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Digital Money and Central Banks Balance Sheet

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ABSTRACT: Digital money is a logical step in a process of continuous technological advancement in payment systems. In response, central banks are reviewing their conduct of monetary operations in light of the new shape of financial markets and systems. The impact of digital money will depend on the type of money substitution by digital money. The paper straddles several cases where substitution of CiC (currency in circulation), and bank deposits may take place via digital money such as CBDC or other e-money, and how it would impact the central bank balance sheet. Remuneration of CBDC, if aligned to a new objective, could potentially amplify the effect on the interest rate channel of monetary policy.

JEL Classification Numbers:	E5; E41; G15; F30
Keywords:	CBDC; digital money; currency-in-circulation; bank deposits; central bank balance sheet; money base (M0); seigniorage

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Contents

Glossary

AAA	Triple-A
ATM	Automated Teller Machine
BCB	Central Bank of Brazil
CBDC	Central Bank Digital Currency
CBs	Central Banks
CiC	Currency in Circulation
ECB	European Central Bank
FD	Financial Dollarization
FX	Foreign Exchange
GDP	Gross Domestic Product
GFC	Global Financial Crisis
IT	Inflation Targeting
LOLR	Lender of Last Resort
M0	Monetary (or Money) Base
NPCI	National Payments Corporation of India
NPV	Net Present Value
OMO	Open Market Operations
PSP	Payment Service Provider
QE	Quantitative Easing
RBI	Reserve Bank of India
RD	Real Dollarization
SMEs	Small and Medium-sized Enterprises
UPI	United Payments Interface
USDC	USD Coin

I. Introduction

The creation and evolution of central banks is a landmark in the long history of financial markets and payment systems. The universal use of mobile phones and the platform revolution has created the conditions for a financial revolution. Digital money is the next step in the process of continuous technological advancement in payment systems. In response, central banks are reviewing their conduct of monetary policy and operations in light of the new topology of financial markets and payment systems. This paper studies the potential implication of digital money on central banks balance sheet.

For a long time, society chose a metal (i.e., gold) as money, and governments facilitated the payment mechanism by producing coins with a standardized weight. Banks further contributed to the process by opening accounts (private money) at one-to-one exchange rate with gold (or silver). These accounts reduced both the risk of theft and transaction costs, in particular for large amounts. However, there was no central bank in charge of regulating the money supply, since using a metal as currency was the norm; banks only provided payment services under a narrow banking structure. The latter provided security against liquidity shortages, as deposits were backed 100 percent by gold (or silver). The aggregate money supply was the amount of available gold (or silver).

A significant change took place when banks engaged in lending activities by the time of the Industrial Revolution, as they realized that deposit withdrawals were not simultaneous, and therefore it was not necessary to keep a gold/silver backing of 100 percent; (i.e., a reserve requirement of 100 percent). This gave birth to bank credit and maturity transformation of financial assets. Bank lending (was envisaged) to increase potential GDP by allowing more efficient allocation of savings to economic activities through financial intermediaries. The Federal Reserve System was created in 1913, as a result of crisis and thus there was a need for lender of last resort (LOLR), with a mandate to provide *elasticity to the currency*.

The collapse of the Bretton Woods exchange rate peg system in 1971 and the high inflation episode during the 1970s and early 1980s—with central banks in the developed economies operating under a floating exchange rate system—paved the way for a new monetary policy framework. However, together with these macroeconomic developments, there were also important improvements in payment systems, which induced changes in monetary practices. Financial innovations, such as debit cards and automated teller machines (ATMs) during the 1970s and 1980s, facilitated payments from bank accounts; demand for money became unstable. The traditional transaction demand for money—based on the notion of "shoe-leather costs" (Baumol, 1952) became irrelevant, as ATMs could be found everywhere, and credit cards replaced currency in circulation (CiC). To keep monetary aggregates as an intermediate target in the context of higher substitution between CiC and savings deposits, central banks began to use a broader definition of money. In the end, unstable demand for money was not conducive for monetary targeting in low-inflation countries and their central banks adopted interest rate as operational target —including those adopting inflation targeting (IT). As the former central bank of Canada's Governor Gerald Bouey put it (1983): "*Central banks did not abandon monetary targeting; it was the other way around: money demand left central banks.*"

As of today, the impact on digital currencies differs across countries depending on the status of their respective currencies. The challenge for central banks is to preserve the efficiency of monetary policy and adapt to the impending wave of digital money.

In section II we describe the main features of bi-monetary (or partially dollarized economies), with a focus on the functions of money and the reason for the hysteresis phenomenon. In section III, we discuss how central banks balance sheet and monetary policy may change under the new environment of digital money, including the issuance of CBDC. Section IV discusses the implementation of digital money and new costs that may accrue to the central bank from cyber-related risks, (distinguishing between wholesale and retail costs). Section V shows six simulations of how banking loans, money and central banks balance sheet may change for different types of substitution with digital money (e.g., stablecoins, MNOs, and CBDC), and complements recent IMF policy work in this area (e.g., IMF (2021); IMF (2020)). Section VI concludes with some forward-looking suggestions.

II. Lessons from Bi-Monetary Systems

Most economies operate with a foreign exchange (FX) (e.g., the dollar) bias for international trade and finance invoicing. Additionally, banking systems in many developing economies are bi-monetary. This section reviews the main features of partially dollarized economies, with a focus on the functions of money as unit of account, means of payment, and store of value.

