

# Monetary Policy with Negative Interest Rates: De-linking Cash from Digital Money\*

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Monetary policy space remains constrained by the lower bound on nominal interest rates in many countries, limiting the policy options available to address future deflationary shocks. The existence of cash prevents central banks from cutting interest rates much below zero. In this paper, we consider the practical feasibility of recent proposals for de-linking cash from digital money to achieve a negative yield on cash which would remove the lower bound constraint on monetary policy. We discuss how central banks could design and operate such a system, and highlight some issues that require further research.

JEL Codes: E42, E52, E58.

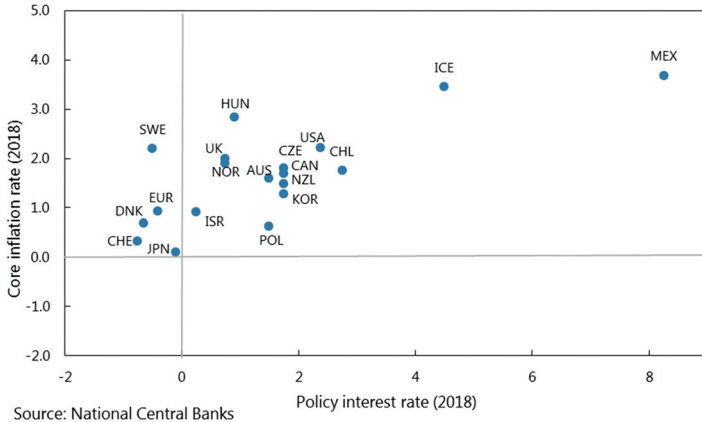
## 1. Introduction

The global financial crisis brought policy rates to the so-called zero lower bound (ZLB) in many countries. Most of these remain in the vicinity of this lower bound 10 years after, as illustrated in figure 1. Central banks may not have sufficient policy space to counter the next recession, as the normal playbook would suggest countries

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**Figure 1. Monetary Policy Space in OECD Countries (Turkey, omitted, had a policy rate of 24% in 2018)**



should be able to cut rates by around 500 basis points to effectively respond to important negative shocks.<sup>1</sup> Figure 1 shows that the majority of OECD countries have monetary policy space of less than 250 basis points. Only two OECD countries, Mexico and Turkey (not shown), have policy space that exceeds 500 basis points.

The lower bound on interest rates is due to the existence of cash, which by design yields a nominal interest rate of zero.<sup>2</sup> If a central bank attempts to move its policy rate significantly below zero, commercial banks will see their interest margin compressed as long as they do not pass on the negative interest rate fully to all deposits.<sup>3</sup> Sufficiently negative interest rates on bank deposits may cause depositors to switch from (negative) interest-bearing deposits to cash, which could lead to a substantial outflow of deposits from the banking sector.<sup>4</sup>

<sup>1</sup>See Summers (2018).

<sup>2</sup>In this article, the term cash refers to physical currency, i.e., coins and banknotes.

<sup>3</sup>In most countries with negative interest rates, banks have, to date, refrained from passing on the negative interest to retail deposits. This compression is more pronounced if a bank relies more on deposit funding relative to funding from money and capital markets.

<sup>4</sup>Banks themselves face a similar tradeoff. When the negative interest rate on reserves exceeds the storage cost for vault cash, they may decide to convert excess

This risk of substitution from bank deposits into cash is at the core of the existence of a lower bound on interest rates. The experience of recent years suggests that the lower bound is somewhat below zero, as storing and handling cash is associated with cost and inconvenience compared with using money in a deposit account. No large-scale substitution toward cash has been observed in connection with negative interest rates as of yet. But there is no doubt that substitution would eventually set in and erode banks' funding base if interest rates were to become sufficiently negative. The intended stimulating effects of interest rate cuts substantially below zero would be undermined as the zero rate on cash, and not the negative rate on central bank reserves, would become the economically relevant interest rate.

The lower bound on interest rates hence poses a hard constraint on the ability of monetary policy to counter cyclical downturns, deflation, and unemployment in an environment where interest rates are already low. Numerous proposals have been made to increase the ability of monetary policy to provide stimulus when faced with the lower bound on short-term interest rates, such as adjusting exchange rate policy, raising the inflation target, conducting large-scale asset purchases, or phasing out cash to allow for substantially negative interest rates (Svensson 2003, Blanchard, Dell'Ariccia, and Mauro 2010, Rogoff 2014, and Ball et al. 2016). Each proposal has advantages and drawbacks, and only the latter fully removes the lower bound constraint.

In this paper, we discuss the practical feasibility of de-linking the value of cash from digitally issued central bank reserves as a way of fully removing the lower bound constraint on monetary policy while preserving a role for cash. In current monetary systems, banknotes and central bank reserves are issued and exchanged at par at the central bank, i.e., central bank reserves can be exchanged one-for-one into banknotes and vice versa on demand at the central bank's cash window. In a dual domestic currency system that we analyze in

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reserves into cash. Storing large amounts of cash centrally, however, will create security and insurance issues. Moreover, in many countries vault cash is part of the minimum-reserve regulation, giving the central bank a lever to influence cash holdings at banks (see, e.g., Switzerland). Affecting the behavior of private agents is much more difficult.

this paper, cash can still be exchanged on demand for central bank reserves but at a time-varying cash reserve exchange rate rather than at par.

In the more recent literature, Buitert (2007) is the first to discuss such a proposal. Agarwal and Kimball (2015, 2019), Goodfriend (2016), and Pfister and Valla (2018) consider the depreciation of cash relative to reserves as a means to overcome the lower bound on interest rates. Our paper is close to Agarwal and Kimball (2015, 2019) in that we discuss how a central bank could design and operate such a system. Our contributions include considering the transmission and financial stability implications in more detail. We also discuss how a dual domestic currency system would work within different exchange rate regimes, as well as its interrelations with central bank digital currency (CBDC). While Agarwal and Kimball (2019) frame their proposal as a time-varying transaction fee for net deposits of cash at the central bank, we prefer to analyze the scheme in terms of an exchange rate between cash and digital currency, allowing us to apply economic concepts such as uncovered interest parity to investigate credibility and robustness. We stress that the central bank would need to apply this exchange rate symmetrically for deposits and withdrawals of cash at its cash window in order to not interfere with the cash cycle. A simpler, one-sided fee for cash withdrawals would not ensure that cash in circulation flows back to the central bank for quality checking and redistribution.<sup>5</sup>

De-linking the value of cash from central bank reserves establishes a system in which two different types of domestic currency circulate. The dual domestic currency system would allow the central bank to stabilize the economy in a severe downturn by implementing substantially negative interest rates. The negative interest rate would not trigger a large-scale substitution into cash, because the system would feature a similarly negative yield on cash in terms of central bank reserves. Banks, subject to both the negative interest

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<sup>5</sup>Bordo and Levin (2017) analyze CBDC and propose a schedule of fees for transferring funds between CBDC and cash, which increase with the frequency and the amount of a transfer, in order to remove the ZLB. In their setup, however, they do not discuss how digital money on bank deposit accounts would be treated. A fee on transfers of cash into CBDC would not remove the ZLB if—like today—agents can still switch at no cost between bank deposits and cash, eroding banks' funding base.

rate on reserves and the depreciating rate of cash at the central bank's cash window, would transmit both to their deposit holders, implying that not only the value of central bank reserves would de-link from the value of cash but any form of digital money, such as bank deposits, would de-link as well.

