

Does digitalization require Central Bank Digital Currencies for the general public?

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This paper critically discusses the idea of introducing central bank digital currencies (CBDC) in view of central banks' responsibility for monetary and financial stability. We first argue that cash cannot be digitalized without being deprived of its characteristics as an inclusive, crisis-proof and anonymous means of payment. We then lay out that much of the debate about CBDC is a debate about structural reforms of the monetary-financial system rather than technological innovation. While CBDC has the potential to increase the speed and efficiency of the payment system, it involves risks associated with financial disintermediation, centralization of credit allocation within the central bank, and bank runs. We discuss the channels through which money today acquires legitimacy as a means of payment, a store of value, and a unit of account, and we stress that it cannot be taken for granted that CBDC will achieve the same level of legitimacy that currency enjoys today.

JEL classification: E42, E58, H11, O33

Keywords: central bank digital currencies, monetary reform, digital transformation, payment systems

Innovations in digital technologies, such as social media, artificial intelligence, big data analysis, cloud computing, the Internet of Things² or blockchain technology, are expected to transform all realms of society (OECD, 2019). This *digital transformation* brings about fundamental changes in socio-economic structures, organizational patterns, business models and consumption patterns: Online communication, online collaboration, online banking, and online shopping and the like have become ubiquitous in our everyday lives.³ Against this background, people often expect that money, too, must undergo a *digital transformation* in order to satisfy the needs of an increasingly digital economy. Because physical banknotes and coins cannot be used to pay for online purchases, they are sometimes viewed as technologically outdated.⁴ Proponents of this view call for the provision of central bank-issued digital currencies (CBDC), enabling the public to store value and make payments also in electronic central bank money. They argue that CBDC should replace banknotes and coins, or at least complement physical cash.

In this paper we examine the potential implications of central banks issuing digital currencies for the general public. In section 1 we argue that cash cannot be

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² See for instance <https://www.wired.co.uk/article/internet-of-things-what-is-explained-iot>.

³ See Cochoy et al. (2017) for a detailed discussion of the effects of digital transformation on consumers.

⁴ Clearly, the exchange of physical objects such as cash requires both counterparties of a transaction to be in the same physical location.

digitized without being deprived of several of its advantages as a means of payment and store of value, because many of its unique characteristics are inherent in the physicality of cash. In section 2 we discuss the role of cash in the prevailing monetary-financial system, where many monetary instruments are created not by the central bank but by private commercial banks extending credit to the economy. We argue that the introduction of CBDC, independent of its technological implementation, will radically transform the monetary-financial system, with potentially large consequences for financial intermediation, money creation, credit allocation, monetary policy implementation and macroeconomic stabilization. Any decision about the introduction of CBDC must be based on the social desirability of these fundamental changes. In section 3 we argue that money needs ‘legitimacy’ to perform its economic functions, and that it cannot be taken for granted that a monetary system involving CBDC will maintain, or even improve, the level of legitimacy that money enjoys today. In section 4 we conclude that issuing CBDC is ultimately a political, not a technological issue.

1 Cash and CBDC: outdated versus advanced technology?

Banknotes and coins dominate our perception of money today, because they provide the most direct encounter of money and its functions in everyday life.⁵ Small children, even, are well aware that the banknotes and coins they receive as pocket money from their parents can be used to buy goods (such as candy bars) and services (such as pony rides), that they can be put in a piggy bank and stored for later purchases, and that the price tags displayed in shops reflect how many (and what type of) banknotes and coins have to be handed over in exchange for a particular item. Children thus already understand the three key economic functions of cash as a *means of payment*, a *store of value*, and a *unit of account*.

But in modern economies, cash is not the only object that fulfills these functions and hence serves as *money*. Most payments in modern economies are made by transfers between accounts of bank customers. Due to the technological advances of the last decades, deposits held with commercial banks can quickly and easily be transferred today through devices such as smartphones and contactless debit cards, serving as an efficient means of payment. Moreover, as deposits are redeemable in cash at par value, they inherit the properties of cash as a store of value and unit of account.⁶ Bank deposits thus are a very close substitute for cash from any individual user’s perspective. Indeed, among retail payments, electronic transfers of funds held in commercial banks already surpass the use of banknotes and coins in many economies. Most money that is being used today is hence *digital* rather than *physical* in nature, and the trend toward cashless payments leads to a steady decline in cash payments.⁷ Against this background, many view the calls for a digital version of cash provided by the central bank as an almost inevitable next step in the evolution of money.

⁵ See Pichler et al. (2018).

⁶ This is true except for extremely rare periods of banking crises, where users question a bank’s ability to honor its promise to redeem deposits with currency.

⁷ See Bagnall et al. (2016) for evidence on the growing use of cashless payments. Note also that while the use of cash in payments has been declining the total circulation of cash over the past decade (to be used as a store of value and other purposes) has even been increasing in many countries and in the world (Jobst and Stix, 2017).