Table 1 describes four types of countries according to the functions of local currencies. On one end, the U.S. enjoys a privileged status as issuer of the most widely used international currency (Type A); and on the other end, countries like Venezuela and Zimbabwe have very limited monetary room to maneuver due to high dollarization (Type D). It is a simple characterization of current status, and any country could combine some features of different type-cases of Table 1. It may be useful to use dollarization literature in assessing crypto assets. As the latter is not money, but performs some of its functions, there is imperfect substitution among them.

Table 1. Countries Classified by Dollarization Level

Country/Function of Money	Unit of Account	Means of Payment	Store of Value
Issuer of International Currency (Type A)	Fiat currency used in domestic and most international trade transactions.	Fiat currency used in domestic and most international trade transactions.	Fiat currency used in domestic and international lending/securities operations.
Open Economy under Dominant Currency Paradigm (Type B)	Fiat currency used in domestic transactions. FX used in foreign trade.	Fiat currency used in domestic transactions. FX used in foreign trade.	Fiat currency used in domestic financial contracts. FX used in international lending/securities operations (except for sovereign bonds in certain cases).
Partially Dollarized Economy (Type C)	Fiat currency used in transactions of final goods and services. Partial dollarization of prices of durable goods and tradable inputs. FX used in foreign trade.	Bi-monetary system, with pricing denominated in the fiat currency. Tax payments in the fiat currency. FX used in foreign trade.	Bi-monetary system, where FX is used to diversify risks in turbulent episodes. FX used in international lending/securities operations (except for sovereign bonds in certain cases).
Highly Dollarized Economy (Type D)	Extended use of the exchange rate for price indexation (high real dollarization and almost complete pass-through from depreciation to inflation). FX used in foreign trade.	Limited scope for fiat currency (tax payments, public expenditure, non-durable goods, and low-value transactions). Extended FX use for durable goods, real estate, capital goods, and high-value transactions.	FX takes over the role of store of value. Lending capacity in domestic currency becomes limited. Most loans become FX-denominated when FX bank deposits are allowed.

A bi-monetary system embodies the failure to conduct monetary policy in an effective way, i.e., secure price stability, efficient payment systems, and well-functioning financial markets (including long-run financial contracts at comparatively low nominal interest rates). Particularly, under high and persistent inflation, market participants defend themselves by shifting to FX.

The most common type of dollarization is financial dollarization (FD), or asset substitution, caused by a poor performance of the local currency. The local currency is used more for *payment* *transactions* but is replaced by the dollar as saving asset or *store of value*, in line with Gresham's law. Under extremely high inflation, such as in Venezuela or Zimbabwe, real dollarization (RD)—i.e., use of the dollar as means of *payment transactions and store of value*—also takes place (Table 1, Type D).

On the one hand, in some countries dollarization is entrenched and a bi-monetary system is formally allowed as it is described in Table 1 for Type C (e.g., Uruguay). On the other hand, in other countries it is not allowed, or dollar accounts are restricted. Under high inflation (e.g., Argentina or the Democratic Republic of the Congo), the public holds a large share of financial assets abroad and local financial intermediation is low. Countries with no history of extreme high inflation (e.g., Malaysia) impose restrictions on dollar deposits, but there seems to be no significant impact on local financial intermediation (Table 1, Type B).

Once a country gets used to a bi-monetary system, the process is not easy to reverse, even when the initial trigger (e.g., high inflation) subsides, a phenomenon known in the literature as hysteresis. The optimal choice between domestic currency vs. FX will depend on the monetary framework and the benefits that each may offer as they co-exist as two currencies.

From the recent performance of bitcoins (and the like), and stablecoins vis-à-vis the functions of money, it is apparent that stablecoins has significant implications for monetary policy design and liquidity management, as a fast-growing stablecoin industry may induce financial disintermediation (Kahn and Singh, 2021). Furthermore, stablecoins backed by central bank reserves allow money supply control with the central bank; this control with the central bank will be diluted, if backed by anything other than central bankreserves. In the case of international currency issuers (U.S. and the Eurozone), higher demand for bonds (e.g., U.S. Treasuries or German Bunds or AAA private bonds) to back stablecoins might result in larger capital markets and smaller banking systems.[1] In other countries, financial disintermediation might take place through capital outflows, as the expansion of stablecoins linked to an international currency may increase dollarization or euroization.[2]

A bi-monetary system limits the role of the exchange rate as a shock absorber, as RD implies a high pass-through from exchange rate depreciation to inflation. FD creates currency mismatches

[1] Kahn and Singh (2021) argue that reserves at the central bank may be the best option to keep stablecoins "stable"; this is preferred to (for example) U.S. Treasuries as collateral as they will be siloed and adversely impact market plumbing; central bank reserves are also more liquid than U.S. Treasuries for T0 settlement. See: If stablecoins are money, they should be backed by reserves - Risk.net.

[2] A similar outcome is expected if a retail CBDC of an international currency is developed, but as of today it is unclear that the Fed or the European Central Bank (ECB) will choose to do that in the near future.

and liquidity risks for the financial system and the economy as a whole. Therefore, the exchange rate amplifies negative external shocks rather than absorbing them. Both FD and RD jeopardize monetary transmission mechanisms, as inflation expectations are difficult to anchor with a weak interest rate channel. FD-related financial instability would need to be addressed via policy responses such as a central bank FX reserve buildup and associated regulation.

