

Central Bank Digital Currencies: a proper reaction to private digital money?

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The emergence of private digital currencies poses a threat to payment systems and monetary policy because they challenge all functions of money as we know them. In this paper, we focus mainly on the banking and monetary policy issues raised by stablecoins and Central Bank Digital Currencies (CBDCs). We begin by describing the current working of bank-centered payment systems. We next touch upon cryptoassets and focus on the domestic and international impact of stablecoins. We identify two problems with stablecoins: their role in the breakup of uniform currency, and as a source of financial instability due to the lack of a monetary backstop in the event of a run to withdraw funds in adverse situations. We then deal with the pros and cons of CBDCs, whether they are an adequate response to the challenges raised by stablecoins, their possible impact on monetary and banking policy, and some open economy issues. While we do not see major advantages in private digital currencies as a payment system or as an investment, we also do not find any robust motivation for the introduction of CBDCs beyond geopolitical reasons and the oversight of a technological area.

Keywords: *Stablecoins, CBDCs, endogenous money, narrow banking, payment system, banking intermediation, financial instability*

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*‘The most important financial innovation that I have seen the past 20 years is the automatic teller machine.’ Paul Volcker, *New York Post*¹*

1 INTRODUCTION²

The emergence of private digital currencies (DCs) is one more step in the technological revolution that is sweeping an increasingly cashless financial system.³ Still, they

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1. See <https://nypost.com/2009/12/13/the-only-thing-useful-banks-have-invented-in-20-years-is-the-atm/>.

2. Specific page numbers for the citations are not indicated when not identifiable in the online documents.

3. Prasad (2021, ch. 3) distinguishes between innovations that improve already existing products and innovations of greater depth that transform the structures or mechanisms of financial markets, making room for new products and services. Private digital currencies fall into this category.

also pose a threat to our monetary and payment systems because they challenge almost all functions of central bank money on which the entire structure rests: they are a new unit of account; they can be used to settle debts through new channels based on crypto-technologies without using central bank reserves or relying on banks as intermediaries; and their function as a store of value is undermined to the extent that their market valuation is grounded on speculation.

Two types of *private* digital currencies can be roughly identified: (i) unbacked *cryptoassets*, which are pure assets and are, therefore, not a liability to anyone (perhaps the most famous is Bitcoin); and (ii) asset-backed *stablecoins*, which are a liability to their issuers once they collect assets in the process of selling this currency. The main problem with the former is their unstable value, caused by a rigid supply and a demand that is very sensitive to its expected future price (Landau 2022). As to the latter, it recalls the Free Banking Era (Eichengreen 2019), when several private agents issued their own currencies without the support of a central bank.

The advantages of using private stablecoins come hand in hand with the financial stability risks stemming from the breakup of a uniform currency of a monetary system by big issuers that lack the liquidity backstop of the central bank. This is a serious problem in the event of investors rushing to withdraw funds quickly (Landau 2021, p. 12, 15). As an alternative to prohibiting the issuing of a private currency, authorities can offer a public digital currency that is a safer competitor for cryptocurrencies. However, this solution also has some secondary effects: banks may see their funding getting more expensive (and more volatile) if depositors prefer to use central bank money instead of bank deposits. This could affect the profitability of banks and the interest rate at which they grant credit.

In this regard, digital currencies have given rise to two opposing fronts: the alarmed, who see impending dangers of domestic or foreign origin that must be addressed through the establishment of central bank digital currencies (CBDCs): *si vis pacem, para bellum*; and the relaxed, who believe that issues can be resolved through public regulation and do not necessarily require central bank involvement. In our view, while cryptocurrencies have brought about some uncertainty regarding the evolution of monetary and payment systems, no actual revolution beneficial to ordinary citizens is still in sight. It can be argued at present that while the instability brought about by cryptocurrencies can be checked through strict regulation (or prohibition), which depends on political will, the main motivations for CBDCs are geopolitical, basically an *ex ante* defense of sovereignty over a technological territory. Like Chieftain Drogo in Dino Buzzati's *The Tartar Steppe*, Western central banks vigilantly await the assault of some remote hostile population that they glimpse moving over the horizon, beyond the desert: but is it a mirage?

In this paper, we focus mainly on the motives and the consequences of issuing CBDCs for the monetary and banking system, particularly in view of the challenges raised by stablecoins. Given our expertise, we will not go into the technical details of the decentralized circulation of digital currencies. Innovations in payment systems that do not require the participation of banks are often seen as the novelty that will, somehow, survive the present issues with these new forms of money (the literature on these aspects include, among others, Auer et al. 2021a; BIS 2021; Grasselli and Lipton 2022; Prasad 2021; Azar et al. 2022; Panetta 2022; Munchau 2022).

Section 2 illustrates the current workings of bank-centered payment systems. Section 3 touches upon cryptoassets, and Section 4 focuses on the main risks posed by stablecoins that should motivate CBDCs. In Section 5, we deal with CBDCs and discuss its pros and cons, looking at the possible impact on monetary policy and bank lending. Finally, Section 6 lays out the conclusions.

2 BANKING PAYMENT SYSTEMS AND E-MONEY

In present times, most payments are made using bank transfers. These are brokered by the banking system, which in turn carries out its transactions through the mediation of the central bank. In short, it is a hierarchical system. Bank deposits are created *ex nihilo* when banks grant credit. Deposits can then be used as a means of payment to cancel a debt between two agents by transferring them from the debtor's bank to the creditor's bank. While the debt between banks' customers is thus settled, a new debt is created between banks which, in turn, is settled through the transfer of central bank reserves between banks' accounts on the liability side of the central bank's balance sheet. The central bank, which is the only provider of reserves, conducts monetary policy by fixing the (policy) interest rate at which it lends reserves to the banking system and ultimately controlling the (operative) interest rate in the monetary (reserves) market, keeping a smooth working of the payment system in view.

Nowadays all these operations are normally carried out online. Notably, both bank deposits and reserves (often called wholesale CBDCs) are digital currencies that were in use well before the current advent of new technologies and cryptocurrencies (Panetta 2022).

Credit card or prepaid card payments are variants of bank deposit transfer payments. When we use a *credit card* to make a payment, our creditor currently receives a deposit advanced by the card issuer; at the end of the month, our debt is settled by a transfer from our account to the card issuer's account. The latter has thus granted us temporary credit, which is why the use of the card involves commissions (partly paid by the seller). The same thing happens with *prepaid cards*. When we load one, it is as if we have made a withdrawal from an ATM. Unlike banknotes, however, prepaid card payments are an order to our bank to transfer a certain amount from our account to the payee account, within the limits, of course, of what we have loaded on the card.

For at least a couple of decades, new forms of payment based on so-called electronic money (such as PayPal, Alipay, etc.), have become established, offering a variety of additional services. In Asia, and in some African countries, retail payments via mobile phone (e-wallet) have become very popular, using a service offered in China by operators such as Alipay, that are now also active in Europe. In this region, however, the use of cash and credit cards is still widespread – except in Sweden, where cash is disappearing (see Rösl and Seitz 2022 for updates on the use of cash in the euro area; Skingsley 2018 for information on the use of means of payment in Sweden). In Europe, PayPal is very popular for online payments, thanks to its presumed advantages over the use of a traditional credit card, including its ease of use, supposedly greater security, the possibility of sending and receiving money transfers and payments to other PayPal account holders, and insurance in the event of non-delivery of the items purchased (see Kantar Public 2021).

Be that as it may, the use of these forms of e-money is comparable to that of banknotes. Once an agent has transferred an amount of money from her bank deposit to the account of the e-money operator, she can then make a payment to another agent who also has an account with this operator. The recipient agent might in turn make other e-money payments or transfer this deposit back to her bank. Hence, e-money circulates just like banknotes that are drawn from a bank deposit and can be turned back into them. Moreover, e-money operators are obliged (at least in the European Union) to convert their currencies one-to-one into legal tender (which makes them attractive), they cannot issue loans, and they must hold only very liquid assets.

In short, although e-money systems differ from payments using bank transfers, they do not represent a disruption of the traditional payment system (see, for instance, Bilotta and Botti 2021, p. 19).

Two types of private digital currencies can be distinguished: *unbacked cryptoassets* and *backed cryptoassets* or *stablecoins*. Let us examine them.

3 UNBACKED CRYPTOASSETS

Also known in short as cryptoassets, unbacked cryptoassets are an asset to the issuer and a liability to no one. These digital currencies are not backed by financial or real assets, and their supply is rather inelastic,⁴ so their value is extremely volatile as it is merely determined by the price that the market is willing to pay at any given time. Since they do not ‘behave as a safe asset’ and, therefore, are of limited efficiency as a means of payment⁵ (apart from illicit transactions) and as a store of value, can a demand for cryptoassets exist ‘other than for speculative purposes?’ (Landau 2022).

‘Cryptoassets grew by roughly 200% in 2021, from just under \$800 billion to \$2.3 trillion today’, Cunliffe (2021, p. 2) reports,⁶ compared with \$250 trillion of global financial assets. A full 95 per cent of this \$2.3 trillion, Cunliffe (2021, p. 3) adds, is composed of unbacked cryptoassets. The number of individuals who invested in cryptoassets is not irrelevant, (2.3 million in the UK alone, *ibid.*, p. 4), although financial institutions, especially banks, are much less directly involved. The volatility of cryptoassets can obviously lead to direct losses for holders, but also for other parts of the financial market (especially those who take leveraged positions) where, for example, ‘a severe drop in the value of cryptoassets could trigger margin calls on crypto positions forcing leveraged investors to find cash to meet them, leading to the sale of other assets and generating spillovers to other markets’ (*ibid.*, p. 5).

