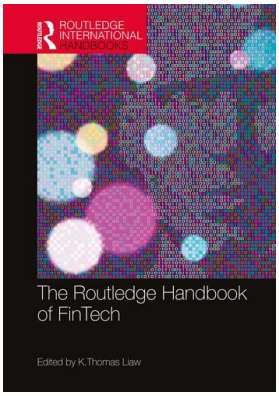

The Routledge Handbook of FinTech

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Digital currencies

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DIGITAL CURRENCIES
What role in our financial system?

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1. Introduction

Under the Bretton Woods monetary arrangement put in place in 1947, the main global currencies were anchored to the US dollar (through a fixed exchange rate) and were, at least partially, convertible with gold. This system broke down in 1971 when US President Richard Nixon declared a temporary suspension of the dollar's convertibility into gold. Since then, monetary systems in most developed countries have been based on fiat currencies, in other words, currencies that are not backed by physical assets but that rely on the ability of monetary authorities to ensure the currency's stability. These currencies are issued by central banks in the form of (physical) coins and banknotes and (dematerialised) reserves, combined with highly regulated (dematerialised) bank deposits convertible at par with central bank money.

The fiat-based monetary system has functioned in this form since the demise of Bretton Woods, with only minor innovations. However, there have been four major developments in the last decade that have challenged and continue to challenge the *status quo* and have reopened the debate on the forms that money will take in the future.

1. The share of transactions in cash in developed countries has fallen. In countries such as Sweden, coins and banknotes have become so marginalised as a means of payment that there is even talk of abandoning them completely. The Riksbank, the Swedish Central Bank, has opted against the total elimination of cash, but there is unequivocally a trend towards less cash usage in some countries.
2. The emergence of distributed-ledger technology, or blockchain (i.e. a decentralised, secure and unalterable record of financial transactions), has enabled the appearance of thousands of cryptocurrencies, such as Bitcoin, which launched in 2009. This technology has since given rise to many private forms of digital money.
3. While the first generations of digital coins proved not to be stable means of payment and storing value, more recent versions have explicitly aimed to provide stability. A number of so-called 'stablecoins' have been issued in recent years, but the idea became more prominent with global tech giant Facebook announcing on 18 July 2019 its intention to issue its own fiat-currency-backed stablecoin: the Libra. Given its potential to reach

millions, if not billions, of users across the world, authorities have taken a significant interest in how this might challenge official currencies and the need for regulation.

4. Finally, if cash is scarce or even disappears, citizens risk losing direct access to sovereign money, the ultimate safe asset. Should cash altogether disappear, citizens would only have access to bank deposits, which are not as tangible as cash and not as safe to store value. Given the existence of digital technology, central banks are now contemplating the idea of creating central bank digital currencies (CBDCs). These could replace coins and banknotes and potentially make central banks' digital reserves available to all economic agents and not only to banks.

We will review the emergence of these different forms of digital currencies and whether they fulfil a good role as currencies. To this end, we will also examine how and whether they could be able to challenge traditional currencies as well as the role guardians of money, price and financial stability, namely central banks, play. Last, we will review the need for central banks to also adapt by becoming more digital and to what effect.

2. The first generation: cryptocurrencies

Money is a social convention that facilitates trade when there is a lack of a double coincidence of wants, by solving the problem of a lack of trust in exchanges.

In practice, money tends to be defined by the three functions it traditionally performs: first, a unit of account, as it serves as a common measure of values for goods and services traded in an economy; second, a medium of exchange, as an item accepted for the payment of goods and services, and for the repayment of debts; and third, a store of value, a way to store wealth to transfer purchasing power from the present to the future.

To perform these three functions, money can take various forms, including non-perishable goods and non-financial and financial assets. Historically, various goods and assets have been used and even co-existed as money, but some have been very successful while others have led to monetary instability and have been replaced. Therefore, money can vary both with respect to its characteristics and its relative success in performing its three main functions.

2.1 A taxonomy of money: where do cryptocurrencies fit in?

We classify the various types of money to understand how cryptocurrencies differ from other forms of money based on three main criteria (among others discussed by Bech and Garratt, 2017): a) the issuer – government or private; b) the form it takes – physical or digital; and c) how transactions are settled – centralised or decentralised.

Cryptocurrencies represent a form of money that has not previously been available, as a particular combination in the money taxonomy. Specifically, they are:

- *Privately issued*. This is not new *per se*. Privately issued currencies have been used and have sometimes performed well in the past. However, unlike bank deposits for instance, cryptocurrencies are not a liability and cannot be redeemed.
- *Digital*. This is also not new *per se*; it is similar to electronic money issued by central and commercial banks. Cryptocurrencies are also fiat money in that they have no intrinsic value.
- *Decentralised* settlement of transactions. Exchanges via cryptocurrencies are peer-to-peer, based on the distributed-ledger technology (DLT). Such technology is used to avoid the so called 'double spending problem', which is traditionally solved through

