-krona is that it could open up for large-scale runs on banks, especially at times when confidence in the banking sector falls.[24,25] It is important, however, to understand that runs on banks can and do take place even in the current system without an e-krona. The relevant policy question is therefore how much additional stress an e-krona may cause and what tools and measures can be used to manage this additional stress.

5.1 Runs with and without an e-krona

5.1.1 Risk of bank runs in the current system

In the current system, a typical run manifests itself as creditors fleeing banks that are perceived risky. This can take a number of different forms, depending on the claim of the creditors and the asset that is used for a run:

1. Creditors, who fund banks via debt with some maturity, can run the bank by not rolling over their maturing debt claims. In practice, this means that the troubled bank needs to make a payment to the bank of these investors.
2. Creditors, who fund banks via demand deposits, can simply transfer their deposits from the troubled bank to another bank.
3. Creditors can also use their funds to buy existing safe assets, such as government bills.[26] In this case, the troubled bank has to make the payment to the bank of the seller of the asset.

21 See Juks (2015) and Sveriges Riksbank (2018).
22 See Cadamagnani et al. (2015).
23 See also Armelius et al. (2018).
24 See Carney (2018).
25 Note that runs into e-krona could also take place for other reasons than a crisis of confidence in the Swedish bank sector. For instance, if an e-krona was seen as a global safe haven, then the demand for e-krona could increase in times when foreign banking sectors were deemed risky. Such a scenario is not necessarily harmful for Swedish banks since there is no crisis of confidence in them. Such a scenario could, however, have implications for the exchange rate, something that in turn has monetary policy implications.
26 This case would even include reverse repos and collateralized lending.

4. Creditors can also use their funds to take out cash or move their funds to tax accounts[27]. In this case, the troubled bank has to make the payment to the Riksbank or to the National Debt Office[28].

All these cases, except the last one, illustrate that a run on a bank in the current system means that the troubled bank needs to make payments to some other bank(s). These payments would typically be made through the central bank payment system with the help of intraday credit. Since the troubled bank would have a massive need to make payments, the outflows from the account would be larger than inflows leaving the bank with a negative end-of-day balance vis-à-vis the central bank. In normal non-stressed times, this negative balance would be small and can be covered by borrowing from other banks that have experienced more inflows than outflows. However, in stressed situations, banks with positive end-of-day balances would prefer to place their surplus into central bank deposit facility instead of lending it to the troubled bank. Therefore, the troubled bank subject to a run would inevitably need to borrow from the central bank to deal with the situation.

An e-krona would not change the end situation for the bank experiencing a run. Instead, it would offer an additional way to run since creditors of the troubled bank could now run directly to the central bank. However, the amount of liquidity that the troubled bank would need to borrow from the central bank would be exactly the same irrespective of whether the run took place via e-krona or through the first three ways described above.

Cases 1 to 3 mentioned above describe so-called individual runs. These runs take place within the banking sector, creating negative and positive positions for individual banks, but for the banking sector as a whole, there is no outflow. An e-krona may however create a so-called aggregate run, that is, a situation where the banking sector as a whole experiences an outflow. Even though aggregate runs are rare, they can take place even in the current system without an e-krona, either via cash or tax accounts.

Creditors could take out their funds in the form of cash. A run to cash would constitute a run on the entire banking sector since the banking sector as a whole would need to borrow from the central bank to manage the situation. An aggregate run could also take place electronically via tax accounts. If creditors moved their funds to tax accounts, the National Debt Office would experience an inflow into its account at the central bank and the banking sector as a whole would have a negative balance at the central bank. In the end, either the National Debt Office or the central bank would need to take measures to manage this aggregate run.[29]

In short, the current system without an e-krona is already exposed to the risk of both individual and aggregate runs. An e-krona would introduce an additional way to run the banking sector. Given that a run with a certain magnitude takes place, the consequences for the concerned banks are the same irrespective of whether the run takes place via moving funds to stronger banks, buying safe assets, taking out cash, using tax account or buying e-krona.

5.1.2 An e-krona and the size of runs

An e-krona may however put additional stress on the system by increasing the number of banks experiencing a run. This will happen if an e-krona has features that make it significantly more attractive in crisis times than existing assets used for runs.