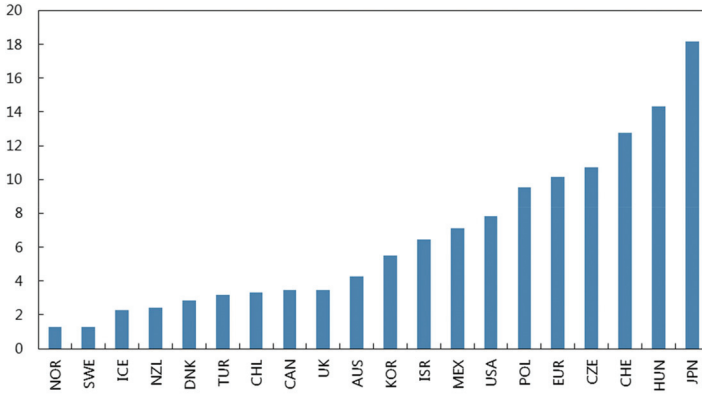
We discuss some remaining unanswered questions concerning the system's legal and institutional implications, the transmission of monetary policy, financial stability and seigniorage revenues, and point to areas where more research is needed. We conclude that de-linking the value of cash from central bank reserves would fully restore monetary policy space by removing the lower bound. The system would be technically feasible and not require fundamental changes to central banks' operating frameworks. Moreover, it would be entirely reversible once the need for negative interest rates disappears. It would work in both fixed and flexible exchange rate systems and could be implemented unilaterally, even by small and highly open economies. Its benefits and drawbacks should be considered alongside the pros and cons of other proposals for increasing monetary policy space in a low interest rate environment.

The paper is structured as follows. The next section sets the stage by first considering why abolishing cash may neither be practically feasible nor desirable in many countries. In section 3, we describe how the dual domestic currency system that preserves the role of cash but allows for negative interest rates would work in practice. We consider the central bank's operating framework, the relationship with foreign currency and exchange rate policy in fixed and flexible systems, and the transmission of negative interest rates to cash and deposits, as well as payments in the broader economy. Section 4 addresses some open questions, and the final section concludes.

## **2. Why Not Simply Phase Out Cash?**

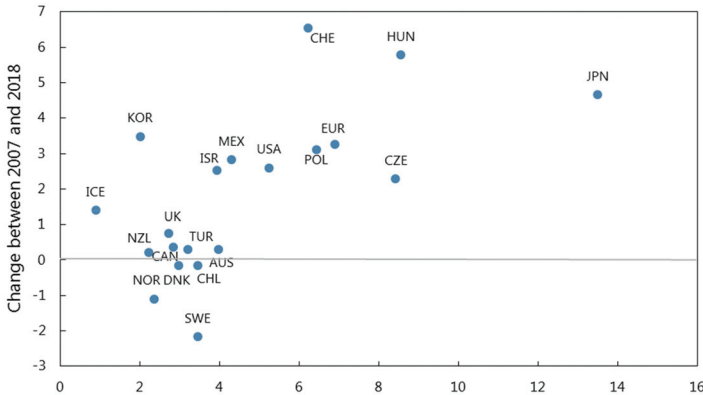
Rather than de-linking cash from digital money, it would arguably be much simpler to phase out cash altogether, which would achieve many of the same advantages in terms of allowing monetary policy to operate below the lower bound. However, while some countries, notably Sweden, are quickly heading in the direction of a

**Figure 2. Cash in Circulation in Percent of GDP in 2018**



Source: National Central Banks

**Figure 3. Cash in Circulation in Percent of GDP Level in 2007 and Change since 2007**



Source: National Central Banks

cashless society, other countries remain strongly reliant on cash, as shown in figure 2. Figure 3 shows that only two countries—Sweden and Norway—saw an outright reduction in currency in circulation in percent of gross domestic product (GDP) in the past decade. For Canada, Engert, Fung, and Hendry (2018) conclude that the emergence of a cashless society would not generally cause material

financial-system-wide problems. Khiaonarong and Humphrey (2019) estimate that, with the exception of India, cash usage will further fall in a sample of 11 countries, supported—among other factors—by demographic developments. Countries with relatively high outstanding amounts of currency in circulation also had high growth rates of cash circulation in the past decade, illustrating how the development in outstanding cash differs across countries.

Moreover, there are reasons why phasing out cash completely may be premature or undesirable. Cash currently serves three main uses in our societies. It plays a key role in retail payments, it is used for storage (i.e., hoarding of banknotes as a means of saving), and it is used for tax evasion and illegal activities. Rogoff (2014) argues that the first two functions of cash can nowadays be conveniently performed by digital forms of money, whereas the prevalent use of cash in tax evasion and illegal activities is an important reason for central banks to consider phasing it out. An added benefit to phasing out cash, he argues, is that a society without physical currency has no lower bound on nominal interest rates, allowing monetary policy to address cyclical downturns without constraints.

Cash remains important in retail payments in many countries, however. For this reason alone, central banks with mandates to promote the stability of payments systems cannot actively phase out cash. In the euro area, for example, cash is still the dominant payment instrument at the point of sale (Esselink and Hernández 2017), though the use of cash varies strongly between European countries.<sup>6</sup> Removing cash as a payments option before digital means of payment have become near-universal could disrupt the retail economy. Moreover, the use of cash and access to digital means of payment is not evenly distributed across demographic groups. Low-income and older population groups, for example, tend to use digital means of payments less. Phasing out cash could be particularly disruptive for the financial livelihoods of such population segments.<sup>7</sup>

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<sup>6</sup>Similar results are found for Switzerland; see Swiss National Bank (2017).

<sup>7</sup>One option is to tailor public policy to achieving universal access to digital means of payment, and some countries—in particular, Sweden—are currently heading down this route (see, e.g., Sveriges Riksbank 2018). But such changes to the structure of payments systems take time and cannot be achieved overnight.

Beyond the stability of payments systems, there are institutional and cultural reasons why some countries may wish to hold on to physical currency. That cash payments are anonymous is seen in some countries as important for ensuring the right to privacy. Another key property exclusive to cash is exactly that it is not digital. If digital systems break down, cash is still usable and hence provides a hedge of the retail financial system against digital disruptions. This has turned out to be of high value in areas plagued by natural disasters that interfere with digital networks. Preparations for natural disasters in fact often include securing the provision of sufficient cash stocks.<sup>8</sup> Finally, if cash were abolished, the decision would be difficult to reverse, whereas in a dual domestic currency system all payment instruments that are in use today could remain in use and the corresponding infrastructures could remain in place and running.

### **3. De-linking Cash from Central Bank Reserves**

Making cash as costly to hold as digital money in bank accounts or short-term money market instruments when interest rates are negative is an alternative to phasing out cash while creating space for monetary policy to stabilize severe downturns. Various proposals have been put forth for how to impose a cost on cash holdings. Gesell (1916) suggested discouraging cash hoarding by introducing a demurrage fee. His idea was that money would need to be stamped at regular intervals to remain valid and that these stamps would have to be purchased. Such a scheme was implemented in some Austrian and German communities during the Great Depression, but the practice was soon stopped by the respective central banks. A similar but untried proposal is to let banknotes expire at certain dates, forcing their holders to pay a conversion fee for changing them into new, valid banknotes (Seltmann 2010). Goodfriend (2000) suggests integrating magnetic strips into banknotes that record when the note

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<sup>8</sup>See, e.g., <http://ready.gov>. Cheney (2006, p. 7) documents that in advance of Hurricane Katrina the Federal Reserve had to dispense exceptionally high amounts of cash to the affected regions. In light of the need to distribute financial relief to affected families, however, schemes to improve the digital payment infrastructure were seen as highly important as well.



was last withdrawn from the banking system and how much carry tax on that note is due. This option gets very close to simply replacing cash with a digital currency. Mankiw (2009) proposes a lottery scheme that declares a certain number of banknotes invalid at regular intervals. While all these ideas achieve a carry cost on cash, they seem impractical or unworkable.

A different proposal for implementing a negative carry cost on cash is to change the one-to-one conversion of reserves held at the central bank into cash. Buiter (2007) shows that, in theory, a negative yield on cash can be achieved by de-linking the value of cash from the value of digital money, such as bank deposits, allowing cash to depreciate over time in terms of digital money. Effectively, the idea entails a split of the domestic base money supply into two different domestic currencies: cash and digital central bank reserves. The central bank could then impose a negative yield on cash in terms of central bank reserves and thereby continue conventional monetary policy below the lower bound. Agarwal and Kimball (2015) show that by introducing a time-varying deposit fee, the central bank effectively would establish an exchange rate between cash and central bank reserves. The implicit negative yield would transmit to the economy through conventional channels while private digital money creation (e.g., bank deposits) can be left to adjust freely. They also consider many practical and operational aspects of how such a system would work.