Prevailing Neoliberalism may have suggested a broad tolerance for cryptoassets in the name of market freedom,⁷ despite the evident waste of material energy and intellectual resources on purely speculative and often illicit pursuits. The ECB’s view leaves no room for doubt. As one member of the ECB’s governing board, Fabio Panetta (2021c) puts it: ‘In spite of the substantial sums involved, there is no sign that cryptoassets have performed, or are performing, socially or economically useful functions. They are not generally used for retail or wholesale payments, they do not

4. Prasad (2021, ch. 4, p. 108, 125) explains why the Bitcoin supply is limited in accordance with the Bitcoin protocol at 21 million. One paradoxical consequence of this supply inelasticity is that, despite Bitcoin being conceived as a means of exchange, it came to be seen as a store of value because investors thought that its value was not subject to debasement by an unlimited supply.

5. Contrary to the view that ‘money is debt’, very often held by Post-Keynesian authors (for example, Wray 2022, ch. 1), we agree with Lawson (2019, 2022), that such a requirement is not needed: money is what the members of a society accept as a means to settle debts and has a stable value. In that sense, a non-backed cryptocurrency like Bitcoin might become money in a social group if all members accept it as a means of payment. However, as Lawson (2022) notes, this is not the case because of its unstable value. See also Palley (2001-02, pp. 217–218).

6. For more recent data, see for instance <https://coinmarketcap.com/charts/>. Here we can see that the market capitalization of cryptoassets peaked in November 2021, and since then has fallen by roughly 70 per cent in one year (January 2023).

7. Supporters of cryptoassets have found some justification in Hayek (1976). For a critical view, see Brunnermeier et al. (2019).

fund consumption or investment, and they play no part in combating climate change' (see also Bindseil et al. 2022). Prasad (2021) tempers this conclusion by arguing that, despite the uselessness of cryptocurrencies as a means of payment or even stores of value, the technology on which they circulate, the so-called Digital Ledger Technology and blockchain, will outlast them.

Keeping the purposes of this paper in mind, and leaving financial instability aside, cryptoassets do not seem to present particular challenges to the banking and monetary systems. For this reason, we will conclude our exploration of the topic here.

4 ASSET-BACKED STABLECOINS

4.1 Description

Like e-money, stablecoins are digital assets that promise full and stable convertibility into official currency. However, they differ in the sense that the unit of account for stablecoins has a different denomination from official currency; the payment method (token based) is digital, and to some extent, anonymously transferable, like cash, without any intervention by banks or central banks. They also differ when it comes to services offered, with stablecoins having been mostly concentrated on digital asset trading platforms until now.

Issuance of stablecoins is very simple. Let us take a stablecoin, call it 'Goofy' and assume an exchange parity of $1\text{€} = 1 \text{ Goofy}$. In the example below, a household transfers 100€ from a commercial bank deposit to the Goofy operator, in exchange for 100 Goofies. Next, the Goofy operator employs the bank deposit to fund the purchase of a financial asset. The sequence of Figure 1 does not appear to differ significantly from the acquisition of e-money described in Section 2. However, in addition to the denomination, the electronic platform through which stablecoins circulate may differ, as well as the services provided by that platform.

From an endogenous money view, Aramonte et al. (2021, p. 25) single out the difference between 'liability-driven' stablecoins and an 'asset-driven' banking system: unlike banks that issue liabilities (deposits) by creating assets (loans) on demand, issuers of stablecoins create liabilities (stablecoins) when they receive assets. In keeping with this view, Fed Governor Christopher Waller (2021b, p. 123) assimilates fully backed stablecoins to 'narrow banks' which 'hold only liquid, very safe assets that back up their liabilities 100% ...' and '... do not make loans or hold risky securities'.⁸ Is this only true in principle?

To date, stablecoins are mainly in demand to facilitate trading, lending, and borrowing of other digital assets across digital platforms, especially in decentralized finance (DeFi).⁹ Nevertheless, in the near future, it is possible that they might also be used as currency for everyday transactions (Brainard 2022, p. 2).¹⁰ It is the latter use that raises

8. On 'narrow banking', see Section 5.3.3.

9. See PWG (2021, p. 2, 8); Azar et al. (2022, p. 5) and Levy Yeyati and Katz (2022). On DeFi, see for instance Allen (2022), Aramonte et al. (2021), Born et al. (2022) or OECD (2022).

10. 'Several existing stablecoin issuers ... have the stated ambition for the stablecoins they create to be used widely by retail users to pay for goods and services, by corporations ... , and in the context of international remittances. The extent to which stablecoins will be used for these purposes is difficult to predict However, the transition to more widespread use could occur quickly: for example, due to network effects or the ability of stablecoins to expand through relationships with existing user bases or platforms' (PWG 2021, p. 8). Facebook's Libra/Diem

Commercial bank		Goofy operator (G)		Household (H)	
	Deposit (H) -100€			Deposit -100€	
	Deposit (G) +100€	Deposit +100€	Goofy +100	Goofy +100	
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		Deposit -100€			
		Assets +100€			

Note: N.B. 1€ = 1 Goofy.

Figure 1 Issuance of stablecoins

the most interest among academics and central bank officials. And it is on the problems that such use may cause that we focus our attention in the following sections of this paper.

4.2 Domestic concerns of stablecoins: the breakup of uniform currency and financial stability

In advanced market economies, a large proportion of money is issued by private banks in the form of deposits and is denominated in the official unit of account. People accept this bank money because of its exchangeability, which is on par with central bank money. Confidence is reinforced by the existence of deposit insurance mechanisms. Moreover, banks are supervised and regulated by their respective central bank, which checks their solvency and is also ready to be the lender of last resort, provided that banks have sufficient eligible collateral. A monetary system adopts ‘uniform currency’ when there is only one unit of account and ‘all monetary instruments with the same nominal value will be exchangeable at par in all circumstances’ (Brunnermeier and Landau, 2022, p. 16). The uniformity of currency increases the efficiency of a monetary system; in particular, it avoids the existence of multiple exchange rates between different types of money which could lead to the emergence of separate ‘digital currency areas’ (Landau 2021, p. 14). It also allows the central bank to keep some control over it, mainly through the rate of interest on the reserves of which it is the monopoly issuer.¹¹

The issuance of stablecoins challenges the uniform currency of a monetary system because they involve different units of account and a stable exchange rate with official currency is promised but not guaranteed (Arner et al. 2020, pp. 10–12; Aramonte et al. 2021, p. 5; Hohanen 2021; Velasco 2021; Waller 2021c, p. 6). Unlike bank deposits, the convertibility of stablecoins rests on the value of the reserve assets that the issuers hold on the asset side of their balance sheet. Those reserve assets may not be enough to

project was an attempt to launch a stablecoin to be used as a means of payment by retail users. For an account of this project, see for instance Prasad (2021, pp. 168–175); see also footnote 24 in this paper.

11. The uniformity of currency is the result of a historical process, with the American Free Banking experience during the nineteenth century, which ended with the Federal Reserve Act of 1913 as a good example of this (Brunnermeier and Landau 2022; see also Eichengreen 2019).

guarantee that stablecoins can be transformed into legal currency when required, for two reasons: on the one hand, their value may fall, especially in the event of a run on stablecoins (Panetta (2020) mentions it could happen not only when investors expect a fall in the value of the reserve assets but also if issuers ‘are perceived as being incapable of absorbing losses’). On the other hand, stablecoins may be only partially collateralized – for instance, Eichengreen (2019, p. 7) reports that while Saga, a digital currency, was initially issued under a 100 per cent reserve backing, its reserve asset ratio later declined to around 10 per cent.¹² One recalls the American free banking anarchy in the nineteenth century (Eichengreen 2019; Gorton and Zhang 2023, pp. 940–945; Bordo 2021a):

In the event of a run on the Reserve, ... rather than forcing the Libra¹³ Network to convert its securities into cash and incur fire-sale losses, the Libra Network might adopt redemption stays (delays in providing cash) and early redemption haircuts (additional fees for redemption). Financial historians will recognize these devices for what they are. They resemble the clearinghouse certificates issued by bank groups in the US in the 19th century in response to bank runs and financial crises. This practice created a situation where not every dollar was as good as every other dollar. It was this unsatisfactory state of affairs that led to the establishment of the Federal Reserve System in 1913. (Eichengreen and Viswanath-Natraj 2020)

Convertibility risk increases the possibility of runs on stablecoins, which in turn may lead to direct and indirect financial instability. Among other risks, Panetta mentions the possibility of destabilizing markets where safe assets backing stablecoins are traded, especially under a ‘fire sale’ of reserve assets following a large-scale redemption of stablecoins.¹⁴ Díez de los Ríos and Zhu (2020) point out the difficulty of the central bank to act as a lender of last resort in the event of a liquidity crisis in a scenario where the financial system is dominated by private digital currencies.

Additionally, if stablecoins are used as a store of value, ‘a large shift of bank deposits to stablecoins may influence banks’ operations and the transmission of monetary policy’ (Panetta 2020; Financial Stability Board 2020, p. 14). The problem might become more pressing if issuers also get engaged in lending activities.¹⁵ While this latter case would also mean a return to the anarchy of Free Banking, as Brunnermeier et al. (2019, p. 8) point out, in the event that issuers begin to lend in stablecoins and agents sign contracts in the new unit of account, the monetary policy transmission mechanism may also be affected: if a stablecoin reaches the status of a true parallel currency (see Section 4.3), the central bank will have little to no influence on the interest rate that platforms (and banks) could charge to loans granted in a different unit of

12. A weak regulatory and supervisory frame may facilitate fraudulent behavior by the custodian of assets backing stablecoins, leading to a run when investors lose confidence in the financial management of those assets by the stablecoin issuer. For further details regarding the risks associated with stablecoins, see PWG (2021, sec. II), Allen (2022, pp. 10–15), or Azar et al. (2022, pp. 7–9), among others.