27 Large institutional creditors could also indirectly rely on the reverse repo facilities offered by the National Debt Office. Dealers with access to the facility could use it to obtain government securities that could be lent further to large investors via repo transactions. In the end, these measures would lead to inflows into the National Debt Office simply as tax accounts.
28 The payment will be first made to the bank that has an agreement with the Tax Agency. But later on, the funds would move on to the National Debt Office. See Finansiella Sektorns Privat-Offentliga Samverkan (2015).
29 The National Debt Office could choose to place its extra liquidity in the Riksbank, which means that the Riksbank would need to take measures to manage the banking sector's negative position. The National Debt Office could also take measures that result in liquidity flowing back to banks, for instance via collateralized lending. Irrespective of what happened, banks would need enough good-quality collateral to manage the situation.

Whenever a confidence crisis occurs, creditors compare relative merits of different alternatives. In a system without an e-krona, creditors would evaluate possibilities of moving funds to different banks, buying safe assets, moving funds to tax accounts or taking out cash. Creditors would then choose the best possible option and act on this. This activity would lead to price adjustments if the supply of best-run assets is limited. For instance, prices of safe assets such as government securities with short maturities would typically increase until a resulting fall in expected returns discouraged additional purchases. Prices would adjust until creditors became indifferent to either buying these safe assets or implementing the next best alternative. This next best alternative in the current system would be bank deposits in the most creditworthy banks or, in case of a total crisis of confidence in banking, tax accounts and cash. We consider these two cases below and discuss how an e-krona could change the existing tradeoffs.

An e-krona may be perceived to be more attractive than bank deposits at the most creditworthy banks. It is therefore possible that an e-krona could trigger a situation whereby an outflow from a few risky banks transcended into an aggregate run in which even depositors from the relatively safe banks found it optimal to run to e-krona. The stress would be magnified in this case since an otherwise individual run would turn into an aggregate run, increasing the amount of liquidity that central banks had to provide to the system due to an additional number of banks experiencing a run.

An e-krona may be perceived to be more attractive than having cash or moving funds to tax accounts. Creditors might then choose to run to e-krona even at times when they would not have run to cash or tax accounts. Such a situation would be relevant if creditors deemed the entire banking sector to be unreliable but, without an e-krona, would still keep these deposits due to disadvantages that cash and tax accounts have in comparison to bank deposits. Cash cannot be used for online payments and it also has a storage cost either in the form of an insurance fee or the risk of theft. Tax accounts, even though electronic, cannot be directly used for retail payments. Due to these costs, stress in the entire banking sector has to be large enough to incentivize creditors to change their deposits into cash or move them into tax accounts. An e-krona could change this balance if deemed more attractive than tax accounts or cash. An e-krona may therefore become a valuable alternative to bank deposits at times when the entire banking sector is deemed risky, increasing the amount of liquidity that central banks need to provide to the system at these times.

All in all, an e-krona could create additional stress in times of crisis since it may more easily turn a run within the banking sector into a run from the banking sector, magnifying the amount of liquidity assistance needed to manage the situation.

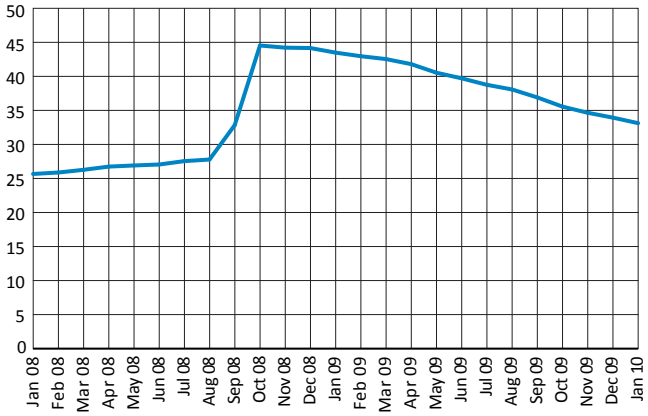
5.1.3 Recent evidence on aggregate runs

An important step in understanding the magnitude of run risk associated with an e-krona is to look into historical runs that are as close as possible to potential runs with an e-krona in place. In this respect, we can refer to the National Debt Office's role as a commercial bank during the crisis of 2008/2009. Deposit accounts offered by the National Debt Office were probably the best run assets available to the general public at that time. We can therefore use the size of deposit inflows to the National Debt Office during the crisis of 2008/2009 to estimate how large runs to e-krona could be. This specific run is suited to estimate a magnitude of a run risk with an e-krona at times when a crisis of confidence is concentrated to a limited number of banks and there being banks still perceived as safe.[30]