We argue below that such a system could be implemented with relatively small changes to central bank operating frameworks. It would work in fixed as well as flexible exchange rate systems, even when foreign banknotes are close substitutes to domestic cash. In short, we conclude that a dual domestic currency system should be workable from a technical and operational perspective. Moreover, we argue that interest rate changes in negative territory would transmit in a similar way as conventional interest rate cuts to the real economy once such a system is in place and that financial stability implications are broadly equivalent to those in current low interest rate environments. Nevertheless, in a monetary system in which cash and central bank reserves circulate with different value, new challenges arise with regard to the legal environment as well as communication with and behavioral responses of the public. We discuss some of these issues in section 4.

### 3.1 *How Would It Work? Setup and Operating Framework*

The central bank would divide the monetary base into two separate domestic currencies, referred to as cash and reserves in the following. Cash would be issued in physical banknotes and coins. Reserves would be issued only digitally. Reserves would pay nominal interest, possibly negative.<sup>9</sup> Denote the overnight rate on reserves  $i_t^R$ , also referred to as the policy rate. Moreover, the central bank would set the spot cash reserve conversion rate (henceforth referred to as the CRC rate) for cash withdrawn from or deposited in the central bank's reserve accounts and supply cash fully elastically on demand against reserves at this price. This cash conversion rate would apply to the central bank's operations with financial institutions that hold reserve accounts with the central bank, i.e., mainly bank counterparties.

Under such a monetary framework, banks depositing cash into their reserve accounts with the central bank would see their reserves credited not at par, but at the prevailing CRC rate. The CRC rate would apply symmetrically, just like any other exchange rate. Banks taking out cash from their reserve account would see their reserve account debited at the CRC rate. The change of the CRC rate, not its level, would determine the yield on cash in terms of reserves. To remove any incentive for banks to move into cash when a negative interest rate is applied to reserves, the central bank would use the CRC rate to steer the demand for cash, by changing the spot conversion rate between reserves and cash over time in order to impose a sufficiently negative yield on cash in terms of reserves.

Assuming that the negative yield on cash would be set equal to the negative interest rate on reserves, the central bank would set the conversion rate such that  $i_t^C = \{360 \times (CRC_{t+d} - CRC_t)\} / \{d \times CRC_t\}$ , where the subscript  $d$  refers to time units (days) between adjustments of the CRC rate, and  $i_t^C$  is the annualized yield on cash in terms of reserves during that time. Note that there are no expectations signs in this interest parity because the conversion rate tomorrow and the rate on reserves held from today

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<sup>9</sup>Interest on reserves is currently used by several central banks to establish a floor for money market rates and has been discussed as a monetary policy tool in times of high liquidity, especially in the United States; see Gagnon and Sack (2014).

until tomorrow are both known and set by the central bank.<sup>10</sup> In essence, the time-varying CRC rate would give the central bank a tool to control the demand for cash relative to the demand for reserves. For ease of exposition, we assume in the following that the conversion rate is set such that the negative yield on cash equals the interest on reserves.

To ensure a smooth functioning of the scheme, the conversion rate applied to the central bank's cash operations with its counterparties would have to be adjusted continuously, preferably daily. Discrete jumps in the CRC rate would redistribute wealth between cash holders and reserve holders at the moment of the jump, which would be destabilizing. The chosen adjustment frequency would have to be announced up front to ensure transparency and avoid speculation in the timing of adjustments. For example, at the end of each business day, the central bank could announce that tomorrow's rate of conversion of cash into reserves is  $CRC_{t+1} = CRC_t (1 + i_{t+1,t}^c/360)$ . Alternatively, the central bank could announce a path for the CRC rate that would be followed until the next policy meeting. If the central bank were to change its policy rate, the corresponding new level for tomorrow (or the new path) of the CRC rate would be announced simultaneously and accordingly. The central bank could use the same setup and frequency for changes in the CRC rate as for changes in its usual policy rate.

Once the system has been used to engineer a negative rate on cash, the central bank cannot exit by simply setting the conversion rate back to par when interest rates move back to zero. Such a discrete "appreciation" of cash in terms of reserves would redistribute wealth from deposit to cash holders and be destabilizing. If the central bank were expected to eventually exit in this way, there would be strong speculation in taking out cash before the exit, which would be counterproductive to the purpose and functioning of the system.

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<sup>10</sup>The yield would not need to be equal to the interest rate on reserves. In principle, a slightly less negative yield on cash than the interest on reserves could be enough to deter a shift into cash, given the storage cost of cash. In contrast, if the central bank were aiming to reduce the demand for cash even further—for example, during a run out of bank deposits and into cash—the yield could be made even more negative. In current systems, a return differential between cash and reserves is the norm when reserves pay interest, as in the current Federal Reserve system.

It could also pose financial stability risks. Instead, an exit would not be disruptive when interest rates have been positive for long enough to bring the CRC rate back to par. Cash would appreciate by the same amount that it has depreciated during the preceding negative-interest episode in order to not create arbitrage opportunities for cash holders by switching out of depreciated cash into digital reserves at par. Cash holdings would thus receive an implicit positive interest equal to the positive interest on reserves for as long as necessary to bring the CRC rate back to par.

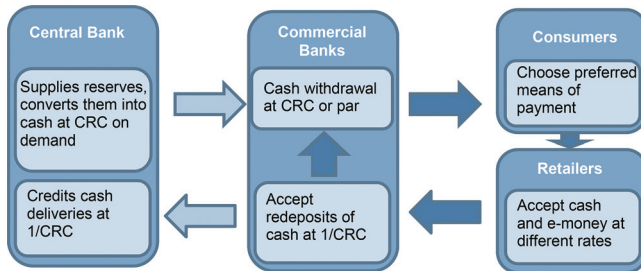
To increase transparency and avoid disruptive speculation in the exit, the central bank could announce up front if and how it plans to exit the system, whether the conversion rate would remain in place or whether it would be abandoned at the moment it is back to par. To illustrate this point and to fix ideas, a numerical example of how a dual domestic currency system could be operated is presented in the next section.

In principle, however, such a dual domestic currency system could remain in place even when the CRC rate has reached par again. The obvious benefit from leaving it in place, once the fixed costs of introducing the system were borne, would be to always be ready for an accommodative monetary policy at negative interest rates. There could also be disadvantages, such as possibly reducing seigniorage revenues, as we discuss in section 4.1 below, or having cash prices deviating from digital money prices permanently. It could also be more politically palatable and easier to introduce if the measure is announced as temporary.

### 3.2 *A Numerical Example*

Suppose a central bank moves from a zero to a negative rate of  $-3$  percent per annum (p.a.) on reserve accounts at the central bank. If cash remained convertible one-for-one with central bank reserves, there would be a strong incentive for banks and, in turn, for the non-bank public, to hoard cash. This could trigger a run toward cash, which could endanger economic and financial stability—the lower bound on interest rates would be reached. To prevent a run to cash, the central bank simultaneously announces a shift to a dual domestic currency system with an initial  $CRC_0 = 100$  (defined in units of cash per 100 units of reserves). At the same time, the central bank

**Figure 4. Transmission of the Cash Reserve Conversion Rate**

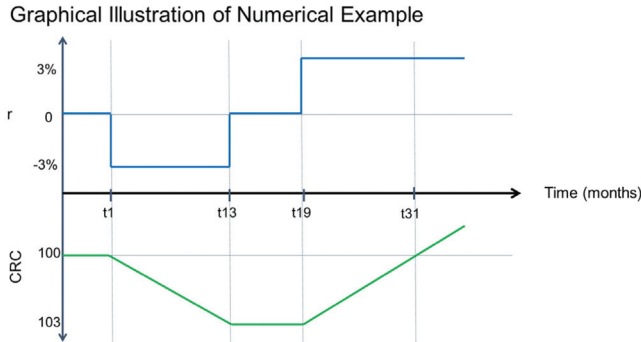


announces that the yield on cash in terms of reserves is set equal to the interest on reserves (for simplicity of the example) and hence that tomorrow's CRC rate will be  $CRC_1 = \frac{100}{\sqrt[360]{1-0.03}} = 100.0085$ .<sup>11</sup> After a year with  $-3$  percent p.a. interest on reserves, the CRC rate would be 103, i.e., 100 units of cash would be converted into roughly 97 units of reserves. Figure 4 depicts this case, based on monthly CRC rate adjustments for the sake of illustration. As long as the interest rate is negative, banks would receive increasingly more cash over time when they withdraw funds from their account at the central bank. The effective depreciation of cash over the holding period would correspond exactly to the accumulated negative interest on reserves over the same period.