13. See footnote 10 in this paper.

14. Smialek (2022) recalls that Tether, the largest stablecoin, had invested half of its assets in short-term commercial paper. That debt market melted down in March 2020, ‘forcing the Fed to step in to fix things’.

15. From a historical point of view, this is a well-known temptation (Arner et al. 2020, p. 15). Allen (2022, pp. 10–12) warns of this possibility, showing certain similitudes between DeFi and shadow banking.

account, because in that situation central bank reserves would no longer be needed to settle debts or to convert deposits into cash (Palley (2002-03) had presciently noted this problem before the emergence of cryptoassets).

Summing up, stablecoins are still being used mostly for trading on digital platforms. However, if they come to be used as a generalized means of payment by households and businesses, they may break the uniformity of domestic currency reached over a century ago, bring about financial instability, and invade banking credit activities and the monetary policy authority on interest rates. The threat is real. But is this just a matter of financial regulations and surveillance or does this justify the introduction of CBDCs? Further troubles caused by stablecoins at the international level could also become a reality.

4.3 International concerns with stablecoins: dollarization and alternative payment systems

Insofar as they are transborder currencies, stablecoins are said to facilitate international transactions,¹⁶ which will not take place in the traditional centralized clearing and settlement scheme.¹⁷ Lack of control may allow for the international financing of illegal activities (money laundering, tax evasion, terrorism activities, etc.).

A second alleged advantage of stablecoins would be their easier accessibility for households than bank accounts, thus increasing financial inclusion. These advantages may be more relevant in developing countries with weak monetary and banking systems or frequent episodes of high inflation, and whose monetary authority lacks credibility (IMF 2020).¹⁸ In these countries, stablecoins might even be seen as safer assets vis-à-vis domestic currencies. Stablecoins might thus become a true parallel currency, causing a problem of ‘dollarization’ (for example, Brunnermeier et al. 2019, p. 28).¹⁹ A key difficulty in those countries is that, very often, the local currency is not directly convertible into stablecoins, which are provided globally by non-resident Big Techs that presumably wish to be paid in international (reserve) currencies. Consequently, the benefits that may come with the introduction of global stablecoins will be accompanied by risk and vulnerability for the local currency: namely, the financial instability

16. Kuehnlenz et al. (2023, p. 8) hold that Big Techs issuing stablecoins have entered the market for cross-border transactions once banks have stopped serving them, because of higher transaction costs and risks stemming from anti-money-laundering (AML) regulations. This was particularly relevant in emerging market and developing economies.

17. A detailed account of how digital currencies can be used for international transactions can be found in Bindseil and Pantelopoulos (2022).

18. Financial inclusion is a problem in developed economies as well. As the Board of Governors of the Federal Reserve System (2022, p. 8) reports, ‘Digital financial services and commercial bank money have become more accessible over time, and increasing numbers of Americans have opened and maintain bank accounts. Nonetheless, more than 7 million—or over 5 percent of U.S. households—remain unbanked. Nearly 20 percent more do have bank accounts, but still rely on more costly financial services such as money orders, check-cashing services, and payday loans’.

19. ‘The madness of dollarization is that it tends to be adopted by countries suffering from chronic shortage of foreign exchange caused by structural deficiencies of competitiveness’ (Franklin Serrano quoted by De Lucchi (2013, p. 339) to which we refer for criticism of dollarization in an endogenous money perspective).

brought about by larger and more volatile capital flows, and limits to the conduct and transmission of monetary policy when issuers of the currency do not need local central bank reserves.

Levy Yeyati and Katz (2022) extend the parallelism to currency boards in which, like in Argentina in the 1990s, ‘if there is secondary creation of inside money [loans in stablecoins], the backing will prove to be badly inadequate [mainly consisting of reserves in foreign currencies]’.

From a geopolitical standpoint, stablecoins issued abroad will pose a threat to the international payment system as a tool for sanctions and embargoes at the international level (the *de facto* international payment system is SWIFT, under the control of the US): the threat of being disconnected from the international payment system network is an extremely powerful weapon. As Fantacci and Gobbi (2022, secs. 3 and 4) put it, the proliferation of stablecoins might be seen in light of international tensions, as a strategy to avoid being disconnected from international clearing and settlement systems. Eventually, digital currencies and alternative payment systems may even challenge the status of the US dollar as *the* international currency. The verdict on such an eventuality will depend on political events.

4.4 Just a question of regulations?

As mentioned previously, Waller (2021b, p. 123; 2021c, p. 6) likens strictly regulated stablecoins to ‘narrow banks’. He maintains that ‘despite the jargon surrounding stablecoins, we can also understand them as a new version of something older and more familiar: the bank deposit’. He dismisses the idea, however, that the issuance of stablecoins be restricted to banks, precisely because ‘it serves as a viable competitor to banking organizations in their role as payment providers’ (ibid., p. 9).²⁰ In this sense, he is in favor of well-regulated stablecoins as ‘a source of healthy competition for existing payment platforms that can help the broader payment system reach a wider range of consumers’.²¹ In particular, regulation should ban lending activities:

If an entity were to issue stablecoin-linked liabilities as its sole activity; if it backed those liabilities only with very safe assets; if it engaged in no maturity transformation and offered its customers no credit; and if it were subject to a full program of ongoing supervisory oversight, covering the full stablecoin arrangement, that might provide enough assurance for these arrangements to work. (Ibid., pp. 9–10)

Highly regulated stablecoins could also be assimilated into e-money, by adopting more exoteric denominations. Thus, ‘well-behaved’ private non-bank digital currencies would not alter the basic working of the system of payments and of monetary policy. Conversely, Arner et al. (2020) are more skeptical of stablecoins, maintaining that traditional financial institutions and/or a CBDC may well perform the same new functions stablecoins supposedly carry out.

20. BIS (2021, p. 68) mentions the exorbitant costs for merchants but ultimately for consumers of current payment systems such as credit or debit cards (costs that can reach up to 1 per cent of GDP in some regions). Of course, the entry of global players into payment systems might not necessarily guarantee more competition.

21. To the extent that stablecoins are well regulated, Waller (2021a) is similarly skeptical of the usefulness of CBDCs as an alternative to stablecoins.

Eventually, strictly regulated stablecoins, whose issuers would be prohibited from lending, would not differ much from the e-money described above in Section 2. As the BIS (2021, p. 67) puts it:

To the extent that the purported backing involves conventional money, stablecoins are ultimately only an appendage to the conventional monetary system and not a game changer.²²

Indeed, this seems to be the direction in which the European authorities are moving: regulating the sector but leaving room for innovative solutions in the payment system (including the introduction of CBDCs).²³ The Federal Reserve seems to share this position. As Lael Brainard, a member of the Board of Governors of the Federal Reserve System, puts it: ‘It is prudent to explore whether there is a role for a CBDC to preserve some of the safe and effective elements of the financial system of the present in a way that is complementary to the private sector innovations [say, new forms of digital money] transforming the financial landscape of the future’ (Brainard 2022, p. 4).²⁴

4.5 Final thoughts on stablecoins

Summing up, there are two interrelated problems with stablecoins that may lead to central banks offering CBDCs. Firstly, it is not a given that stablecoins will be convertible at a one-to-one rate into fiat currency (Panetta 2020). The fluctuating value of the reserve assets, especially in a run on stablecoins, raises this possibility. The situation will prove even more problematic if providers of stablecoins shift from narrow banking to ‘free banks’ by granting credit, and thus creating more stablecoins than safe reserve assets. A further consequence, especially in countries with weak currencies and monetary authorities that lack credibility, is that the stablecoin platforms might create a *parallel currency* which could pose a threat to financial stability and the central bank’s authority and control of the economy. Total or partial substitution of local currencies with stablecoins in developing economies may bring about the same problems as dollarization (for example, Bradbury and Vernengo 2008; Landau 2021 p. 15).

The second problem is that due to the intrinsic characteristics of the platform’s business (economies of scale and scope, externalities as a result of more people participating in the same network, and the ability to manage vast amounts of data from a large number of users), there is a natural tendency for big platforms to become even larger, leading to an oligopolistic market structure with just a few large corporations dominating the world market. The dynamic is reinforced by the rapid pace of technological innovations occurring in the payment system.

The combination of both problems may lead to large platforms being able to create a parallel monetary system, which is hard for central banks to keep under control (Brunnermeier et al. 2019, p. 28). Monetary authorities have two (not necessarily alternative) options: either regulating platforms or issuing their own CBDCs, challenging private stablecoins. Efforts at regulation might have to deal with the economic and political power of proponents, as well as the difficulty of controlling issuers based offshore. In short, the problem lies in the potential threat that platforms may create of

22. See also Ferrari and Ferrero (2020, pp. 38–40).

23. See, for instance, Lagarde and Panetta (2022).

24. It is not clear if the final abandonment of the Libra/Diem project was due to a greater than expected disciplinary power of regulators (the Fed) or, on the contrary, to the Fed not giving the green light to the project once it realized that its regulatory powers were not up to the task (see Baker et al. 2022 and, especially, Murphy and Stacey 2022).

central banks behaving as issuers of a non-official currency: a problem of authority and power. Let us now turn to the alternative option of CBDCs.