The risk of higher dollarization induced by dollar-denominated stablecoins will be larger in countries with high inflation, capital control measures, and/or restrictions to open accounts in foreign currency within the local banking system.

III. Monetary Policy and Central Banks Balance Sheet

Monetary policy actions usually go beyond monetary procedures to reach the operational target or discount window operations as a LOLR. In recent years, central banks in developed economies started to expand their balance sheet in the aftermath of the Global Financial Crisis (GFC), and central banks of developing economies did the same, before resorting to international reserves and other balance sheet operations.[3]

Under a *monetary dominance* regimen, a central bank has full control on its balance sheet under its legal mandate of price stability (or dual mandate in some countries). The profit or losses made by the central bank pursuing its own mandate is taken as a given for the fiscal authority who is responsible for keeping public sector finance sustainable overtime. The equation from the classical paper of Sargent (1981) about the unpleasant monetaristic arithmetic makes this point:

$$b_{t-1} = R^{-1}\sum_{i=0}^{\infty} R^{-i} s_{t+i}^{f} \; + \; R^{-1}\sum_{i=0}^{\infty} R^{-i} s_{t+i}$$

The equation essentially says that the net present value (NPV) of the primary fiscal surplus plus the NPV of seigniorage must be equal to public debt. Therefore, any changes of seigniorage under monetary dominance must be accommodated by a change in the fiscal position. On the contrary, if the digital money revolution occurs under a fiscal dominance regimen and reduces seigniorage, central banks may be inclined to take actions to avoid that situation by raising

[3] According to Ceccheti (2008), the management of a central bank's balance sheet has two general principles. The first is that a central bank controls the size of its balance sheet, and by doing so can affect the level of the risk-free interest rates. The second is that a central bank controls the composition of its assets. Depending on that composition, central banks may influence relative prices of bonds and exchange rates.

inflation tax or preventing the development of financial innovations. From a welfare perspective, it is preferable to have a regime of *monetary dominance* or central bank autonomy as the price stability goal than a *fiscal dominance* regime where central bank is not able to achieve its mandate because of lack of operational independence (Leeper, 1991).

Payment Systems and Seigniorage: If seigniorage is not a constraint (i.e., profits to be transferred to the Treasury), the development of a payment system should focus on how to improve its efficiency. Regulation should encourage a competitive environment of competition where tech firms can innovate, and citizens benefit from these new technologies. For all participants (newcomers and incumbent ones), a level playing field, or the principle of "same regulation for the same type of financial activity or risk", should apply to avoid regulatory arbitrage. Regulators should embrace positive externalities wherever possible (e.g., interoperability networks). Only in cases where private sector does not find it profitable to invest in externalities, should the state step in.

From a monetary policy perspective, the interest rate and credit channel may become weaker in the cases where: (i) a Fintech issues stablecoins backed by treasury bonds; and (ii) substitution of bank deposits by stablecoins in foreign currency. The common factor in these cases is the reduction of banking credit. On the contrary, when CiC is substituted for private digital money that is deposited in the commercial banks, there is an expansion of the banking credit—see Section V for six illustrative cases of how digital money will impact central banks balance sheet line items.

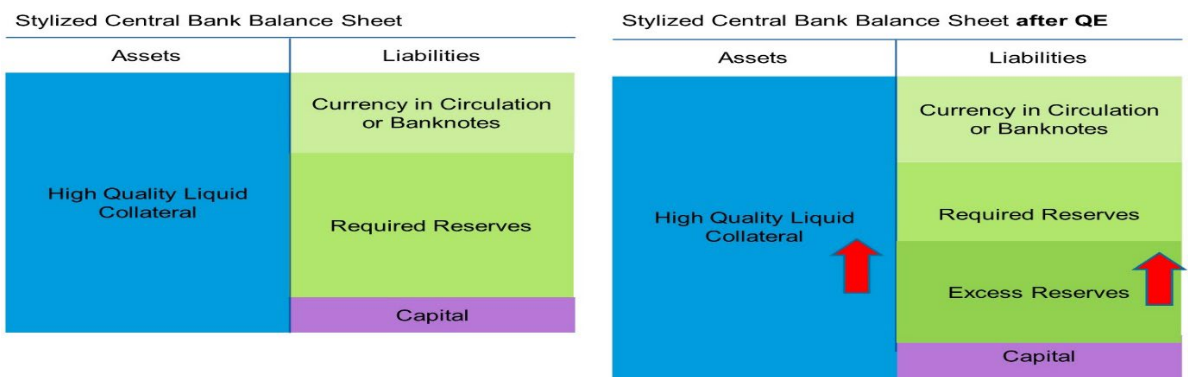
IV. Base Money Issues: M0 or Not

Any CBDC would coexist with other forms of money (so not an exclusively M0 world). The question is what the liability structure even if being distributed by banks (or nonbanks). One state of the world is where someone would have a traditional or bank tokenized deposits (M1), and some balances as CBDC (M0). Or, the bank holds all the M0 (like they do with reserves today) and use that to offer tokenized deposits (M1). The value added of a CBDC may lie in the ability to establish a token platform that enables new technologies to do things that cannot be easily done in traditional systems. The distribution model and account of M1 and M0 could look the same (or different) but the platforms may offer alternatives (see also Adrian and Mancini Griffoli (2019) on synthetic CBDC; Mancini Griffoli et al. (2017)).

