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The Future of Money

Compilation of papers

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The Future of Money

Compilation of papers

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CONTENTS

The Impact of Digitalisation on the Monetary System

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Abstract

Against the backdrop of a trend towards a cashless society and the emergence of private electronic monies, the paper discusses properties of digital currencies and implications for currency competition, describes benefits and risks of digitalisation of money for the society, explains the concept and implications of a CBDC, and discusses implications of digital money for monetary policy. The upshot is that the trend towards digitalisation will probably continue, but has to be closely monitored and accompanied with an appropriate regulatory framework.

This document was provided by Policy Department A at the request of the Economic and Monetary Affairs (ECON) Committee.

CONTENTS

LIST OF ABBREVIATIONS

CBDC	Central Bank Digital Currency
DCA	Digital Currency Area

EXECUTIVE SUMMARY

- Digital money can take different forms representing inside or outside money, account-based or token money, and may be an independent currency or part of a traditional currency domain.
- Currency competition has been limited historically due to strong network externalities in the usage of money. By unbundling the properties of money, digitalisation substantially raises the potential for currency competition. Re-bundling of digital money along large social or commercial platforms works in the opposite direction.
- The decline in the relative importance of cash in most economies is mainly driven by the convenience and efficiency gains offered by electronic payment methods in combination with mobile devices. In the transition to a cashless society, a major social challenge is to prevent parts of the population from being left behind.
- Introduction of digital currency has the potential to be welfare enhancing by exploiting the potential of linkages and exchange in a network's ecosystem and by providing users with the possibility of direct, peer-to-peer transfers of money. However, a plethora of legal and regulatory challenges will have to be addressed before the launch of stablecoins with global scale and scope. Different regulatory regimes in different countries may ultimately lead to an increasingly fragmented international financial system. A serious concern is the possibility that the association of a widely used electronic currency with a large social or commercial electronic platform will reinforce monopolistic tendencies already inherent in network industries.
- A digital currency issued by a central bank (CBDC) can be disruptive for the fractional reserve system, because money users would have the option to hold direct claims against the central bank. Commercial banks would increasingly have to replace deposits with more reliable sources of funding.
- There are plenty of reasons why central banks may actually decide to launch a CBDC, independently or jointly: Installation of a backup payment system, higher revenue, financial inclusion, efficiency of the payment system, traceability of illegal transactions, surveillance, upholding the public monopoly of money while satisfying the need for digital money, and countering competition from private currencies as well as from foreign CBDCs.
- It is unclear if and when a major central bank will actually introduce a CBDC of global relevance. Intuition suggests that CBDCs will be a realised at some point in time, and that today's leading currencies will rather not be the frontrunners of such a move.
- The implications of digital money for monetary policy are not straightforward. If digitalisation means the replacement of cash with central bank derived digital money, then the central bank's ability to produce inflation will increase because the effective lower bound on interest rates will loosen. However, if digitalisation raises the possibility of the introduction of (private or foreign) competing currencies, the ability of central banks to inflate their currencies would be constrained by the threat of people switching to these competing currencies.
- The welfare implications from digital currencies thus depend on the optimal rate of inflation. If the optimal inflation rate is high, then constraints on the central bank's ability to increase inflation could pose a problem. If, however, optimal inflation is low, then the reverse is true.
- There is considerable disagreement on the optimal rate of inflation. The choice of the targets of around 2 percent used by many central banks today are to a considerable degree arbitrary.

1. INTRODUCTION

Digitalisation has changed the way monetary systems work for many years already, but recently it has started to change its structure more fundamentally. Developed economies rapidly reduce the importance of cash, and in some cases envisage becoming cashless entirely in the foreseeable future. At the same time digital currencies have appeared. The first wave of cryptocurrencies such as Bitcoin, Ethereum or Ripple have failed to gain relevance in terms of their share in monetary transactions. This was due to systemic deficiencies leading to extreme volatility, limited capacity, unpredictable transaction costs and limited transparency, which have reduced their ability to fulfil the basic functions of money and hence their attractiveness as a medium of exchange.[1] More recently, stablecoins have entered the scene which were specifically designed to deal with the issue of volatility by tying the digital currency to an underlying set of assets. Another important difference to the first generation of cryptocurrencies is that they rely on third-party institutions to some extent and may be issued by a central entity.

The potential for a widespread adoption of stablecoins, which so far also failed to materialise, has hugely increased with the announcement of Facebook to introduce Libra, a stablecoin based on the blockchain technology and backed by a basket of reserve assets (bank deposits and short-term government securities denominated in major currencies) to give the currency intrinsic value (Libra Association 2019). The huge number of billions of users on Facebook's various platforms (including Facebook, Whatsapp, Instagram) that Libra can potentially capitalise upon raises the probability that this project will successfully reach global scale in a relatively short period of time. Meanwhile, the discussion around the introduction of central bank digital currencies (CBDC) as a possible response has continued.

Against this backdrop, this paper discusses some of the specific properties of digital currencies and implications for the monetary system in terms of currency competition (Section 2), describes benefits and risks of digitalisation of money for the society (Section 3), explains the concept and implications of a CBDC and assesses the probability of its introduction (Section 4), and discusses implications of digital money for monetary policy (Section 5). Section 6 briefly concludes.

[1] See Fiedler et al 2018 for a discussion of technical aspects and different use cases of virtual currencies.

2. THE MONETARY SYSTEM AND THE IMPACT OF DIGITALISATION

When discussing the impact of digitalisation on the monetary system it is useful to distinguish between architecture and technology of a monetary system. While digital money and electronic payment systems have become increasingly important elements of the monetary system for many years already, they so far have not substantially changed the architecture of the traditional two-tiered monetary system based on central bank money and deposits in commercial banks. New developments such as private money in the form of cryptocurrencies and the prospect of digital currencies issued by the government or private entities have the potential to radically alter the way the monetary system works.

2.1. Money

Money is traditionally defined as a financial instrument that fulfils three main functions:

(1) Facilitate the indirect trade of goods and services as a generally accepted medium of exchange,

(2) serve as a store of value, and

(3) provide a common unit of account to accurately compare the value of goods and services.[2]

Irrespective of its concrete form, being the generally accepted medium of exchange is arguably the identifying characteristic of money, with the other two functions being of subordinate nature (Fiedler et al. 2018). As the most pervasive good, money constitutes a category of its own as it is neither an object of consumption (it does not directly satisfy human needs) nor a means of production (the usefulness of money to allow for increasingly complex production processes does not depend on its quantity).

In order to promote broad acceptance and safeguard its value, money was historically linked to a commodity such as gold as an anchor, i.e. the issuers of money made a legally binding commitment to convert their instrument on demand to the anchor. Today the anchor is government-issued fiat currency. Issuers of money that is used for payments are typically banks, which commit to converting deposits into an equal quantity of government-issued fiat currency. But also private non-bank money designed to circulate in a designated, limited economic sphere abound, including regional money which has become popular in Germany (with the "Chiemgauer" being a prominent example) or company debit cards (such as the Starbucks Gift Card).

An important distinction is between inside and outside money. Inside money is created by simultaneously producing a claim on the private issuing entity. Outside money by contrast is not a claim on anything, although the issuer may promote the value and acceptance of the money by promising to maintain a certain (although in principle adjustable) exchange rate to another financial instrument and support this commitment by backing it with a collection of assets. Along these lines, traditional electronic payment systems such as credit cards are examples of inside money, whereas the vast number of cryptocurrencies as well as stable coins such as the projected Libra are representing outside money.

Another important distinction is between account-based money and token money. Account-based money is related to a specific person (or company) – the account holder – that needs to prove its identity to verify authenticity of a transaction. In a token system, it is central to verify the authenticity of item (the token) irrespective of the identity of the agents. Cash is the (so far) most familiar example of token money, but modern e-money (e.g. Alipay and WeChat in China) and cryptocurrencies such as

[2] In its original version introduced by Stanley Jevons in 1876, being a standard of deferred payment was identified as a fourth distinctive function of money, which in modern textbooks is usually subsumed in the other three functional categories.

Bitcoin are also token money. Account-based money is typically related to the provision of credit, token-based money is typically not.

An independent currency can be defined as payment instruments that are (1) denominated in the same unit of account and where (2) each payment instrument within the currency is mutually convertible (Brunnermeier et al. 2019: 5). Put differently, the constitutive criterion for belonging to the same currency is denomination in the same unit of account irrespective of the specific medium of exchange (cash, reserves, bank deposits) and a legally binding fixed exchange rate among the different financial instruments. According to this definition, many of the recent forms of digital money are independent currencies. This includes fiat cryptocurrencies, such as Bitcoin or Ether to name the two largest, but also some stable coins, including Libra, which would be denominated in its own unit of account, have fluctuating exchange rates to individual official currencies, and retain the possibility of adjusting its initially fixed exchange rate to the underlying basket of official currencies.

2.2. Currency competition

Currency competition has been advocated as a possibility to discipline governments in managing government-issued currencies for many years, starting with Hayek (1976). Currency competition in the sense of Hayek does not necessarily imply the actual simultaneous existence of several currencies in the same economy, but may even work through the mere potential for competition, thereby restricting the room to manoeuvre for monetary policy. While governments often made competition with privately issued currencies impossible by legal restrictions, a certain amount of competition remained due to the existence of large internationally traded currencies such as the US-Dollar or the euro. In some cases, this competition from relatively stable major currencies resulted in a substantial loss of relevance of the domestic currency in the process of "dollarization" of an economy.

In general, however, currency competition is inhibited by the existence of strong network externalities (Dowd and Greenaway 1993). Historically, competing currencies needed to satisfy all three properties of money to a sufficient degree, raising high bars for a newcomer to establish sufficient prominence in terms of unit of account and acceptance as a medium of exchange even if credibility as a store of value was achieved. Moreover, switching costs (such as exchange fees) used to be relatively high, giving an incentive to stick to an incumbent official currency. In terms of the possibility to fulfil all money functions from the start, large commercial and social digital networks (such as Facebook, Amazon or Alibaba) have changed the potential for diffusing information among a large number of users at very low cost. These networks are international and allow for access to a huge number of potential counterparties beyond national boundaries. Accordingly, such digital ecosystems facilitate the successful introduction of a new (own) currency, and this explains to some extent the nervous reaction of some major central banks in response to the announcement of Libra, with billions of users on the various platforms involved – including Facebook. With regard to switching costs between currencies, in the modern digital environment they can become relatively low, with peer-to-peer exchange within networks without a third party involved and mobile devices that enable on-the-spot execution of currency exchanges. The reduction of switching costs contributes to a possible unbundling of the roles of money. The incentive to use the same currency to fulfil all functions of money (medium of exchange, unit of account, and store of value) at the same time is reduced, as soon as switching the currency is easy and cheap. For example, one currency may be particularly strong in the role as medium of exchange due to its prevalence in a large social or commercial networks, so it is used for payments, while another currency can be strong in the role as store of value, so it is used to hold money.

While the existence of network effects in the digital economy contributes to the potential unbundling of the functions of money and thus promotes currency competition, an opposite effect originates from

the role of electronic platforms. Platforms are digital market places bringing together consumers, merchants and service providers facilitating exchange (of goods, services, capital, ideas…). If digital currencies are associated with platforms, they will effectively combine the functionalities and data of the platform, resulting in a re-bundling of money along the demarcation line between different platforms, which tends to weaken competition among currencies.

In the presence of large network externalities produced by transnational social or commercial platforms, new "digital currency areas" (DCA) may arise when payments and transactions are made by a digital currency that is specific to the network (Brunnermeier et al. 2019 : 19). A currency specific to a DCA could be an independent currency representing an own unit of account distinct from currencies already existing, such as Facebook's Libra. Its unit of account is derived from a basket of official currencies but remains different from any of the incorporated individual currencies. A DCA specific currency may also continue to use an official currency's unit of account (which implies that it is no independent currency according to the definition above), but would be restricted to transactions and exchanges inside the network. Major examples of this type of digital currency area can currently be found in China, with two large networks (Tencent and Ant Financial) entertaining payment systems without interoperability.