However, when thinking about CBDC as a replacement for cash, it is important to realize that physical cash has very distinct characteristics as a payment instrument.⁸ The first characteristic is that cash is the most *inclusive* means of payment at the current stage. Cash is particularly easy to use and is available to everybody in society, including people without access to electronic devices (e.g., children, the extremely poor, or elderly people). Its device-independence makes cash also particularly *crisis-proof*; physical banknotes and coins can be used to make payments even in extreme scenarios where electronic devices fail on a large scale, such as extended power blackouts or regional internet outages in the aftermath of natural disasters (events which are expected to become more frequent in the years to come). Moreover, cash is the only means of payment that allows for true *peer-to-peer* transactions, i.e. transactions between two parties without the physical presence of a third party.⁹ For two contracting parties to exchange cash, they do not depend on the issuer or another intermediary to verify the authenticity of the means of payment (i.e. because banknote security features enable users to easily spot common forgeries¹⁰). Nor do they need to disclose their identities and the change in ownership to third parties (making anonymous payments possible).¹¹

Importantly, the advantages of cash outlined above cannot be preserved to full extent in any form of CBDC. Clearly, digital means of payment under current conditions cannot be as inclusive and crisis-proof as cash, because they necessarily rely on electronic devices for storage and transfers. Moreover, any digital currency without physical representation requires record-keeping of each transaction to verify its authenticity and record changes in ownership. There is a clear need for a register that records who is the legitimate owner of a unit of digital currency, since digital objects ultimately consist only of bits and bytes and hence can be copied easily and at virtually zero cost. Record-keeping, in turn, requires third parties for validating and processing transactions,¹² making true offline transactions infeasible. Finally, the reliance of digital means of payment on electronic devices and a register necessarily brings about technical traceability of payment flows, which limits their anonymity relative to cash.

The discussion about cash versus CBDC is thus not primarily a discussion about the (outdated versus advanced) technology underlying the currency issued by the central bank. CBDC would necessarily be less inclusive, less crisis-proof and less anonymous (for better or worse) compared to physical currency (cash). Moreover,

⁸ See *Wissenschaftlicher Beirat des Bundesministeriums für Wirtschaft und Energie Berlin (2017)*.

⁹ *At the technological research frontier, concepts of offline digital payments, which are peer to peer payments have been known since the seminal work of Baqer, Anderson. et. al. 2017. Now these technologies are not yet widely available for payments in practice. We thank Rainer Böhme for pointing us to this literature.*

¹⁰ *The security features of the Euro banknotes such as the watermark, the feel of paper, the security thread, the hologram and the color changing number support the easy detection of forgeries. How easy these forgeries are to detect by users in practice is less clear.*

¹¹ *At the individual level, anonymity is an advantage because it allows for effective protection against the abuse of information about individual payments. For society, however, anonymity can be a disadvantage of payment instruments, because it facilitates criminal activities such as money laundering or the financing of terrorism.*

¹² *This register can take different forms, e.g. it can be a ledger of account balances (as in the case of bank deposits) or a ledger of transactions (as in the case of crypto coins such as Bitcoin). Within the traditional payment system, banks perform record-keeping and intermediation tasks as trusted third parties. The ledger of crypto coins such as Bitcoin (i.e. blockchain technology) does not require a single trusted third party but still requires record-keeping and intermediation, which is performed in a decentralized way by the mining community.*

as we will argue in the following section, the introduction of CBDC – either as a substitute for or a complement to cash – would necessarily bring about fundamental changes to the prevailing monetary-financial system, which must be evaluated to assess the potential benefits and costs of CBDC.

2 The monetary-financial system, cash and CBDC

In all major economic areas, physical banknotes and coins are the only form of central bank-issued money available to individual citizens.

While public perception of money is focused on the tangibility of cash and the manual process of banknote printing or coin minting, most payments exchanged today do not involve the physical exchange of cash. Most payments today are made by banks or central banks moving money electronically on behalf of their customers. Behind both tangible and intangible monetary objects, there is an elaborate immaterial architecture, where monetary instruments are liabilities of an issuer who guarantees their value and backs these liabilities with corresponding assets. A large part of this architecture has been digital for a long time, and is therefore not challenged by digitalization per se.

Commercial banks have access to reserves accounts with the central bank, where they hold central bank money in electronic form. This electronic central bank money serves as means of payment in interbank transfers, and hence banks critically depend on it for their operations. The central bank increases the supply of cash and electronic central bank money by purchasing financial assets from commercial banks (paying banks with central bank money) and reduces it when selling assets to banks (being paid with central bank money).¹³ At all times, its liabilities (cash and reserves) are fully backed by financial assets. By setting and periodically adjusting the terms at which commercial banks can access its balance sheet (i.e. exchange money against financial assets or vice versa), the central bank implements monetary policy to fulfill its public mandate to maintain price stability, guaranteeing money's value relative to goods and services.

While the central bank can directly control its monetary liabilities, often described as “high-powered money,” the total supply of non-cash money (e.g. bank deposits) is determined endogenously in the monetary-financial system. The monetary policy stance (availability, level of interest rates, and collateral required for central bank reserves) is a key determinant for commercial banks' ability to create new means of payment for their customers. When a commercial bank gives out a new loan, it credits its customer's deposit account, thereby issuing a liability that can be used as means of payment by the recipient (the latter being required to repay the loan over time). The bank's balance sheet grows because of this lending activity: total bank liabilities increase (due to the newly created deposits) in tandem with total bank assets (due to the buildup of claims on, e.g., credit customers or the government). Like central bank money, the money created by banks is thus also backed by assets. Regulatory requirements ensure further that a fraction of banks' deposits is invested in central bank reserves, to guarantee that banks can meet their customers' liquidity needs and are able to honor their promise to redeem deposits in cash at par value, and that banks issue equity to absorb possible losses.