5 CBDCs

5.1 Definition

A CBDC can be defined as the possibility for the private non-financial sector to hold current accounts at the central bank, or ‘reserves for all’, as Niepelt (2021) put it.²⁵ In formal terms, CBDCs are issued as shown in Figure 2.

In step 1, the deposit at the commercial bank, held by the non-financial private sector, is converted into a deposit at the central bank, in CBDCs; the deposit then disappears from the liability side of the commercial bank’s balance sheet and, simultaneously, the central bank transfers an equivalent amount of reserves from the bank’s current account to the CBDC account of the non-financial private sector. Next, in step 2, the central bank replenishes the volume of reserves that the commercial bank is required to hold (or in any case necessitates for payments) by means of a refinancing loan. In this process, the liability side of the commercial bank’s balance sheet has changed: the deposits are replaced by central bank refinancing loans.

Several reasons have been provided for the introduction of CBDCs, each subject to some objection.

5.2 The Drogo syndrome: motivations for the introduction of CBDCs

An *initial* set of motivations is related to a possible progressive *demise of physical cash* (Landau 2021, p. 13; Panetta 2021b). The increasing presence of e-commerce and changing habits associated, for instance, with the increasing use of mobile payment apps are supposedly causing a decline in the use of banknotes. Other factors,

	Commercial bank		ECB	Non-financial PS	
<i>Step 1</i>	Reserve – 100 €	Deposit – 100 €	Reserve – 100 € CBDC + 100 €	Deposit – 100 € CBDC + 100 €	
<i>Step 2</i>	Reserve + 100 €	Refinancing loan + 100 €	Refinancing loan + 100 €	Reserve + 100 €	

Note: PS = private sector.

Figure 2 Issuance of CBDCs

25. Unlike current accounts, the public could obtain CBDC tokens that can be more anonymously spent using an e-wallet. Concerns over the control of illicit activities would suggest a policy preference for CBDCs in the form of deposits (Auer et al. 2021b; BIS 2021, p. 72; Meaning et al. 2021).

like the COVID-19 shock, have contributed to this shift toward substituting cash with electronic means of payment. CBDCs should be seen, in this sense, as the natural evolution of cash whose use declines over time. After all, CBDCs would be nothing more than a form of digital cash that would substitute physical cash (Meaning et al. 2018, pp. 4–5).²⁶

More importantly, ultimately, bank deposits are widely accepted for payments because they can be exchanged at parity with legal tender, which is viewed by the general public as the means of payment *par excellence*. Fatás (2021, pp. 51–52) talks of ‘physical currency’ as the cornerstone of trust in private money since: ‘Private forms of money – bank deposits – coexist with physical currency, but individuals always have an option to redeem those assets for cash’. Moreover, the introduction of CBDCs would keep the void left by the demise of cash from being filled by stablecoins, thus breaking the uniform currency character of the monetary system.

However, are not reports of the death of banknotes greatly exaggerated (Rösl and Seitz 2022; Bofinger 2022)?

A *second* group of motivations and related objections around introducing CBDCs has a microeconomic ‘efficiency’ nature.

Transaction costs of domestic and international payments, and those of connecting savers and investors, might fall by reducing intermediation. Efficiency, especially in international payments, is lamentably low (Kuehnlenz et al. 2023, p. 8). However, this could be improved without the introduction of CBDCs, which in any case would require international cooperation (Cecchetti and Schoenholtz 2021, p. 61; Waller 2021b p. 122; Andolfatto 2021, p. 130).²⁷

Greater safety could be brought about by *CBDC accounts*. However, although safety is a cause of concern for the public, bank deposits are already generally insured and surveilled (Andolfatto 2021, p. 129; Bofinger 2022).

Access to the financial system could be improved, but this might also be achieved through appropriate policies to facilitate access to banking services (Cecchetti and Schoenholtz 2021, p. 61; Waller 2021b, p. 122; Andolfatto 2021, p. 129). Incidentally, it is generally held that the physical management of current accounts in CBDCs should be left to commercial banks, which also have more experience in providing the various payment services (Passacantando 2021, p. 116; BIS 2021, pp. 78–79), while centralizing CBDC management at the central bank would lead to obvious inefficiencies (Bindseil 2020, p. 9). We wonder whether this would improve general efficiency (Rösl and Seitz 2022).

Preserve privacy in payments: issuers of stablecoins, usually Big Tech companies, would be able to collect, manage, and make a profit from data when people make digital payments (Ahnert et al. 2022) without any clear control by public authorities. In principle, CBDCs would be subjected to the problem of a lack of anonymity, though this could be sorted out by allowing private banks to manage the accounts of CBDCs

26. CBDCs allow direct (P2P) payments like banknotes, which are not intermediated by banks; the possibility of withdrawing them as tokens for e-wallets is a further option.

27. The launch of CBDCs can be seen as an ‘opportunity to start with a “clean slate”’ (Auer et al. 2021b, p. 21): a good chance to remove friction and fragmentation in payment systems. Nevertheless, beyond problems with the infrastructures on which payment systems run (Kuehnhold et al. 2023), problems of currency substitution, fluctuating exchange rates, and cross-border capital flows – or granting CBDC access to non-resident financial institutions over which issuing central banks have no control – may lead to legal and operational problems (CPMI-MC 2021, pp. 15–16).

at the central bank (Prasad 2021, pp. 196–197). At the same time, CBDCs can facilitate effective payment tracking and support the fight against *tax evasion, money laundering, and criminal activities*.

A *third* group of advantages of CBDCs would be of a macroeconomic nature (problems with banking and monetary policy shall be dealt with in the next section).

For starters, along with regulation, CBDCs could be part of the answer to the challenge that stablecoins pose to traditional banking and monetary systems.

Next, CBDCs are also said to facilitate *government monetary transfers* to the people, so-called ‘helicopter money’ or quantitative easing (QE) for the people. Through CBDCs, the government could make direct fiscal transfers from its treasury account at the central bank to the accounts of citizens, thereby avoiding doing so through commercial banks, which is a disturbance to monetary policy.²⁸ Taking a more critical view, BIS (2020, p. 7) points to a threat to the independence of central banks: ‘If fiscal transfers were made through CBDC, there is a risk of blurring the separation between monetary and fiscal policy and a potential reduction in the independence of monetary policy’. Post-Keynesian economists would look at this objection regarding the lack of independence of the central bank and fiscal dominance with little conviction (D’Ippoliti et al. 2022).

In addition, if cash disappears, an interest-bearing CBDC is said to facilitate a *policy of negative interest rates*, overcoming the zero lower bound (Bordo 2021a, 2021b; Brunnermeier and Landau 2022, pp. 30–31). In the extreme hypothesis that CBDCs would completely replace cash, this would lead to a broadening of the instruments of monetary policy by allowing the central bank to impose negative interest rates on reserves and deposits to encourage spending. Currently, even if the central bank wanted to induce banks to bring the rates on bank deposits into negative territory to encourage spending, this would be met with a possible flight over banknotes (which have a zero rate by definition).²⁹

A *fourth* group of motivations concerns *geopolitical considerations*. There is indeed no doubt that the ability to issue legal tender gives immense funding power to whomever controls it. The very nature of a network associated with payment systems, that is, economies of scale as more agents use this platform, can bestow great privileges to the issuer(s) of currency. In the event of stablecoins becoming widely accepted as a means of payment, their issuers, which could be Big Techs, would be difficult to control, especially if they are out of the jurisdiction of the central bank. The same argument would hold for foreign CBDCs used at home. Critics consider the importance of this threat to be overstated. For instance, Waller (2021b, p. 124) doubts that a Chinese CBDC would challenge the status of the US dollar because

28. This disturbance is explained as follows: presently, in order to distribute money to citizens, the central bank must create reserves in the current account of the government; the latter will in turn transfer the reserves to the current accounts of banks so that they can credit the funds in the deposits of citizens. This operation creates excess reserves in the monetary market and a decrease in the short-term interest rate below target. The central bank should therefore sterilize the operation by reducing the amount of liquidity supplied through ordinary refinancing operations. No disturbance would occur of course if we were in a floor-type system where the decoupling between interest rate targeting and liquidity supply is perfect.

29. Some authors have objected that, during deep recessions, an expansive fiscal policy is more powerful than a monetary policy of negative interest rates: Cecchetti and Schoenholtz (2021, p. 131), Andolfatto (2021, p. 131), Di Bucchianico (2021), among others. On the contrary, those who criticize the ‘expropriation of the saver’ argument would oppose this reason for introducing CBDCs (see arguments for and against this in Bindseil 2020, p. 6).

this would mean that non-Chinese firms would agree to have their financial transactions monitored by the Chinese government. Similarly, Andolfatto (2021, p. 132) rejects the assertion that the US dollar's status as a world reserve currency would be in jeopardy if the United States does not follow the lead of China: first, a world reserve currency supplier must stand prepared to run current account deficits that are potentially very large. And second, growth in the global demand for US dollars, treasury securities, and dollar-denominated assets continues unabated nonetheless. Kuehnlenz et al. (2023, pp. 8–10) concede that multiple CBDC frameworks might contribute to a more multipolar international financial and monetary system, yet the position of the US dollar would not be at risk because this currency facilitates access to a very large financial market, because of the willingness of the Fed to act as a lender of last resort at the international level, and because of its liquidity premium. The current conflict between Russia and Ukraine and tensions between the US and China have led to diverging opinions about the impact on the US dollar's status – reinforcing it, according to Dooley et al. (2022). Fantacci et al. (2022) are, however, more doubtful.