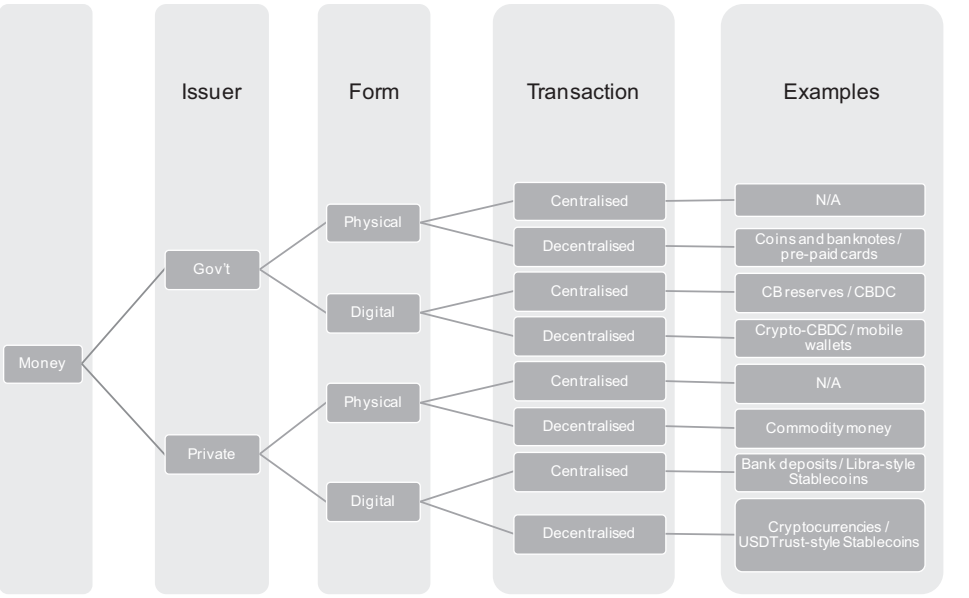

Figure 4.1 A taxonomy of money

Source: Authors based partly on the typology proposed by Bech and Garratt (2017)

record-keeping by a trusted central agent. This means that with a DLT there is no central authority needed for the settlement of digital transactions between counterparties.[1] In fact, no single entity is responsible for operating cryptocurrencies, though a number of intermediaries are needed to provide technical services (a digital wallet is needed to use the cryptocurrencies, and intermediaries are involved when exchanging them with other currencies, etc.). Essentially, the novelty of cryptocurrencies is the feasibility of peer-to-peer digital transactions (see Figure 4.1).

What could be the main advantages of cryptocurrencies given these main characteristics?

- *Anonymity*. Decentralisation would ensure (almost) anonymity of transactions, which is good for privacy, although it could also mean that cryptocurrencies can facilitate transactions related to illegal activities or tax evasion. Arguably cryptocurrencies are even more prone to such activities than cash given the enhanced possibility to handle large transactions. The DLT is also in principle less vulnerable to malicious attacks compared to centralised systems and therefore should allow a reliable ledger of past transactions to be maintained.
- *Free of political backing*. Private issuance is decided not by a political institution but by an algorithm which is seen by supporters of cryptocurrencies as a way to avoid discretionary decisions that can lead to excessive inflation. The automatic issuance of cryptocurrencies would also increase transparency (for anyone able to read the algorithm at least) and the predictability of their 'monetary policy'. As we will later discuss, this is also a disadvantage because discretionary decision making allows for flexibility to deal with shocks.
- *Global reach*. The digital form of cryptocurrencies and the absence of a link to a particular jurisdiction allow for a truly global and easily accessible currency that could facilitate global trade.

2.2. Cryptocurrencies: where do we stand?

There are over 2000 cryptocurrencies[2] but a vast majority of transactions is done in just a few of them. The total market capitalisation is $221bn (as of 8 October 2019).[3] The 10 most important cryptocurrencies represent just below 80 percent of the total market, while the two most important currencies, Bitcoin and Etherium, represent around 65 percent of the market value.

As Claeys *et al.* (2018) have shown, the first generation of cryptocurrencies traded in small volumes and therefore never threatened to challenge traditional global currencies, like the euro or the dollar. The main reason behind this is that they were not able to fulfil the three main functions of money.

First, currencies like Bitcoin have been very volatile and therefore unable to store value properly. This is the direct result of its supply protocol. In the case of Bitcoin, the quantity supplied follows a predictable, near-predetermined path towards a fixed upper limit (21 million of bitcoins). Importantly this means that supply does not move to match the quantity demanded. The inelastic nature of the supply embedded in the protocol rules led to huge volatility of its purchasing power of goods and services which prevented it from functioning as a good store of value. This, in turn, also limited its adoption and kept the network of users relatively small, thus reducing its role as a medium of exchange and as a unit of account.[4] These two problems reinforced each other because the high volatility in price is partly the result of their limited use and the fact that the networks of users consisted mainly of speculators. Cryptocurrencies have so far therefore been more akin to speculative assets, expected to yield returns only as a result of capital gains.

The second reason why first-generation cryptocurrencies have not been a good medium of exchange is the time they took to be verified in the decentralised ledger. While this democratised the verification process, it came at the expense of time and energy efficiency (Krause and Tolaymat, 2018). The amount of computing power needed to validate cryptocurrency transactions in order to avoid any falsification of the ledger has been very energy inefficient and has represented a significant waste of resources.