¹³ In principle, of course, the central bank can purchase assets from anyone. In practice, the main transaction partners are, however, commercial banks.

This supports banks' willingness and ability to extend credit to the economy and allows for the financing of various forms of economic activity (corporate investment, household asset acquisition, public sector expenditures, etc.) based on the decentralized decisions of competing banks within the prevailing regulatory framework, with little direct involvement of public institutions such as the central bank.

Monetary policy can influence this process because commercial banks depend heavily on the central bank for their operations; they need central bank money to settle liabilities among each other (e.g. resulting from deposit transfers on behalf of customers), to satisfy cash withdrawal demands by their customers, and to fulfill minimum reserve or other regulatory requirements. By varying the price (interest rate) banks must pay for obtaining central bank money, a central bank influences the operating costs of commercial banks and hence their lending and money creation activities. An increase in the policy rate, for example, increases banks' cost of obtaining central bank money, and commercial banks in general respond to this increase by raising the interest rate they charge on new loans; all else equal, a higher interest rate reduces the demand for new loans in the economy, such that borrowing and lending (and hence money creation) declines.

The dependence of commercial banks on the central bank introduces an element of hierarchy into the monetary system. Unlike in a hierarchy, however, the central bank is not in a direct line of command vis-à-vis the commercial banks; all financial transactions between the central bank and the commercial banks are based on voluntary contracting and governed by price mechanisms, within the requirements for commercial banks set by the regulatory framework. Moreover, the central bank as a government institution does not use its position in the system to maximize financial profits. Rather, monetary policy is conducted to fulfill the central bank's public mandate, which – in the euro area – is primarily to stabilize and guarantee the purchasing power of money relative to goods and services.¹⁴ Commercial banks, in turn, guarantee the equivalence of cash and their customers' deposits in terms of nominal value and transferability. The main mechanisms in place to support this guarantee are proper risk management of banks, monitored by equity owners, creditors and competing banks, the regulation and supervision of banks by government agencies, and deposit insurance provided by the banking sector community (together with the central bank's ability to serve as a lender of last resort). This elaborate institutional setup enables money, independent of its physical or digital representation, to fulfill its functions as a means of payment, a store of value, and a unit of account.¹⁵

Note finally that modern money exists as various national currencies. Most currencies are used as a unit of account, a means of payment and a store of value only within the borders of a single economic area, whereas a few currencies such as the euro or dollar take these roles also in international transactions. At both the national and international level, a currency's dominant status is explained by network effects. From each individual user's perspective, the attractiveness of a

¹⁴ To achieve its mandate, the central bank regulates the access of commercial banks to its balance sheet. It determines, e.g., the interest rate on new credit provided to commercial banks, the maturity of new loans, as well as collateral requirements.

¹⁵ This aspect is emphasized by Borio (2019), who argues that "... money is much more than a convention; it is a social institution. It is far from self-sustaining. Society needs an institutional infrastructure to ensure that money is widely accepted, transactions take place, contracts are fulfilled, and, above all, agents can count on that happening."

currency increases with the number of other users,¹⁶ because it implies a greater choice of available goods priced in the currency as well as a larger number of potential transaction partners accepting this currency as means of payment. Moreover, because the parallel use of several different currencies involves costs, there is a tendency for the dominance of a single currency in any economic area. The fact that national tax systems impose tax duties on domestic economic actors in domestic currencies, together with the costs of switching to a foreign currency, keeps users anchored in domestic currencies and prevents the spread of the network logic across national borders toward the evolution of a single world currency.¹⁷

2.1 Cash and CBDC in the monetary-financial system

Our discussion so far has made clear that, even though most money being used today is digital in nature and issued by private commercial banks, cash plays an important role in the monetary-financial system: eventually, all digital means of payment represent an issuer's promise to provide cash at par value on demand. The value of commercial banks' privately issued money is tied to their ability and willingness to honor this promise, and thus anchored to the value of central bank money.

The growing use of cashless payments in industrialized economies¹⁸ has led to a steady decline in the share of cash among payment instruments. In some countries, most notably Sweden, the total demand for cash has declined so strongly that the possibility of a demand-driven disappearance of cash cannot be ruled out completely.¹⁹ If cash were to disappear indeed, which means that bank deposits would no longer be redeemable in cash, individual citizens would lose the possibility to hold cash (a central bank liability) rather than deposits (a commercial bank liability). In vast countries such as Sweden there is also the issue that making cash available to customers in remote northern regions creates considerable costs for commercial banks. A CBDC would enable commercial banks to refuse handling cash and save considerable costs.²⁰ Against this background of loss in variety, the Swedish central bank has started to elaborate concepts for a central bank digital currency, referred to as the e-krona, which would provide individuals with access to central bank money should cash disappear and parliament should decide to call for a CBDC (Sveriges Riksbank, 2017). The Swedish experience as well as the pervasive media coverage of cryptocurrencies such as Bitcoin has spurred the interest of the general public in alternative digital payment instruments, which explains why the recent debate about CBDC has gained a much higher profile than similar discussions in the past.²¹

¹⁶ In this respect, money has similar properties like language, digital social networks, computer software and other infrastructural phenomena.