3. POTENTIAL BENEFITS AND COSTS FOR SOCIETY FROM INCREASED DIGITALISATION OF MONEY

3.1. Advantages of and concerns with a cashless society

One manifestation of digitalisation of money is a trend towards a reduction in the use of cash in transactions. This trend is indeed almost universal, although it differs substantially across countries. According to a recent IMF study, the share of cash in "cash-like transactions", as measured by the amount of cash withdrawals plus the amount of transactions using two of the closest substitutes (card and e-money) has been falling significantly in almost all countries covered by the analysis, with India being the sole exception (Khianonarang and Humphrey 2019). On average, the share of cash in the economy declined at an average annual rate of change of 6 percent between 2006 and 2016, from 49 percent to 29 percent (Table 1).

Table 1: Reductions in Cash Use in Selected Countries, 2006 to 2016

	Cash Share, Level 2006	Cash Share, Level 2016	Annual reduction of cash share in Percent
Australia	37	21	6
China	54	18	10
Denmark	47	22	7
Germany	84	70	2
India	45	45	0
Japan	64	23	9
Netherlands	49	31	5
Norway	22	10	8
Singapore	61	30	7
UK	39	24	5
US	40	29	3
Average	49	29	6

Source: Khiaonarong and Humphrey (2019).

The lowest level of cash use in 2016 is found in Norway at 10 percent (down from an already low level of 22 percent in 2006), the highest level remains prevalent in Germany at 70 percent (2006 : 84 percent). East Asian economies seem to experience an especially rapid decline (-10 percent annual change of cash use in China and -9 percent in Japan). The government of South Korea actively nudges its population to reduce the use of cash further and reportedly plans to phase out cash by 2020, although the parting from bills and coins will probably be more gradual. Sweden is inquiring the possibility of complementing cash with an e-krona, a digital central bank money (see discussion in section 4).

The decline in the relative importance of cash is partly driven by the convenience and efficiency gains offered by electronic payment methods in combination with mobile devices. Other arguments in favour of a cashless society include an expected reduction of crime, as absence of physical money implies that theft and robbery of cash are eliminated as well as counterfeiting. Moreover, funding of illegal activities, money laundering and tax evasion is more difficult without cash, particularly in electronic payment systems that rely on a central counterparty that records all transactions. Clearly, the use of digital money that allows for quasi-anonymous peer-to-peer transactions – such as cryptocurrencies like Bitcoin – reduces this advantage, which is why the crypto market is heavily regulated in a number of countries. With respect to monetary policy, abolishing cash would increase the scope of monetary policy to introduce negative interest rates, as the effective lower bound to nominal interest rates depends on the possibility to switch to cash as an interest free alternative to deposits (see section 4 for further discussion).

At the same time, giving up cash altogether comes with a number of problems and concerns. These include privacy issues. As far as payments made are traceable, private companies as well as governments are able to track individual transactions (and actions) in order to compile an individual profile or engage in widespread surveillance. The potential for digital crime, including fraud, unauthorised access and data breaches may rise with a rising share of electronic payments. A serious risk is the complete reliance on a functioning electronic infrastructure in a cashless society, making the economy even more vulnerable to cyberattacks. Another challenging issue is to ensure that those currently relying on cash as a means of payments are included. These tend to be concentrated in the poorer parts of the population and in the elderly population, which are generally less accustomed to the use of electronic payment systems, and includes illegal migrants, homeless people as well as children. Finally, there is the concern that electronic payment systems make it more difficult for people to control their budgets and may lead to a problematic increase of consumer debt.

3.2. Advantages of and concerns with digital currencies

Traditional currency areas are usually defined along national boundaries and evaluated according to the theory of optimal currency areas, according to their ability to smoothen economic shocks and to improve risk sharing. This situation basically remains unchanged with the potential introduction of a central bank digital currency. Digital currency areas based on a (national or international) digital network, by contrast, aim to exploit the linkages and exchanges in a network's ecosystem by providing users with the possibility of direct, peer-to-peer transfers of money. This could in principle increase economic welfare. The introduction of private independent digital currencies, especially if they promise to deliver the functions of traditional money as in the case of stablecoins, can also serve as an additional insurance against irresponsible monetary policy with respect to the official currency. The drawback, however, could be a reduced scope for monetary policy response in the case of an adverse macroeconomic shock (see section 5).

There are a number of severe additional concerns related to the introduction of stablecoins with global scale and scope like Libra (Brainard 2019). A number of legal and regulatory challenges will have to be

addressed in advance. These include compliance with rules and regulations introduced to counter the use of digital currencies for illegal activities and illicit finance, and compliance with national jurisdictions' anti-money laundering laws, which may differ across countries. In the case of transnational networks it has to be determined which jurisdiction is responsible for which financial activity conducted by the various players in the system, and whether the respective regulatory environment is appropriate. Consumer protection is an important issue as well. It is unclear to which extent consumer protection of Libra users is comparable to those delivered by statutory regulation in many countries. At the very least, differences with respect to the risks of digital currencies in comparison with traditional deposits should be made sufficiently transparent. Finally, there is the issue of data security, given the large number of data breaches that have become public in recent years.

A serious concern is the possibility that the association of a widely used electronic currency with a large social or commercial electronic platform will lead to an unprecedented aggregation of personal data, which may strengthen the competitive advantage of the supplier of that platform and currency over potential competitors, thereby reinforcing monopolistic tendencies that are already inherent in network industries.

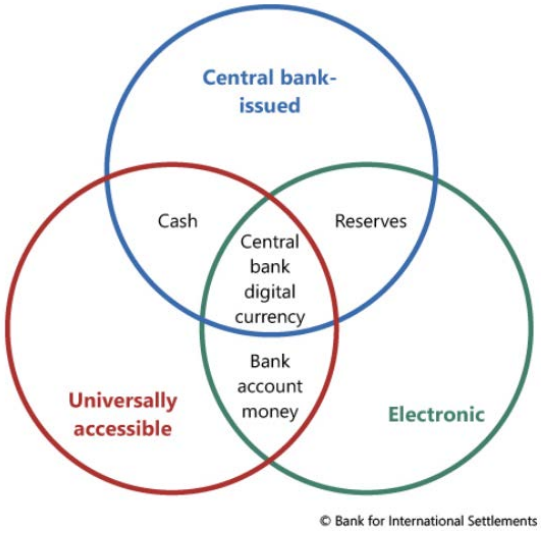
In their pursuit to allow for an evolution of the financial system while at the same time guarding against the above mentioned risks, national governments can be expected to employ different regulatory regimes, for instance to take account for different priorities with respect to the prevention of illicit transactions or privacy issues. As a result, it may become impossible to easily use a single digital currency on a global scale. Thus, despite the potential of digitalisation to facilitate transnational transactions, the outcome could ultimately be an increasingly fragmented international financial system.

4. CENTRAL BANK DIGITAL CURRENCIES (CBDC)

4.1. Main idea

In today's banking system, money issued by the central bank is available as either cash or reserves. The former (cash) is accessible to anyone; the latter (holding reserves) is only accessible to banks. If non-banks intend to hold non-tangible money, they have to rely on deposits at commercial banks. In essence, these deposits represent claims against commercial banks, instead of claims against the central bank. Put differently: It is a mere promise of the bank to pay out cash. With a central bank digital currency (CBDC), households and businesses can actually choose to hold non-tangible central bank money, i.e. direct claims against the central bank ("digital cash"). Base money is extended beyond cash and reserves to a third aggregate state – unless reserves are simply merged with CBDC units by granting unrestricted access to reserve accounts. In any case, the central bank guarantees at-par convertibility between all sorts of central bank money. The Venn diagram below visualizes former arguments, with CBDC being the intersection of all three subsets of electronic, central-bank-issued and universally accessible types of money (Figure 1).

Figure 1: A taxonomy of money



Source: Bjerg (2017).

Another way to consider CBDCs is that they are "light" versions of a full reserve system. In June 2018, there was a referendum in Switzerland on "Vollgeld", which would have radically transformed the Swiss banking system into a full reserve system. Banks would have been prohibited to create money "out of thin air" in a credit contract and to offer deposit accounts on a fractional reserve basis. The referendum spurred a vivid debate on the foundations of our monetary system in Switzerland and abroad. International newspapers followed the election campaign closely. In the end, the initiative was voted down by a large margin. It is no coincidence, however, that many proponents of a full reserve system are attracted to the concept of a CBDC, because this effectively provides the option to hold liquidity on a full-reserve account (100% money). At the same time, banks can still to offer accounts on fractional reserve basis. Therefore, a CBDC simply introduces an additional option for money users, without any radical changes to banks' balance sheets on the day of introduction, without prohibiting fractional

reserve deposits and without forcing banks to change their long-standing business practices from one day to the next. Basically, a CBDC is "Vollgeld light".

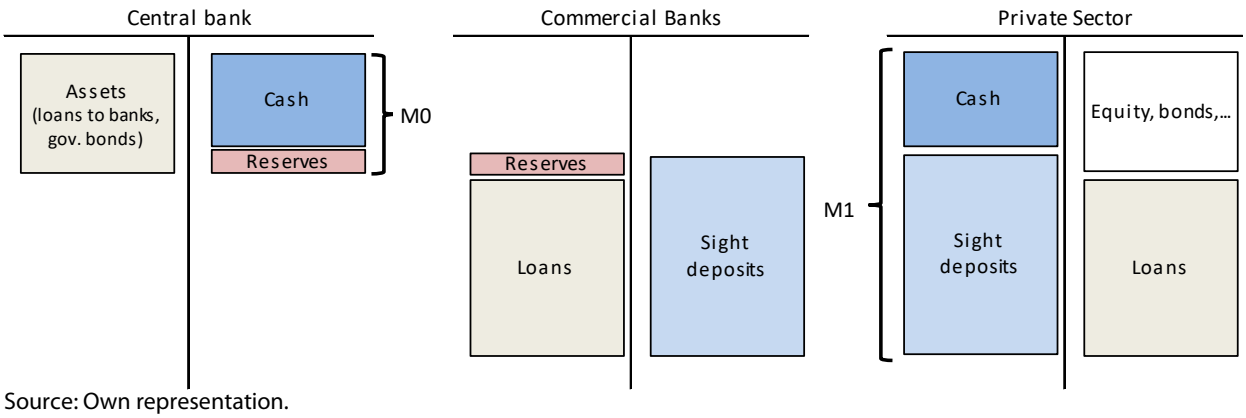
An additional distinction is whether payment systems are account-based (like bank deposits) or token-based (like cash). In an account-based payment system, authentication of a transaction requires the payer to prove his or her identity. In a token-based system, the payer does not have to reveal his or her identity, but authentication requires proof that the transferred amount of money is valid – like a banknote (Brunnermaier et al 2019). Therefore, a token-based CBDC allows for anonymous payments between peer-to-peer users. A more complex Venn diagram with four ellipses incorporates this distinction between account-based and token-based payment systems ("money flower" by Bech and Garratt 2017). However, the economic interpretation of a CBDC is not affected, but the distinction is rather a matter of technology, of feasibility of anonymous peer-to-peer transactions, of cryptographic and computing power requirements. Therefore, the remainder of this article deals with economic implications rather than applied technologies.

The easiest way to introduce a CBDC is an account-based version administered by the central bank as trusted counterparty. This implies a "permissioned" instead of a "permissionless" blockchain, by which the need for computer-intensive algorithms to prove authenticity of transactions through a distributed network of users largely vanishes. Granting digital access to CBDC accounts is possible without any retail infrastructure – a few high-performance servers to handle hundreds of millions of additional users would do, combined with software to allow for fast, secure and convenient transactions.

4.2. Possible consequences for the fractional reserve system

Currently, non-banks hold liquidity largely in the form of sight deposits. Recently, the share of deposits in the monetary aggregate M1 was more than 80% in the Euro area. For commercial banks, deposits are a cheap way to refinance. In fact, an integral part of the business model of banks consists of collecting short-run deposits and granting long-run loans (maturity transformation). Indeed, the sum of deposits in the Euro area is approximately half of the entire sum of credit to non-banks. In a balance sheet representation of the monetary system, the central bank issues cash and a small amount of reserves, which sum up to base money M0. Commercial banks, on the other hand, "issue" the bulk of money that is actually used for payments (namely sight deposits) and are required to hold only a small fraction of it as minimum reserves (Figure 2). Put differently, the quantity of money M1 that is actually used for retail payments is created in a public-private partnership, where private banks contribute by far the larger part of it.