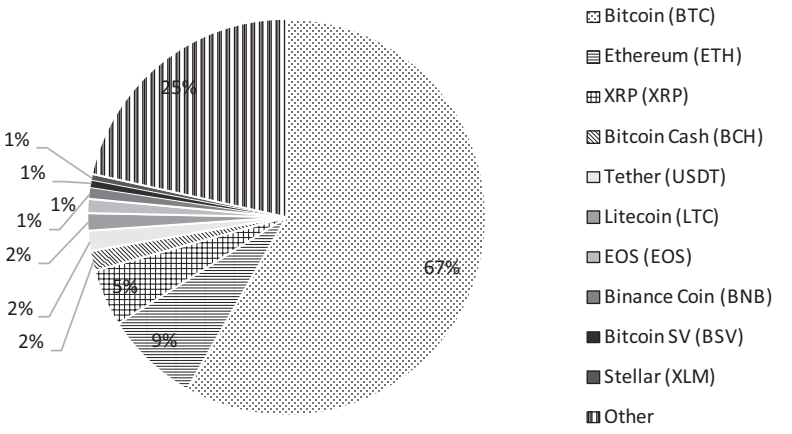

Figure 4.2 Market shares of the 10 most popular cryptocurrencies (market capitalisation, October 2019, in %)

Source: Bruegel based on Yahoo Finance.

Third, the borderless nature of cryptocurrencies runs against the national nature of protecting price stability. From a monetary policy perspective, a global cryptocurrency area is unlikely to be an optimal currency area, as this would lead to an inability to adjust exchange rates within the 'area'. The result would thus be a crypto-monetary policy (i.e. its supply protocol) that would be consistently too tight and too accommodative for different countries at different times.

Last, the first generation of cryptocurrencies is also prone to other major risks: the market concentration which could lead to the falsification of the ledger and to 'double spend' issues; the manipulation of the value of the currency via insider trading; or the lack of regulation for intermediaries necessary to use cryptocurrencies.[5]

3. The second generation: stablecoins

The second generation of private digital currencies aimed at resolving some of the first generation's shortcomings. A number of so-called 'stablecoins' have been issued in recent years, including Tether in 2014, which was intended (originally at least) to be fully backed by US dollar reserves, TrueUSD with a similar model in 2018, and Basis in 2017, which promised to create an algorithmic stablecoin.[6]

However, the stablecoin idea has recently become more prominent, when global tech giant Facebook announced the creation of its own stablecoin in 2019 – the Libra – in the form of a private digital currency, run on a (more) centralised network and backed by fiat-currency reserves to ensure stability. Even if the initiative is currently in limbo, it is worth discussing how it tried to resolve some of the shortcomings of the first generation of cryptocurrencies.

First, the Libra intended to solve the problems of energy and time inefficiency by being a centralised system (permissioned blockchain), at least in the initial phase, in which the founding members – the so-called 'Association' – would be in charge of the validator nodes. This would have the aim of ensuring an optimal balance between effectiveness and security of the system. However, a centralised system in the hands of a limited number of association members posed the risk of collusion (Abadi and Brunnermeier, 2019) to the detriment of users. The ability of the Libra association to be an unequivocally trustworthy custodian of the ledger was immediately challenged.

Second, Facebook wanted to ensure the stability of the Libra by backing it with reserves composed of a basket of liquid and stable assets (themselves in official credible fiat currencies),[7] not unlike a currency board[8] or a simple investment fund guaranteeing redemption at par. As long as the Libra Association would back each Libra coin with an identical pool of safe and liquid assets, its value should be stable.

However, as explained in Claeys and Demertzis (2019) and Chang and Velasco (2019) such an arrangement is not incentive compatible. Motivated by the profit motive, the Libra Association might be tempted to renege on its promise and to not back each coin fully, or to change the composition of the pool of assets. The problem arises because there might be a conflict between maintaining a stable price for Libra (which implies the issuer honouring the initial pledge at any price) and profit maximisation (which gives the issuer the incentive to deviate from full collateralisation and a stable basket). The value of the Libra would depend crucially on the Association's commitment to keep it stable. But unlike central banks that have a public function and are accountable to citizens to fulfil their stability mandate, the Association is not bound by a similar commitment. Stability of the basket and profit maximisation are not necessarily aligned objectives.

But perhaps the biggest issue with Libra was that it was going to be issued by a global tech giant that would immediately grant it scale and accessibility, two features that are pivotal for critical uptake of currencies. This immediately implied that it might be a more credible competitor to traditional forms of money. But what were the risks for central banks and governments?

The first risk was that of scale. By means of a comparison, almost ten years after its creation, Bitcoin was estimated in 2017 to have 7.1 million owners worldwide.[9] The active number of users of Facebook (and hence Libra's immediate potential network size) is, at around 2.5 billion, much larger than the number of people using international currencies such as the euro or even the dollar on a daily basis. As former Bank of England Governor Mark Carney pointed out,[10] Libra could become 'instantly systemic' on launch day and should therefore be put under tight regulatory scrutiny. Similarly, Financial Stability Board Chair Randal K. Quarles highlighted the need to contain the risks that arise from financial innovation and particularly the 'wider use of new types of cryptoassets for retail payment purposes would warrant close scrutiny by authorities to ensure that that they are subject to high standards of regulation'.[11]

Second there were concerns beyond financial stability arising from complex trade-offs between competition and data protection (BIS, 2019). Calibra, the digital wallet on which Libra would be stored, was going to be bundled with Facebook's ecosystem and made available to all its users. This would give Facebook the power to push its customers to use its own digital wallet, just like Amazon had the power to push their Kindle e-book reader to many of its customers that used its other services. The potential for a massive user base can lead to monopoly power for the issuer, which in turn can lead to severe financial vulnerabilities from system failures (either deliberate and fraudulent or simply erroneous).