In the example in figure 5, the negative interest rate is abandoned at month 13. If an exit from the dual local currency system is desired, the conversion rate would have to remain in place for at least the amount of time that it would take to bring the conversion rate back to par. After a period with a negative interest rate, this would imply that the cash yield would have to be positive for a while. In the example in figure 5, the CRC rate is kept at 103 for as long as the interest on reserves remains zero. In month 18, we assume that the central bank wishes to tighten policy by increasing the interest rate to 3 percent p.a. Now the CRC rate starts reversing, in order to ensure that the yield on cash in terms of reserves is also a positive 3

<sup>11</sup> Using compound interest, the square-root expression refers to the daily equivalent gross compound interest of a yearly interest rate of  $-3$  percent, with a year defined as 360 days.

**Figure 5. Negative Interest Rates and the Cash-Reserve Conversion Rate**



percent p.a. If the interest rate remains at 3 percent, the CRC rate returns to par in month 30. At this point, the system can be safely exited.

### *3.3 Transmission to Bank Deposits and Beyond Banks*

How would the introduction of the conversion rate transmit to the cost of using cash and digital bank deposits for payments in the rest of the economy? The answer to this question depends on behavioral, legal, and other types of responses of the broader economy. There are no obvious empirically relevant historical episodes that can inform these questions.<sup>12</sup> We briefly discuss how banks and wholesale clients

<sup>12</sup>After a failure to stabilize successive cycles of hyperinflation, the Reserve Bank of Zimbabwe (RBZ) demonetized the Zimbabwean dollar from June to September 2015 and converted all remaining currency into U.S. dollars (RBZ 2015). In 2016, the RBZ began issuing so-called USD-denominated bond notes that were pegged 1:1 to the U.S. dollar and could be deposited into existing U.S. dollar accounts (RBZ 2016). As trust in the U.S. dollar accounts (the so-called RTGS dollar) evaporated, U.S. dollar bills were exchanged at a premium against digital U.S. dollars, but also bond notes traded at a (smaller) premium to the digital RTGS dollar; see <https://zwnews.com/latest-us-dollar-zimbabwe-bond-note-trgs-exchange-rates-today-9-october-2018/>, retrieved on October 27, 2019). Zimbabwe is thus a rare example of a country that experienced a spread between physical and digital currency. We were unable to find any evidence on how this spread affected pricing in the economy. Though confusion on pricing was large (<https://www.victoriafalls-guide.net/zimbabwe-currency.html>, retrieved on

are likely to respond given current behavior and use these considerations as a bridge to the central questions about broader transmission to financial markets, instruments, and the real economy addressed in section 4.

At first, the central bank's counterparties, i.e., banks, are faced with the CRC rate at the cash window in conjunction with a negative interest rate on their reserve holdings. Whether and how a commercial bank would pass on the conversion rate between reserves and cash to its customers would not need to be dictated by the central bank but could remain a business decision by banks, just as is the case with negative interest rates on central bank reserves, as also pointed out in Agarwal and Kimball (2015). All else equal, providing cash to a bank deposit holder would require the bank to demand cash in exchange for reserves at the central bank's cash window, where the CRC rate applies.

For relatively short and mild episodes of policy rates below zero (e.g., below a margin of a few percentage points and within a reasonably short period), the CRC rate might not be passed on to banks' customers, as the necessary changes to cash systems would imply a one-off cost for banks. Automatic teller machines could continue to work with a unit conversion factor, at least for retail-sized withdrawals and deposits, and merchants would likely continue to accept payments in whatever form the customer prefers.<sup>13</sup> During episodes of mildly negative interest rates on central bank reserves, the negative interest rate would probably not be passed on to retail-sized bank deposits and its transmission would remain limited to wholesale deposits, as we have seen in some countries. It could take time to overcome the psychological or institutional barriers to negative

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October 27, 2019), other issues related to Zimbabwe's history of monetary instability seemed to be more important than the spread between bond notes and RTGS dollars.

<sup>13</sup>As Agarwal and Kimball (2015) also pointed out, this would correspond to the current system, in which different means of payment also bear different costs, but businesses prefer to take these costs onto their margins and generally do not differentiate prices according to different means of payment. Based on current limits for credit card fees that are absorbed by banks and businesses, one can speculate that this threshold resides somewhere around 3 percent accumulated depreciation of cash relative to reserves.

interest on retail bank deposits that have been observed in recent episodes.

Eventually and with sufficiently negative interest rates, however, banks would have to pass on negative interest to bank deposits in order to remain profitable. The pressure on banks' profits would not result from customers withdrawing cash at par since cash would depreciate in terms of digital money, meaning that customers would actually get more cash for their withdrawal of an equivalent amount of digital money. Instead, the CRC rate would transmit via cash deliveries from businesses that banks would have to credit at less than par to remain profitable. Via this channel, businesses would have a strong incentive to differentiate between cash and digital-money prices once the CRC rate between cash deliveries and digital payments becomes too steep. While a dual domestic currency system has not been tried yet and we cannot analyze consumer behavior in response to different prices for cash and digital money, results of De Grauwe, Rinaldi, and Van Caysele (2006) suggest that consumers react strongly to changes in the cost of using cash or digital means of payment.

How would this affect the demand for cash overall? While cash as a means of payments could become less attractive, a large share of cash seems to be demanded for hoarding purposes (see Bech et al. 2018). Agents would need to understand that—because of the depreciation of cash in terms of digital money—the value of their cash holdings at any point in time during a negative interest episode is exactly equivalent to the balance on a bank account with accrued (negative) interest at the official policy rate. Once this has been understood, banks should be able to pass on the negative interest rate without triggering a run into cash. This requires transparent and convincing communication on the part of the central bank and rational behavior on the part of the public, a point to which we return in section 4.3.

When banks have paid the one-off cost of adapting systems to the CRC rate and the stickiness of retail deposit rates at zero has been overcome, passing on the CRC rate and interest rate cuts into negative territory to retail customers could be immediate. Based on current experiences with banks passing on mildly negative interest rates to institutional clients but not to retail clients, it is probable that the conversion rate would first be passed on to institutional, nonbank



financial firms and possibly nonfinancial firms before households and small enterprises would be confronted with it.

Figure 4 provides an illustration of how the CRC rate would be passed on from the central bank via the commercial banking system to retailers and consumers. The figure shows that the behavior of cash-handling companies, which typically carry out the transfer of cash between the central bank and commercial banks, and their price setting, would play a central role in the transmission of the CRC rate to the economy.

To make sure that the transmission is working properly, it is crucial that the CRC rate is applied symmetrically, i.e., that withdrawals are credited at above par, giving the cash-handling companies an incentive to obtain cash at the central bank instead of trying to re-issue banknotes without channeling them through the central bank. If the CRC rate would only apply to deposits of cash and not to withdrawals, there would be an incentive to short-circuit the cash cycle, and the transmission of the CRC rate to the broader economy could be at risk.