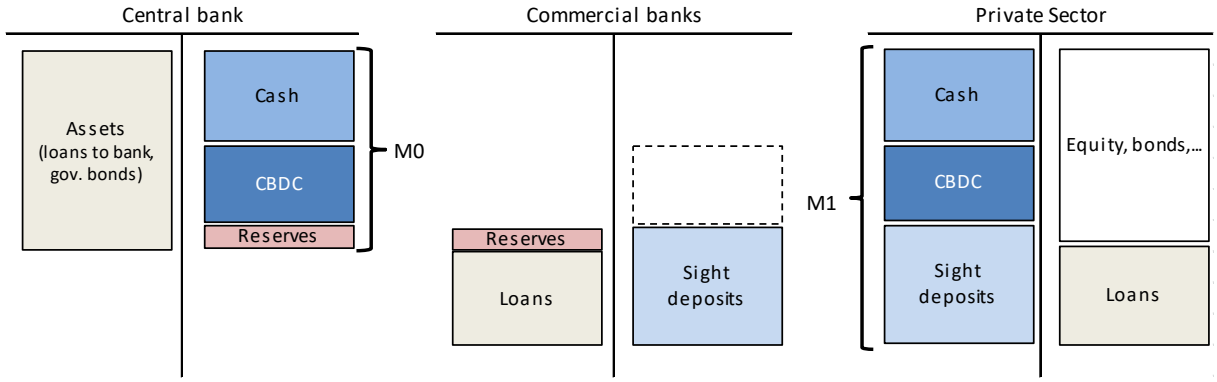
Figure 2: Current monetary system (fractional reserve system)



Source: Own representation.

A digital currency issued by the central bank is direct competition for bank deposits and can potentially substitute them as the main form of money holding. As soon as holding and transferring money on CBDC accounts is convenient and safe, a growing number of people and businesses will probably prefer to hold liquidity there. CBDC is legal tender, so no counterparty risk and no bank run risk is involved, thereby rendering this option superior to bank deposits. As a result, commercial banks will at least in part lose the ability to attract deposits. In the balance sheet representation, CBDC is both part of base money M0, as well as part of monetary aggregate M1. As non-tangible money, CBDC will replace a part of today's sight deposits (Figure 3). The "lost" deposits would cease to contribute to commercial bank's funding, and bank credit currently refinanced with deposits would require a new source of funding.

Figure 3: Monetary system with a CBDC



Source: Own representation.

Commercial banks may still retain attractiveness of deposit accounts to some extent, (1) if the payment infrastructure is more convenient or superior, (2) if they are able to bundle the deposit account with essential financial services, or (3) if they offer higher interest rates than the rate imposed on CBDC accounts. The third argument implies that the policy rate imposed on CBDC accounts is the lower bound for the interest rate on bank deposits. To offset the counterparty risk associated with fractional reserve accounts, banks will have to offer a risk premium dependent on their own credit rating: In normal times, this premium is probably close to zero; at times of financial stress it could suddenly increase to prohibitively high levels. A pro-cyclical in- and outflow of liquidity into and out of the banking system is a possible outcome**.**

Sudden transfers of bank deposits to CBDC accounts, however, affect the financial sector in the same way as a bank run. In order to withdraw liquidity from a bank, people do not even have to line up in front of ATMs, but instead simply use online banking tools to transfer it to CBDC accounts. The impact on the banks' balance sheet is identical to a bank run, with liquidity flowing out at an alarming rate. In that situation, banks have to replace withdrawn liquidity with new sources of (re)financing. In the end, the central bank in its function as lender of last resort will flexibly provide sufficient liquidity (Riksbank 2017).

A CBDC still disrupts the traditional business model of commercial banks, even if they manage to retain attractiveness to some money users. The mere option of a full reserve account clearly implies the loss of some of today's depositors. Banks will have to offer additional benefits and services to the remaining customers, and they will be even more vulnerable to financial stress if they keep on relying on deposits

to refinance credit. Therefore, a digital currency issued by the central bank can be disruptive to the fractional reserve system, since deposits will become a less reliable source of funding (Gern et al. 2018).

4.3. Would a CBDC relax the zero lower bound?

So far, central banks are subject to an effective zero lower bound on nominal interest rates due to the option of withdrawing cash and still ”receiving” a nominal return of zero percent. With subdued inflation and low potential growth, this restriction to monetary policy becomes binding more often, so central banks tend to switch to extraordinary measures which themselves are increasingly inefficient and have unwanted side effects (Fiedler et al. 2018). With a digital currency, the central bank could impose positive as well as negative interest rates on CBDC units. However, only if cash is abolished simultaneously, there will be “no way out” of the banking system, and people will be forced to accept even negative interest rates (Rogoff 2016).

Without cash, the effective lower bound is indeed relaxed, and the central bank will improve its ability to affect economic activity in low interest rate environments. With substantially negative interest rates in place, a CBDC constitutes a workable implementation of previous suggestions to add carrying costs to money in order to prevent cyclical hoarding (Gesell 1916, Fisher et al. 1933). In this setting, substantially negative interest rates incentivse economic actors either to spend money immediately or to put it to a savings account in the bank. Even with perfectly stable prices, money of this kind (“stamp scrip”) loses some of its functionality as a store of value. Therefore, this CBDC currency would likely be vulnerable to – and would probably require regulatory protection from – direct competition with currencies that are better stores of value.

In most countries, however, a CBDC will likely be introduced as a complement to cash rather than a replacement. Cash plays an important role in the life-long experience and payment habits of many people, and numerous businesses still rely on cash as a main or only accepted means of payment. Moreover, cash payments do not leave a digital trace. Therefore, availability of cash is not only desirable for criminals, but also constitutes institutionalised freedom from government control and personalised data collection. Moreover, it requires political support to abolish cash legally, which currently appears well out of reach in most countries – any attempt to do so certainly faces strong political resistance. Therefore, a more likely path to a cashless society would start with introducing a CBDC as a mere complement. Once people are used to the new and more convenient means of payment, and once the digital currency is accepted everywhere, the government can actually consider abolishing cash. Only then, the zero lower bound will be effectively relaxed.

4.4. Why would central banks issue digital money?

What is the business case for central banks to issue CBDCs, independent or jointly? In general, central bankers tend to be hesitant and careful when it comes to launching a potentially disruptive innovation to the monetary system. At least in theory, there is a considerable list of reasons to launch a CBDC:

Backup payment system: At times of financial stress, the fractional reserve system is vulnerable to systemic crises, even though there are mechanisms in place to handle this issue (financial regulation, deposit insurance, lender of last resort function). Nevertheless, if large banks are in trouble, governments tend to bail them out in a hurry to prevent bank runs from unfolding and in order to protect the payment system, which lies at the core of economic activity in societies that rely on division of labour. With a CBDC, a different payment system would be available that is not at all vulnerable to systemic crises. Financial crises can be resolved more calmly if economic actors are able to switch to a different payment system.

Higher seigniorage: The central bank can partly replace bank deposits with CBDC, so that the amount of interest-bearing assets in its balance sheet increases and thereby its ability to generate public revenue. However, generating profit is probably not a primary motive for most central banks of today.

Payment system efficiency: Potential benefits include availability of CBDC accounts on a 24/7 basis and faster settlement. However, private institutions can well introduce innovative payment methods. A CBDC issued by a national central bank will also not increase the efficiency of cross-border payments.

Cash phase-out: If people increasingly rely on digital means of payment, whereas businesses start refusing cash payments due to relatively high cost of maintaining a retail cash infrastructure, legal tender will lose relevance for money users. Issuance of a CBDC allows central bank-issued money (which defines the unit of account) to continue to play an important role in retail payments.

Financial inclusion: In particular in less-developed countries, a considerable share of the populations has no or a rather limited access to financial services. With digital money, the hurdles to access payment systems were much lower, because a physical retail bank is not necessarily required. For developed countries, however, financial exclusion is less of a problem, and in fact with a rising importance of digital payments, financial exclusion of some (elderly) people might become a problem instead as their payment habits are affected more by a potential phase-out of cash.

Surveillance: Digital payments always leave a trace, while cash allows for anonymous peer-to-peer transactions. A CBDC would improve options for preventing and tracing illegal transactions, money laundering, crime, tax evasion and so on, and would also extend possibilities for surveillance of the population. Privacy and civil liberties are key elements of western democracies, so the possibility of increasing surveillance may raise doubt and resistance there. In other countries, more possibilities for close surveillance may be an argument in favour of a CBDC.

Upholding the public monopoly of money: Private issuers of e-money certainly try to provide a currency that indeed fulfils the needs of money users – if only to reach or maintain a position as trustworthy money provider. Nevertheless, money is currently provided by public authorities (public monopoly of money), and it is debatable whether this core competence of nation states should be allowed to shift to private issuers beyond democratic control (as Hayek (1978) indeed proposed). After all, being in charge of money provision brings power and revenue, and private issuers of money may have other aims (in particular profit maximisation) that do not necessarily align in all potential situations with the provision of an indispensable public good like money. Therefore, a digital currency with central bank backing can be a credible alternative to satisfy some of the needs of potential users of private e-money. At the same time, the government will continue to regulate emerging cryptocurrencies, especially if they have the potential to reach macroeconomic relevance.

Countering competition from foreign CBDCs: If a major foreign central bank introduces a universally accessible CBDC, this innovation will considerably raise interest in – and possibly attraction of – that currency, for example as a reserve medium or even as an international currency. If this sets the international relevance of currently leading currencies on a downward trend, policymakers in these countries have to consider launching their own CBDC in order to maintain their position.

Countering competitive devaluations: A foreign central bank might not only introduce a CBDC, but also abolish cash. In that case, monetary policy authorities in the respective currency area are able to drive interest rates deep into negative territory. In the recent past, many countries entered a near-zero interest rate environment where traditional transmission channels of monetary policy like the bank lending channel lost relevance, whereas the exchange rate channel gained importance instead. As a result, some of the monetary policy decisions of major central banks in the 2010's –including quantitative easing – have been interpreted as "competitive devaluations" or even "currency wars" by

major newspapers. Against this background, a currency that replaces cash with a CBDC would allow the respective central bank to penetrate the exchange rate channel much further, so that the remaining central banks – who are restricted by the zero lower bound – would be unable to counter. To prevail in such a competitive devaluation, they would also have to replace cash with a CBDC.

Countering the challenge of Libra: Privately issued e-money like Libra, which are not restricted to a specific territory and therefore are truly international, can challenge major national currencies as global reserve media. This would divert power and seigniorage from national central banks to private institutions (probably large multinationals). If Libra is successfully introduced, it will – by construction – immediately be as stable as the major currencies it builds upon. Due to its large network (Facebook), it immediately reaches out broadly and beyond national borders. This makes a perfectly stable currency suddenly available to people in developing countries, whose home currencies often fail to provide a similar degree of stability. People would probably start to hold money in that currency ("digital dollarization", or "liberation"?). In developed counties, on the other hand, Libra will start as a mere internet currency accepted in online shops and for services offered via internet. Frictionless convertibility to each major currency ensures that many shops actually accept Libra, as long as regulatory measures do not prevent them from doing so. Over time, people will probably start to hold money partly on Libra accounts for online purchases. On a global scale, the newly established unit of account – Libra – would gain relevance and there might even emerge a capital market to intermediate between Libra savers (in developed countries) and Libra borrowers (in developing countries) with a common risk-free interest rate. Once users continuously hold large amounts of money on Libra accounts, the Libra network can confidently reduce its 100% backing with established currencies step-by-step and still maintain full convertibility. Libra would evolve to a currency on its own that (perhaps rather temporarily) maintains a currency peg to a certain basket of traditional currencies. To prevent the affiliated loss of relevance for national currencies, authorities could impose strict regulatory measures to prevent Libra from gaining any relevance in the first place (e.g. outlaw all transactions). Another probably less likely approach to counter private international e-money from gaining much relevance is to issue a CBDC jointly with a number of major central banks – with regulatory support to ensure its dominance – in order to provide a global digital currency as an alternative (that retains power and seigniorage in public hands).

4.5. Will any central bank actually launch a CBDC?

The concept of a CBDC is widely debated among central bankers and academics. Numerous central banks around the world currently explore the prospects of a CBDC, not only theoretically, but some of them are already in the process of developing technical solutions to implement it. Sometimes, the investigation takes place behind closed doors, whereas other central banks like the Swedish Riksbank communicate their investigation of the possibility of an "e-krona" quite openly: In 2017, there was a brainstorming phase and the publication of the first e-krona report (Riksbank 2017). In 2018, the bank engaged in a deeper analysis of prospects and challenges leading to two additional reports. The years 2019 and 2020 are dedicated to develop technical solutions, and they even hired external experts for this purpose. No decision was made so far whether the e-krona will actually be launched, however, and such a move would probably require political support. Further legislative steps towards actually introducing the "e-krona" would take additional time. Overall, it is unclear if and when a major central bank actually introduces a CBDC that has global relevance. Intuition suggests that (1) CBDCs will become a reality at some point in time, and (2) today's leading currencies will rather not be the frontrunners of such a move.