¹⁷ Nevertheless, if the perceived quality of a national currency departs too much from available alternatives, users can become prepared to overcome switching costs and adopt a foreign currency in domestic transactions (this is the experience of countries having undergone dollarization, euroization etc.).

¹⁸ See Bagnall et. al. (2016).

¹⁹ While the use of cash in payments has been declining, the total circulation of cash over the past decade has even been increasing in many countries and in the world. For more detailed evidence, see Jobst and Stix (2017).

²⁰ We thank our referee for having pointed out this motivation for introducing an e-krona.

²¹ The debate on electronic money and related issues emerged two decades ago but was limited to small circles of academics and central bankers at the time. See Capie et. al. (2005) or Stix (2002).

2.2 Token-based versus account-based CBDC

Technically, CBDC could be implemented in one of two ways: either based on tokens or based on accounts. CBDC tokens, working very much like cryptocurrencies (Bitcoin, Ethereum, etc.), would be the closest digital equivalent of physical banknotes and coins. In other words, users would store CBDC in electronic wallets and use their tablet computers or smartphones to make transfers to other users. The wallet software would be either provided directly by the central bank or the central bank would provide a reference implementation. It would also maintain the ledger for recording all token transactions. Essentially, this means that, unlike today, we would no longer necessarily have to rely on private profit-oriented banks for transfers. At the same time, these institutions would continue to play the role of the agent that brings the money into circulation. Like physical currency today, newly issued electronic tokens would be bought first by commercial banks, who can acquire these tokens from the central bank in exchange for financial assets. Individual citizens, in turn, would then be able to acquire these tokens from banks in exchange for cash or bank deposits. Token-based CBDCs are thus close to cash in their functionality (within the limitations for digitalizing cash discussed in section 1).²²

Alternatively, central banks could offer individuals and firms access to central bank CBDC accounts, which are currently the prerogative of banks.²³ Note, however, that providing central bank accounts to citizens requires an identification system. It raises the challenge whether the central bank would then rely on national identification systems or must build a universal (national) identification system on its own. The requirement for identification to get access to a CBDC account makes such an implementation less inclusive than a token-based system. Providing CBDC based on accounts does hence not necessarily require central banks to adopt fundamental technological innovations such as distributed public ledgers like the blockchain. History teaches us that central banks have in fact run accounts for households and firms before (see Bindseil, 2019). Nevertheless, upscaling the current central bank system to serve the general public would have huge operational and resource implications, and the engineering problems that come with the implementation of a CBDC, even when building on known concepts such as systems of deposit accounts, are typically underrated. Böhme (2019) points out that the potential marginalization of cash and bank deposits as payment instruments by CBDC could require central banks to engage in new infrastructure activities like the provision of network services or the supervision of telecommunication systems, to guarantee the ability of the monetary system to recover from technical failures and thus provide resilience. It is debatable whether we want central banks to take on this key player position in critical infrastructures.

Note that the distinction between token-based and account-based systems is less clear cut than often claimed in the literature. While implementation details might be different, for reasons discussed in section 1, both forms of CBDCs must be based on a form of record-keeping and are thus very similar. Referring to some technical implementations of CBDC as “tokens,” i.e. playing with a physical

²² See Mancini-Griffoli et al. (2018) or Kahn et al. (2018).

²³ Bindseil (2019) estimates that for the Eurosystem this would require an increase from approximately 10.000 accounts today to approximately 500 million accounts.

metaphor, may be misleading. There is, in fact, no such thing as a digital token; there are only register records of imagined token ownership.²⁴

Finally, independent of the implementation details, a CBDC would represent central bank liabilities, like banknotes and central bank reserves today.

2.3 CBDC, cash and deposits: complements or substitutes?

In the current monetary-financial system, each form of money – cash, bank deposits, and electronic central bank reserves – has a unique combination of characteristics (see Bjerg, 2017). Cash and bank deposits are both universally accessible, but electronic reserves (which are only available to commercial banks) are not. Bank deposits and reserves are both digital, but cash is not. Cash and electronic reserves are issued by the central bank, but bank deposits are not. Because of these differences in attributes, there is no single form of money that dominates other forms in terms of usability. By contrast, independent of its technological implementation a CBDC for the public would combine all three desirable attributes: it would be universally accessible, digital, and central bank issued. As stressed by Bjerg (2017), CBDC would thus be in fierce competition with all the different forms of money existing today, and potentially replace cash or even bank deposits as a means of payment and store of value. Clearly, this could have large (and potentially adverse) consequences for the current monetary-financial system, where banks' ability to extend credit *inter alia* depends on their ability to privately create a universally accepted means of payment. The debate about CBDC thus necessarily invokes a debate on the basic architecture of the current monetary system (Grym, 2018).