Passing on the CRC rate to bank customers should not create any problems for cash circulation or payments. Cash is usually withdrawn by the banks' retail customers from their deposit accounts and spent for purchases of goods and services. The bank would decide whether customers can withdraw cash at par or at the CRC rate from their accounts. Shops and other firms receive cash payments and bring them back to the bank, which would likely credit these cash deposits at the conversion rate that it faces at the central bank, i.e., firms' accounts with their bank would be credited at less than par.<sup>14</sup>

It is uncertain how the dual domestic currency system would transmit to pricing and price quotes—i.e., which currency, cash or reserves, would become the main unit of account. Confronted with a higher cost for depositing cash, firms would perhaps first—before quoting cash prices that differ from prices in digital money to their

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<sup>14</sup>The setting of the conversion rate would be a business decision of the bank. There would not be any requirement that this conversion rate has to be identical to the one the central bank is applying. Banks would be free to set a more or less favorable conversion rate for their customers. They could also choose to adjust it less frequently than the central bank, as has generally been the case with deposit rates relative to the policy rates.

customers—have an incentive to influence their customers toward paying with digital money instead of using depreciating cash.<sup>15</sup> If the value of cash were to deviate sufficiently from bank deposits and reserves, however, firms would have to choose which currency to use for price quotes and let prices in the two currencies deviate. Having legislation in place that supports price quotes in digital money would help economic agents to coordinate on a common unit of account and ensure that the dual domestic currency system is able to remove the lower bound on interest rates. We address this question, central for the functioning of a dual domestic currency system, in more detail in section 4.3 below.

### *3.4 Small Open Economies and the Exchange Rate Regime*

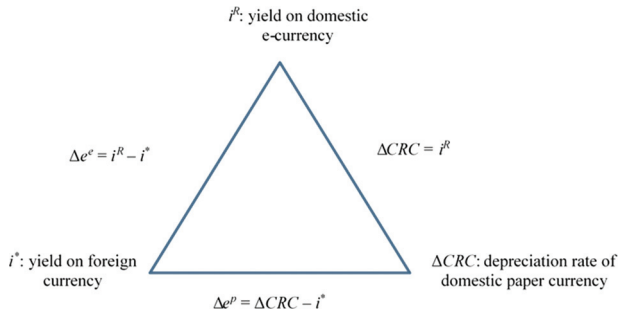
With cash and central bank reserves de-linked into two distinct domestic currencies, there would also be two foreign currency exchange rates, namely one for domestic cash per foreign currency and one for domestic digital central bank reserves and bank deposits per foreign currency, assuming that foreign currency is not unbundled into cash and reserves (in which case, four exchange rates would apply). The relationship between the two foreign exchange rates would in market equilibrium be determined by the central bank's choice of the CRC rate between domestic cash and reserves, as the central bank would be the monopoly supplier of both cash and reserves. The relationship between the three exchange rates would be identical to the relationship between the bilateral exchange rates of three pairs of freely traded separate foreign currencies, except that, in this case, at least one of the exchange rates (the CRC rate) would be deterministically fixed by the central bank. The relationship between the other two exchange rates would be determined by the CRC rate. There would only be one exchange rate left for either the market or the central bank to fix.

Figure 6 illustrates the uncovered interest parity (UIP) relations between foreign currency and the two domestic currencies. If cash were depreciating at a rate consistent with the negative interest rate on reserves, UIP between the three bilateral exchange rates would

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<sup>15</sup>For small accumulated rates of depreciation of cash, this could initially take the form of bonuses or coupons for noncash payments.

**Figure 6. Illustration of Uncovered Interest Parity with a Dual Domestic Currency System**



apply, abstracting from risk premiums. Financial market equilibrium would ensure that agents would be indifferent between currencies (cash, reserves or foreign) to invest in. If the central bank were to let cash depreciate more or less quickly than the negative rate on reserves to accommodate demand fluctuations, the two foreign exchange rates for cash and digital currency would reflect this difference.<sup>16</sup> Overall, this would not create any new arbitrage opportunities as compared with the single domestic currency case. In short, adding a foreign currency to the dual domestic currency system with a corresponding exchange rate does not change the relationship between the two domestic currencies.

In a floating exchange rate system, the exchange rate of domestic central bank reserves against foreign currency would be market determined, and the exchange rate for domestic cash against foreign currency would be given by the exchange rate of digital reserves against foreign currency times the CRC rate. There would be no arbitrage incentive to shift to foreign currency—whether foreign reserves or foreign cash—in light of a negative yield on domestic cash and bank deposits. If the domestic central bank wanted to ease monetary policy further below zero, it could do so by implementing a faster depreciation of domestic cash in terms of digital reserves. This

<sup>16</sup>We would expect the relations on the foreign exchange market to be dominated by the exchange rate for domestic digital currency, as cross-border transactions are primarily digital. In general, foreign exchange rates for cash transactions exhibit almost prohibitively wide spreads.

would transmit to the economy through the normal monetary policy transmission channels, including through the exchange rate channel. Thus, initially, a lower domestic interest rate would increase the demand for foreign currency. This would trigger a domestic currency depreciation which would help boost domestic demand and inflation. The domestic interest rate could in turn be increased, sooner rather than later.

In a fixed exchange rate system, in contrast, the goal of the central bank would be to keep the foreign currency exchange rate of domestic reserves stable, and the interest rate would be chosen with this objective in mind. In this situation too, a dual domestic currency system would provide the tools necessary to meet the mandate in a low interest rate environment. Suppose, for example, that domestic and foreign interest rates were at their lower bound as a negative risk shock in the foreign currency area causes safe-haven-like appreciation pressures on the domestic currency. These appreciation pressures could be countered by cutting domestic interest rates into negative territory by switching unilaterally to a dual domestic currency system. The negative yield on cash and negative interest rate on bank deposits would trigger substitution away from domestic currency and into foreign banknotes, reserves, or bank deposits, thereby alleviating the risk-induced appreciation pressures on the domestic currency.

Suppose instead that the central bank issuing the foreign reference currency cuts interest rates into negative territory in response to a negative shock by unilaterally implementing a dual domestic currency system. The lower foreign interest rate would induce appreciation pressures on the domestic currency. In this case, the domestic central bank could maintain its peg by following suit and implementing a dual domestic currency system too, which would allow the domestic interest rate to fall in tandem with the foreign rate.

It is important to note that the dual domestic currency system discussed here is not akin to so-called dual exchange rate regimes operated in some countries in history. In typical dual exchange rate regimes, central banks impose two different exchange rates for converting a unique domestic currency into foreign currency, where the applied rate depends on the motive for the transaction (e.g., imports or capital account transaction) or the types of counterparties in the transaction. Dual exchange rate regimes suffer from a

number of problems, making them unsustainable. If the market for foreign currency is not controlled and fully segmented, there would be unlimited arbitrage opportunities from buying and selling foreign exchange at the two rates. To avoid such arbitrage, the central bank has to restrict or ration access to domestic or foreign currency at some of the rates. In history, black markets and rent seeking in response to the arbitrage opportunities have inevitably developed and led to the downfall of dual exchange rate systems. Similar problems have characterized the historical experiences of early banks in issuing parallel currencies during eras of free banking.<sup>17</sup> In contrast, the dual domestic currency regime that we discuss here is not associated with any unlimited arbitrage opportunities as long as the CRC rate is set according to the principles discussed above. The central bank would issue two domestic currencies, and set the interest rate on reserves and the conversion rate for reserves into cash consistent with this interest rate, allowing the market to set the interest on bank deposits, bonds, and the respective exchange rates vis-à-vis foreign currencies. Arbitrage would be stabilizing for the system. It would ensure that the foreign exchange rates would be consistent with UIP. Currency controls or market rationing would not be required to make the system operational.

We conclude that the practical operation of a dual domestic currency system should not require major changes to current monetary policy frameworks. The interactions of the central bank with its counterparties under a dual domestic currency system would be straightforward and would follow the same lines as monetary policy operations under contemporary systems. Both fixed and floating exchange rate regimes could implement the system, unilaterally as well as in coordination with foreign monetary authorities. We next turn to issues surrounding the introduction of a dual domestic currency system and its ability to provide monetary policy space at the lower bound.

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<sup>17</sup>The Bank of Amsterdam operated an early version of a dual local currency system in the 17th century by unbundling its deposits in unredeemable account balances (reserves) and coins that could be withdrawn (Quinn and Roberds 2014). The main difference to our scheme is that in a modern central bank both components, i.e., cash and reserves, are fiat money and thus unredeemable.