5. IMPLICATIONS OF DIGITAL MONEY FOR MONETARY POLICY

There are a number of scenarios about how a digitalisation of money might play out, each with different implications for monetary policy. In the following, we discuss two types: digital government (or government-derived) money that potentially replaces cash and digital private (or foreign) money.

5.1. Abolishment of cash

The scenario of digital government money would be one in which the use of cash had been curtailed a lot and supplanted with digital payments based on central bank currency. This could happen for several reasons: first, there could be a straightforward abolishment of cash via fundamental changes in the relevant body of law. Second, a central bank digital currency could be issued with properties so attractive that people voluntarily shift towards it. Third, other means of digital payments, such as credit cards, Paypal, etc., crowd out cash payments (this, once again, could happen voluntarily). While these digital payment services are provided by private companies, they are still conducted on the basis of central bank money.

Regardless of whether it happens organically or is imposed via law, the upshot of a situation where people do not use cash anymore – but rather digital means of payment based on a central bank currency – will be that the effective lower bound constraint on monetary policy will loosen. Standard monetary policy theories prescribes a reduction of central bank interest rates whenever inflation threatens to fall below target. However, because people could always shift into holding zero-yielding cash, the central bank cannot reduce interest rates too much below zero; the point after which too large a shift into cash occurs is then called the effective lower bound. Insofar as cash is replaced by digital money based on central bank controlled currency, monetary policy could gain additional room for manoeuvre.

5.2. Competition from other digital currencies

A different scenario sees the introduction of currencies (including private ones) that potentially compete with central bank-issued or central bank-based money. Digitalisation may help improve competition between currencies because it can provide easier on-the-spot unit conversions and currency exchanges. If then some new money is developed that can credibly promise to keep its value (or even increase it) over time, this would directly constrain the central bank's management of its own currency: if it implements too inflationary a policy, people can abandon government money and shift to the competition's currency (a similar argument is made in Hayek 1978). This would be similar to the dollarization phenomenon observable in some countries at times of extreme inflation rates for the respective local currencies. As digitization simplifies shifting between currencies, the inflation that a central bank can produce before people abandon the money it issues will be lower (assuming the central bank is indeed able to produce inflation deliberately, which was more obvious in Hayeks time). Note that even the threat of potential competition would already be a check on inflationary policies.

In short, a shift away from cash towards a CBDC would increase the central bank's ability to produce inflation, while competition from third-party digital currencies constrains it.

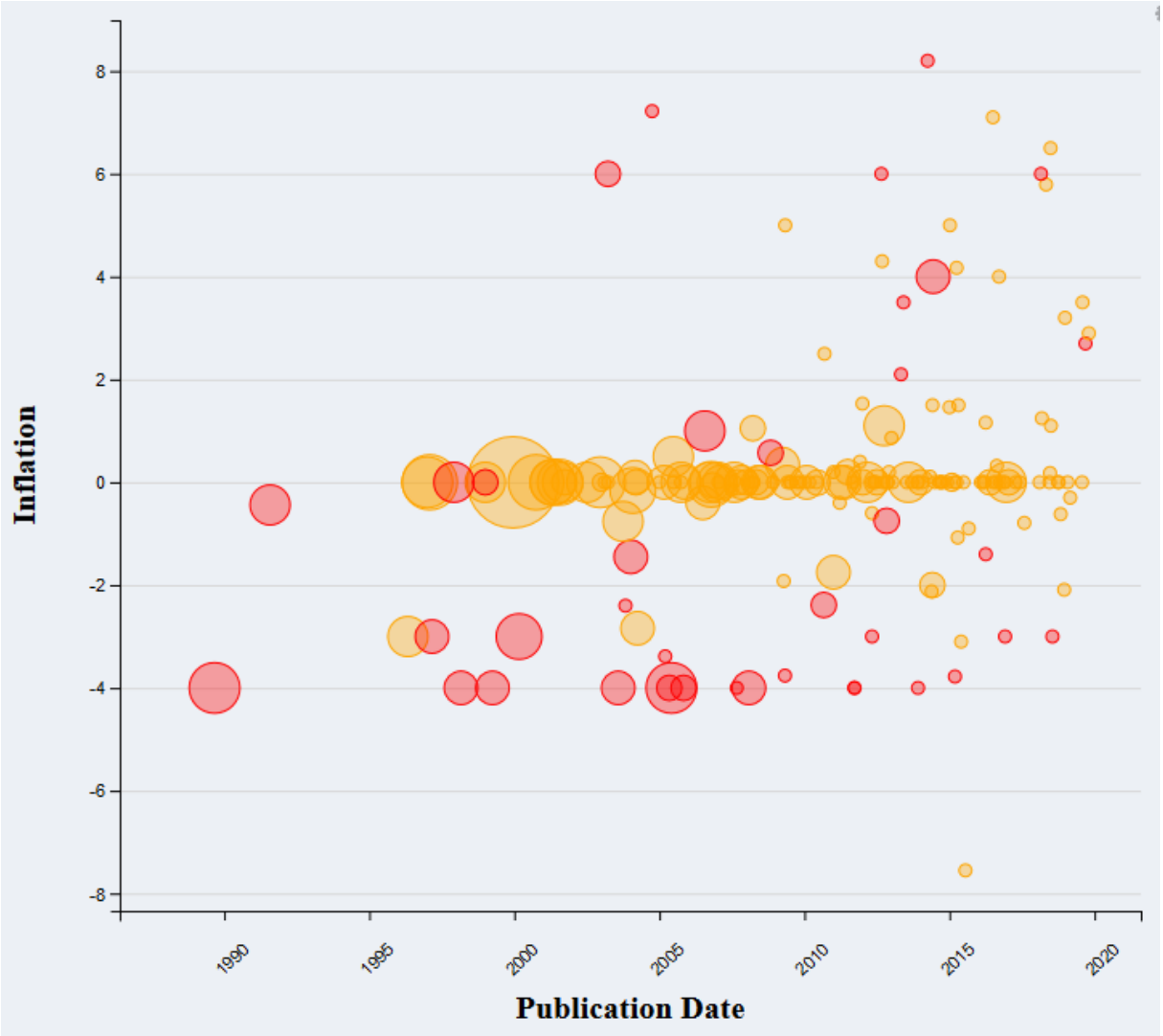
The welfare implications of such changes to the constraints faced by central banks depend on the optimal rate of inflation. If it were very important for monetary policy to be able to create sizeable price inflation, then the additional room for interest rate cuts described in the first digitalisation scenario would be quite welcome, but the availability of competing currencies as in the second scenario may prove harmful. The reverse would be true if it were more important to keep inflation low.

5.3. What is the optimal rate of inflation?

Currently, many central banks in developed economies, including the European Central Bank (ECB), try to achieve annual inflation rates of roughly two percent. But there is a certain degree of arbitrariness in the choice of the two percent figure, since, when looking at the relevant scientific literature, there is a lot of disagreement about which rate of inflation would be optimal.

Diercks (2019) looks at over 250 studies on optimal inflation published since 1988. While there is a very large cluster at zero percent, and the average optimal inflation rate found is 0.01 percent, there are also some studies that deviate markedly from this (Figure 4).

Figure 4: Optimal Inflation Rate



Note: Optimal inflation rates in percent per annum found in different papers; dots scaled by citations; red dots: paper uses flexible prices, yellow dots: paper uses sticky prices.

Source: Diercks and Langlois: The Reader's Guide to Optimal Monetary Policy.

Arguments for a lower or even negative inflation target

What are the reasons behind substantially different recommendations for optimal inflation rates? One standard argument in favour of mild deflation is the Friedman rule: to eliminate the opportunity costs of holding money (which is thought to be zero-yielding and to have negligible production costs), nominal interest rates should also be zero. Aiming for nominal interest rates of zero implies that inflation must exactly offset the real interest rate. Since real interest rates are generally somewhat larger than zero, this implies a certain degree of deflation in the optimum.

Inflation rates close to zero can be supported by arguments involving so-called sticky prices. If firms adjust their prices infrequently (because changing prices may be costly) and on different schedules, both inflation and deflation will lead to additional inefficiencies. For example, if there is general inflation, firms who did not adjust their prices for a relatively long period of time will have artificially cheap prices compared to firms who did adjust recently (not least because firms would raise prices above the optimum whenever they set new prices if they expect to be overtaken by inflation again before their next adjustment date). Customers would then shift towards the artificially cheaper firms' offerings, inducing an increase in production here (and a correspondent decrease at the firms who adjusted prices more recently). These shifts in production are inefficient since they are not based on economic fundamentals (such as changes in the structure of production costs or consumer preferences). However, the progress of digitization weakens the sticky price argument. For example, Gorodnichenko and Talavera (2017) find that prices in online markets are more flexible relative to regular stores, and Cavallo (2018) reports that in conjunction prices at brick-and-mortar stores have also become more flexible.

The frictions typically introduced by tax systems also support low optimal inflation rates. For example, most countries tax nominal capital returns, which means that higher inflation rates directly increase real tax burdens. Consider a project with a pre-tax real (that is: adjusted for inflation) return of 4 percent and a tax rate of 50 percent. If inflation is 0 percent, then the tax on the real return will be 50 percent and the after-tax real return will be 2 percent. But if inflation is 2 percent, the after-tax return shrinks to 1 percent and the tax rate effectively increases to 75 percent. And if inflation is 4 percent, then the tax would take 100 percent of the real return, leaving the investor with nothing. Other difficulties can arise whenever nominal thresholds are not adjusted for inflation. For example, in progressive income taxation schemes that tax incomes past certain levels at higher rates, inflation will lead to automatic tax increases, since some unchanged real incomes will fall into higher nominal tax bands.

Arguments for slightly positive inflation targets

But there are also some arguments in favour of the slightly positive inflation targets that are set in practice. First, measured inflation is commonly thought to overstate actual inflation, for example due the failure to sufficiently account for the introduction of new products and quality improvements for existing ones. Boskin et al. (1996) report that the US Consumer Price Index overstates inflation on average by about 1.1 percentage points (but there is considerable uncertainty and their estimated plausible range of mismeasurement reaches from 0.8 to 1.6 percentage points). Although there are some indications that the mismeasurement has decreased somewhat over time (cf. e.g. Adam and Weber 2019), an update on the Boskin report by Moulton (2018) still sees the CPI overstating actual inflation by 0.85 percentage points. Note, however, that there are also arguments for the view that measured inflation understates actual inflation. For example, Gros (2018) argues that the European Harmonised Index of Consumer Prices (HICP) is biased because it excludes owner-occupied housing.

Second, some believe that nominal wages are downwardly rigid, and that this can lead to excess unemployment. According to this theory, people have a strong aversion to nominal wage cuts such

that in a downturn, which would necessitate lower real wages to attain the new labour market equilibrium, employers would rather reduce their workforce than impose nominal wage cuts on a per employee basis. If, however, real wage growth were lower than nominal wage growth due to inflation by some margin, then simply holding wages steady would already produce real wage cuts. There is some disagreement about how relevant nominal wage rigidities are and by how much, if at all, inflation targets should be increased in response. For example, Billi and Kahn (2008) see no large role for these rigidities in shaping real world central bank targets. Kim and Ruge-Murcia (2011) estimate that nominal wage rigidities could justify an average inflation rate of roughly 0.4 percent per year. The evidence for nominal wage rigidity is also not consistent across countries and wage setting regimes. Fagan and Messina (2009) report that in some cases it may even be real wages that are rigid. They derive optimal inflation rates for four European countries as well as the US. While the estimated inflation rates range from 2 to 5 percent for the latter, they range from 0 (Belgium, Finland) to 2 percent (Portugal) in Europe (with Germany being in the middle of the range). Schmitt-Grohé and Uribe (2013) argued at the time that an increase of inflation to 4 percent for five years could restore full employment in the European periphery.