Figure 1 shows a standard balance sheet with M0 depicted in a green shade (typically, CiC and required reserves; lately some advanced economies due to QE have excess reserves also). The importance of CiC is illustrated by Bindseil, in his 2016 Jackson Hole speech:

"*[An] outstandingly lean central bank balance sheet was the one of the Fed pre-crisis, where the total balance sheet length was only around 1.1 times the total amount of bank notes in circulation. [ ]...the idea that the central bank permanently injects monetary accommodation through a longer balance sheet with substantial holdings of a portfolio of less liquid assets with long maturity and possibly some credit riskiness does not appear sufficiently convincing.*"

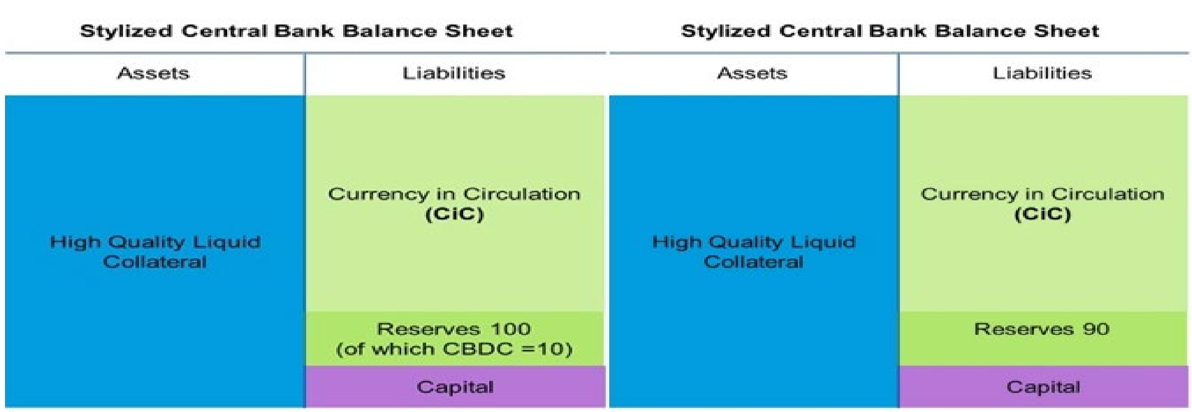
Figure 1. Standard CB Balance Sheet (Focus on CiC and Monetary Base)



Source: IMF staff

Figure 2 shows central bank issued CBDC or a bank/non-bank issued stablecoins counted as part of M0—think of access to central bank master account or payment rails. The central bank acknowledges liability *ex- ante*. So "10" is part of the central bank liability. However, the right side of the figure shows bank/non-bank issued stablecoins, but not a CBDC; so, not a central bank liability *ex-ante*. In this scenario, stablecoins worth "10" will be outside M0; this will be in the liabilities side of banks/nonbanks, as banks/nonbanks issued them by debiting their excess reserves at central bank (preferably ringfenced to back-up their coins). Successful cases of payment interconnection, such as Pix in Brazil and UPI in India, are examples of that trend.

Figure 2. Issuance of CBDC or Stablecoins by the CB (left) or Outside the CB (right)



Source: IMF staff

More importantly, if the basic features of CiC hold (non-interest bearing, no caps, and complete privacy), then CBDC is digital CiC. CBDCs may also play a role in the process of improving payment systems and supporting financial inclusion in the near future. A recent speech by the Reserve Bank of India (RBI) articulates the CiC and CBDC relation very well:[4]

"To sum up, CBDC is the same as currency issued by a central bank but takes a different form than paper (or polymer). It is sovereign currency in an electronic form and it would appear as liability (currency in circulation) on a central bank's balance sheet. The underlying technology, form and use of a CBDC can be moulded for specific requirements. CBDCs should be exchangeable at par with cash."

However, if CBDC deviates from CiC (e.g., interest bearing and/or capped), then it is a different instrument (a policy tool) that arguably targets a new objective.[5] This will be a subtle issue (e.g., as an illustration, if Eurozone's caps CBDC for retail at €1 trillion, with the underlying assumption that caps will not be binding as average retail transactions are around €1 trillion); also see Annex I.[6] Also, digital money velocity (instantaneous payment) will be faster than CiC (Kahn et al., 2002). Thus, a mix of CiC and CBDC in time t+1, may be less than CiC in time t=0; base money may decline; and then so will seigniorage.

For emerging markets, Brazil is at the frontier. The basic idea of Brazil's potential for adopting a CBDC are laid out in Araujo (2022). The paper focusses on CDBD under the premise that it should, in order to be useful, *go beyond* what an instant payments system should do.[7] The underlying economic argument by Brunnermeier and Payne (2022) that describes an economy where a smart CBDC arises as a new instrument for regulation in a digital assets environment

[4] Reserve Bank of India - Speeches (rbi.org.in), July 2021 by Deputy Governor T. Rabi Sankar.