Figure 8 shows that the National Debt Office experienced a sudden inflow of deposits during September and October 2008. The total amount of deposits increased by 17 billion, from 28 to 45 billion during this two-month period alone.

30 This was the case in Sweden during 2008/2009.

Figure 8. The deposit run from commercial banks to the National Debt Office around the time of the Lehman bankruptcy
SEK billion



Source: Statistics Sweden

According to unpublished data from the National Debt Office, 70 per cent of the inflow came from households and 30 per cent from companies. Roughly half of the inflow came from new clients with no previous accounts. The data also show that the inflow tended to come from banks that needed to use government guarantees for their borrowing.[31]

This limited historical evidence suggests that an e-krona could create aggregate runs. However, the run was rather limited in scope, amounting to less than 2 per cent of total bank deposits from the real sector. There are some reasons to believe that a run to e-krona would have been somewhat larger than the flows into the National Debt Office. One such reason is that it took up to two weeks before the deposits were actually moved to the National Debt Office. Another such reason is that there was a daily limit on how much could be transferred. This limit was 30 million per day. Finally, these deposits were treated as saving accounts and depositors could not use these funds to pay directly at retailers.

5.2 Actions that could be taken to mitigate the adverse impact of an e-krona on banks in stressed times

Previously we argued that an e-krona may increase the magnitude of runs if it were perceived to be more attractive than existing run assets. It is therefore important to discuss what tools and measures could be used to control or manage this additional stress.

To start with, it is important to note that the Riksbank already has some standard tools in place to deal with individual and aggregate bank runs. The Riksbank can provide loans, either via its monetary policy tools or extraordinary measures such as those undertaken in 2008/2009.[32] Due to its ability to create money, the Riksbank has no limits on how much credit it can grant. However, the volume of credit that can be offered by the Riksbank is limited in practice by the amount of suitable collateral that its counterparties have and the Riksbank's willingness to take financial risks.

5.2.1 Adjusting the current liquidity and funding regulations

The current liquidity[33] and funding regulations are based on the assumption that retail deposits, despite their short maturity, are relatively sticky: a rather moderate share of deposits is assumed to run away in a potential crisis. In practice, this means that banks need to hold a relatively modest amount of liquid assets against these deposits. The introduction of an e-krona may, however, change the presumed stickiness of these deposits in a crisis

31 For the list of banks that needed guarantees, see Swedish National Debt Office (2014).
32 See Elmér et al. (2012) and Sellin (2009).
33 LCR requires banks to have enough liquidity assets to be able to meet the net outflow over the 30-day stress period.

since an e-krona may become a valuable alternative to bank deposits during stressed times. It may therefore be reasonable to adjust the current regulation so that banks have enough collateral to cover potential outflows of retail deposits into an e-krona in times of distress.[34]

5.2.2 Actively managing the demand for e-krona

The central bank could also take active steps to adjust the attractiveness of an e-krona. One way to do this is to introduce time-varying pricing of an e-krona and in this way control its demand. An e-krona could be priced as a spread to the repo rate (for example, repo − x, where x > 0), where the size of the spread is time-varying. The spread could be decreased if the demand for e-krona needs stimulation and it could be increased if the demand for e-krona needs to be cooled off.

Active pricing would allow the central bank to introduce costs into owning e-krona, similar to the costs present for existing run assets such as cash and tax accounts.