Third, there is the aforementioned effective lower bound. Higher inflation will lead to higher nominal interest rates in equilibrium such that the lower bound becomes a problem less often. Since natural real rates have most likely declined over the past decades (Fiedler et al. 2018), this buffer may currently be particularly important. For example, Andrade et al. (2019) argue that in the empirically relevant region, a reduction of the natural rate would optimally be compensated by an almost one-for-one increase in inflation.

Apart from these, there are many more factors that influence the optimal rate of inflation, such as financial frictions and collateral constraints, the possibility to extract seigniorage from foreign users of one's currency, and the implications for capital investment in the optimal portfolio choice (on the last point cf. Brunnermeier and Sannikov 2016). There are also interactions between the different factors mentioned here. For example, Amano and Gnocchi (2017) argue that the presence of wage rigidities reduces both the frequency and costs of a binding lower bound on interest rates.

Interim conclusion

All in all, there is still considerable disagreement about the optimal level of inflation, and a priori there is no strong reason to favour the current targets of roughly 2 percent. This does not necessarily mean they should be changed. Frivolous changes, especially in a situation where a central bank has failed to achieve its target for some time, could further erode the credibility of its monetary policy. Furthermore, insofar as monetary policy would actually produce markedly different inflation outcomes after the target change, distortions are introduced for all actors that made long-term plans on the basis of the previous targets (e.g. investors in fixed-rate long-term contracts would lose).

Overall, it is very unclear whether general welfare would be increased or reduced in either of the two scenarios – central banks being able to produce additional inflation after a switch from cash to central bank-derived digital money on the one hand, and constraints on inflation due to competing currencies on the other. Both the Federal Reserve as well as the European Central Bank have recently announced a review of their monetary policy strategies. Taking account of the benefits and drawbacks of different forms of digital currencies during these reviews would certainly be warranted, but the question of whether their introduction should be welcomed cannot be answered definitively without a much deeper understanding about the appropriate inflation target.

6. CONCLUSION

The process of digitalisation of money is proceeding and may even pick up further speed. The decline in the relative importance of cash in most economies is mainly driven by the convenience and efficiency gains offered by electronic payment methods in combination with mobile devices. The transition to a cashless society could already be completed in the next couple of years in some countries. However, a major challenge is to prevent that part of the population is left behind.

The chances of successfully launching a private electronic currency on a global scale have increased with Big Tech appearing on the stage. There are, however, a number of legal and regulatory challenges to be addressed, including security concerns, issues of consumer protection and the risk that the association of a widely used electronic currency with a large social or commercial electronic platform will reinforce monopolistic tendencies already inherent in network industries. On the other hand, different regulatory regimes between countries may ultimately lead to an increasingly fragmented international financial system, thus preventing full realisation of potential welfare gains from digitalisation and therefore calling for international regulatory cooperation.

A digital currency issued by a central bank (CBDC) can be disruptive for the fractional reserve system, because money users would have the option to hold direct claims against the central bank. Commercial banks would increasingly have to replace deposits with more reliable sources of funding. There are plenty of reasons why central banks may actually decide to launch a CBDC, independently or jointly: Installation of a backup payment system, higher revenue, financial inclusion, efficiency of the payment system, traceability of illegal transactions, surveillance, upholding the public monopoly of money while satisfying the need for digital money, and countering competition from private currencies as well as from foreign CBDCs. It is nevertheless unclear if and when a major central bank will actually introduce a CBDC of global relevance. Intuition suggests that CBDCs will be a realised at some point in time, and that today's leading currencies will rather not be the frontrunners of such a move.

The implications of digital money for monetary policy are not straightforward. If digitalisation means the replacement of cash with central bank derived digital money, then the central bank's ability to produce inflation will increase because the effective lower bound on interest rates will loosen. However, if digitalisation raises the possibility of the introduction of (private or foreign) competing currencies, the ability of central banks to inflate their currencies would be constrained by the threat of people switching to these competing currencies. The welfare implications from digital currencies thus depend on the optimal rate of inflation. If the optimal inflation rate is high, then constraints on the central bank's ability to increase inflation could pose a problem. If, however, optimal inflation is low, then the reverse is true. There is considerable disagreement on the optimal rate of inflation. The choice of the targets of around 2 percent used by many central banks today are to a considerable degree arbitrary.

In short, our conclusion is that the trend towards digitalisation will probably continue, but has to be closely monitored and accompanied with an appropriate regulatory framework.

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Virtual Money: How Much do Cryptocurrencies Alter the Fundamental Functions of Money?

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Abstract

Advanced economies are moving towards a cashless system, with a recent surge in cryptocurrencies, issued by private entities. Although digital currencies may increase welfare, due to a reduction in transaction costs, they introduce risks to monetary and financial stability. Furthermore, they barely serve as money due to their large volatility. To partly overcome these problems, the issuance of a stablecoin would be an intermediate solution between private and central bank issued digital currency.

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CONTENTS

LIST OF ABBREVIATIONS

CB	Central Bank
CBDC	Central Bank Digital Currency
DLT	Distributed Ledger Technology

EXECUTIVE SUMMARY

- It is widely agreed that the functions of money can be divided into three layers (primary, secondary, and tertiary), where each layer reflects the descending degree of direct functionality but increasing degree of generality and transcendence that money plays. The primary functions relate to it as a medium of exchange and measure of economic value. The secondary functions reflect its store of value, and standard for payments. The tertiary layer reflects its contingent functions such as basis of credit, liquidity to wealth, distribution of income, and measurement and maximization of utility.
- The preference for money, in particular fiat currency has increased since the 00's in both the Euro Area and the US, not decreased as one may expect by the emergence of cryptocurrency. This coincides with the launch of the Euro in January 2002, which hints that the issuance of the new currency increased the demand for it and the share of it in broad money.
- By end of 2019, market capitalisation of cryptocurrencies is just under EUR 1 trillion, and of similar magnitude to total currency in circulation in the third quarter of 2019 (at EUR 1.2 trillion).[3] While the growth in total market capitalisation has somewhat slowed down since the latest peak in 2018, in not so distant future, the activity in this market will surpass the size of the traditional Euro currency market, which shows its rapid growing importance.
- In 2018, Bitcoin amounted to almost 46% of the market.
- Volatility is another important driver of the price. Given the absence of the underlying sovereign guarantee (which in case of fiat currency comes through the central bank), it is prone to larger speculative activity. This implies that the introduction of a reserve guarantee would also reduce the volatility. Moreover, a regulatory system aimed at safeguarding the currency and preventing it from speculative attacks and Ponzi games would increase its reliability and effectiveness as a monetary alternative. Considering the cross-border nature and usage of cryptocurrency, the regulatory architecture would require an international coordination in the compliance as well as supervisory tasks, as advocated by the International Monetary Fund and Bank of England.
- Several benefits of the blockchain technology have been proposed in the literature. Amongst the most prominent is the decentralised nature makes it less prone to corruption and manipulation. Another important benefit is that the blockchain transactions are less expensive and quicker than those of the normal fiat currency transactions. There are recent developments in blockchain which indicate that it can play a very significant role in the future payment systems. One of the last documented large benefits of blockchain is that payments are validated 24/7.
- Bitcoin and other digital currencies may change the function of money. The limited evidence we can collect so far may suggest that digital currencies are primarily viewed as stores of value and are not typically used as medium of exchange. At present, there is little evidence of digital currencies being used as units of account. Thus, digital currencies do not really function as money in the economy and imply some risks if they were to be overall used in the long run. Therefore, it is not likely that digital currencies, in their current form, replace the traditional form of money in any economy.
- From a macroeconomic point of view, cryptocurrencies could pose a risk to monetary and financial stability. From a microeconomic perspective, they imply a risk to investors, who could lose all their money. However, nowadays, the small size of digital currency schemes makes it unlikely to pose

[3] ECB's Statistical Data Warehouse: http://sdw.ecb.europa.eu/reports.do?node=1000005717.

real risks to financial stability. Risks to monetary stability could, in theory, emerge if a digital currency were to achieve widespread usage, but this is extremely unlikely.

- Private digital instruments possess the following two advantages: First, they introduce the fintech technology to reduce the costs of transacting across different fiat currencies. Second, in countries with underdeveloped financial systems in which many consumers are excluded from the financial system, private digital currencies are potentially contributing to financial inclusion.
- The demand for a stable asset, which uses the DLT has opened the debate about the possibility of issuing a central bank digital currency. Central banks can take advantage of digital currency technology and still make use of monetary policy in its usual way. Digital currencies could be directly converted into cash and notes. However, this may also pose problems, questioning the role of banks in financing economic activity.
- Stablecoins may be seen as an intermediate solution between privately issued cryptocurrencies and central bank digital currency. In view of the volatility of cryptoassets and given the remaining questions surrounding CBDCs, stablecoins have come to the fore as a potential third type of asset that aspires to bring stability to the volatile market for cryptoassets. Nevertheless, stablecoins are still in their infancy, and therefore not a sufficiently secure investment vehicle. Maybe, with time and the refinement of the different models in the future, they could end up replacing the traditional digital currencies like Bitcoin or Ripple.

1. THE FUNDAMENTAL ROLE OF MONEY

Before we discuss the evolution of money and the role of digitalisation of cash and cryptocurrencies, we need to first go back to the basics and define money in terms of its role and functions in an economy. Despite a very long literature on money and many heated debates on its fundamental role for the overall economy, there is not a unified and single definition for it. Possibly because money has been at the centre of most battles in economic debates between the various schools of thought over the past century, spanning from no role at all (money neutrality theorem) to being the core ingredient, like an atom of an economic system (Minsky-Keynes, Marxism), this has prevented economists from reaching a unified view of money. Yet, there is some common terrain that (most of the) economic schools would agree on, namely the function of money in modern economic systems. We should spend some time outlining these, and they will be crucial in understanding why money can change form and transaction nature, without fundamentally altering its function or economic role.

It is widely agreed that the functions of money can be divided into three layers (primary, secondary, and tertiary), where each layer reflects the descending degree of direct functionality but increasing degree of generality and transcendence that money plays. The primary functions relate to it as a medium of exchange and measure of economic value. The secondary functions reflect its store of value, and standard for payments. The tertiary layer reflects its contingent functions such as basis of credit, liquidity to wealth, distribution of income, and measurement and maximisation of utility.

1.1. Medium of exchange

The most common function attributed to money is as medium of exchange, facilitates the buying and selling of goods, thereby eliminating the need for double coincidence of wants as under barter. A man who wants to sell wheat in exchange for rice can sell it for money and purchase rice.

1.2. Measure of value

Money serves also as a common measure of value. The values of various commodities are expressed in terms of money. This measure is universally accepted and standardised. Money as a measure of value has made transactions simple and quick. As such, money also serves as a unit of account.

1.3. (Intertemporal) Store of value

Keynesian economists also emphasised the function of money as a store of value. Agents store money for the rainy day and to meet unforeseen contingencies. In addition, according to Keynes, people also store money to take advantage of the changes in the rate of interest. Thus, money preserves value through time and space. Money as a store of value implies postponing consumption to the future and thus the link between current and future times is crucial. In that respect, money becomes an 'asset' because it is a claim. It is the most convenient way of laying claim to such goods and services. Thus, rather than keeping their wealth in the form of non-liquid assets (houses, shares, etc.), people prefer to keep their wealth in the form of money.

Currency (or cash) is the most liquid form of assets, i.e. money can be very cheaply and immediately exchanged for goods and services and its value is stable at least over a short period of time. In fact, all assets like bonds, saving accounts, treasury bills, government securities, inventories and real estate do serve as stores of value, but they differ in the degree of liquidity. In advanced economies, currency is stored in the form of bank deposits.

1.4. Standard of (deferred) payments

Money can also be viewed through a standard of deferred payment. This function has boomed over time with an increase in trade based on credit. Hence a person who purchases on credit agrees to pay in future when his bills become due. As a result of this function, it has also become possible to express future payments in terms of money. A borrower who borrows a certain sum in the present undertakes to pay the same in future.

1.5. Contingent functions

Money makes the distribution of joint production amongst various factors easy. Further, a consumer as well as a producer measures the utilities of different goods and factors of production with the help of money.

In the financial system, money constitutes the basis of credit. Banks create credit with the help of cash/currency reserves. These reserves are not only important for regulatory compliance, but also as a means of counter-payment or off-setting balances during difficult or distressed times.

1.6. Money as basis of economic activity

Monetary theory is a branch of economics concerned with explaining how the use of money, in its various forms, affects production, consumption and distribution of goods. For advocates of monetary theory, money is not only medium to facilitate exchange of goods, but something more vital, which affects the general level of economic activity.