[5] Armelius et al. (2018), suggest non-interest-bearing CBDC supplied according to demand would diminish the impact on a negative policy rate as economic agents now have the chance to demand CBDC which is a closer substitute of financial assets (for example, demand deposits) than CiC.

[6] Visa, Mastercard, and related credit card use has been just over 1 trillion for the eurozone. Visa and Mastercard provide transaction volumes: for example, Q3FY22-Visa-Operational-Performance-Data-FINAL-v2.pdf (q4cdn.com); Page 1, Visa USD 661b; similar numbers for Mastercard (around 600 bn).

[7] The primary use for a digital Brazilian Real is to serve as the basis for a smart settlement platform. The proposed basic architecture, tokenized deposits (in banks or other PSP) constitute a form of private money, effectively fulfilling the role currently played by stablecoins. Digital services could, thus, be built on that form of money. Constraints on unannounced conversion flows (e.g., USD/period of time) among CBDC and other private monies, could suffice to avoid bank runs.

(new objective)—is in line with the Tinbergen rule.[8] If the underlying economics argue for a system to build financial services on top of the digital *real* instead of using their own "stablecoins" then there will be need to reflect the change in the central bank balance sheet. Thus, at present, Brazil's Pix system, an instant payments system, is not part of the M0 world. However, if Brazil adopts CBDC, (assuming benefits are significantly more than Pix offers) then the central bank embraces the additional "10" liability (i.e., 100 in Figure 2, left panel; not 90 as in right panel).

Costs from cyber-risk: Analytically, although the central bank liability is lower if issuance of quasi-CBDC/stablecoins is outside the central bank, ex-ante, large costs "C" (i.e., systemically important) from cyber-risk will be picked up by the regulator, due to financial stability and the too-big-to-fail logic.[9] Thus, it is likely that in wholesale CBDC literature, C will be absorbed by the central bank (or ministry of finance/fiscal authority), irrespective of the issuer. If the costs are small "c" (e.g., as in retail CBDC issuance) then private vendors (i.e., PSPs), or banks/nonbanks/ Fintechs may pick up the cost, c.

This cost issue (C vs. c) is germane to those central banks contemplating both *retail* CBDC and *wholesale* CBDC, especially interoperability between the two. The discussion is preliminary but when the economics and technology of interoperability converges, C and c will not be separable.

V. Monetary Aggregates and Bank Credit Under Digital Money

In this section, we discuss how banking credit and money may change under this new environment of digital money. Our starting framework is a central bank with a policy rate as operational target and we will see the impact of different development of digital money depending on the type of money substitution that take place.

[8] Tinbergen rule: Macroeconomic variables the policy maker wishes to influence are targets; instruments are variables that the policy maker can control directly. Achieving the desired values of a *certain number of targets requires the policy maker to control an equal number of instruments*.

[9] Cyber risk and associated costs much higher than counterfeit paper currency that (in the literature) is not more than 0.01 percent of currency issued. (The costs referred to here have no reference to lower printing cost as fiat money reduces in favor of CBDC.) In the US, Fed is required by law to do full cost recovery for all payments services. This puts the Fed on an even playing field with private sector PSPs. In Euroland, the ECB does full cost recovery minus a "public good" adjustment; thus priced below private sector.

The cases to study are substitution of:

(i) Bank deposits by stablecoins or e-money (assets outside the banking system) backed by banking deposits.[10]

(ii) Bank deposits by stablecoins or e-money (assets outside the banking system) backed by treasury bonds or similar assets (i.e., good collateral).

(iii) Bank deposits by dollar-denominated stablecoins in a partially dollarized economy.

(iv) CiC by e-money.

(v) CiC by CBDC.

(vi) Bank deposits by CBDC (similar to reserves at central bank).

Case (i) Substitution of Banks Deposits by Stablecoins or E-money backed by Banking Deposits

To illustrate this case, our starting point is period 0 when we have a traditional banking system framework with a reserve requirement (RR) of 5 percent on deposits with zero excess of reserves. In order to diversify credit and liquidity risks commercial banks hold 10 percent of deposits at current interest rates at time t=0.[11] At the current interest rates, the preference for CiC (CiC/Money) is 25 percent. M1, M0 and deposits are equal to 4000, 1150, and 3000 respectively.[12] Therefore, the central bank's balance sheet at time t=0 is:

Commercial Bank (t=0)

Assets	Liabilities
2550 Commercial Loans	3000 Individuals' Demand Deposits
300 Treasury Bonds	
150 Reserves at Central Bank	

[10] For example, USDC.

[11] The paper of Bernanke-Blinder (1988) determines a credit channel of monetary policy in a model where banks choose the composition of portfolio among banking reserves, loans and treasury bonds depending on the relative yield between loan rates and bonds and the RR conditions. However they do not consider net worth of the CB.

[12] For illustration we take CiC/M1; any other denominator can also be used (e.g., M0 or the size of the balance sheet).

Central Bank (t=0)

Assets	Liabilities
1150 Interest Bearing Financial Assets	1000 CiC
	150 Reserves

In period t=1, a mobile operator phone company starts to provide e-money and by regulation (or its own decision), the float that the company captures is deposited at a commercial bank. We assume that this e-money improve payments made through the banks, so there is no substitution with CiC at the central bank; only a change in banking deposits that breaks 3000 at t=0 into 2800 (individual demand deposits) and 200 (mobile phone company deposits).