Presciently, Fantacci and Gobbi (2021, p. 21) suggested that China is taking steps towards creating a financial and payment system that is less dependent on US-dominated infrastructures and US currency:

From the point of view of defense economics, the Chinese conduct indicates the Chinese objective of building a state-of-the-art financial system in order not to have to depend on other countries and to create means and channels of payment that allow it to circumvent US sanctions. From the point of view of the economy warfare, the creation of a Chinese cryptocurrency could be seen as an instrument of currency warfare which aims to undermine the role of the dollar in international markets. The intensification of trade between China and developing countries, often characterized by very fragile financial systems and poor infrastructures, could be facilitated by a user-friendly Chinese CBDC. Indeed, the Chinese economic penetration in these countries could rebalance the use of the dollar that traditionally characterizes developing countries. Given that China has such a level of economic relations with the US that it does not fear disconnection from SWIFT, the launch of a Chinese CBDC can be read as a sign of a de-dollarization strategy.

On balance, the great variety of motivations and objections seems to weaken rather than reinforce the case for CBDCs as pointed out by Honohan (2021):

When asked why they are studying CBDC, responses from central banks do not focus on a single reason. The safety or robustness of the payment system, financial stability, efficiency of payments, implementation of monetary policy and the goal of greater inclusivity in accessing payment systems by lower income populations—all seem to be considered at least somewhat important. Lacking a single vision of what they want to accomplish, central bankers seem to be afflicted by a generalized sense of unease. Though scenarios can be only vaguely delineated, shifting sands in the payments and monetary landscape suggest to central banks that, if they do not provide a digital currency, they could find themselves isolated and weakened in unfamiliar ways. Having sufficient control over the retail payments system might, they suppose, prove to be essential for ensuring the stability and efficiency of the monetary and payments system.

Similarly, Bofinger and Haas (2021) doubt the necessity of a CBDC from a *microeconomic* point of view, because, they argue, there is no market failure in the payment system that justifies the introduction of CBDCs: already existing deposit insurance schemes render the safety argument irrelevant, and the central bank cannot compete with commercial banks in the provision of a wide spectrum of services.

In our opinion, it is not fears of a premature decline in the use of cash, dubious efficiency gains, or feeble monetary policy motivations, but the delimitation of a national technological territory that is by far the most powerful explanation for the launch of western CBDCs. However, the threat (which we might call the *Drogo syndrome*, is not yet in sight.

Concerns about CBDCs are heightened by considering their impact on banking and monetary policy.

5.3 Consequences of CBDCs on banking and monetary policy

Although motivated, *inter alia*, as a response to the challenge posed by stablecoins, CBDCs might not come without undesired consequences. The problem most frequently cited with regard to CBDCs is that of the disintermediation of the banking sector, that is, the possible transmigration of deposits from commercial banks to CBDC accounts, and of potential bank runs in the event of distrust in the banking system (for example, Landau 2021, p. 16).³⁰

We consider the key policy distinction to be that which exists between non-interest-bearing CBDCs and interest-bearing CBDCs.³¹ The former would assimilate CBDCs to digital banknotes which, like their paper counterparts, do not pose particular problems to banks and monetary policy. Disintermediation of banks is expectedly irrelevant in this case. More complex is the case of interest-bearing CBDCs, which may lead to disintermediation and perceptible changes in banking and monetary policy. Proposals on how to keep disintermediation at bay relegate that issue to a theoretical case that evokes a 100 per cent reserve system (or the Chicago Plan).

5.3.1 Non-interest-bearing CBDCs

Disintermediation will only occur if CBDC accounts at the central bank compete with traditional bank deposits in terms of interest returns and services. On the contrary, the more CBDCs resemble banknotes, that is, they are a form of e-cash, yielding a zero interest rate without offering additional banking services, the more unlikely disintermediation will be. By not competing with commercial banks when it comes to banking services, central banks would also avoid competing with the subjects they normally regulate and supervise.

In terms of banking activities, given their limited impact on bank intermediation, non-interest-bearing CBDCs would have no perceptible impact on banking (for example, on lending procedures) and on monetary policy (Meaning et al. 2018, p. 7). A withdrawal of bank deposits exchanged with CBDCs would be treated by the central bank in the same way as a withdrawal of banknotes from an ATM.

In terms of monetary policy, with zero remuneration, the interest rate on CBDCs could not be used as a monetary policy tool (Meaning et al. 2021, p. 8; see also

30. Of course, banks intermediate deposits only in an *ex post* sense: as it is well known, from an endogenous money view, the causality runs from loans to deposits.

31. ‘Most CBDC proposals are non-interest bearing’, Kuehnlitz et al. (2023, p. 4) report. And, they add, ‘already established domestic retail CBDCs ... have ... imposed limits on how much of a CBDC can be transacted and held’ (ibid.). Nevertheless, remunerated CBDCs are of interest as a case study, once interest rates are above the zero level.

Bank of England 2020, p. 38).³² Further, as Meaning et al. (2021, p. 8) observe, a non-interest-bearing CBDC might make a negative interest rate policy more arduous.³³ All this considered, Meaning et al. conclude: ‘If the objectives of the policymaker were to improve payment efficiencies and financial inclusion, it is not essential that a CBDC pays interest’ (ibid., p. 8). A non-interest-bearing CBDC might then be introduced without major consequences for the conduct of monetary policy, at least in normal times.

Nonetheless, while reducing the risk of bank disintermediation in normal times, non-interest-bearing CBDCs (as well as, of course, interest-bearing CBDCs) could make bank runs easier and more tempting for the non-bank public, even after small rumors, by digitally shifting funds towards the central bank. Limits to the size of deposits in CBDCs might limit these runs. They are discussed below, in the context of interest-bearing CBDCs.

5.3.2 *Interest-bearing CBDCs*

With an *interest-bearing CBDC*, we could expect some degree of bank disintermediation, depending also, as Meaning et al. (2018, p. 12) have pointed out, on the attractiveness of CBDCs relative to deposits (through remuneration, services provided, and the ceilings imposed on central bank accounts). Therefore, banks might have to raise interest rates on deposits to retain them, which would increase the cost of credit or decrease bank profitability (Bindseil 2020, p. 9; Bank of England 2020, pp. 35–37; Waller 2021b, p. 123; Adrian and Mancini-Griffoli, 2021, p. 74, and many others).

The literature has suggested two remedies for bank disintermediation (setting aside the option of not introducing CBDCs): the first is a ceiling in the amount of funds each subject can hold in a CBDC; the second is a two-tiered remuneration system differentiating between a higher remuneration of bank reserves (which are already a CBDC) and a lower return on the general public CBDCs (Bindseil 2020, pp. 22–26).

With regard to the first remedy, this has been authoritatively proposed by ECB exponents to limit free access to current CBDC accounts to amounts up to €3,000 (a mini-CBDC), penalizing higher amounts with negative interest (Bindseil 2020; Bindseil and Panetta 2020; Panetta 2021a; Passacantando 2021, pp. 122–124). However, a mini-CBDC would be irrelevant if the aim is to compete with private payment systems, or with foreign CBDCs.

With regard to the second remedy, Meaning et al. (2018, p. 26) endorse the two-tiered remuneration system on, respectively, ‘universally accessible CBDCs’ and ‘restricted access central bank reserves’:

The primary rate of monetary policy would be the rate paid on reserves, while the rate paid on CBDC would be used to control demand for CBDC relative to bank deposits. ... In this world, reserves (the first form of CBDC) would continue to function as they currently do, being used to settle between banks, but could not be used to pay for goods, services and assets in the wider economy. They would also continue to be at the heart of setting monetary

32. An implicit assumption here is that, for banks, a CBDC is not a substitute for reserves.

33. As is well known, storing cash is expensive. For this reason, the rate on deposits (bank or reserves) can be brought into negative territory to the extent that the cost of holding a deposit is lower than that of holding cash. Non-interest-bearing CBDCs have a zero cost, however, so this would impose an effective zero lower bound on rate policy (see also Bank of England 2020, p. 38 and Panetta 2021c). A negative interest rate policy would then imply quantitative limits on the amount of money transferable to non-interest-bearing CBDCs.

policy ... E-cash (the second form of CBDC) would not be used in setting monetary policy, but rather as a means of establishing an efficient and safe payments system.

BIS (2021, pp. 80–81) and Panetta (2021c) also endorse this two-tier remuneration system.

In terms of banking activities, according to Meaning et al. (2021) not much would change if disintermediation remained at a low level. As in the case of cash, if some of the deposits are transformed into CBDC, the central bank will have to refill the banks' reserve account with an equivalent amount of reserves, leading to a liability substitution.³⁴ And if banks have unlimited access to central bank reserves, their ability to make loans will remain unaffected.³⁵

In terms of monetary policy, Meaning et al. (2021, p. 3) hold that, with partial disintermediation, monetary policy would not change much either. If the demand for CBDCs from the non-bank public varies, funded with bank deposits, it should be promptly accommodated by the central bank varying the supply of reserves, just as it currently does with shifts by the public to and from banknotes. Although a corridor system could be implemented (*ibid.*, pp. 17–18), the volatility of the demand for CBDCs from the non-bank public would be less problematic in a floor system where reserves are in excess by definition (*ibid.*, pp. 16, 18).

The main difference, as compared with the extreme case of a full migration from deposits to CBDCs (examined in the next subsection), is that the public will continue using deposits for payments, along with banknotes and CBDCs. Therefore, the inter-bank market for reserves does not disappear and with it Borio's obscure corner of monetary policy where 'the ultimate source of the central banks' power to influence economic activity resides' (Borio 1997, p. 14).