Third, the most important concern voiced since the Libra announcement in mid-2019 has been distrust about the way Facebook operates, particularly in relation to data privacy and Facebook's global dominance. Wolf (2019), for instance, was very critical of Facebook's continuing failure to appreciate the way it is affecting modern democracies. Libra therefore would start with a sizable trust deficit that could hinder its promised popularity.

Following these concerns, the European Council and Commission declared in November 2019 that 'no global stablecoin arrangement should begin operation in the European Union until the legal, regulatory and oversight challenges and risks have been adequately identified and addressed'.[12] Facebook has since then significantly scaled back from its original plans.[13]

The possibility of a big-scale stablecoin is therefore for the moment not imminent. However, the possibility for future stablecoins to challenge established currencies remains real. We discuss next whether private digital currencies could possibly dominate over traditional currencies.

4. Private and official currencies: a 'peaceful' coexistence?

At the moment, private digital currencies operate alongside official currencies. The current volumes are small and do not challenge the position of official money as the main currency. But is that always going to be the case, and if not, would that entail risks for central bank monetary policy? Could central banks lose their grip on respective economies as a result?

4.1 The control of money

The interaction between private currencies and central bank monetary policy is treated in detail by Fernandes-Villaverde and Sanches (2018). Their theoretical model predicts that the

coexistence of central bank and private money depends on the type of monetary policy the former follows. In particular, privately issued currencies would be used if the official currencies do not ensure price stability, but would lose their value as a medium of exchange when the central bank credibly guarantees the real value of money balances.

The ramifications are two-fold. First, the coexistence of government money and private currencies that are valued as mediums of exchange is not a theoretical impossibility. Second, central banks have an advantage in that by choosing a specific type of monetary policy they can prevent private currencies from being valued as a medium of exchange (but they could still be valued for other reasons, for instance as a pure speculative asset).

From this perspective, rather than posing a threat, the coexistence of government money and cryptocurrencies can have a positive effect by acting as a disciplining device on central banks. This is a partial vindication of Hayek (1976), who argued in favour of breaking the state monopoly on money as a way to ensure the stability of the official currency.

Nevertheless, from a more practical standpoint, central banks' monopoly position could be threatened by the emergence of cryptocurrencies as relevant mediums of exchange with stable purchasing power.

First, the extent of the substitution of cash and bank deposits for cryptocurrencies by economic agents will determine the effectiveness of monetary policy. Extensive substitution of bank deposits would shrink the amount of broad money in the economy and therefore reduce control over monetary conditions. At the extreme, the provision of base money and the resulting influence over interest rates would be rendered ineffective. However, as Stevens (2017) points out, as long as money issued by central banks retains the role of unit of account, the switch to private currencies as a medium of exchange would be limited and thus the associated threat to monetary control would also be limited.

Second, the shrinking role of central bank money creates a possible fiscal risk in the form of reduced seigniorage revenue. The response could be higher distortionary taxes that would hurt growth. That said, such risks appear to be exaggerated given that seigniorage revenues make up an insignificant fraction of total government revenue.

The last, but probably most pertinent threat does not emanate from the potential use of cryptocurrencies as money, but from their attractiveness as investment assets. As a speculative investment – an investment made in expectation of a return from capital gains only – private currencies will be prone to bubbles. The collapse of such a bubble could reverberate into wider financial instability if households, corporates and financial institutions hold unhedged debt positions. Central banks would then face a double risk: first to the stability of financial institutions they supervise, from the potentially unregulated cryptocurrency debt markets, and, second, to price stability, from the effects on the real economy of deleveraging and defaulting by economic agents.

4.2 Financial stability implications of a potential private currency takeover

Given the natural monopoly enjoyed by central bank-controlled currencies, it would take a deep crisis of trust for a private currency to substitute an established currency in full. An episode of very high inflation could be such a shock, but even then, agents might wish to switch to other established safe-haven currencies (such as the US dollar or the Swiss franc) before resorting to private digital currencies. However, as argued on p. 53, the broad accessibility of these currencies, compared to traditional currencies, might offer an easily accessible alternative. What would that mean for the financial system and the broader economy?

Focusing on the case of cryptocurrencies, can a fractional reserve banking system, as we have today, function in a cryptocurrency world and how would the cryptocurrency protocol influence it? In a fractional reserve banking system, bank deposits are matched by currency (bills, coins and central bank reserves) only up to a fraction. In such a system, bank deposits are the result of the provision of loans by commercial banks to companies and households, and, therefore, money and credit creation are closely intertwined.