5.2.3 Issuing e-krona against a specific asset class

Another way to reduce the adverse impact of an e-krona on banks in stressed times is by changing the supply mechanism of an e-krona. So far, we have assumed that only bank depositors could buy e-krona from their banks that in turn would buy e-krona from the Riksbank using reserves. An alternative supply mechanism would be to issue e-krona directly to the public against a specific non-bank asset class.[35] In practice, this would involve the Riksbank buying specific assets and paying the sellers in e-krona.

Such a supply of e-krona would not affect the total amount of deposits available to banks. Bank depositors, like any other investors, could still buy e-krona, but first they would need to purchase these specific assets. When depositors bought these assets from other agents, the total amount of deposits in the banking sector would not change since the seller of an asset would be paid with bank deposits.

Such a supply method would also mean that the central bank could create e-krona without being restricted to the availability of collateral owned by banks. An additional advantage is that such a supply method would not affect the amount of reserves available to banks.

A special case of this alternative supply mechanism is when e-krona is issued without buying an asset. The Riksbank could issue e-krona by directly debiting the e-krona accounts of either the private sector or the government without obtaining any asset in return. Such a supply mechanism would be especially useful in circumstances when e-krona is designed to have a zero interest rate and when central bank reserves and e-krona are treated as separate claims, without possibility of conversion between the two. In this case, e-krona would not incur any interest cost nor would it generate financial returns to the central bank.[36]

6 The broader aspects of an e-krona on financial stability

An e-krona would change the current financial system in a number of important ways. It would represent a new payment system in which the general public could access electronic central bank money and make payments with it. An e-krona could also mean that bank lending would be more dependent on central bank funding and collateral policy, that banks may have less retail deposits and that they may need to issue more long-term market funding to maintain their funding stability.

34 There may also be other reasons to reconsider the stickiness of retail deposits, such as a move towards real-time payments and the increasing role of different fintech players on the payment market.

35 See also Kumhof and Noone (2018).

36 This is similar to the proposals of 'sovereign money', or 'positive money', see for example Jackson and Dyson (2013).

These important changes lead to three fundamental questions:

- Is it desirable to create a new payment system in which the general public could directly access electronic central bank money and make payments with it?
- Is it desirable that commercial bank lending may become more dependent on central bank funding and collateral policy?
- Is it desirable that banks fund themselves less with retail deposits and more with long-term market funding?

The introduction of an e-krona as a means of payment and a new payment infrastructure can benefit the real sector and make the economy more resilient both to economic and technological disturbance. An e-krona as a means of payment could make the economy more resilient to economic shocks since an e-krona would maintain a stable value even in stressed times. An e-krona would maintain a stable nominal value in stressed times since it would be a direct claim against the central bank and therefore would not be exposed to credit risk. This means that an e-krona would be different from bank deposits, especially those not covered by the deposit guarantee. An e-krona would also provide a stable real value since the mandate of the central bank is to maintain price stability. This means that an e-krona would also be different from so-called cryptocurrencies that typically experience large price fluctuations in nominal and real terms. An e-krona as a payment infrastructure could also increase technological resilience since it could act as a redundant payment system in times when other electronic payments did not work. This would require an e-krona system to be based on an independent payment platform, and there should also be some amount of e-krona circulating in the system prior to a shock.

An e-krona may increase banks' reliance on central bank funding and its collateral policy.[37,38] To accommodate the outflow of bank deposits into e-krona, central banks may need to create new reserves that could be used to buy e-krona. Central banks could create new reserves either by lending to banks or buying assets. These activities mean that central banks would be more exposed to financial risks, implying that central banks' risk management would become more important. In addition, these activities would also increase central banks' direct involvement in financial markets even in normal times. This increased involvement would create an opportunity for central banks, for instance, via an increased control over bank lending through collateral policy, but it would also increase the risk of undesired effects, for instance, due to unwanted price effects after asset purchases.

An e-krona may reduce the use of retail deposits as a stable funding source for banks. The reduced use of retail deposits in banking could enhance financial stability since these deposits are typically guaranteed and guarantees inevitably create distortions. Since guaranteed depositors do not bear the potential cost of bank failures, the cost of funding that these depositors provide would not be risk-sensitive. Therefore, guaranteed deposits would create incentives for banks to take higher risks than would be the case otherwise.[39] Another undesired effect of guaranteed deposits is that bank lending and other banking services have an unfair competitive advantage over alternative sources of funding and services, making the banking sector larger than it would otherwise be.