In fact, Meaning et al. hold that with partial disintermediation, 'there may even be reason to believe that the monetary transmission mechanism would be stronger for a given change in policy instruments' (*ibid.*, p. 3). A change in the target rate would indeed have a *stronger* influence on market rates as it would not only affect the inter-bank rate, but would also have a direct effect on CBDCs and, consequently, bank deposit rates (if massive transfers into CBDCs have to be avoided), and ultimately on lending rates. With the launch of a universally accessible, remunerated CBDC:

... the funding costs of banks would likely become more sensitive to changes in policy rates. This should strengthen the bank lending channel. ... If the policy rate which is paid on CBDC is increased, then this could result in a fall in demand for bank deposits, while if the policy rate is cut, this could drive demand from CBDC into bank deposits. ... To the extent that pass-through from policy rates to deposit and wholesale rates has been estimated

34. As Panetta (2021c) points out: 'if the digital euro attracted deposits (and the banks did not have the unencumbered reserves to cope with the outflow of funds), it could affect the cost and supply of credit and the transmission of monetary policy through bank balance sheets. The central bank could mitigate or eliminate these effects by increasing refinancing of banks or through asset purchases, thereby expanding its own balance sheet'.

35. Since banks do not need to collect deposits before they can make loans, as the endogenous money view holds, the withdrawal of bank deposits does not constrain their power to grant credit: the latter is simply conditioned on their ability to obtain central bank reserves (as the deposits created once loans are granted are next transferred to the central bank). On the other hand, if banks' profits fall (when the increasing costs of liabilities cannot be totally shifted to lending rates), their capital would grow at a slower pace (Meaning et al. 2021, p. 26). However, this would not constrain the ability of banks as a whole to grant credit either. On this, see Lavoie (2014, p. 199).

to be currently less than one, CBDC is likely to strengthen this stage of transmission. ... This increased sensitivity of both funding costs and lending rates to changes in the policy rate could act to strengthen the bank *lending* channel. (Ibid., p. 22, pp. 25–26)

Finally, as observed in Section 5.2, interest-bearing CBDCs facilitate a negative interest rate policy only to the extent that cash disappears (BIS 2021, p. 81; Bordo and Levin 2017; Auer et al. 2021c, p. 20). Additionally, if non-banks can hold CBDCs, unconventional monetary policies like QE, which lead to an excess reserve on banks' balance sheets, become more powerful since banks can get rid of them by funding the purchase of assets from the non-banking sector (Meaning et al. 2021, p. 15).

5.3.3 *Full disintermediation: a special case of the Chicago Plan?*

Limited disintermediation of banks is the most plausible result of non-remunerated CBDC or of quantitative limits to remunerated CBDC. When it comes to the theoretical case of full bank disintermediation, banks still grant loans by creating deposits (as the endogenous money principle still holds), and those deposits are then converted into CBDCs while the central bank replenishes the reserves that banks have lost, as illustrated in Figure 2. In this process of full liability substitution, banks are now liable to the central bank and not to depositors, while the central bank is liable to depositors and not to banks (Niepelt 2021, p. 39). In this extreme case, the interbank market for reserves stops existing, given that the public carries out payments directly using CBDC. The official interest rate becomes the rate on the refinancing operations at which central banks provide reserves to commercial banks as in a floor system (a manifestation of the decoupling principle, see Borio and Disyatat 2009).

One difficulty with this situation is that banks would need huge amounts of collateral in order to replace borrowed reserves for deposits. As the Bank of England (2020, p. 37) notes, full funding of lending activities by the central bank may create a shortage of good collateral as well as tensions in the financial market, which may interfere with the bank interest rate target.³⁶

The unlikely case in which all deposits are transferred to the central bank would be a special case of 'narrow banking'.³⁷ In practice, banks would become the operational arms of the central bank. This would likely imply that the central bank will wish to closely monitor the lending activities of banks (Cecchetti and Schoenholtz 2021). A parallel can be posited between full-disintermediation and the famous 'Chicago Plan', a proposal that banks should operate with a 100 per cent reserve ratio, which has been circulating for almost a century and periodically resurfaces – most recently, see Benes and Kumhof (2012). The proposal is aimed at curbing the extensive power

36. 'Banks could react to [bank disintermediation replacing] lost deposit funding with central bank borrowing, provided that they have adequate collateral ... unless the central bank increases its outright holdings of securities (ECB 2020, p. 16). Bordo (2021a, p. 14) writes approvingly that 'disintermediation could be offset by central bank expansionary balance sheet policy'.

37. A 'narrow banking system' is a 100 per cent reserve system (for example, Ferrari and Ferrero 2020, p. 20) as opposed to the traditional 'fractional' system, in which reserves are a small fraction of the deposits created. CPMI-MC (2018, p. 16, fn. 29) points out that there are two differences between narrow banking and CBDCs. First, under CBDCs, residents hold claims on the central bank, while in narrow banking they hold commercial bank money fully backed by central bank reserves; and second, CBDCs can coexist with commercial bank money, while in narrow banking commercial banks cannot create money.

wielded by banks to create credit *ex nihilo*, a view not surprisingly held by economists who acknowledge the endogeneity of money.³⁸

5.3.4 Synthetic or privatized CBDCs

An alternative response by central banks to the challenges posed by stablecoins would consist of ‘synthetic CBDCs’ (see Adrian and Mancini-Griffoli 2019; see also BIS 2020, p. 4). We have seen above that one of the problems with stablecoins is that under some circumstances the value of their reserve assets may not be enough to ensure that they can be converted at par into official currency.

A ‘synthetic CBDC’ is another variant of a ‘narrow banking system’ (Bindseil 2020, p. 30 calls it ‘narrow bank digital currency’). In essence, it requires that the stablecoin issuer keeps its backing assets in the form of central bank reserves. Figure 3 shows how this works.

Under synthetic CBDCs, the issuer of stablecoins (Big Tech) becomes a true narrow bank, whose stablecoins are 100 per cent backed by central bank reserves. On the other hand, commercial banks still have the ability to create deposits when they grant credit. When deposits are converted into stablecoins, banks lose reserves. As in the case of banknotes or of ‘genuine’ CBDCs, the central bank will provide commercial banks with a corresponding amount of reserves. The only difference is that now the newly issued reserves are not held by households or firms as in the ‘proper’ CBDC case, but by the issuers of stablecoins (synthetic CBDCs).

Panetta (2021c) is critical of synthetic CBDCs because the issuance of currency, a public good, would be delegated to the private sector:

The risks posed by stablecoins would be reduced if reserve assets could be held entirely in the form of risk-free deposits at the central bank. However, this would limit monetary sovereignty, as one of the key tasks of the central bank – money creation – would in effect be delegated to private operators. They would perform that task with the aim of maximizing profits, rather than fulfilling public interest objectives such as inflation control and the cyclical stabilization of the economy.

What’s more, problems of bank disintermediation might also arise in this context.

Central bank		Commercial bank		Big Tech	
	-100€ Reserves (bank)	-100€ Reserves	-100€ Deposit (non-financial private sector)	+100€ Reserves	+100 stablecoins (non-financial private sector)
	+100€ Reserves (Big Tech)				
+100€ Refinancing Loan (bank)	+100€ Reserves (bank)	-100€ Reserves	+100€ Refinancing Loan		

Note: 1€ = 1 stablecoin.

Figure 3 Stablecoins as synthetic CBDCs

38. For full discussion, see the working version of this paper (Cesaratto and Febrero 2022, sec. 3.5.3).

6 SUMMARY AND CONCLUSIONS

Let us now take stock of this lengthy review by providing a logical throughline and related conclusions we have drawn. We focused on *stablecoins* and *CBDCs*, leaving aside speculative *cryptoassets*, to which we do not attribute any positive economic or social value, and which we believe should be banned (see the *de profundis* critique by Bindseil and Schaaf in the ECB blog in November 2022).

Fully backed and strictly regulated stablecoin platforms may not pose big problems either to the central bank or to the monetary and payment system. The collapse of the Libra/Diem project has shown that issuers of stablecoins may prefer to give up before accepting the conditions imposed by regulators. Although strict regulation can discourage the most aggressive forms of stablecoins, CBDCs are often presented as the public answer to stablecoins. Yet, as with stablecoins, their presumed advantages could possibly be achieved by innovation in the current banking system, without causing trouble in the banking and monetary systems that is related to the possible migration of bank deposits to CBDCs.

In this regard, we examined three cases in light of the endogenous money theory:

- (1) *Zero-remunerated CBDCs*, as an e-surrogate of banknotes, do not disturb the existing banking and monetary policy, or no more so than when we withdraw banknotes from an ATM (one limit is that, in this case, the ‘zero lower bound’ will become effective).
- (2) *Remunerated CBDCs* might instead induce a massive shift away from bank deposits, obliging banks to raise the remuneration of deposits, likely translating into higher lending rates. This may be prevented by keeping the remuneration of CBDCs sufficiently low, or by setting quantitative limits to CBDC holdings. In this case, monetary policy will not change fundamentally, either based on the standard corridor or on the floor system.
- (3) The *extreme case* of a complete conversion of deposits into a CBDC would indeed change the working of the central bank interest rate policy. The central bank would be obliged to replenish the bank’s reserve accounts with the liquidity lost due to deposit migration to the CBDC (a liability substitution for banks). This implies that the central bank can influence bank lending rates by fixing the interest rate on reserves and not by acting through the interest rate corridor or the floor systems since the interbank money market, where reserves were traditionally re-distributed, no longer carries out this function.

In all of these cases, the ability of banks to create money through the granting of credit would not be affected in principle as long as the central bank automatically provides reserves when deposits are turned into CBDCs. This may imply a stricter control by the central bank of bank lending. There are parallels between fully disintermediating CBDC and the Chicago Plan (or narrow banking).