In theory, there is nothing that prevents the creation of a fractional reserve banking in a full cryptocurrency form. However, money creation by private banks would reduce the level of control the cryptocurrency protocol exerts over the money supply, placing additional complexity on the supply algorithm. In fact, central banks that have tried to target the total stock of money in the past renounced it because they found it difficult to achieve price stability with that strategy. Today, the money stock that is created by private banks is ultimately influenced, but not fully controlled, by the central bank. Monetary policy operates mainly through the interest rate at which the central bank provides currency to private banks. Successful influence over monetary conditions in the presence of a fractional reserve banking system would, thus, require an algorithm that manages to affect the lending behaviour of banks.

Even if this were to be achieved, these banks would still be vulnerable to bank runs. Under a fractional reserve system, banks generate profits by engaging in maturity transformation: using short-term, money-like deposits as funding for illiquid, long-term loans. This leaves them vulnerable to the possibility of bank runs. When there is such a general flight to liquidity, the central bank acts as a lender of last resort that restores confidence in the banks and ensures financial stability. Arguably cryptocurrencies would not be able to provide liquidity readily in times of crisis as that is not part of their 'mandate'. This is not unlike the gold standard, where new currency could not be mined in real time and made available to absorb excessive demand. Similarly, deposit guarantees would not be available as a solution in a crypto-financial system.

A third *ex-post* solution would be for the banks themselves to suspend the convertibility of their deposits into the cryptocurrency. However, the existence of such *ex-post* risk would translate to an *ex-ante* discount of each bank's respective IOUs. The uniqueness of money would then break down, as private-bank issued money would fragment into assets that are not traded at par with the predominant cryptocurrency (which is in some way similar to what happened during the free-banking era in the US between 1836 and 1864[14]). Therefore, the *ex-ante* absence of credible solutions to bank runs would increase their likelihood and lead to instability in the system.

Does that mean, at the opposite end of the spectrum, that we could see the emergence of a financial system similar to full reserve banking? In such a system, the bank's IOUs that serve as money (e.g. bank deposits) are fully backed by a government fiat currency or by a commodity. Here, the cryptocurrency could play the role played traditionally by official fiat currencies. This would have two main advantages: first, money supply would be decoupled from credit and would thus only depend on the cryptocurrency algorithm; and, second, there would be no bank runs.

However, one has to ask what forces would give rise to banking in such a cryptocurrency world. In the case of today's fiat government currency, the possibility for users to hold and store its physical form (i.e. bills and coins) is fraught with security risks and inconvenience. Full-reserve banks (which do not provide lending) would at least provide a solution to this problem, by serving their clients' needs to make payments. In a cryptocurrency world by contrast, full-reserve banks would be irrelevant: as payments would be done directly in the decentralised ledger, there would be no need to resort to an intermediary to complete a payment.

In summary, in a full crypto-financial system, savers would have to choose between holding IOUs labelled in a cryptocurrency unit of account issued by unstable banks (not benefiting from a lender of last resort) or sticking to cryptocurrencies that stay idle in the ledger. In that case, who would provide lending to the rest of the economy? One possibility is direct peer-to-peer lending but this would force individuals to screen, monitor and diversify their investments themselves. Or individuals could pool their wealth to share risks and lend to other agents. However, these entities, say 'cryptobanks', that would provide loans to the economy would look more like investment funds than banks, as their funding sources (in cryptocurrencies) would not be deposits but equity. Although liquidity risk would be less of a concern for the holders of equity, they would also be more exposed to credit risk than bank depositors, because they would not benefit from the seniority that bank depositors enjoy in case of default. This risk could thus disincentivise savers from lending and lead to a system that is inherently unstable by being prone to severe credit squeeze that would clearly be detrimental for the economy.

4.3 Money and power: ensuring a system of checks and balances

The potential of private currencies to credibly challenge official currencies cannot only be based on the intelligence of underlying algorithms. Technology and our understanding of underlying economic mechanisms can always help improve those algorithms just as they currently inform monetary policy decisions. But is that all we need, or is there something more intrinsic to the power of the money issuer? Can a private currency ever be a credible money?

Currency management has a societal value – effectively the societal value of monetary policy. The value and stability of money is what enables societies to function well and is not separate from broader choices governments make when they run policy. It is therefore also a part of what constitutes the social contract (Collard, 2017) between the principal (the citizen) and the agent (the government). Manipulating a currency has historically been a powerful means of enabling the sovereign to pursue certain objectives, including financing wars. In other words, this power of controlling money can be used and abused. This is why in modern democracies currency management goes through appropriate layers of legitimacy and accountability. A modern authority that controls the currency will be evaluated according to how well it sticks to the implicit social contract agreed through democratic procedures. This means that it can be released for deviations from agreements made.

In the case of cryptocurrencies, how could an intelligent algorithm that is automatic and anonymous ever be held responsible for failing to deliver agreements? The complexity of currency management implies that the system will fail sometimes, just like financial crises periodically happen. No algorithm, no matter how intelligent (and indeed benevolent), will remove the possibility of crisis. The automation of monetary policy would remove it also from the system of checks and balances. This type of 'independence' of monetary policy effectively also removes the possibility of accountability, and makes monetary policy exogenous to the process that identifies, monitors and evaluates agreements.