Bindseil (2019) contributes to this debate by analyzing the system of financial accounts between households, corporates, government, commercial banks and the central bank. For the Eurosystem, his estimates show that in an assumed scenario where CBDC replaces only the use of banknotes by households, the balance sheets of commercial banks and the central bank would hardly be affected; the overall effects on financial intermediation by banks, and hence on the macroeconomy, would be minor. If, however, users were to substitute CBDC for bank deposits, the fierce competition for funds would imply higher funding costs and lower profits for commercial banks. The Eurosystem balance sheet would lengthen, because the funding gap of commercial banks would have to be filled by central bank credit. Moreover, larger recourse to central bank credit would increase collateral scarcity in the economy, and the collateral framework would become more instrumental for the allocation of credit. Bindseil (2019) argues that this risk of structural disintermediation of banks and centralization of the credit allocation process within the central bank could be a controversial consequence of introducing a CBDC.

A full substitution of bank deposits by CBDC would lead to an elimination of money creation by commercial banks and would lead to the establishment of what some monetary reform enthusiasts call a “sovereign money system.”²⁵ It would also fundamentally change the way monetary policy works. Rather than steering overall money creation by setting interest rates for the refinancing of commercial banks

²⁴ It might be appropriate to point out that proposals for true digital tokens exist in the literature, but these proposals rely on hardware or cryptographic assumptions nobody so far considered in the CBDC discussion. An important reference in this respect is Chaum 1983. We thank Rainer Böhme for pointing this out.

²⁵ Huber 2017.

with the central bank, monetary policy in such a system would control money creation through the interest rate paid on CBDC. Whether it would be a good or bad idea to actively pursue a monetary reform agenda which would result in a “sovereign money” system is controversial, and it is not logically linked to the concept of a CBDC. It is clear that centralizing the function of issuing means of payment at the central bank would be a major revision of the current division of labor between the public and the private sector.²⁶ While CBDC implemented as accounts at the central bank might in fact lead to the implementation of a “sovereign money” system, CBDC and “sovereign money” are conceptually different issues.

A further important concern in the CBDC debate²⁷ is financial stability. Clearly, the existence of CBDC accounts at the central bank would facilitate systemic runs²⁸ on banks in crisis situations, for the simple reason that risk-free central bank issued deposit money could be perceived as vastly more attractive than bank deposits.²⁹ As stressed by Bindseil (2019), this is a second key argument against CBDC. Against this background, he proposes a two-tier remuneration system for CBDC that addresses both structural disintermediation and bank runs. Under this scheme a menu of interest rates would discourage CBDC holdings that exceed the amounts needed for day-to-day transactions of most customers. While Bindseil’s proposal provides interesting ideas for the implementation of an account-based CBDC potentially avoiding the immediate crowding-out of commercial banks, many details still need to be clarified. While – for instance – the proposal might work well for individuals and households, it is not so clear how it would work for (financial and nonfinancial) firms of differing sizes and complexity. Taking into account households and firms would perhaps make the system very messy.³⁰

Irrespective of this, the analysis by Bindseil (2019) makes clear that whether a central bank should actively pursue the idea of introducing CBDC is a matter of monetary-financial system design and politics. It is not primarily a question of technological innovation, and hence should not be guided by the debate on digital transformation.

As a matter of fact, there are currently many different forms of money available, including digital forms. If the digital transformation results in a growing demand for digital forms of money relative to banknotes and coins over time, a simple shift in market shares among already existing forms of money could be expected. Such shifts in payment preferences can be handled already within the current institutional setup. There may be room for innovation by established or new payment providers with respect to cost or other payment features of increased relevance in a digitalized economy. But it is hard to see a technological case why the current monetary system needs CBDC to provide digital forms of payments.

²⁶ For a detailed discussion on the “sovereign money” proposal, see Weber (2018), pp. 160–192.

²⁷ See Mersch (2018) for a typical example.

²⁸ It is sometimes argued that as long as cash exists, and can be withdrawn by owners of bank deposits on demand, the availability of CBDC would not significantly increase the likelihood of a panic run on banks. We doubt that this is true for the simple fact that with the availability of CBDC and the online infrastructure coming with it the costs of a run on the bank from the perspective of a depositor are much lower because withdrawing money is much easier: No queuing in front of cash machines, all it takes would be a few mouse clicks.

²⁹ Brunnermeier and Niepelt (2019) argue that this will not, however, necessarily lead to financial instability if the central bank is willing to replace private deposits with central bank lending.

³⁰ We thank our referee for pointing out these important aspects.

Box

Libra and currency competition: a new case for CBDC?

What if money became increasingly challenged by a more digitalized means of payment in a currency other than one's own? Cryptocoin advocates have promoted this narrative for a decade by now, but a digital "coin" that would be able to compete with official currency in terms of stability, cost, and usability has yet to emerge. Thus, cryptocurrencies have not been adopted for retail payments; much rather, they have fostered the development of a niche of speculative trading activity.

Many expect this situation to change following the presentation of plans for a global virtual currency called "Libra" by the U.S. online social media and social networking service company Facebook in 2019.³¹ According to Facebook, Libra will be conceptualized as a "stable coin," i.e., the receipts earned from selling Libra coins against official currency will be used to acquire safe backing assets in a basket of stable currencies. The Libra issuer (a consortium of corporations including Facebook and other platform-based businesses) will thus closely resemble a central bank running a currency board to peg its currency to foreign currencies. This concept breaks fundamentally with the core characteristics of cryptocurrencies such as Bitcoin or Ethereum, whose supply is predetermined by algorithms, whose administration is decentralized, and whose value is not backed by any official currencies or other assets (and thus fluctuates strongly in response to changes in demand).