## 4. Issues and Unanswered Questions

As the above discussion suggests, breaking the unit conversion between cash and reserves would be operationally feasible with small changes to central banks' operational frameworks. To make a dual domestic currency regime ready for implementation in case of need, however, would also require changes to current legal frameworks. Concrete proposals are beyond the scope of this paper. Instead, we discuss below what we consider to be the main questions needing attention. Following the structure in figure 5, we first consider issues that might arise for the central bank, such as implications for monetary policy implementation and seigniorage revenues. Next, we discuss issues related to the banking system such as transmission of negative rate to bank lending and implications for financial stability. Finally, we consider the transmission of deeply negative interest rates to the broader economy, which will depend critically on the behavior of firms and consumers.

### *4.1 Implications for the Central Bank's Balance Sheet*

Introducing a dual domestic currency system will have implications for the size of the central bank's balance sheet with potential consequences for monetary policy implementation and seigniorage revenues. Introducing a dual domestic currency system with the digital currency as the relevant unit of account would presumably lead to an increased use of digital payments at the expense of cash. Depending on how much digital money replaces cash in circulation and whether commercial banks or the central bank itself provides non-banks with digital currency, the central bank's balance sheet might either expand or shrink.

Prospects of a significant reduction of the central bank's balance sheet have led to discussions about the size of the monetary base that is necessary to effectively implement monetary policy. Friedman (1999) expresses concerns that an evaporating demand for base money would make it more difficult for the central bank to control financing conditions in the economy. By contrast, Woodford (2000) argues that the central bank would continue to be able to control short-term interest rates even if the demand for base money

evaporated completely, and that monetary policy effectiveness was independent of the size of the central bank's balance sheet.

While the central bank's balance sheet would presumably shrink when commercial banks continue to provide nonbanks with digital money, its evolution is ambiguous if the central bank itself were to open its balance sheet to the general public, motivated, for instance, by a desire to provide a generally accessible legal tender. If consumers were to replace cash with CBDC, the central bank's balance sheet would remain of the same size but its liability structure would change, with reserves increasing at the expense of banknotes (see Meaning et al. 2018). If consumers were to substitute CBDC for bank deposits, the central bank's balance sheet would lengthen, forcing the central bank to acquire more (interest-bearing) assets to counterbalance its increased liabilities. This could raise governance issues, as more credit would be intermediated through the central bank instead of the private sector. Both scenarios imply that if the CRC rate were to remain in place with positive policy rates (as discussed in section 3), a larger part of the central bank's liabilities would be remunerated at the policy rate. Although the central bank would not incur losses as long as interest rates are negative, this could change once interest rates rise.<sup>18</sup>

Seigniorage revenue arises from the difference between the yields on the central bank's assets and its liabilities. The zero interest rate on cash—and in some countries also reserves—is currently the primary source of the central bank's seigniorage revenue. A decrease of cash in circulation or an increase of the share of remunerated reserves could both reduce seigniorage and thus affect the long-term profitability of the central bank. Whereas the average yield spread narrows when interest-bearing reserves replace cash, total seigniorage revenues might increase or decrease, depending on how much the balance sheet expands.

While generating profits is not an objective of a central bank, sufficient seigniorage revenue to cover operating costs is often seen

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<sup>18</sup>Some central banks, e.g., the European Central Bank, have always paid interest on reserves whereas other central banks, e.g., the Federal Reserve, recently shifted to paying interest on reserves. Interestingly, proposals on CBDC currently under discussion consider a zero rate on CBDC (Sveriges Riksbank 2018). To effectively remove the lower bound, however, CBDC would need to be interest bearing, at least when the policy rate becomes negative.

as important in ensuring central bank independence and therefore credibility. As important as these considerations are, central bank seigniorage revenue is likely to change in the future, driven by financial innovation and the ensuing increased use of digital payment options at the expense of cash. More research is needed to assess how much seigniorage could decline and whether it could be severe enough to affect the central bank's ability to pursue its price stability target.

#### *4.2 Implications for Monetary Policy Transmission and Financial Stability*

In this section, we consider issues relating to the middle panel of figure 4, namely possible implications of the introduction of a dual domestic currency for the banking system. Our reflections are centered on two main questions. First, would interest rate cuts in negative territory transmit in the same way to financial conditions and bank lending as interest rate cuts in positive territory? Second, would more negative interest rate levels—coupled with the introduction of a dual domestic currency system—have adverse implications for financial stability? To answer these questions, we consider how the experience with moderately negative interest rates in some economies to date can inform our thinking about more deeply negative interest rate environments.

In general, the recent experience with negative interest rates suggests that the transmission to money and bond markets of moderate policy rate cuts to negative values works like rate cuts in positive territory. When policy rates were lowered into negative territory, interest rates fell more broadly, as in normal times (Bech and Malkhozov 2016, Christensen 2019). It seems reasonable to assume that money market and bond market rates would keep declining with policy rates if these were to be lowered further. Evidence on lending rates and bank lending is more mixed (Ball et al. 2016) but overall points to a positive impact of negative interest rates on bank lending so far.<sup>19</sup> By contrast, banks to date have not generally imposed

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<sup>19</sup>See Albertazzi, Nobili, and Signoretti (2017), Demiralp, Eisenschmidt, and Vlassopoulos (2017), International Monetary Fund (2017), Altavilla et al. (2019), and Eisenschmidt and Smets (2019).



negative interest rates on retail deposits of households (Jackson 2015, Bech and Malkhozov 2016, Jobst and Lin 2016). Although non-deposit funding has become cheaper for banks, their funding costs have not decreased as much as policy rates because of the stickiness of retail deposit rates, narrowing their interest margin.

In a dual domestic currency system, however, a negative yield on cash can be imposed and, therefore, deposit rates could possibly more easily breach the sticky line of zero, eliminating one of the obstacles to the full transmission of negative rates.<sup>20</sup> Banks would not face the threat of a bank run when interest rates are cut on retail deposits, and banks would hence be able to lend at more negative interest rate levels while maintaining their interest margins.

Studies that question the ability of negative interest rates to transmit to bank lending take a zero yield on cash and therefore a lower bound on deposit rates as given.<sup>21</sup> For instance, Brunnermeier and Koby (2019) suggest that due to the interplay between negative interest rates, regulation, and liabilities fixed in nominal terms (such as deposits on sight or savings accounts), interest rate cuts cease to stimulate bank lending if rates become too low. Once recapitalization gains are offset by tighter interest margins, low interest rates reverse their effect. Following similar reasoning, Eggertson, Juelsrud, and Wold (2017) build a model showing that a lower bound on deposit rates limits the extent to which a central bank can stimulate the economy by lowering its policy rate.

Accordingly, it has been argued that negative interest rates have adverse effects on bank profitability with ensuing negative consequences for financial stability. Though periods of low interest rates tend to coincide with lower bank profitability, there is no evidence that negative interest rates are causing low bank profitability (Ball et al. 2016). Typically, bank profitability suffers from weak

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<sup>20</sup>Some countries (e.g., France) currently face legal or regulatory constraints to lower deposit rates to negative values. Such regulation or law would have to be changed to make the transmission of negative rates effective. In section 4.3 we discuss other regulation that might need to be adapted to ensure the effectiveness of a dual domestic currency system.

<sup>21</sup>Evidence presented in Ball et al. (2016) suggests that the transmission to bank lending rates in Switzerland following the interest rate cut into negative territory was indeed weaker than usual. This pattern, however, was not seen in other negative interest rate countries where bank lending rates responded normally.

macroeconomic dynamics and central banks respond by lowering policy rates. Moreover, Altavilla, Boucinha, and Peydró (2018) conclude that the adverse effects of monetary policy accommodation on banks' net interest margins in the euro area were largely offset by a positive impact on credit demand and quality as well as capital gains derived from the increase in the value of the securities held by banks. In the recent episode of low interest rates, the use of large-scale asset purchases and the flattening of the yield curve may be more important factors affecting bank profitability. A dual domestic currency system would enable banks to lower deposit rates, perhaps steepen the yield curve, and hence affect interest margins positively.