Mobile Operator Phone Company (t=1)

Assets	Liabilities
100 Infrastructures	100 Capital
200 Deposits with Commercial Banks	200 Customer Accounts

Now the balance sheet of the commercial bank looks like this in period t=1:

Commercial Bank (t=1)

Assets	Liabilities
2550 Commercial Loans	2800 Individuals' Demand Deposits
300 Treasury Bonds	200 Phone Company Demand Deposits
150 Reserves at Central Bank	

In this case, there is only a redistribution of demand deposits and no changes of the asset side. The central banks balance sheet does not change at all.[13]

[13] As core elements and regulators of traditional payment systems, central banks have also encouraged more integrated systems, mostly via interoperability, particularly in developing economies, e.g., Pix in Brazil and UPI in India. Pix, a platform created by the Central Bank of Brazil (BCB), interconnects multiple payment systems.

(continued…)

Case (ii) Substitution of Banks Deposits by Stablecoins or E-money Backed by Treasury Bonds (i.e., good collateral)

Let us now see the case of a stablecoin with a policy of keeping 100 percent of treasury bonds as backup of its liabilities (period t= 1a). Our starting point is again period t=0.

Fintech Issuer of a Stablecoin (t=1a)

Assets	Liabilities
100 Infrastructures	100 Capital
200 Treasury Bond	200 Stablecoins

This a case of financial disintermediation. Fintech is increasing the demand for treasury bonds and commercial banks face a withdrawal of 200. Demand for bank reserves falls by 10 (i.e., 5 percent of 200); other market players reaction matter. In the very short term, we can assume that commercial banks will sell bonds to the Fintech, probably with an increasing impact on Treasury bond yield and they will try to avoid fire sales of commercial loans as they are illiquid assets. The central bank would probably sell treasury bonds to accommodate lower banking reserves and therefore there is a moderate reduction of seigniorage. The balance sheet of commercial banks and the central bank may look like this in period t=1a:

Commercial Bank (t=1a)

Assets	Liabilities
2550 Commercial Loans	2800 Individuals' Demand Deposits
110 Treasury Bonds	
140 Reserves at Central Bank	

Connection to Pix is mandatory for payment service providers (PSPs) with more than half a million active customer accounts and voluntary for all other BCB-regulated banks and non-bank entities. Pix interoperability enables individuals, businesses, and government entities to perform instant payments and transfers. For their part, the Reserve Bank of India (RBI) and India's national bank association established a new entity called the National Payment Corporation of India (NPCI), which developed an instantaneous payment interface called the United Payments Interface (UPI) in 2016. Like in Brazil, RBI regulates UPI.

Central Bank (t=1a)

Assets	Liabilities
1140 Interest Bearing Financial Assets	1000 CiC
	140 reserves

As we can see, base money declines from 1150 to 1140 and traditional money (M1) from 4000 to 3800. If stablecoins are included in the definition of broad money, there is no change, and the figure is 4000. Given the nature of the stablecoins, it is likely to have relative more use as a means of payment and less as store of value compared with the average banking demand deposits (in particular time deposits) and therefore the implicit velocity from the quantitative money equation will be larger.[14] An efficient liquidity management for the Fintech will depend on the depth and liquidity of the treasury bond market (including repo market).

In this example, the stablecoins are out of the regulatory (and counterparty) perimeter of the central bank. Under the current framework, central banks run OMO (open market operations) with depository institutions (mainly banks) because they are in charge of the functioning of the payment system. Central banks generally do not transact with capital markets (i.e., mutual funds, hedge funds, private equity, etc.), except in extraordinary circumstances to protect the transmission mechanisms of monetary policy. An open question in this context if authorized stablecoins and PSP should have access to open current accounts at the central bank.[15]

Following our example, in the long run commercial banks may be willing to reaccommodate their portfolio as before given that loans will start to be repaid. Assume that this event will take place in period t=2a. Now the balance sheet of commercial banks will look like this (we assume no changes in central bank's balance sheet).

[14] Fisher's quantitative money theory (MV=PT), suggests that money (M) times velocity of circulation (V), equals average price level (P) times number of transactions (T).

[15] The impact of stablecoins (backed by central bank reserves) on credit and monetary aggregates is similar to the case of CBDC replacing deposits (Case vi). The reason is that in both cases money base increases and banking multiplier falls.

Commercial Bank (t=2a)

Assets	Liabilities
2380 Commercial Loans	2800 Individuals' Demand Deposits
280 Treasury Bonds	
140 Reserves at Central Bank	

Banking credit to the private sector falls 4.8 percent. Large companies may be able to substitute the reduction of the supply of commercial loans by issuing corporate debt in the capital market or from external bank lending. In the case of small and medium-sized enterprises (SMEs) that will not be the case. However, there are other developments in the Fintech world regarding the credit market that could improve financial conditions to SME and consumer loans. On the transmission mechanism of monetary policy, as banking credit shrinks in this case, credit will be lower.