Given Libra's improved design in terms of stability compared to the major cryptocurrencies and given the market power of Facebook and its allies, many expect Libra to challenge existing official currencies, even if some of its features are inferior to official currency (e.g. stability in relation to domestic prices). Some observers see the introduction of a CBDC in official currency as a necessary defense measure against this alleged challenge (e.g. Landau, 2019).

Indeed, the introduction of Libra may lead to the same disruptions of the monetary-financial system that the introduction of CBDC could lead to. If users of official currency were to convert bank deposits in official currencies into Libra and use Libra instead of euros or dollars to make payments, bank deposits could stop to function as a retail payment instrument and become relegated to exist as reserve assets held by the Libra Association to back its virtual currency. In an extreme scenario, Libra could dominate the global digital retail payment market as a result of de facto currency substitution, with cash in official currency becoming a relic for hoarding wealth and a niche for offline payments. Under such circumstances, central-bank issued digital currencies could become a means to uphold the possibility to make digital retail payments in domestic currency.

Such an extreme scenario is, however, unlikely. First, it is hard to believe that Libra will be able to deliver its promise – making money transfers as easy and cheap as sending a text message – and at the same time fulfill global regulatory standards. For example, banks and payment providers are required to ensure the legitimacy of any international payment against the background of anti-money-laundering and financing-of-terrorism laws, which is both cost- and time-intensive. Moreover, switching to Libra (or any other currency that is backed by a basket of various currencies) would result in a loss of purchasing power stability for any user whose salary is paid in euro.³² Libra would have to offer massive comparable advantages in other dimensions in compensation for that weakness (e.g. financial incentives to use Libra, exclusive access to goods and services when paying in Libra etc.). It is hard to think of any features which could neither be copied by competitor payment services in official currency, nor challenged by competition authorities or other regulatory measures (G7 Working Group, 2019). Prima facie, while the Libra project deserves full regulatory and supervisory scrutiny, it does not create a clear case to introduce a CBDC in major currency areas.

³¹ See <https://libra.org/>.

³² Because exchange rate fluctuations between official currencies within the backing basket, Libra can be expected to result in fluctuations of Libra's purchasing power as measured in prices of goods and services denominated in any single official currency.

3 Legitimacy and CBDC

Our economic system is mainly characterized by decentralized decision-making of private property owners, coordinated through markets. In this system, monetary instruments require legitimacy to be accepted and perform monetary functions; after all, value is a social phenomenon and acceptance of an instrument by market participants is a social phenomenon, too. Accordingly, introducing a new form of money into the economy requires ensuring a widespread perception among potential users that it is legitimate, which involves two key dimensions. The first dimension, “input legitimacy,” refers to the relation between issuer’s and users of a monetary instrument. Do users trust the issuer, do they have a form of influence or control over its goals and behavior? The second dimension, “output legitimacy,” refers to the characteristics of a monetary instrument with respect to its economic performance. Does it conform to users’ quality requirements? The notion of legitimacy thus goes beyond a narrow focus on technical or economic properties of money, instead involving a comprehensive look at all features that turn a (physical or digital) object into money.

3.1 Input legitimacy

In the current monetary system, issuers are subject to several channels aimed at producing “input legitimacy,” a trustful relationship between issuers and users of money. Central banks are subject to a public mandate, which in general comprises, or at least includes, some form of inflation target. In most currency areas, legal provisions require independence of central banks with respect to employing instruments at their disposal in pursuit of their mandates without government interference (e.g. interest rate policy). Equity of central banks is held and guaranteed by the public sector, and it is the prerogative of governments to appoint central bank management. Accountability toward parliaments and the general public typically takes the form of mandatory hearings, and transparency requirements (publications, minutes of key meetings etc.). Commercial banks are subject to licensing requirements, public regulation and supervision, as well as market competition among banks, plus monitoring by their equity owners and creditors. The co-existence of public and private issuers in the contemporary monetary system in each currency area mirrors the co-existence of both sectors in the broader system of economic activity, where both the public sector and commercial activity by private property owners share responsibility. This elaborate institutional setup is key to a trustful relationship between issuers and users of money, and hence to “input legitimacy.”

Any project to introduce CBDC must be prepared to face a public debate involving questions regarding input legitimacy concerns. This is because a CBDC does have potential implications for the division of labor and the relative weight among current issuers of monetary instruments. For instance, the introduction of CBDC could be perceived as an attempt to monopolize the payment system and restrict freedom of choice among means of payment, leading to the crowding out of private issuers. Conversely, CBDC could be perceived as a measure to uphold freedom of choice among digital means of payment, by closing a gap created by the market-driven disappearance of cash. When citizens become owners of central bank deposits, the more direct contact with the central bank could challenge current legitimacy arrangements built on a narrow mandate and central bank independence to fulfill it (e.g. by nurturing expectations that the central bank

allows overdrafts on accounts, finances transfers, grants attractive interest rates and other fiscal demands that may conflict with monetary policy objectives).³³

Input legitimacy concerns are a key reason why both advocates of a purely state-based or purely private monetary system are very active participants in the debate on digital currency. They perceive digitalization as a window of opportunity to uproot the current hybrid monetary system, which is based on a hierarchical division of labor among public and private entities, and as a window of opportunity to trigger monetary reform.