More fundamental implications for the structure of the financial system could arise if a dual domestic currency system were accompanied by the introduction of CBDC. Demand for traditional bank deposits as well as for physical currency could drop, eroding traditional bank funding models, causing bank disintermediation, and affecting the nature of payments systems. The literature on CBDC is developing quickly (Andolfatto 2018, Bank for International Settlements 2018, International Monetary Fund 2018, Brunnermeier, James, and Landau 2019, Chiu et al. 2019, Keister and Sanches 2019) and raises questions about the role of the central bank in payments and the allocation of credit that are beyond the scope of this paper. These issues are not specific to a dual domestic currency system and should be studied in their own right, as cash increasingly gives way to new digital means of payment.

Another financial stability concern relates to financial institutions' business models that incorporate nominal return targets and might lead to increased risk-taking.<sup>22</sup> Short-term debt is often regarded as "money-like" in the sense that holders consider its value fixed in nominal terms though it earns interest and is subject to credit risk. If nominal values or guaranteed nominal returns are written into contracts or regulation, negative interest rates may lead agents to invest in higher-risk assets and intensify search-for-yield behavior. Such behavior, however, is not specific to negative interest rates but relevant for long periods of below-average interest rates as

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<sup>22</sup>Heider, Saidi, and Schepens (2017) found evidence that deposit-funded banks started to lend to riskier borrowers when interest rates became negative.

well. As such, it might be even more of a risk in the present system where countercyclical monetary policy is hampered and cannot contribute to reducing the length of a downturn.<sup>23</sup>

The financial stability implications of more negative interest rates would need to be weighed against the consequences of long periods of low interest rates and below-average economic performance when monetary stimulus cannot be provided forcefully at the lower bound during steep downturns (International Monetary Fund 2016). Being able to remove the constraint on monetary policy resulting from the lower bound would help shorten a downturn and the resulting low-growth period, getting the economy back on track, and thus back into positive interest rate territory, more quickly.

A number of other, less significant issues might arise in the context of negative interest rates, related to the implied change in direction of interest payment flows and the current definition of default (McAndrews 2015). During the recent experience with negative interest rates, negative yields on bonds have been achieved by issuing the bond at a price above par. While this is unproblematic at slightly negative rates, it could become more contentious when interest rates become significantly negative. Other issues are taxes, which often apply to coupon payments but not to capital gains, or the calculation of present values at negative rates. Since negative interest rates would be able to respond forcefully to a downturn, we would expect them to stay in place for only a limited time to help the economy recover more quickly. We hence do not see these issues as fundamental caveats to implementing more negative interest rates.

Summing up, the reason for introducing a dual domestic currency system is to recover monetary policy space in response to strong downturns when nominal interest rates are near zero. We do not see any reason for this to change monetary transmission to the financial sector fundamentally, nor do we see any unmanageable financial

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<sup>23</sup>Lucas, Schaumburg, and Schwaab (2017) investigated bank business models at zero interest rates. They found that banks responded to changes in the yield curve. In particular, lower long-term interest rates led to increased size, leverage, complexity, and a less stable funding base for banks. This suggests that monetary policy measures targeted at longer-term rates may also have financial stability implications.

stability implications.<sup>24</sup> By using the CRC rate in a dual domestic currency system to steer the demand for cash, the authorities could even obtain a new tool to strengthen financial stability in situations where bank customers face an incentive to withdraw cash on a large scale.

### 4.3 Consumers and Retailers

In this section, we discuss whether deeply negative interest rates would successfully stimulate consumption and investment, addressing the right-side panels of figure 4. Moreover, we address issues related to the functions of money as a unit of account and legal tender that may arise for consumers and retailers in a dual domestic currency system.

If interest rates can be turned deeply negative, will economic agents respond by increasing investments and reducing savings or might they save even more to compensate for decreased interest income? From a theoretical perspective the *real*, not the nominal, interest rate should matter for saving and investment behavior. Real interest rates have been negative on many occasions in many countries, as expected inflation has exceeded policy rates substantially, notably in the 1970s, without triggering a discreet behavioral shift toward savings (see also Ball et al. 2016). When appropriately accounting for changes in neutral real interest rates, such episodes seem to be associated with improvements in macroeconomic conditions, as theory and the Euler equation would suggest (Krogstrup 2017; see also Cúrdia 2019).

We cannot exclude, however, that negative *nominal* interest rates might have different effects. Economic agents may partly allow nominal considerations to guide their decisions, at least in the short term, due to money illusion (e.g., Fehr and Tyran 2001). Cliffe (2016) reports that in a survey of bank clients across 15 countries, 11 percent out of 78 percent of respondents that would change their saving

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<sup>24</sup>Concerns have been voiced in the context of the Federal Reserve's reverse repurchase (RRP) program, which gives financial institutions access to the Federal Reserve's balance sheet as a counterparty in repo operations; see, for example, Anderson and Kandrak (2016). Observing how the RRP program works during a possible future financial instability event could help inform on this issue.

behavior if they were confronted with negative interest rates indicated that they might save *more* in reaction to negative interest rates. Another 10 percent answered that they would spend more, whereas the rest would either shift into alternative assets or hoard cash. It should be kept in mind that these responses need not necessarily match with actual behavior if such a situation were to occur. Financial education might help reduce the impact of money illusion. Moreover, a shift to a dual domestic currency system could in itself reduce money illusion by confronting economic agents with more than one unit of account.

A dual domestic currency system can only remove the lower bound on nominal interest rates if digital currency rather than cash becomes the relevant unit of account, which may require legal and regulatory reforms. The unit of account is the currency used to value goods, services, assets, liabilities, income, expenses, and so forth. Nominal contracts and invoices are written in the unit of account. To ensure that the dual domestic currency system would work to transmit negative interest rates, citizens would have to measure their wealth and income in terms of units of digital currency, not cash. Prices would have to be quoted predominantly in digital currency; wage contracts and other important nominal contracts should be written in digital currency to ensure this. Mental accounting also should take place in the unit of account, which affects behavior and decisionmaking. The unit of account determines the currency through which monetary policy is transmitted to the economy and, therefore, the currency in which potential frictions apply.<sup>25</sup> As Buiter (2007) explains, if cash instead of digital currency were to become the unit of account in a dual domestic currency regime, economic agents would measure their incomes and assets in units of cash. The depreciation of cash in terms of reserves would instead be perceived as an appreciation of reserves relative to cash. This appreciation could in turn nullify the negative interest on reserves, which consequently would not transmit to the rest of the economy.

To support digital currency as the relevant unit of account, digital currency could be given legal tender status. Throughout history, legal tender served as an economy's main medium of exchange as

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<sup>25</sup>See Buiter (2007) for a formal model of this link.

well as the unit of account.<sup>26</sup> Legal tender status implies that a given means of payment is recognized by the legal system to be valid for meeting financial obligations.<sup>27</sup> Agents usually cannot refuse legal tender for settling debts, though the obligation to accept legal tender can be abrogated based on the freedom of contract. In most countries, cash is the legal tender for historical reasons. Central bank reserves are sometimes included as well. In contrast, bank deposits—the main form of digital money that nonbank citizens currently use and have access to—are not. They are accepted in payments only by convention, for convenience, and through trust. Legal tender is usually a liability toward the central bank, whereas other means of payments such as bank transfers or credit cards constitute a liability toward the financial institution that issues them. Holding and accepting other means of payment might be convenient, but is related to incurring some creditor risk. Declaring bank deposits legal tender therefore seems problematic.

Agarwal and Kimball (2015) advocated that the legal tender status of cash be revoked in a dual currency system, leaving ordinary citizens without central bank reserve accounts without access to legal tender. To address this, central bank reserves could be made available to nonbank citizens—for example, in the form of a legal tender CBDC (Niepelt 2015, Bordo and Levin 2017, Ricks, Crawford, and Menaud 2018). Some central banks are discussing the pros and cons of issuing CBDC as a complement to cash to nonbanks; see, e.g., Mersch (2017) and Sveriges Riksbank (2018). Alternatively, banks could be required to offer special deposits that are backed by the bank's holdings of central bank reserves—a type of indirectly issued CBDC.<sup>28</sup> These special deposits could then be granted legal tender

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<sup>26</sup>Buiter (2007) discusses some exceptions to this rule. Another example is the Chilean UF (Unidad de Fomento), which was introduced in 1967 and successfully used as an indexed unit of account (indexed to consumer price developments), while the pesos remained the means of exchange, means of storage, and legal tender (Shiller 2002).