37 This and the next point are mostly relevant when e-krona is issued in the same way as cash is, see also Section 5.2.3.

38 E-krona can be viewed as a special reserve requirement for banks. In the current system, bank lending requires an inherently small amount of own funds and liquid assets. The reason is that banks create their own funding, in the form of deposits, whenever a new bank loan is issued. Individual banks must still manage their liquidity situation whenever these new deposits are used and potentially moved to another bank. However, in normal times, the net flows among banks tend to be rather small and can be managed via interbank markets and a small amount of liquid assets. So the current supply of bank lending has relatively few inherent constraints and is ultimately determined by the demand and the interest rates set by central banks. E-krona could potentially change banks' current ability to create their own funding since newly created deposits might be converted into e-krona. This means that banks would need more central-bank-eligible collateral to deal with a potential outflow of deposits into e-krona, essentially constituting an implicit reserve requirement.

39 For the empirical evidence, see, for instance, Ioannidou et al. (2010).

The decreased usage of retail deposits may also imply the increased issuance of market funding. It is sometimes argued that the increased reliance on market funding increases funding risks for banks.[40] This does not, however, have to be the case since market funding can be issued with long enough maturities so that the funding stability from market funding is similar to funding stability obtained from retail deposits.

7 Conclusions

The introduction of a central bank digital currency (CBDC) is often perceived to have far-reaching implications for banks with adverse effects on financial and macroeconomic stability. How would banks fund their lending if deposits were converted into CBDC? What would CBDC mean for bank lending rates? And would not CBDC open up for large-scale bank runs? These are frequently asked questions in the context of CBDC.

To find answers to these questions, we study the effects of CBDC on banks in the Swedish context. We find that in normal non-stressed times, the magnitude of a potential outflow of retail deposits into e-krona would be low. An indicative calculation shows that the demand would be around 120 billion or below 3 per cent of nominal GDP under plausible assumptions. One reason for this low demand is that banks could disincentivize a potential outflow of retail deposits into CBDC by adjusting their deposit rates. Since deposit rates are typically under the repo rate, while the cost of alternative market funding is above the repo rate, banks have strong incentives to adjust their deposit rates if necessary to manage a potential outflow. We estimate that the impact of an e-krona on banks' funding cost via increased deposit rates would be up to 22 basis points.

Banks could manage an outflow of retail deposits into e-krona by using their existing central bank reserves or by borrowing new reserves from the central bank. Banks could also issue more long-term market funding to compensate for a loss of funding stability resulting from an outflow of retail deposits. Using the historical costs of deposits and relevant market funding, we show that the banks' funding cost would increase approximately 2 basis points for every 100 billion of additional market funding issued after an outflow of retail deposits.

The total increase in banks' funding cost due to e-krona is estimated to be up to 25 basis points. The macroeconomic impact that may result from this increased funding cost is deemed to be limited since non-bank funding sources would limit banks' pass-through of this increased cost to their lending rates and a potential increase in lending rates could be offset by a more expansionary monetary policy.

In stressed times, the demand for e-krona as a safe medium of exchange and storage may increase drastically, especially if existing alternatives become risky or unavailable. We explore various run mechanisms in the current system and compare them with an e-krona. We find that an e-krona would not add additional stress under a given magnitude of run. We do, however, find that individual runs may more easily transform into aggregate runs if an e-krona were to have more attractive features than those of existing run assets. This additional stress can, however, be managed by an appropriate design of an e-krona, for instance, by letting its pricing be time-varying or supplying e-krona directly to the public against specific assets.

In short, we do not find any decisive argument against the issuance of an e-krona. We do, however, see significant benefits that an e-krona could bring to the real sector in the form of economic and technological resilience. An e-krona has the potential to make the real economy more resilient to economic and technological shocks since an e-krona would facilitate continued access to a safe, generally accepted means of payments even when other means of payments became either economically or technologically unreliable.

40 See, for example, Broadbent (2016).

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