Case (iii) Substitution of Bank Deposits by Stablecoins in Foreign Currency in a Partially Dollarized Economy

It is envisaged that the impact on stablecoins in foreign currency would be larger in countries with relatively high inflation and existing capital controls and restrictions to open deposits in foreign currency. The reason is that there are countries with currencies with the potential to be partially replaced by foreign currency, but regulations make it impossible. To illustrate the argument let's assume now that it is allowed to open dollar deposits in period t=0 and the regulation establish a reserve requirement or liquidity ratio of 25 percent for those deposits.[16] At period t=0 the balance sheets are:

[16] Armas et al. (2015) makes the case of high reserve requirements for foreign currency liabilities as a case of lack of lender of last resort (LOLR) in foreign currency. We asume a zero foreign currency exposure for banks (i.e., no long or short positions).

Commercial Bank with Dollar Deposits (t=0)

Assets	Liabilities
2380 Commercial Loans in Domestic Currency	2800 Individuals' Demand Deposits in Local Currency
280 Treasury Bonds in Domestic Currency	200 Individuals' Demand Deposits in Foreign Currency
140 Reserves at Central Bank	
150 Commercial Loans in Foreign Currency	
50 U.S. Treasury Bond	

Central Bank in the Case of Partial Dollarization (t=0)

Assets	Liabilities
1140 Interest Bearing Financial Assets	1000 CiC
	140 Reserves

Now in period t=1 there are stablecoins in foreign currency, but the demand for them will be lower because citizens have the option to keep dollar savings in the local banking system. For the same reason, the substitution between stable coins and deposits in foreign currency will be larger than the one with local deposits. Assuming the latter is zero and local credit in dollars cannot change in the very short term, the balance sheets are the following:

Fintech Issuer of a Stablecoin in Foreign Currency when Dollar Deposits are Allowed (t=1)

Assets	Liabilities
100 Infrastructures	100 Capital
100 U.S. Treasury Bond	100 Stablecoins in Dollar

Commercial Bank with Dollar Deposits (t=1)

Assets	Liabilities
2380 Commercial Loans in Domestic Currency	2800 Individuals' Demand Deposits in Local Currency
280 Treasury Bonds in Domestic Currency	100 Individuals' Demand Deposits in Foreign Currency
140 Reserves at Central Bank	75 External Borrowing or, CB liquidity to support foreign currency liquidity (e.g., FX swap line)
150 Commercial Loans in Foreign Currency	
25 U.S. Treasury Bond	

Central Bank in the Case of Partial Dollarization (t=1)

Assets	Liabilities
1140 Interest Bearing Financial Assets and CB Liquidity Support in Foreign Currency to Commercial Banks	1000 CiC
	140 Reserves

Capital outflows bring shortage of dollar liquidity in the banking system, and it is faced by borrowing from international commercial banks; or some liquidity support in foreign currency from the CB (as it takes time to adjust and cushion from such capital movements).

In period t=2 when credit can change, and commercial banks would reshuffle their portfolio to overcome the liquidity shortage (i.e., the external borrowing of 75 or, liquidity support, will no longer be needed), with a lower amount of commercial banks in dollars. In our example, the balance sheets are:

Commercial Bank with Dollar Deposits (t=2)

Assets	Liabilities
2380 Commercial Loans in Domestic Currency	2800 Individuals' Demand Deposits in Local Currency
280 Treasury Bonds in Domestic Currency	100 Individuals' Demand Deposits in Foreign Currency
140 Reserves at Central Bank	
75 Commercial Loans in Foreign Currency	
25 U.S. Treasury Bond	

Central Bank in the Case of Partial Dollarization (t=2)

Assets	Liabilities
1140 Interest Bearing Financial Assets	1000 CiC
	140 Reserves

The example shows that the impact on banking credit for a partial dollarization is lower because local deposits in foreign currency allow banking lending in the same currency.[17]

Case (iv) Substitution of CiC by E-money

As shown in Kahn et al. (2022), there is a declining trend of CiC before the pandemic and as the world is leaving the COVID-19 era and entering to a "new" normal situation, the development of digital payment tools will likely continue driving this trend. Let us see now this case starting from period t=0 (without partial dollarization of deposits) and in period t=1b e-money surges induces a substitution of CiC.

[17] A fixed exchange regime will be more vulnerable than a floating rate regime.

Commercial Bank (t=1b)

Assets	Liabilities
2720 Commercial Loans	3000 Individuals' Demand Deposits
320 Treasury Bonds	200 Phone Company Demand Deposits
160 Reserves at Central Bank	

Central Bank (t=1b)

Assets	Liabilities
960 Interest Bearing Financial Assets	800 CiC
	160 Reserves

The substitution of CiC by e-money is equivalent to a reduction of preference of currency. This would entail a larger banking multiplier effect and lower money base (1150 to 960), keeping constant the total amount of Money (4000); CiC as a fraction of M1 is 20 percent now. As a consequence, the supply of credit to private sector increases and the seigniorage falls.

Case (v) Substitution of CiC by CBDC

Today, money is mainly issued by banks, as share of CiC is relatively low, in particular in developed economies (with some exceptions such as Switzerland). In developing economies, the size of CiC as share of GDP is relatively high as many citizens do not have access to banking account (although there is a declining trend). According to Findex 2021, the access of the adult population to at least one banking account is almost universal in Latin America. However, the heterogeneity is large within the region, where Brazil has a relative high share of people with a banking account (84 percent) and Nicaragua only 26 percent. These figures may explain the fact that financial inclusion is a more important argument for emerging and developing economies in the assessment of issuing CBDC.