But what about known associations that are no longer neither anonymous nor automatic. Can private money challenge the sovereign character of traditional money? The private nature of such endeavours and therefore their private objectives, be it profit or other things like accessibility, make them unlikely to take on the 'externality of monitoring prices'. Price stability, a key feature of money, is based on a welfare criterion that alludes to a public good and are therefore best served by public institutions.

Last, it is only the existence of this system of checks and balances that allows modern lenders of last resort to create money out of nothing and provide ample liquidity in times of crisis. As soon as this system breaks down and trust in authorities goes, the currency ceases to be an acceptable means of payment or even a unit of account. The currency is only as strong as its lender of last resort, and the lender of last resort is only as strong as the backing that it has from its constituents. Constituents in turn, build trust depending on how well social contracts are adhered to.

5. Should central banks issue their own digital currencies?

Interest in central bank digital currencies (CBDCs) on the part of authorities is partly motivated by the popularity of private digital currencies that could challenge the role of official currencies. Providing digital currencies issued by the central bank could possibly make private digital currencies less attractive and slow down their adoption.

There is no universally agreed definition of what constitutes a CBDC, but the term has become commonly used[15] to designate any form of central bank digital fiat liability that is accessible to all economic agents. We discuss here what we believe is the most promising version of CBDC: deposit accounts at the central bank available to all.

5.1 What would be the purpose of CBDCs?

A first reason why CBDCs might be useful is that allowing households and companies to open accounts at the central bank would give them direct access to efficient and instantaneous retail payment systems that banks already use to exchange reserves between them. This would remove one reason for switching to a private digital currency with a better payment system. But there are other reasons.

Replicate the 'safety' of cash. If cash were to become scarce or even disappear, citizens would lose direct access to sovereign money, the ultimate safe asset. Should cash disappear, citizens would only have access to bank deposits, which are not as safe. Deposits above a certain threshold (EUR 100,000 in the euro area) are uninsured, and even below this threshold, there is the possibility of losing access to savings even for a few days or weeks. For this reason, they cannot replace the safety that cash provides.

Also, the possibility of re-directing bank deposits to central bank deposits provides incentives for bank discipline. As argued by Brunnermeier et al. (2019), in the absence of cash, banks would not 'fear' convertibility of their deposits into central bank currency, and could lose some of the incentives (even though regulation would still be a major disciplining device) to reduce their solvency and liquidity risks. *In extremis*, if deposits do not have to be converted into a common currency, deposits from different commercial banks could at some point become imperfect substitutes for one another. In that case, the trustworthiness of each issuer, would lead to the creation of 'exchange rates' between them, as was the case during the US free banking era in the nineteenth century. CBDCs would solve this problem by allowing households to access central bank currency in a new form, and thus restore the convertibility threat for banks.

Strengthen the transmission of monetary policy. The introduction of CBDCs could also strengthen monetary policy by transmitting it directly to the general public. Changes in policy rates would be transmitted directly to CBDC depositors, in contrast to what happens today, where interest paid by commercial banks on deposits are relatively sticky.[16] This also means that CBDCs would make unconventional policies easier to implement.

First, as long as the CBDC is interest-bearing, it could help relax further the zero lower bound constraint because interest rates applied to the CBDC could be negative (unlike for banknotes). Abolishing cash altogether would strengthen this effect although it must be acknowledged that this might not be desirable for other reasons. Cash could still be useful at least as a back-up for a CBDC in case of a technical failure or cyberattack, and for privacy reasons. But even if cash continues to exist, as long as its use is inconvenient (which would be even more the case if CBDC were introduced) and its storage is costly, implementing negative rates on CBDC holdings would be possible.

Second, CBDCs could reduce one of the potential side effects of quantitative easing (QE), namely excessive reserves. Currently, central bank bond purchases from non-bank institutions create additional reserves that are inevitably held by the commercial banks in the deposit facility of the central bank. This is because non-banks cannot hold reserves directly at the central bank. On aggregate, this means that banks cannot control fully the quantity of reserves they want to hold. When rates are negative, this becomes costly for banks and might result in potential side effects such as increased rates for lending to the real economy. If non-banks could hold CBDCs directly, QE would not affect the banking sector negatively.

Finally, provided the concept of helicopter money is a politically acceptable monetary policy tool, it would be easier to implement if all citizens had accounts at the central bank, because the central bank would be able to credit their accounts with CBDC units directly.

5.2 The potential risks of CBDCs

The introduction of CBDCs is sufficiently disruptive that it could pose a number of risks.

Cyclical bank runs. First, one the main fears of policymakers (see, for example, Coeuré, 2018) is that CBDCs will lead to cyclical bank runs. If households and companies have access to central-bank reserves, there is a risk of a flight-to-safety from commercial-bank deposits to CBDCs in each economic downturn. This type of run from banks to the central bank happened in the 1930s during the Great Depression in France, when it was possible for non-banks to maintain accounts at the Banque de France (Baubeau et al., 2018). Bank runs are already possible today by withdrawing cash or transferring deposits between banks, [17] but the main concern is that digital bank runs towards CBDCs would be easier and happen more rapidly than traditional bank runs.