The full disintermediation of CBDCs can be avoided, of course, by the aforementioned measures, which limit a complete conversion of deposits into CBDCs. One might wonder, however, whether a mini-CBDC would be a sufficient deterrent against the challenge from unregulated and aggressive stablecoins or foreign CBDCs.

Relevant problems have emerged from this study related to the cross-border use of digital currencies, especially for stablecoins of foreign origin or the users of CBDCs in developing countries. The first challenge is the lack of regulation and supervision of the issuer of a foreign currency by the local monetary authority. The second has to

do with the threat of currency substitution (a sort of dollarization), which poses a limit to the ability of the local central bank to manage its monetary policy, reduce monetary sovereignty, and increase foreign debt and the volatility of capital flows.

In advanced economies, launching an official CBDC could be seen as a defensive reaction to potential threats by foreign stablecoins rather than the outcome of market failures or deficiencies in the payment system in its present form.

In summary, the evidence so far is that neither stablecoins nor CBDCs would bring about clear advantages to society at large, which could not be realized through innovations carried out by the present, regulated banking system (complemented by forms of private e-currencies). At the same time, CBDCs could create troubles for the smooth working of the monetary and banking systems. We are also skeptical of any new technology that favors unregulated, energy wasting, decentralized financial activities and transactions, unbridled international capital movements, and speculation. However, experimenting with CBDCs might be a tool for demarcating a technological territory in view of public control of unleashed financial activities and possible geopolitical threats to monetary sovereignty (De Bonis and Ferrero 2022, p. 17).

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REFERENCES

- Adrian, T. and T. Mancini-Griffoli (2019), 'The rise of digital currency', VoxEU, 9 September.
- Adrian, T. and T. Mancini-Griffoli (2021), 'How will digital money impact the international monetary system?', in D. Niepelt (ed.), *Central Bank Digital Currency - Considerations, Projects, Outlook*, London: CEPR Press and Vox.org, pp. 73–79.
- Ahnert, T., K. Assenmacher, P. Hoffmann and A. Leonello (2022), 'Cold hard (digital) cash: the economics of central bank digital currency', *Research Bulletin*, 100, European Central Bank, 31 October.
- Allen, H.J. (2022), 'DeFi: Shadow Banking 2.0?', Washington College of Law Research Paper No 2022-02, American University.
- Andolfatto, D. (2021), 'On the necessity and desirability of a central bank digital currency', in D. Niepelt (ed.), *Central Bank Digital Currency - Considerations, Projects, Outlook*, London: CEPR Press and Vox.org, pp. 127–135.
- Aramonte, S., W. Huang and A. Schripf (2021), 'DeFi risks and the decentralisation illusion', *BIS Quarterly Review*, December, 21–36.
- Arner, D., R. Auer and J. Frost (2020), 'Stable-coins: potential, risks and regulation', BIS Working Papers No 905.
- Auer, R., G. Cornelli and J. Frost (2021a), 'Central bank digital currencies: taking stock of architectures and technologies', in D. Niepelt (ed.), *Central Bank Digital Currency - Considerations, Projects, Outlook*, London: CEPR Press and Vox.org, pp. 155–162.
- Auer, R., S. Doerr, J. Frost, L. Gambacorta and H.S. Shin (2021b), 'Central bank digital currencies and data in the digital age: a triple imperative', in D. Niepelt (ed.), *Central Bank Digital Currency - Considerations, Projects, Outlook*, London: CEPR Press and Vox.org, pp. 23–29.
- Auer, R., J. Frost, L. Gambacorta, C. Monnet, T. Rice, and H.S. Shin (2021c), 'Central bank digital currencies: motives, economic implications and the research frontier', BIS Working Papers No 976.

- Azar, P.D., G. Baughman, F. Carapella, J. Gerszten, A. Lubis, J.P. Perez-Sangimino, D.E. Rappoport, C. Scotti, N. Swem, A. Vardoulakis and A. Werman (2022), 'The financial stability implications of digital assets', Finance and Economics Discussion Series 2022-058, Washington: Federal Reserve System.
- Bank of England (2020), 'Central Bank Digital Currency - opportunities, challenges and design', CBDC Discussion Paper, March.
- Baker, L., J. Hamilton and O. Kharif (2022), 'Mark Zuckerberg's stablecoin ambitions unravel with Diem sale talks', *Bloomberg*, Technology Crypto, 26 January, available at: <https://www.bloomberg.com/news/articles/2022-01-25/zuckerberg-s-stablecoin-ambitions-unravel-with-diem-sale-talks?sref=ExbtjcSG> (accessed 2 February 2022).
- Benes, J. and M. Kumhof (2012), 'The Chicago plan revisited', IMF Working Paper No 12/202.
- Bilotta, N. and F. Botti (2021), 'CBDCs: The (near?) future of a cashless economy', in N. Bilotta and F. Botti (eds), *The (Near) Future of Central Bank Digital Currencies*, Bern: Peter Lang, pp. 15–40.
- Bindseil, U. (2020), 'Tiered CBDC and the financial system, European Central Bank', ECB Working Paper Series No 2351, January.
- Bindseil, U. and F. Panetta (2020), 'Central bank digital currency remuneration in a world with low or negative nominal interest rates', *VoxEU*, 5 October.
- Bindseil, U. and G. Pantelopoulos (2022), 'Towards the holy grail of cross-border payments', ECB Working Paper Series No 2693, August.
- Bindseil, U., P. Papsdorf and J. Schaaf (2022), 'The Bitcoin challenge: how to tame a digital predator', *VoxEU*, 7 January.
- Bindseil, U. and J. Schaaf (2022), 'Bitcoin's last stand', *The ECB blog*, 30 November.
- BIS (Bank for International Settlements) (2020), 'Central bank digital currencies: foundational principles and core features', Joint report by The Bank of Canada, European Central Bank, Bank of Japan, Sveriges Riksbank, Swiss National Bank, Bank of England, Federal Reserve and Bank for International Settlements, Report n. 1, Basel.
- BIS (2021), 'Annual Economic Report', Basel.
- Board of Governors of the Federal Reserve System (2022), 'Money and payments: the U.S. Dollar in the Age of Digital Transformation', *Federal Reserve System Research and Analysis*, January, available at: <https://www.federalreserve.gov/publications/money-and-payments-discussion-paper.htm> (accessed 17 February 2023).
- Bofinger, P. (2022), 'The digital euro: a flawed concept doomed to flop', *Social Europe*, 19 December.
- Bofinger, P. and T. Haas (2021), 'Central bank digital currencies risk becoming a gigantic flop', *VoxEU*, 1 February.
- Bordo, M. (2021a), 'Central Bank Digital Currency in historical perspective: another crossroad in monetary history', NBER Working Paper No 29171
- Bordo, M. (2021b) 'Central bank digital currency in an historical perspective', *VoxEU*, 19 October.
- Bordo, M. and A. Levin (2017), 'Central bank digital currency and the future of monetary policy', NBER Working Paper No 23711.
- Borio, C. (1997), 'The implementation of monetary policy in industrial countries: a survey', BIS Economic Papers No 47.
- Borio, C. and P. Disyatat (2009), 'Unconventional monetary policies: an appraisal', BIS Working Papers No 292.
- Born, A., I. Gschossmann, A. Hodbod, C. Lambert and A. Pellicani (2022), 'Decentralised finance – a new unregulated non-bank system?', *Macprudential Bulletin*, Issue 18, July, European Central Bank.
- Bradbury, M. and M. Vernengo (2008), 'The limits to dollarization in Ecuador: lessons from Argentina', Working Paper No 2008-12, University of Utah, Department of Economics.
- Brainard, L. (2022), 'Preparing for the financial system of the future. Remarks', 2022 US Monetary Policy Forum, New York, 18 February.
- Brunnermeier, M.K., H. James, J.-P. Landau (2019), 'The digitalization of money', NBER Working Papers No 26300.