Next, let us see the case when a CBDC replaces CiC (e.g., for financial inclusion for instance). The only change here is the composition of base money in period t= 1c. Therefore, there is no impact on the transmission mechanism of monetary policy, there is a clear improvement of the efficiency of the payment system and no changes in seigniorage. Digital money *velocity* is higher

(Kahn et al., 2022). Thus CiC (t1)+ CBDC (t1) may/may not be less than CiC(t0), so seigniorage from base money may decline.

Regarding monetary liquidity management, central banks should now include daily movements of CBDC demand as a new autonomous factor to estimate the magnitudes of OMO needed to reach operational target (policy rate or a banking reserve target).

Central Bank (t=1c)

Assets	Liabilities
1150 Interest Bearing Financial Assets	800 CiC
	200 CBDC
	150 Reserves

Case (vi) Substitution of Bank Deposits by CBDC

In this case where CBDC gets enough traction to replace demand deposits, assuming that the services (and underlying economics) of the CBDC exceeds private banking services. The central bank's balance sheet increases (from 1150 to 1340 in our example) and there is a case of financial disintermediation. This scenario has a low probability according to a survey of central banks (BIS, 2022).

Let us see the balance sheets in period t= 1d, when it is not possible to reduce the stock of credit. Commercial banks need to sell treasury bonds to face this liquidity shortage and the central bank must inject liquidity (may be purchasing treasury bonds) to accommodate the higher base money demand.

Commercial Bank (t=1d)

Assets	Liabilities
2550 Commercial Loans	2800 Individuals' Demand Deposits
110 Treasury Bonds	
140 Reserves at Central Bank	

Central Bank (t=1d)

Assets	Liabilities
1340 Interest Bearing Financial Assets	1000 CiC
	200 CBDC
	140 Reserves

In our numerical example commercial banks can face the liquidity shortage because they have enough good collateral (treasury bonds with a deep secondary market and low credit risk). One obvious buyer of those treasury bonds is the central bank as base money demand has increased. However, in an extreme case the stock of holdings of treasury bonds or other similar assets may be lower than the amount needed to cover banking withdrawals. In this extreme case, liquidity shortage may increase interbank rates significantly above the policy rate if the central bank does not extend the list of collateral to run monetary operations.

In period t=2d commercial banks reduce the amount of commercial loans from 2550 to 2380 to match the availability of deposits. Therefore, we expect a weaker interest rate and credit channel of monetary policy.

Commercial Bank (t=2d)

Assets	Liabilities
2380 Commercial Loans	2800 Individuals' Demand Deposits
280 Treasury Bonds	
140 Reserves at Central Bank	

VI. Conclusion

Digital money will have implications for banking intermediation, external capital flows, and central banks balance sheet. If the digital money revolution occurs under a fiscal dominance regime and reduces seigniorage, central banks may be inclined to take actions and compromise that situation. Under a monetary dominance regime (i.e., independent monetary policy), the development of a payment system should focus on how to improve its efficiency, without jeopardizing the monetary policy transmission.

Depending on the type of substitution that takes place between traditional money and digital money, there could be banking disintermediation as deposits move away from commercial banks. Stable coins in foreign currency may increase international financial integration, while developing economies will face new challenges vis-à-vis capital flows. Furthermore, the operational aspects of digital money and the impact of CBDC on financial disintermediation are in their infancy; thus, it may be preferable to use interest rate on CDBC only in extraordinary cases (and this remains a debatable issue as policy makers implement their pilot studies in this area).

From a monetary policy perspective, this paper summarizes cases where the interest rate and credit channel may become weaker when there are instances such as Fintech issues stablecoins being backed by treasury bonds, or there is substitution of bank deposits by CBDC or even when there is substitution of bank deposits by stablecoins in foreign currency—a possible scenario in developing economies. The common factor in these cases is a reduction of banking credit. However, when CiC is substituted by private digital money that is deposited in commercial banks, there may be an expansion of banking credit.

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Annex I. Potential Impact of Value-Based CBDC with a Cap for Relative Small Amounts

Country Case/ Function of Money	Unit of Account	Mean of Transactions	Store of Value
Issuer of International Currency	None.	CBDC may have relatively small scope to be demanded by residents as those economies already use non-cash tools for most of transactions. More substitution possibilities with CiC in particular from non-residents holders.	Minor impact in the case of residents. More demand from non-residents as safe-haven asset, in particular those with low access to foreign currency accounts.
Open Economy Under Dominant Currency Paradigm	None.	CBDC may encourage competition for faster and lower transaction cost with traditional banking payment system in domestic currency. It has a potential as financial inclusion mechanism if traditional banking is not able to fill the gap; more substitution with CiC is expected.	Minor impact, except in periods of banking crisis where demand for both CiC and CBDC may increase.
Partially and Highly Dollarized Economy	None.	CBDC may encourage competition for faster and lower transaction cost with traditional banking payment system in domestic currency. It has a potential as financial inclusion mechanism if traditional banking is not able to fill the gap. It is expected more substitution with CiC. It could reduce payments dollarization.	Minor impact, except in periods of banking crisis where demand for both CiC and CBDC may increase.
Note: While this may be a possibility in the future, all currently ongoing retail CBDC initiatives center on domestic access only (this is different for wholesale CBDC).			

PUBLICATIONS

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