<sup>27</sup>Throughout the history of economic thought, the notion can be found that fiat money derives its value from being accepted by the government in paying taxes; see the references given in Forstater (2005).

<sup>28</sup>Relatedly, in June 2018, Swiss citizens voted on whether to introduce a form of narrow banking that would go a long way toward backing bank deposits fully with central bank legal tender. The proposal was rejected; see Assenmacher and Brand (2018).

status. Once a digital, universally accessible legal tender circulates, further measures to ensure that it becomes the unit of account would be unproblematic—and perhaps not even necessary.

Regulation would (ideally) take care of how to interpret existing, or legacy, contracts written before the de-linking of cash and reserves. In this context, keeping the legal tender status of cash in a dual domestic currency regime would raise important issues related to how legacy nominal contracts should be honored when these do not specify whether payment should be made in either cash or digital means of payment. If cash is depreciating but can be used to make good on a contractual agreement, this would create incentives for debtors to repay debts in depreciated units of cash, preventing digital money from becoming the relevant unit of account and leading to an unintended redistribution from creditors to debtors in the new regime. Legal uncertainty with respect to which currency a contract refers to can create legal problems and frictions in the transition to a dual currency system. A shift to a new regime in which cash remains legal tender would therefore have to include amendments to legal frameworks governing contracts and payments on financial obligations. Such transitional issues would need to be planned for to minimize disruptions when introducing a dual domestic currency system.

Another key issue is how the public understands and reacts to the introduction of a dual domestic currency system. Given the lack of precedents for systems allowing for deeply negative interest rates and a de-linking of the value of cash from digital money, the behavioral responses during the transition to a new system would be difficult to predict. In theory, it should be clear that a CRC rate above unity means that cash depreciates over time. In practice, however, if public education efforts about the system are not successful, citizens (especially those that are less financially literate) might initially think that they get more cash value for their deposits when deposits bear negative interest. If cash prices do not increase immediately upon the introduction of the new system, it may add to the illusion that cash retains its purchasing power over time. This could initially lead to a run into cash until it is broadly understood that cash can be redeposited only at a depreciating rate. While such problems should be temporary, they could create practical problems for central banks, e.g., they could temporarily run out of cash. Preparations

for a smooth transition should hence include clear communication and large precautionary stocks of cash, as well as taking measures to improve the level of financial education of the population.

Finally, the introduction of a dual domestic currency system could lead people to switch to other forms of currency for their payments, such as foreign currency, gold, or even cryptocurrency. Mechanically, such substitution would lead to a depreciation of the domestic currency and higher inflation, potentially stimulating demand domestically and from abroad. Overall, it seems unlikely that individuals would entirely abandon domestic currency as a means of payments for most transactions. Based on data from five hyperinflations, Barro (1972) showed that even at rates of inflation above 100 percent annually, the domestic currency was still used, though the velocity increased substantially. The introduction of a dual domestic currency system would not change the fact that only domestic currency is legal tender and needed for making good on various obligations. To establish trust in connection with the introduction of a dual domestic currency system, the central bank would have to communicate the system and its merits well and carefully. This is perhaps the most important and also the most challenging part of introducing such a system. Moderately negative nominal rates have been deeply unpopular in some countries. What would successful communication look like? It would create confidence that monetary policy has new and unlimited room to address a downturn. It would thereby reduce any existing crisis sentiments that are likely to be prevalent in a situation where a central bank would want to introduce such a system. Transparency and the quality of communication of the system would be key for building trust.<sup>29</sup>

In conclusion, we see no reasons to anticipate that monetary policy transmission to savings and investment behavior would be hampered with deeply negative interest rates. The main uncertainty

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<sup>29</sup>A related observation is that there is no reason that a large-scale capital flight would have different implications in a dual domestic currency system. We would expect to see a depreciation of the domestic currency in a floating rate system or an expansion of central bank reserves through foreign exchange interventions in a fixed exchange rate system (both of which should help bring back inflation faster). The central bank would have to be prepared in terms of foreign exchange reserve adequacy or macroprudential measures to prevent balance sheet vulnerabilities to such episodes.



is the unknown effects of deeply nominal rates due to money illusion. Associated risks should be addressed with ample and appropriate communication and education efforts.

## 5. Conclusions

The zero lower bound on nominal interest rates is caused by the availability of cash that yields a zero nominal return. De-linking cash from digital currency and making cash depreciate relative to digital currency, as proposed by Buiter (2007) and Agarwal and Kimball (2015), could solve this problem. With such a system in place, a central bank would be able to use conventional monetary policy tools to stabilize the economy without being constrained by the lower bound. In a world of low neutral real interest rates, it would help reduce the length of business cycle downturns and hence the duration of low interest rate episodes. It would reduce the risk of deflationary spirals and the incidence of secular stagnation. It would do so without dispensing with cash. Studies that question the transmission of negative rates to bank lending assume that banks cannot lower their deposit rates, which would not be a constraint in a dual domestic currency system.

Our discussion suggests that the system is technically feasible and would not require fundamental changes to current operating frameworks of central banks. Moreover, in contrast to some other proposals, the system would be fully reversible. After a sufficient normalization of economic conditions, it could be exited if so desired. It would work in economies with fixed or flexible exchange rate systems and could be implemented unilaterally. Communication and financial education would be central for a successful introduction of such a regime and should address any possible risks to the transmission of monetary policy and to financial stability. Further work would be needed to identify, prepare, and implement the necessary legal reforms for ensuring its effective operation.

In our view, the dual domestic currency system should be considered alongside alternative proposals for keeping monetary policy effective at low interest rates, such as phasing out cash all together (Rogoff 2014), a higher inflation target proposed by Blanchard, Dell’Ariccia, and Mauro (2010), or the use of unconventional easing

measures such as quantitative easing and forward guidance. All current proposals, including the status quo, have pros and cons which will depend on specific country circumstances. In comparison with alternatives, the dual domestic currency system has the advantage of completely freeing monetary policy from a lower bound while being neutral for banks' business models and their role in monetary policy transmission, allowing for effectively redressing and hence shortening the duration of recessions. Raising the inflation target and unconventional easing measures do not remove the lower bound but shift it downward by some percentage points (Ball et al. 2016). Another advantage is that the dual domestic currency system can be implemented as a crisis measure, ideally with some preparation beforehand, while preserving a role for cash. In contrast, to reap all benefits of raising the inflation target, it would require time for expectations to adjust and credibility to be built around a higher level of inflation.<sup>30</sup> Other advantages include the dual domestic currency system's reversibility, its preservation of a role for cash, and the fact that its introduction would reconfirm the central bank's commitment to the inflation target rather than raise doubts about it. But the dual domestic currency system clearly also has disadvantages. Most importantly, it would be an enormous communicational challenge. It would also require more far-reaching changes to the financial and legal system than simply raising the inflation target or pursuing quantitative easing.

Technological innovation in digital payments systems is proceeding at a rapid pace, without central banks actively promoting this (Casey et al. 2018, Brunnermeier, James, and Landau 2019). Such changes may force a reconsideration of issues around cash and legal tender in the future, irrespective of ZLB considerations. In this context, new developments should also be evaluated in light of their ability to accommodate negative policy rates or even a dual domestic currency system. Pros and cons of a dual domestic currency system as well as alternative solutions should be carefully compared in the

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<sup>30</sup>If the inflation target is raised as a crisis measure, it works through expectations of future inflation and is akin to forward guidance. This requires strong credibility, and there are limits to the additional firepower that can be achieved, as evidenced by the Japanese experience; see also Ball et al. (2016).

context of a country's institutional, legal, cultural, and economic situation when considering the future of monetary policy frameworks.

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