Altering and possibly removing the need for intermediation. In addition to this cyclical financial stability risk, CBDCs could interfere and distort the objective of financial intermediation. Banks would compete with the central bank to hold deposits. It is very difficult to predict what would happen, because it would depend on the particular properties of the CBDC introduced and on the behaviour of the central bank after its introduction, but this could lead to different outcomes (Stevens, 2017).

A first possible outcome could be an evolution towards a financial system characterised by narrow(er) banks that are less reliant on deposits. Banks could either offer higher returns to depositors to try to retain their deposit base, or they could rely on other sources of financing. This would have profound implications, positive as well as negative. The extra competition from CBDCs would reduce the monopoly power of the banking sector and allow depositors to obtain higher returns on their deposits. For banks, by definition, the effect would be the opposite because they could be forced to rely on more expensive and potentially less stable sources of funding, such as the wholesale market.[18] This new banking model would make banks look more like investment funds, which could be less stable thus requiring an

adjustment of the financial safety net. The need for traditional deposit insurance would be reduced because deposits could be kept safely in the form of CBDCs. However, if we consider that the maturity transformation provided by banks is a valuable service, then it needs to be protected from liquidity risk. Either insurance cover for banks' short-term liabilities would have to be broadened to include wholesale funding, with all the risks that this would entail (but the alternative would be frequent 'wholesale runs' such as those that happened during the last financial crisis). Or regulation would have to be significantly stricter to avoid any maturity mismatch on banks' balance sheets, for example by forcing them to be financed mainly through equity and long-term debt.

Another possibility would be a tightening of credit conditions by banks if they are unable to retain depositors or attract new sources of funding. This tightening would lead to less lending and/or at a higher price, which would, all else being equal, result in a significant drag on investment and ultimately on economic activity.

5.3 How could central banks minimise these risks?

How can policymakers reduce bank runs? Policymakers have several tools at their disposal, should bank runs become more frequent as a result of the introduction of CBDCs. First, deposit insurance offsets the risk of runs when deposits are within the guaranteed amount. Second, the central bank should play its crucial role of lender of last resort by providing liquidity through loans to the banks that suffer runs, as long as they are solvent. The financial instability episodes in France in the 1930s discussed in Baubeau et al. (2018) showed that the main problem was not the bank runs (towards the central bank or towards other saving institutions) *per se* but rather the strong '*gold standard mentality*' prevailing at the Banque de France at the time. This mentality prevented the central bank from playing its role as lender of last resort and replacing the shortfall in deposits held at commercial banks with central bank loans to avoid a strong credit crunch.

How can central banks discourage disintermediation? Central banks would also have various instruments to counter the risk of structural financial disintermediation if that were to endanger price or financial stability. The central bank's reaction could vary depending on the magnitude of the problem.

In moderate cases, such as if the quantity of credit provided by banks was not significantly affected, but banks asked for higher lending interest rates (for example because they needed to increase the returns paid to depositors to retain them), the central bank would have to lower its policy rates structurally to offset this effect and maintain financial conditions at the same (presumably adequate) level, all things being equal. In normal times this should not be a particular problem, but at a time when the effective lower bound is binding, it might be problematic, and might involve the increased use of unconventional monetary policies.

What if disintermediation were to become a more significant issue and there was a clear downward pressure on bank credit availability? The main way for the central bank to offset this trend would be to provide structurally more funding to the commercial banks to replace the lost deposits, so that they could maintain the same level of financing to the economy. This means the central bank balance sheet would have to become structurally much bigger[19] and also more exposed to the banking sector than otherwise.

The debate on the optimal size of central banks' balance sheets has not been settled.[20] However, the two main risks for central banks in increasing massively their refinancing operations would be the following.

- First, the central bank would take more risks onto its balance sheet because it would be more exposed to the risks faced by banks: in a way, the central bank would become itself a financial intermediary between depositors that would hold CBDCs and the commercial banks.
- Second, this means that the central bank would be involved more directly in the credit allocation process. In order to be able to provide a much greater amount of refinancing to the banks, the central bank might have to adjust significantly its collateral framework so that banks are able to access its operations at a sufficient scale. Central banks' decisions on collateral eligibility and haircuts are often perceived as purely technical decisions, but they are not always as neutral as they seem (Claeys and Goncalves Raposo, 2018). In particular, deciding to include new asset classes as eligible collateral (in order to increase the pool so that banks can obtain more refinancing) could have some powerful effects on credit allocation by the banks. The main advantage is that this would give the central bank greater control over the macroeconomic situation. However, the drawback would be that it could potentially make the overall allocation of resources in the economy less efficient, and could also have some distributional effects that central banks cannot and should not control.

The central bank could also try to carefully calibrate the properties of CBDCs in order to reduce *ex ante* the incentive to use a CBDC as a main store of value. This should avoid the extreme situation in which deposit accounts held at the central bank would fully crowd out bank deposits. The simplest way to do this would be through its remuneration system. CBDC accounts should benefit from lower than other policy rates in order to reduce both the structural disintermediation risk and the frequency of bank runs. But these returns should not be so much lower that they make CBDC unattractive mediums of exchange. In particular, when policy rates are negative, a portion of CBDC holdings could be exempted to avoid the negative impact on small savers and prevent households from switching back to holding cash. Bindseil (2019) proposed a very practical system to put that in place with a two-tier remuneration system for CBDCs: below a threshold of €3,500, CBDC holdings would be remunerated at the maximum level between the deposit rate and 0, and above that threshold CBDC holdings would be remunerated at the deposit rate minus 200 basis points. These numbers are indicative and the central bank would need to experiment to find the right balance. Such a balance would incentivise the use of CBDCs as a medium of exchange, and gives access to everyone to the ultimate safe asset when necessary (especially if cash disappears), but disincentivises the use of these accounts as a main store of value in normal times.