For example, in parts of the debate led by Rogoff (2016), the key rationale behind CBDC is to proactively eliminate cash from the current monetary system. This, it is argued, would facilitate the achievement of policy goals such as fighting criminal activities (money laundering and the financing of terrorism). In the debate led by Barrdear and Kumhof (2016), the key argument in favor of CBDC is to expand the toolkit available to monetary policymakers. In a world where CBDC replaces cash, the central bank could implement negative interest rates, and the issuance of CBDC could be a source of revenue for direct monetary finance of government expenditures or for lump-sum transfers in the form of helicopter money (see Assenmacher and Krogrstrup, 2018; Meaning et al., 2019; Agarwal and Kimball, 2019). In this context, it is important to realize that in today's monetary-financial system, money creation results from an exchange of liabilities between an issuer and a counterparty. When central banks acquire securities against issuing either banknotes or crediting central bank reserves to deposit accounts, the returns on these securities in general surpass the interest paid to holders of banknotes and reserves. The spread of income earned on central bank assets over income paid on their liabilities results in *monetary income*. Importantly, monetary income is *not* equal to the full nominal value of money created minus operational costs, and hence certainly not a free lunch for the issuer. This aspect is frequently neglected in proposals that view CBDC as a novel instrument to finance public spending and transfers. Finally, it is important to realize that the engagement of a central bank in essentially *fiscal* policies could undermine its credibility and acceptance within society, with potentially detrimental effects on its ability to fulfill the public mandate of price and financial stability.

While a continuous debate on reforming and regulating the economic and financial system is ongoing and inevitable given expected future challenges, there are strong doubts on the workability and potential benefits of currently known proposals for *monetary* reform (see Weber, 2018). But whatever one's view on this issue, it is important not to conflate a debate on the form of money with a debate on its institutional architecture. From a central bank's viewpoint, it is particularly important to avoid any impression that questionable institutional changes are promoted under the guise of digitalization.

3.2 Output legitimacy

Money acquires the second dimension of legitimacy, "output legitimacy," if it conforms to quality requirements of users. These requirements include, but are not limited to, general acceptance of money as a means of payment, the stability of its value, the stability of the monetary-financial system, and other practical usability

³³ We thank Martin Hellwig for pointing that out; see also Hellwig (2018).

aspects. Macroeconomic effects are certainly of key importance but are too vast a dimension to consider in the context of this article. In what follows we assess whether (or how) CBDC could fulfill these requirements and hence acquire output legitimacy.

3.2.1 General acceptance

In many currency areas, cash enjoys broader acceptance than currently available digital means of payment. Should digitalization result in the gradual degradation of the infrastructure supporting the circulation of cash (ATMs, cash transport services etc.), some groups in society could become constrained in their access to means of payments. In this context, CBDC aimed at replacing cash in terms of easy accessibility could be part of an effort to enhance financial inclusion (see Lagarde, 2018).³⁴

In determining the accessibility of CBDC, its compatibility with existing payment infrastructures (mobile phone apps, point-of-sale terminals) or development of specific infrastructure with specific focus on broad accessibility would be key aspects. Depending on policy intentions, specific measures could be taken to influence the use of CBDC, e.g. encourage it by offering incentives for payment of taxes or certain public services in CBDC or discourage its use for large value payments by imposing limits on the value of individual payments or account holdings in CBDC.

A different route for securing broad accessibility of digital payment instruments in domestic currency in a cashless economy would be to impose regulation on private issuers of payment instruments securing broad access for users and imposing limits on user costs of these instruments.

3.2.2 Stability of value

It can be taken for granted that any CBDC would be denominated in the domestic unit of account (in the European case in euro) and maintain stable nominal value against other means of payment in domestic currency. But does the central bank goal of ensuring the purchasing power of money *require* the introduction of a CBDC? After all, digitalization may lead to the market-driven disappearance of cash. In a monetary system where commercial bank deposits represent a claim on cash, one may be led to believe that the market-led vanishing of cash implies a capping of the anchor tying banks' issuing behavior to stability-oriented monetary policies, resulting in the central bank becoming powerless – unless a CBDC is introduced to replace cash.

But such fears are unsubstantiated. Demand for cash as a means of payment on the retail level may revert to zero without hampering monetary policy focused on price stability. Commercial banks still require central bank reserves to settle payments among each other, and to fulfill both minimum reserve and regulatory liquidity requirements. Monetary policy operates via terms imposed on banks holding central bank liabilities, irrespective of whether they are held in cash or noncash form.