According to them, the existence of a separate monetary sphere of activity is a fact of profound significance; what takes place in the monetary sphere may suddenly and dramatically influence the level and nature of employment, return on capital, and output. Activity in the money market affects the goods market.

At a first glance, the role of money does not seem to have changed with the introduction of virtual money. They still serve the same fundamental functions and remain tightly linked to the goods market. The forces that determine the equilibrium level of money and employment carry on. If those forces come together in a physical or virtual market does not fundamentally alter these. The experience of the stock market, turning from physical to virtual marketplace but without fundamentally altering the process of determining the prices of stocks, proves this. On the other hand, unusual or atypical circumstances such as negative deposit rates and permanently low market rates may fundamentally alter the forces in money markets, and the role of money as a measure of value, store of value, standard of payments, or its contingent functions if it permanently alters the demand for it.

2. THE EVOLUTION OF MONEY IN ADVANCED ECONOMIES

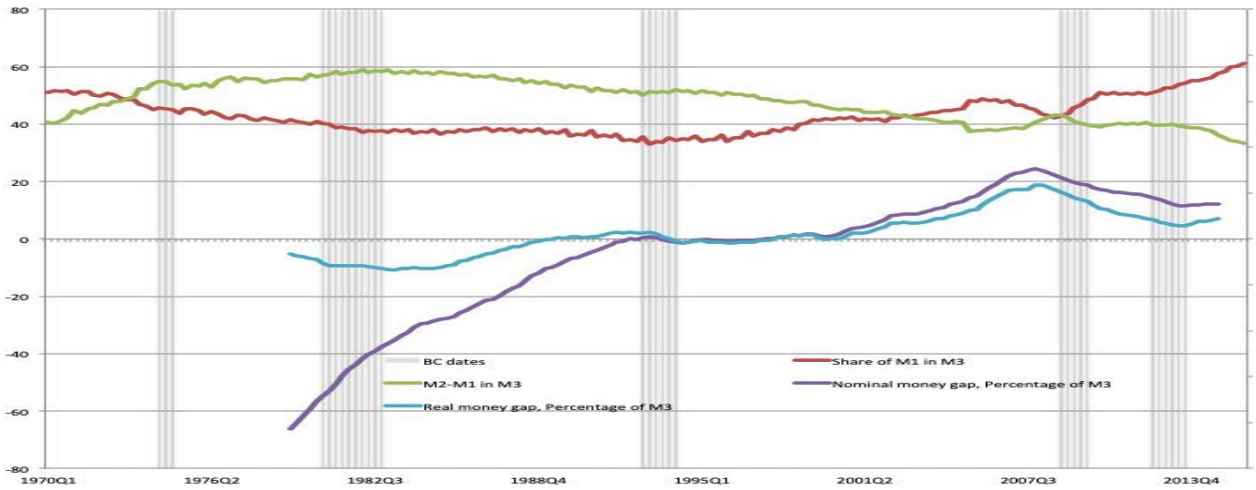
2.1. Monetary aggregates in Euro Area

The ECB has put a lot of effort to understand the historical evolution of money in the Euro Area, including backward extrapolating the data on monetary aggregates to 1970. The information included in the monetary aggregates regards the commonly nominated *money* in an economy, with higher aggregates representing narrow and most liquid money, while lower aggregates are broader but include also less liquid money. In a recent paper, Gerba *et al* (2018) analysed the historical evolution of the various aggregates. According to the official statistics of the ECB:[4]

- **M1** = sum of currency in circulation + overnight deposits.
- **M2** = M1 + term deposits with a maturity of up to 2 years + deposits redeemable of up to 3 months,
- **M3** = M2 + repurchase agreement + money market fund shares + debt securities with a maturity of up to 2 years

Figure 1 reports the evolution of monetary aggregates and the money gaps over a period of almost 45 years. While share of M2 in M3 has decreased over time, in parallel the share of M1 has increased since early 2000's. Taking into account that the Euro was officially launched in January 2002, this means that the importance of currency has just increased since its launch, landing at above 60% at the end of the sample (2014). Not only is this historically the highest share since 1970, but it is also elevated by international standards. Moreover, the money gap has been positive during the same period, implying an excess liquidity above the equilibrium level. Taken together, this means that the preference for money, in particular fiat currency has increased since the 00's in the Euro Area.

Figure 1: Monetary aggregate ratios – evolution over time since 1970



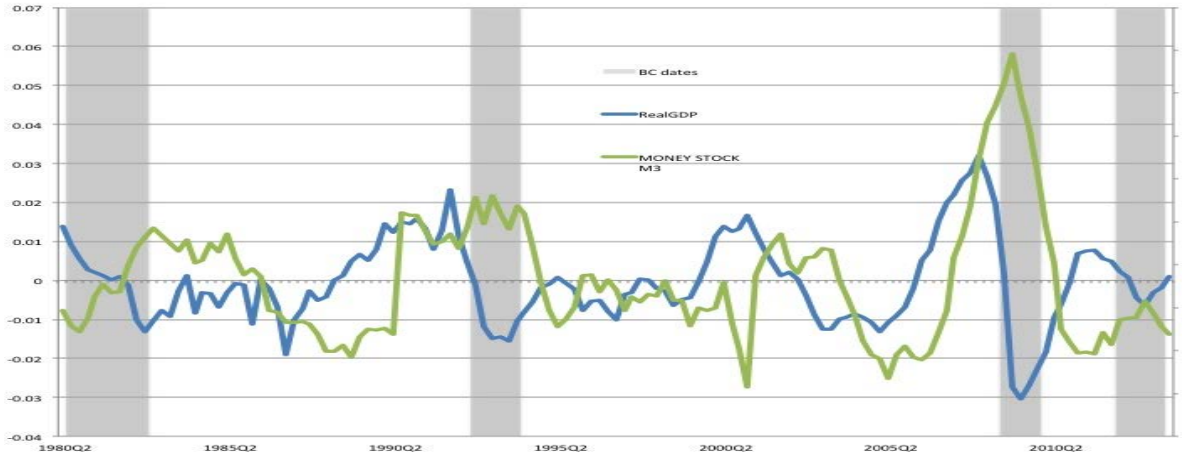
Source: Gerba et al (2018a).

If we then turn to the evolution of money through the business cycle since 1980 in Figures 2-4, we see some very interesting patterns. While liquid money (M1) follows very neatly the business cycle, and

[4] https://www.ecb.europa.eu/stats/money_credit_banking/monetary_aggregates/html/index.en.html.

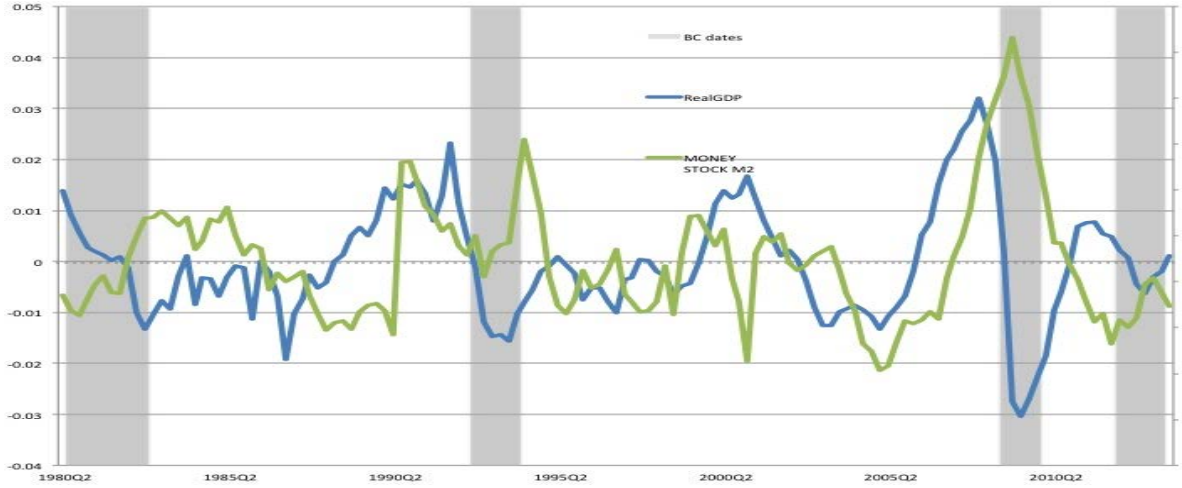
actually leads it a bit, less liquid money, in particular M3 is countercyclical and actually increases (decreases) during recessions (expansions). It seems that preferences for broader and less liquid money dominate in low-growth and contractionary environments. Yet in expansions, the desire to spend increases and hence more liquid money. If we imagine for a moment that preference for liquid money had vanished or the circulation of money had dropped, then monetary aggregates would be acyclical. Both analyses point towards the same conclusion: Quantity of currency and preference for liquid money has only increased over time, in particular during expansions. In contractions, on the other hand, preference for less liquid money (but with higher returns) dominates. Yet, there may be some link between the current low-growth environment with negative interest rates and the demand for (alternative) virtual money as the relations between economic activity and liquidity preferences could be undergoing fundamental alterations.

Figure 2: Business cycle component of M3 since 1980 – comparison to GDP



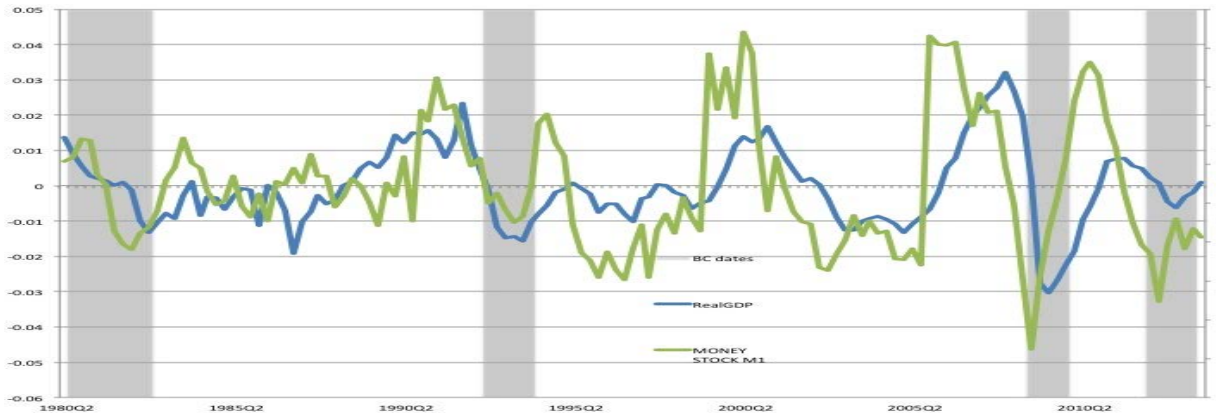
Source: Gerba et al (2018b).

Figure 3: Business cycle component of M2 since 1980 – comparison to GDP



Source: Gerba et al (2018b).

Figure 4: Business cycle component of M1 since 1980 – comparison to GDP



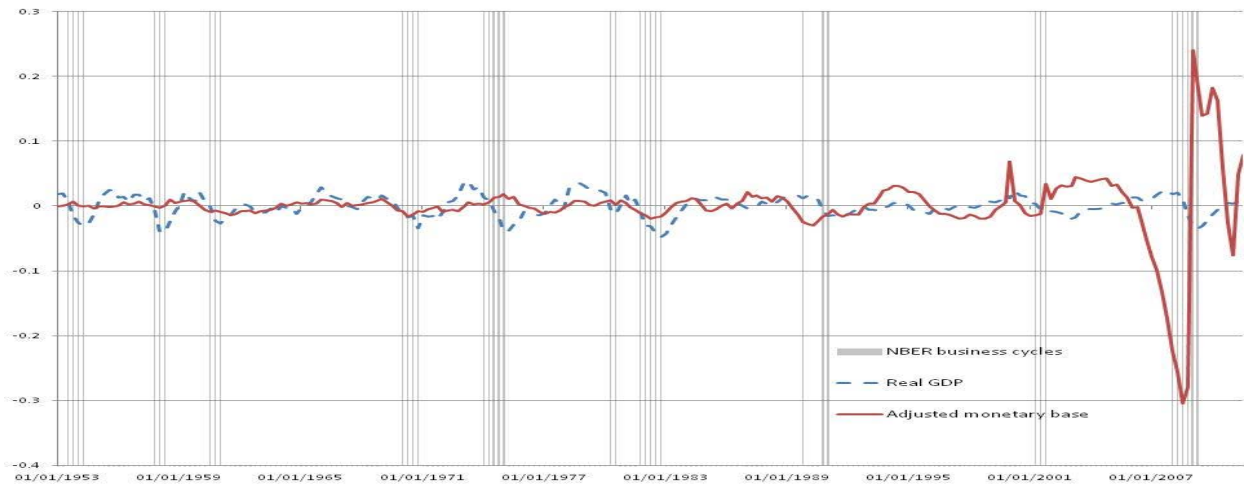
Source: Gerba et al (2018b).