5.4 Who else could provide an equivalent to CBDCs?

Finally, an alternative solution to give the general public access to digital central bank liabilities would be not to provide it directly through a CBDC, but to do it indirectly through what could be considered 'full-reserve banks' (sometimes also referred to as 'narrow banks'[21]).

The idea, as described for example by Adrian and Mancini-Griffoli (2019), would be to allow new entities to hold reserve balances at the central bank, subject to some specific conditions. These entities – which actually would not be so different from some form of stablecoin – would have a very particular balance sheet with only central bank reserves as assets (they would not give credit, nor buy any other type of asset) and only simple deposits as liabilities (they probably would not need to hold much capital, if any at all, given the absence

of risk from their portfolios). The entity would pass the remuneration of central bank reserves to depositors and earn a small fee for the service provided.

This system would allow households and companies to hold indirectly the central bank currency and would have two additional advantages. First, it would allow central banks to focus on their mandates and not use their resources to provide direct services to their new customers (which could also have some negative reputational consequences for central banks if not handled properly). If all households and companies of the euro area opened a CBDC account at the European Central Bank, the number of accounts in the Eurosystem would grow from around 10,000 to more than 500 million (Bindseil, 2019). Second, as argued by Bordo and Levin (2019), this would help prevent a conflict of interest for the central bank. Competition from a CBDC could be considered unfair by banks given the crucial role central banks play in the organisation of the banking sector (for instance as a supervisor, among other functions). For all these reasons, privately managed alternatives to CBDCs should not be discarded by central banks and, on the contrary, should be considered as one way to provide CBDCs to the general public.

6. Conclusion

Privately issued digital currencies have the capacity to change global payment systems and possibly challenge some official currencies. But their issuers are unlikely to play the role of managing price stability, safeguarding financial stability and being the ultimate guarantor of value. This is a task for public authorities serving the greater public good that cannot be met when operating for profit, which is the case for these privately issued coins.

But their potential for scale, global reach and ultimately also convenience has an appeal that has forced public authorities to reconsider their role. One potential effect will be the need for creating Central Bank Digital Currencies, to first meet the rapid reduction and possible elimination of cash. This is not simple and it could imply central banks taking more of a financial intermediation role in the economy. This is not without problems but it is something that needs to be considered as the whole monetary system becomes digital.

Notes

1 See BIS (2018) for details on how a DLT works in practice.
2 See https://capital.com/top-cryptocurrencies-to-invest-in-spring-2020
3 Yahoo Finance (8 October 2019).
4 See Koning (2015).
5 See for instance Griffin and Shams (2018) showing how the cryptocurrency Tether might be used to provide price support and manipulate other cryptocurrency prices.
6 Despite an original and potentially promising model, Basis shut down its operations in December 2018.
7 Although important details are not described in the White Paper (Libra Association, 2019).
8 Anderson and Papadia (2020).
9 See <U>https://www.bitcoinmarketjournal.com/how-many-people-use-bitcoin/.</U>
10 https://www.ft.com/content/189c1c66-91dd-11e9-aea1-2b1d33ac3271
11 https://www.fsb.org/2019/06/fsb-chairs-letter-to-g20-leaders-meeting-in-osaka/
12 https://data.consilium.europa.eu/doc/document/ST-13571-2019-INIT/en/pdf
13 https://www.nytimes.com/2020/04/16/technology/facebook-libra-cryptocurrency.html
14 See details in Frieden (2016).
15 See for instance Meaning et al. (2018) for a detailed discussion on the definition of a CBDC.
16 In the euro area, before the crisis when policy rates were high, interest on bank deposits was significantly lower, while now the opposite is true, as shown by Bindseil (2019).

17 Actually, in France in the 1930s, the run from commercial banks towards safer savings institutions (*caisses d'épargne*) was even more significant than that towards central bank accounts. Similarly, Bindseil (2019) showed that during the European financial crisis (2008–12) transferring deposits from what were perceived as weak banks to stronger banks was a much more important form of run than conversion of bank deposits into cash.
18 This could also have the additional side effect of cutting banks off from their client base in terms of selling them other services generally bundled with deposit holding, including mortgages and overdraft facilities. Banks could also be stopped from acting as intermediaries between their clients and investment funds, insurance companies, etc., which would reduce the fees they receive on such activities and thus their overall profits.
19 Bindseil (2019) estimated that in the euro area, *in extremis*, if all bank deposits needed to be replaced by the ECB, the increase of central bank credit to commercial banks would be EUR 4 trillion, or a doubling of the size of the ECB's balance sheet.
20 See section 4.1 in Claeys and Demertzis (2017) for a summary of this debate.
21 This denomination can however be confusing given that the term 'narrow bank' is also used to describe banks that look more like investment funds, as described on *p. 61*.

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