- Brunnermeier, M.K. and J.-P. Landau (2022), 'The digital euro: policy implications and perspectives', Policy Department for Economic, Scientific and Quality of Life Policies, Directorate-General for Internal Policies, European Parliament, PE 703.337, January.
- Cecchetti, S. and K. Schoenholtz (2021), 'Central bank digital currency: is it really worth the risk?' in D. Niepelt (ed.), *Central Bank Digital Currency - Considerations, Projects, Outlook*, London: CEPR Press and Vox.org, pp. 57–63.
- Cesaratto, S. and E. Febrero (2022), 'Private and Central Bank Digital Currencies: a storm in a teacup? A Post-Keynesian appraisal', Documento de Trabajo del Departamento de Análisis Económico y Finanzas, Universidad de Castilla-La Mancha, DT 2022/1.
- CPMI – MP (Committee on Payments and Market Infrastructures – Markets Committee) (2018), 'Central bank digital currencies', Bank for International Settlements, March.
- CPMI, BIS Innovation Hub, IMF and World Bank (2021), 'Central bank digital currencies for cross-border payments. Report to the G20', Bank for International Settlements, July.
- Cunliffe, J. (2021), 'Is 'crypto' a financial stability risk?', Speech at the Bank of England, 13 October, available at: <https://www.bankofengland.co.uk/speech/2021/october/jon-cunliffe-swifts-sibos-2021> (accessed 3 February 2022).
- D'Ippoliti, C., J. Temperini and L. Gobbi (2022), 'Is the time ripe for helicopter money? Growth impact and financial stability risks of outright monetary transfers', ssrn: <https://ssrn.com/abstract=4277760>; doi: <http://dx.doi.org/10.2139/ssrn.4277760> (accessed 28 November 2022).
- De Bonis, R. and G. Ferrero (2022), 'Technological progress and institutional adaptations: the case of the Central Bank Digital Currency (CBDC)', Bank of Italy Occasional Paper No 690, ssrn: <https://ssrn.com/abstract=4109510>; doi: <http://dx.doi.org/10.2139/ssrn.4109510>.
- De Lucchi, J.M. (2013), 'Endogenous money and public foreign debt during the Argentinean convertibility', *Review of Keynesian Economics*, 1(3), 322–346.
- Di Bucchianico, S. (2021), 'Negative interest rate policy to fight secular stagnation: unfeasible, ineffective, irrelevant, or inadequate?', *Review of Political Economy*, 33(4), 687–710.
- Díez de los Ríos, A. and Y. Zhu (2020), 'CBDC and monetary sovereignty', Bank of Canada, Staff Analytical Note 2020-5, February.
- Dooley, M.P., D. Folkerts-Landau and P.M. Garber (2022), 'US sanctions reinforce the dollar's dominance', NBER Working Paper No 29943.
- European Central Bank (ECB) (2020), Report on a digital euro, October.
- Eichengreen, B. (2019), 'From commodity to fiat and now to crypto: what does theory tell us?', NBER Working Paper No 25426.
- Eichengreen, B. and G. Viswanath-Natraj (2020), 'Libra still needs more baking', VoxEU, 25 April.
- Fantacci, L. and L. Gobbi (2021), 'Stablecoins, Central Bank Digital Currencies and US dollar hegemony', *Accounting, Economics and Law: A Convivium*, 6 January (online).
- Fantacci, L., L. Gobbi and D. Luciani (2022), 'Bene pubblico globale o arma finanziaria? L'egemonia del dollaro alla prova delle sanzioni', *Moneta e credito*, 75(298), 123–147.
- Fatás, A. (2021), 'Can central bank digital currency transform digital payments?', in D. Niepelt (ed.), *Central Bank Digital Currency - Considerations, Projects, Outlook*, London: CEPR Press and Vox.org, pp. 51–56.
- Ferrari A. and G. Ferrero (2020), 'Moneta pubblica e privata in un sistema economico moderno', *Banca d'Italia*, mimeo, available at: <http://www.francodebenedetti.it/http://www.francodebenedetti.it/wp-content/uploads/La-Moneta-Ferrari-Ferrero-2019-08-05.pdf> (accessed 17 May 2021).
- Financial Stability Board (2020), 'Regulation, supervision and oversight of "Global Stablecoin" arrangements. Final report and high-level recommendations', 13 October, available at: <https://www.fsb.org/wp-content/uploads/P131020-3.pdf> (accessed 22 March 2022).
- Graselli, M.R. and A. Lipton (2022), 'Cryptocurrencies and the future of money', in G. Vallet, S. Kappes and L.P. Rochon (eds), *Central Banking, Monetary Policy and the Future of Money*, The Elgar Series on Central Banking and Monetary Policy. Cheltenham, UK and Northampton, MA: Edward Elgar, pp. 23–56.

- Gorton, G.B. and J. Zhang (2023), 'Taming wildcat stable-coins', *University of Chicago Law Review*, 90(3), 909–971.
- Hayek, F.A. (1976), *Denationalisation of Money - The Argument Refined. An Analysis of the Theory and Practice of Concurrent Currencies*, London: The Institute of Economic Affairs.
- Honohan, P. (2021), 'Central banks' uneasy embrace of digital currencies', Realtime Economic Issues Watch, Blog entry 15 March, Peterson Institute of International Economics, Washington DC, available at: <https://www.piie.com/blogs/realtime-economic-issues-watch/central-banks-uneasy-embrace-digital-currencies> (accessed 22 March 2022).
- IMF (International Monetary Fund) (2020), 'Digital money across borders. Macro-financial implications', Staff Report, October, Washington, DC.
- Kantar Public (2021), 'Study on new digital payment methods', Study Commissioned by the ECB, March, available at: https://www.ecb.europa.eu/paym/digital_euro/investigation/profuse/shared/files/dedocs/ecb.dedocs220330_report.en.pdf (accessed 14 February 2023).
- Kuehnlenz, S., B. Orsi and A. Kaltenbrunner (2023), 'Central bank digital currencies and the international payment system: the demise of the US dollar?', *Research in International Business and Finance*, 64, 1–12.
- Lagarde, C. and F. Panetta (2022), 'Key objectives of the digital euro', *The ECB Blog*, 13 July.
- Landau, J.-P. (2021), 'Central banks digital currencies and financial stability', *Bank of Spain Financial Stability Review*, Autumn.
- Landau, J.-P. (2022), 'Crypto currencies and digital money: taking stock', *Vox.eu*, 27 June.
- Lavoie, M. (2014), *Post-Keynesian Economics. New Foundations*, Cheltenham, UK and Northampton, MA: Edward Elgar.
- Lawson, T. (2019), 'The nature of money and possibility of cryptocurrency money', in *Cryptocurrencies and the Future of Money*, Report of the IE Centre for the Governance of Change, Chapter 1, pp. 9–18.
- Lawson, T. (2022), 'Two conceptions of the nature of money: clarifying differences between MMT and money theories sponsored by social positioning theory', *Real-world Economics Review*, 101, 2–19.
- Levy Yeyati, E. and S. Katz (2022), 'The stablecoin paradox', *Vox.eu*, 15 August.
- Meaning, J., B. Dyson, J. Barker and E. Clayton (2018), 'Broadening narrow money: monetary policy with a central bank digital currency', Bank of England, Staff Working Paper No 724.
- Meaning, J., B. Dyson, J. Barker and E. Clayton (2021), 'Broadening narrow money: monetary policy with a central bank digital currency', *International Journal of Central Banking*, 17(2), 1–42.
- Murphy, H. and K. Stacey (2022), 'Facebook Libra: the inside story of how the company's cryptocurrency dream died', *Financial Times Magazine*, 10 March.
- Munchau, W. (2022), 'Now what? Crypto 1.0 has burst, but don't draw the wrong conclusions', 13 November, available at: <https://www.euointelligence.com/column/now-what> (accessed 20 November 2022).
- Niepelt, D. (2021), 'Reserves for all': Political rather than macroeconomic risks', in D. Niepelt (ed.), *Central Bank Digital Currency - Considerations, Projects, Outlook*, London: CEPR Press and Vox.org, pp. 39–44.
- OECD (2022), 'Why Decentralised Finance (DeFi) matters and the polity implications', January, Paris.
- Palley, T.I. (2001-02), 'The e-money revolution: challenges and implications for monetary policy', *Journal of Post Keynesian Economics*, 24(2), Winter, 217–233.
- Panetta, F. (2020), 'The two sides of the (stable)coin', at iI Salone dei Pagamenti, ECB Speeches, 4 November.
- Panetta, F. (2021a), 'Evolution or revolution? The impact of a digital euro on the financial system', Bruegel Online Seminar, ECB Speeches, 10 February.
- Panetta, F. (2021b), 'Central bank digital currencies: a monetary anchor for digital innovation', Elcano Royal Institute, 5 November.
- Panetta, F. (2021c), 'The present and future of money in the digital age', ECB Speeches, 10 December.

- Panetta, F. (2022), 'Demystifying wholesale central bank digital currency', ECB Speeches, 26 September.
- Passacantando, F. (2021), 'The digital euro: challenges and opportunities', in N. Bilotta and F. Botti (eds), *The (Near) Future of Central Bank Digital Currencies*, Bern: Peter Lang, pp. 113–130.
- Prasad, E. (2021), *The Future of Money. How the Digital Revolution is Transforming Currencies and Finance*, Cambridge, MA: The Belknap Press of Harvard University Press.
- PWG (President's Working Group on Financial Markets, the Federal Deposit Insurance Corporation, and the Office of the Comptroller of the Currency) (2021), Report on Stablecoins, November, available at: https://home.treasury.gov/system/files/136/StableCoinReport_Nov1_508.pdf (accessed 26 December 2022).
- Rösl, G. and F. Seitz (2022), 'CBDC and cash in the euro area: crowding out or co-circulation?', Weidener Diskussionspapiere, No 85, Technische Hochschule Amberg-Weiden (OTH), Weiden i.d.OPf.
- Skingsley, C. (2018), 'Considerations for a cashless future', Speech at SNS, the Centre for Business and Policy Studies, Stockholm, 22 November, available at: <https://www.bis.org/review/r181122g.htm> (accessed 16 February 2023).
- Smialek, J. (2021), 'Why Washington worries about stablecoins', *New York Times*, 17 September.
- Velasco, A. (2021), 'Preventing a stable-coin liquidity crisis', *Project Syndicate*, 2 August.
- Waller, C.J. (2021a), 'CBDC: a solution in search of a problem?', Speech delivered at the American Enterprise Institute, Washington (via webcast), August 5.
- Waller, C.J. (2021b), 'Central bank digital currency: a solution in search of a problem?', in D. Niepelt (ed.), *Central Bank Digital Currency - Considerations, Projects, Outlook*, London: CEPR Press and Vox.org, pp. 119–126.
- Waller, C.J. (2021c), 'Reflections on stable-coins and payments innovations', Remarks at the 2021 Financial Stability Conference "Planning for Surprises, Learning from Crises", Federal Reserve Bank of Cleveland and Office of Financial Research, 17 November.
- Wray, L.R. (2022), *Making Money Work for Us. How MMT Can Save America*, Cambridge, UK: Polity Press.