2.2. Monetary aggregates in the US

The availability of longer time series for the US allows us to examine the evolution of money from a much broader perspective. In particular, considering 1953 as a starting date for reliable financial statistics, in an extensive empirical paper, Gerba (2015) examined the evolution of money supply and monetary aggregates during 6 decades, from 1953 to 2013, in quarterly frequency.

The first striking fact from Figure 5 is that for most of the post-war history, money supply has closely followed the business cycle. Unlike the Euro Area, it slightly lags the cycle, yet has a high correlation with it. However, since early 2000, it has intensified, and become up to ten times more responsive. In particular, the contraction in money supply just prior to the 2007-08 crisis, and the subsequent readjustment are notably historically the highest. Thus, there is evidence, even for the US, that the importance of currency and liquid (physical) money has just increased over the past two decades.

Figure 5: Money supply in the US since 1953 – business cycle component compared to GDP



Source: Gerba (2015).

We turn our attention to money in circulation, reported in Gerba (2015).[5] Similar to the Euro Area, we find that M1 follows closely the business cycle, while M2 is broadly countercyclical. Also, cyclical fluctuations of M1 have intensified since 1990's, becoming much more responsive to changes in the general economic environment. Yet the same evolution is not observed in M2, implying that it is currency, through the money supply, that is most responsive to business cycle conditions over the past 3 decades.

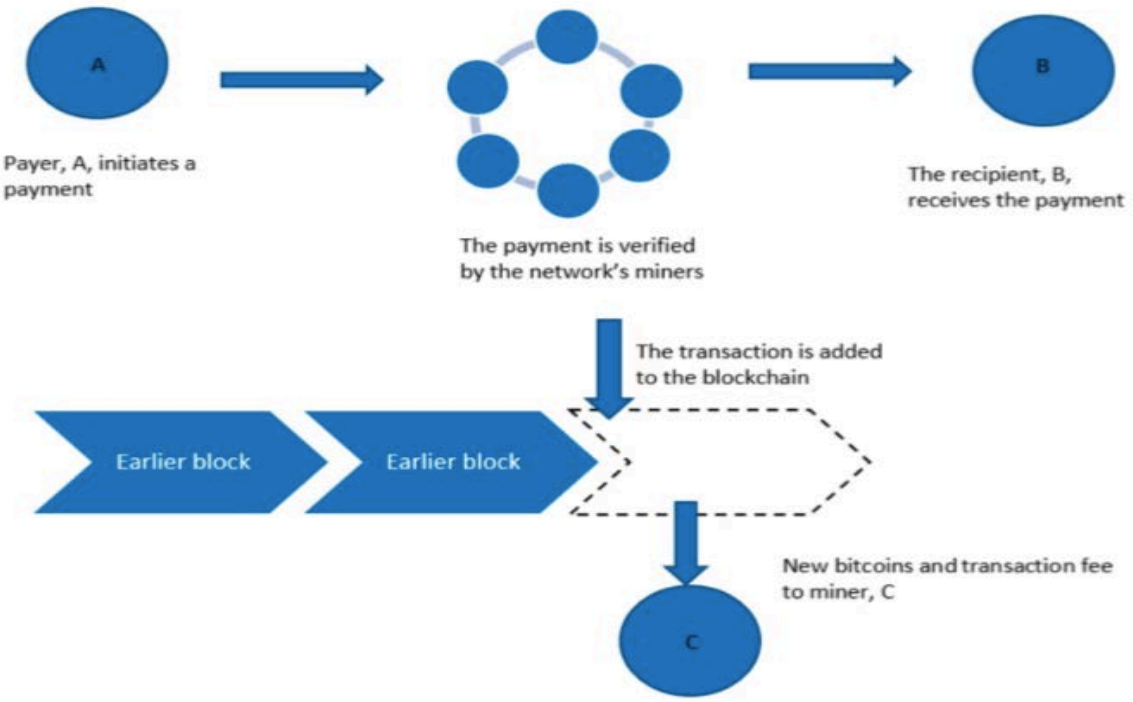
On the money demand side, the evidence is even stronger. Demand for currency has become twice as large as to the pre-00's period. Yet, for demand of less liquid money (M2), this change has not occurred. Summarising the evidence, we observe the same pattern in US money market as in the Euro Area. Demand and supply of M1 (currency) has increased over the past two decades and is very much following the evolution of the business cycle. Considering that at the same time money supply has largely intensified, it means that the preference and use of currency has simply risen.

2.3. Cryptocurrency: risks and opportunities

A cryptocurrency is: "a type of unregulated, digital money, which is issued and usually controlled by its developers, and used and accepted among the members of a specific virtual community" (European Central Bank, 2012). It makes use of cryptography to secure and verify transactions as well as to control the creation of new units of cryptocurrency (Franco, 2015). A bitcoin is essentially an entry into a public ledger shared by all the participants in a network. Once an owner wants to transfer his bitcoin (or a part thereof) to a third party, in order to avoid double spending, the message is transmitted to all the nodes in the network. It has to be confirmed by a certain number of nodes that the bitcoin is registered against the name of the owner before the transaction is executed and then the ownership is transferred to the new entry through an entry into the same public ledger (Powell, 2015). It adds as a block to the chain. Hence the name *blockchain*. Figure 10 explains the blockchain process. The entry once confirmed and the public ledger has amended it accordingly, is irreversible (Narayanan, 2015).

[5] Because of the size of images, we abstain from reporting the Figures here.

Figure 6: Overview of the blockchain process

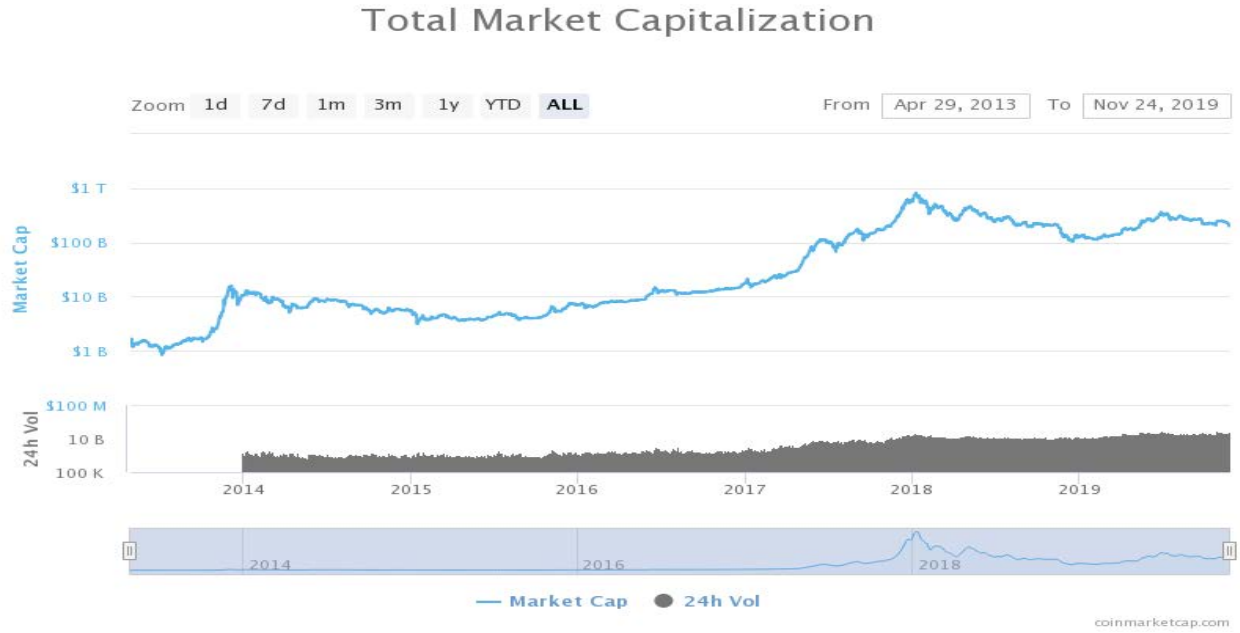


Source: Soderberg (2018).

Total capitalization of the cryptocurrency market has dramatically grown since 2014, as depicted in Figure 11. It grew by *1000 times* in less than *6 years*. By end of 2019, it is just under 1 trillion Euros, and of similar magnitude to total currency in circulation in the third quarter of 2019 (at 1.2 trillion Euros).[6] While the growth in total market capitalization has somewhat slowed down since the latest peak in 2018, in not so distant future, the activity in this market will surpass the size of the traditional Euro currency market, which shows its rapid growing importance.

[6] ECB's Statistical Data Warehouse: http://sdw.ecb.europa.eu/reports.do?node=1000005717.

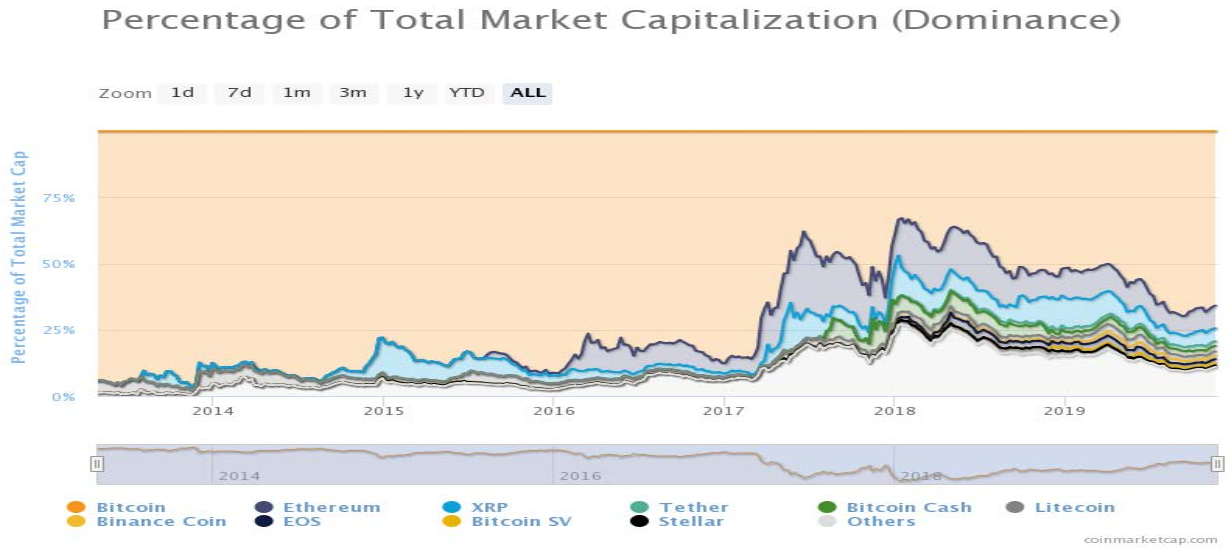
Figure 7: Total capitalization of the cryptocurrency market (in EUR)



Source: Coinmarketcap.com.

In 2018, Bitcoin amounted to almost 46% of the market, or USD 133 billion (Suberg, 2018). Although its dominant position has been somewhat weakened since the early days of cryptocurrency in 2012, it is still the largest and most traded virtual currency on the market, as shown in Figure 8. Because of its apparent leading position, and the permanence in the foreseeable future, it is reasonable to focus on it to better understand the dynamics on that market.