In academic research, some economists have discussed whether CBDC could be used as an instrument to enhance the toolkit available to central banks to pursue price stability beyond current means, e.g. enforcing negative interest rates, establishing a monopoly on the issuing of payment instruments and attempting money supply control etc. But most of these models suffer from a simplified view of the complex

³⁴ Note, however, as we pointed out in section 2.2. a CBDC model which aims at enhancing financial inclusion is incompatible with an account-based implementation, if access to central bank accounts were available on the same terms and conditions as access to commercial banks.

legitimacy requirements for money and possible trade-offs created by such measures. The imposition of negative interest rates on domestic currency beyond a certain limit is constrained not only by the availability of cash in domestic currency, but also by the risk of widespread substitution of domestic by foreign currency and other forms of liquid value. Making CBDC the only legal means of payment may enable the central bank to put all components of the money supply under central control. But it would not contribute to make money demand conform to the stability expectations underlying the quantity theory of money. In both respects, the ability of the central bank to fulfill its mandate is unlikely to improve.

3.2.3 Stability of the monetary-financial system

As users of financial services and products, as borrowers, as recipients of income in an economy dependent on a functioning circuit of money and credit, all economic subjects depend directly or indirectly on financial stability.

Like cash, CBDC could provide a potential safe asset in financial crises. If cash vanished because of reduced demand in markets resulting from digitalization, CBDC could be introduced to secure public access to central bank money, the least risky means of payment and means to self-insure against shortfalls in future personal income. If this sounds reasonable and attractive from an individual user's perspective, it may still create a problem on a collective level. The accessibility and attractiveness of CBDC by itself can have destabilizing effects, by either creating or intensifying banking crisis because of an attractive alternative to holding deposits at commercial banks triggering a bank run among retail customers more easily. It could also structurally crowd out commercial bank deposits. Because retail deposits in commercial banks refinance a major part of banks' credit to the economy, a shift of deposits to the central bank would result in the central bank acquiring an increased role as supplier of credit to the economy, either indirectly (if the central bank decided to compensate retail depositors' role as a supplier of funds to the banking system) or directly.³⁵ To avoid this, the attractiveness and accessibility of CBDC could be limited with respect to maximum holdings per person, returns and costs offered to holders, and various other features aimed at regulating accessibility and user behavior.

3.2.4 Practical usability aspects

The use of digital monetary instruments requires an infrastructure on which to record their existence, ownership and transfer. Such infrastructures involve access requirements for users and can be equipped with several services related to storing and transferring users' funds. Digitalization of the economy may result in a shift of user needs and requirements with respect to access and associated services. The introduction of a CBDC would require decision-making on which kind of access criteria and services would be available to users:

³⁵ *Inter alia, this could imply a huge rise in banks' requirement for adequate collateral to access central bank reserves, potentially resulting in collateral undersupply and price implications on the securities markets concerned, or a pressure on central banks to relax current collateral requirements, resulting in increased risk absorption by the central bank, and an increased role of the collateral framework for credit allocation in the economy. We would like to thank Hans Gersbach for stressing this fact.*

- Which functionalities and which terms of access would the associated payment service offer (fees, interest)? Would there be restrictions related to the amount of funds available per user, and on the purposes for which they could be used?
- Which kind of account services would be provided?
- Which kind and amount of privacy would be offered to users?

These design elements can be used by the central bank to influence a CBDC's attractiveness and availability to users compared to cash and privately issued digital means of payment. Design decisions will be strongly influenced by the expected impact of a CBDC's usability on the output legitimacy criteria referred to above. There are two main dimensions where user requirements are expected to change because of digitalization, creating a gap that could arguably be filled by a CBDC: with respect to the speed of payments and with respect to data protection. Growing demand for instantaneous payments, available around the clock, results from the tendency for time compression in digital commerce. One reason for introducing a CBDC could be to increase the availability of secure instant payments. The collection and analysis of user data, including payment data, has become a major component of business models in the digital domain. The digitalization of payments has also increased the vulnerability of user data to cyber incidents. These trends could over time erode current patterns of privacy protection in existing digital payment instruments, potentially creating a demand for CBDC with superior privacy protection features.

For the time being, European authorities have concluded that both requirements should be approached with measures less bold than the introduction of a CBDC. In 2018, the Eurosystem started a system for instant payments in central bank money among its counterparties, which private payment service providers like commercial banks can use to settle instant payments among retail customers based on commercial payment applications. With respect to data protection, the introduction of the EU's General Data Protection Regulation is a major effort to address privacy concerns in a digitalized economy, while anti-money laundering laws are regularly updated to address misuse of the financial system for illicit activity.

Finally, should cash vanish altogether as a result of market-driven processes, protection of the payment system against a major power failure remains a tricky issue. One may argue that the availability of a CBDC might at least provide an available alternative to private payment systems, but ultimately it is not clear why the central bank would have a better chance to protect its own payment system against a power failure than private system providers.

4 Conclusion

Should central banks issue digital currencies? And if so, how should they be implemented? These questions are inherently difficult to address, as they go far beyond questions concerning the technology underlying central bank money. Any form of central bank digital currency has the potential to crowd out cash, bank deposits, or both as a means of payment and a store of value, with far-reaching consequences for privacy, financial stability and the division of labor between the private and public sector in the allocation of credit. These major disruptions in the institutional architecture of money, banking and finance pose a challenge to the legitimacy of CBDC as a form of money. Ultimately, introducing a CBDC is the outcome how a society is able and willing to handle a broad range of questions, which are by far not only technological ones.

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