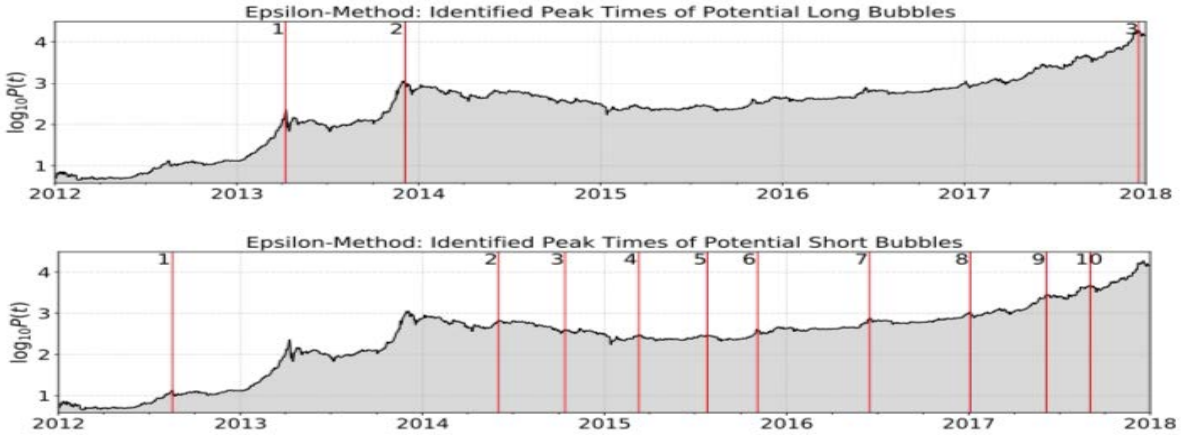
Figure 8: Composition of the cryptocurrency market



Source: Coinmarketcap.com.

Gerlach et al. (2018) have traced the history of bubbles in the bitcoin from 2012 to 2018. They used a robust automatic peak detection method classifying the price time series into periods of uninterrupted growth on one hand, and uninterrupted market contractions on the other. Moreover, they used the Lagrange Regularisation Method to detect the start and end of a bubble episode. Within this approach, draw-up is defined as the succession of positive returns interrupted by negative returns no larger in amplitude than a previously defined tolerance level. Similarly, a draw-down is the succession of negative returns that may be interrupted positive returns no larger than a previously determined tolerance level (Harras and Sornette, 2011). The authors conclude that during a period of 6 years, between January 2012 and February 2018, there were three larger (in 2013, 2014 and 2018) and ten smaller peaks, as illustrated in Figure 13.

Figure 9: Bubbles and crashes using alternative dating



Source: Gerlach et al (2018).

Gerlach et al (2018) found that bubbles in the bitcoin market are a result of the search for safe assets, especially during period of high uncertainty, which also explains the positive correlation between the VIX index and gold price. In particular, given the low return offered by the alternative safe assets (e.g. US Treasury bonds), investors have been encouraged to diversify and invest in other assets, which has also contributed to increased demand for bitcoin. Ciaian et al. (2016), on the other hand, find that advancements in technology and the increased computing power has been an important driver for investors, resulting in an increased demand and price for bitcoin.

Volatility is another important driver of the price. Lahmiri et al. (2018) argue that the underlying nature of bitcoin as a digital (and not a fiat) currency means it is vulnerable to higher volatility. Given the absence of the underlying sovereign guarantee (which in case of fiat currency comes through the central bank), it is prone to larger speculative activity. The value of bitcoin depends on the self-fulfilling expectations of the private agents regarding its tradability (Blau, 2017). This implies that the introduction of a reserve guarantee would also reduce the volatility. Moreover, a regulatory system aimed at safeguarding the currency and preventing it from speculative attacks and Ponzi games would increase its reliability and effectiveness as a monetary alternative. Considering the cross-border nature and usage of cryptocurrency, the regulatory architecture would require an international coordination in the compliance as well as supervisory tasks, as advocated by the International Monetary Fund and Bank of England.

2.4. Blockchain technology

Several benefits of the blockchain technology have been proposed in the literature. Amongst the most prominent is the decentralised nature makes it less prone to corruption and manipulation (Fanning and Centers, 2016). This is very much unlike the currency market, where only a few players such as the central banks and the large commercial banks dominate the market. The system is therefore dependent on the trust in the central authorities and it is vulnerable to a single point of failure or susceptible to a single point of attack. Examples of such failures is the Forex scandal in 2015 when a few big banks and financial institutions clubbed together to fix the foreign exchange rates to the detriment of the consumers and businesses and to their own benefit (Baron et al, 2015). According to Ju et al (2016), one reason for the increased power possessed by these institutions and hence their ability to undertake the manipulative schemes, is that they are the intermediaries for channelling of funds and their repositories. They control the money and financial assets. However, when the system is decentralised, there is less chance that such manipulation is possible, which clearly indicates a major benefit of the blockchains in terms of reducing the monopoly power of the financial institutions.

Another important benefit is that the blockchain transactions are less expensive and quicker than those of the normal fiat currency transactions. For example, PayPal charges up to 3% on currency transactions and transfers. In case of cryptocurrency, these charges are only a fraction of those of PayPal and range from 0.1% to 0.25% (Underwood, 2016). However, it should be noted that the existing lower costs are largely a result of a relative lack of regulatory requirements for blockchain transactions (Yoo, 2017). In case of imposition of regulations in the future, these costs could also increase. This benefit of the blockchain technology is also supported by Swan (2017), who concluded that more frequent use of the blockchain technology can help to reduce the infrastructure-related costs, since it requires relatively smaller human-and technological resources resulting in reduced upfront cost and maintenance. Pieters and Vivanco (2017) argue that blockchain technology is perfect to facilitate efficient payment systems in developing countries, where the existing payment system is less credible and less developed.

There are recent developments in blockchain which indicate that it can play a very significant role in the future payment systems. A good example is the issuance of Basis, a cryptocurrency whose tokens can be robustly pegged to a basket of goods or arbitrary assets. This currency has a more stable price than its predecessors (such as Bitcoin), although it has not yet reached the same market capitalization and reach. In order to make Basis similar to standard central bank currency, one could for instance, peg it to the USD and update the peg to a consumer price index (CPI). This is achieved through an algorithmic adjustment of supply of Basis tokens in response to, for instance, changes in the Basis-USD exchange rate. This allows authorities to implement monetary policy using cryptocurrency similar to that executed by central banks around the world, but through a decentralized protocol-enforced algorithm. Because no direct human judgement and intervention is required, it has also been referred to as an *algorithmic central bank* (Al-Naji et al, 2018).

A good example is that of *Ripple* a system based on remittance services. TenX, a Singapore based start-up is working with MasterCard and Visa to provide a system in which the payments are made to the vendors through the company check cards (Yoo, 2017). The vendor receives the dollar tender. In addition, Luther (2017) reports that even the Federal Reserve has looked at the possibility of introducing blockchain as a way to process interbank payments system. However, at the back end, the virtual currency is being converted into the dollar by the company. The issue whether the authorities permit the transactions in cryptocurrency or the vendors accept the cryptocurrency is circumvented.

One of the last documented large benefits with blockchain is that payments are validated 24/7. This is in stark contrast to the traditional payment system that normally clears only few times per day and

excludes weekends and public holiday. Yet, Pieters and Vivanco (2017) state that some countries have already introduced instantaneous payment services for several sovereign currencies, which are faster than blockchain technology in processing the transactions. An example is the TARGET Instant Payment Settlement, launched in the Euro Area in late 2018. It allows firms and individuals to transfer funds within seconds and irrespective of the opening times of their banks. It functions like a non-stop marketplace for institutions that can access central bank money. Thus, the only requirement is that the institution fulfils the same eligibility criteria as for TARGET2 and performs payments directly in central bank money (ECB, 2019).

3. THE FUNCTIONS OF MONEY IN A CASHLESS ECONOMY

Advanced economies are moving towards a system in which coins and notes are not needed anymore, i.e. a cashless economy. The recent surge of cryptocurrencies (or cryptoassets) has largely contributed to this trend. Cryptocurrencies constitute new payment systems combined with new currencies that are not issued by the central bank. These new forms of currencies are issued by private authorities. Examples include Bitcoin, LiteCoin, Ethereum and XRP.

Bitcoin and other digital currencies may change the function of money. On the one hand, they may overcome the weaknesses of both fiat and gold-based money, because they function as an algorithmic currency with a deterministic supply and growth rate, based on mathematics. Also, because they are privately issued, governments do not intervene in its supply. Instead, digital currency follows some cryptographic rules, which follow a clear computer code. This is done in a decentralised and transparent manner, which may contribute to the trust in the currency.

Whether new forms of digital currencies should be issued by the central bank is still an open question. If central banks were to issue digital currency, then this new form of currency could serve to store value and make payments in electronic central bank money. This would of course have implications for both monetary policy and financial stability.

3.1. Digital Currencies and money

The first question that arises is to what extent digital currencies can be considered money. The answer will depend on how they play the different functions that money traditionally plays. And, if they fall in the category of money, how important their use is, so that they can alter the functions of money in the economy. Theoretically, anyone with internet access could use digital currencies as money. However, evidence shows that this function is very limited and only a few people make use of it.

As we know, money plays three roles in the economy; it is (i) a store of value, (ii) a medium of exchange and (iii) a unit of account. In order to assess whether digital currencies can be considered money or not, we would have to analyse how they can fulfil these three different roles. The limited evidence we can collect so far may suggest that digital currencies are primarily viewed as stores of value and are not typically used as medium of exchange. At present, there is little evidence of digital currencies being used as a unit of account.

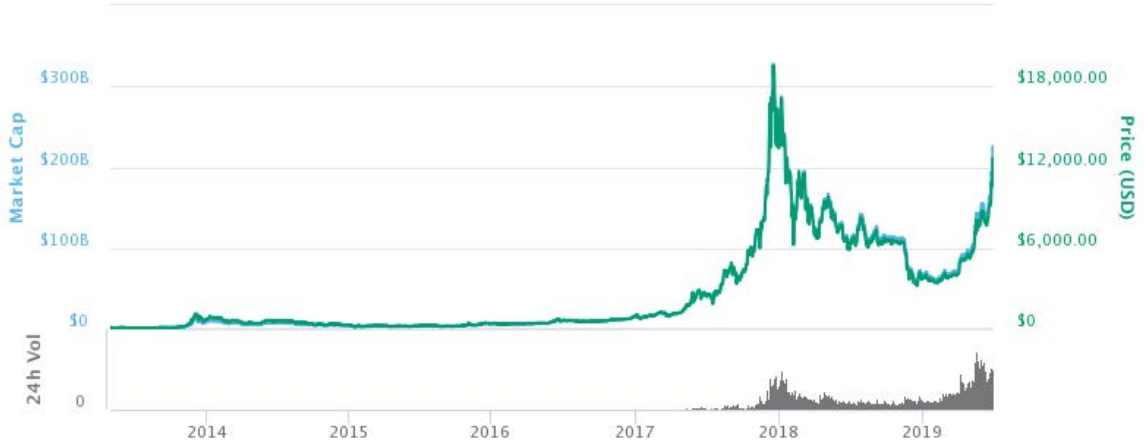
The issue of whether digital currencies are considered to be money or not has been extensively analysed (see for instance Bank of England 2014, Q3 or Yermack, 2013). These studies conclude that in theory, digital currencies could serve as money for anybody with an internet-enabled computer or device. However, in reality, this function occurs only to some extent and only for a small number of people, and always in parallel with users' traditional currencies. Instead, digital currencies resemble a speculative investment similar to the Internet stocks of the late 1990s.

3.1.1. Digital currencies as a store of value

We must distinguish between the long and the short run to study the use of digital currencies as a store of value. For an asset to be a store of value in the long run, it is key what people expect about its future supply and demand. Supply of digital currencies is totally assured because of the algorithmic essence of its production. However, demand is more uncertain. Then, the public belief that digital currencies will continue being on demand is crucial for them to function as a store of value. Thus, the worth of digital currencies as a store of value over the long run is directly linked to their demand, and this is connected with what users believe about the future success of the currency.

However, in the short run, it is difficult that digital currencies serve as a store of value. These sorts of currencies have a large volatility in exchange rates with traditional currencies (See Figure 10). Managing the risk arising from this exchange volatility is a further problem that makes digital currencies a poor short-term store of value.[7] For instance, bitcoin's daily exchange rate with the U.S. dollar exhibits virtually zero correlation with the dollar's exchange rates against other prominent currencies such as the euro, yen, Swiss franc, or British pound, and also against gold. Therefore, Bitcoin is not a good tool to manage risks. (See Yermack, 2013).

Figure 10: Bitcoin price since 2009 to 2019



Source: BitcoinWiki.

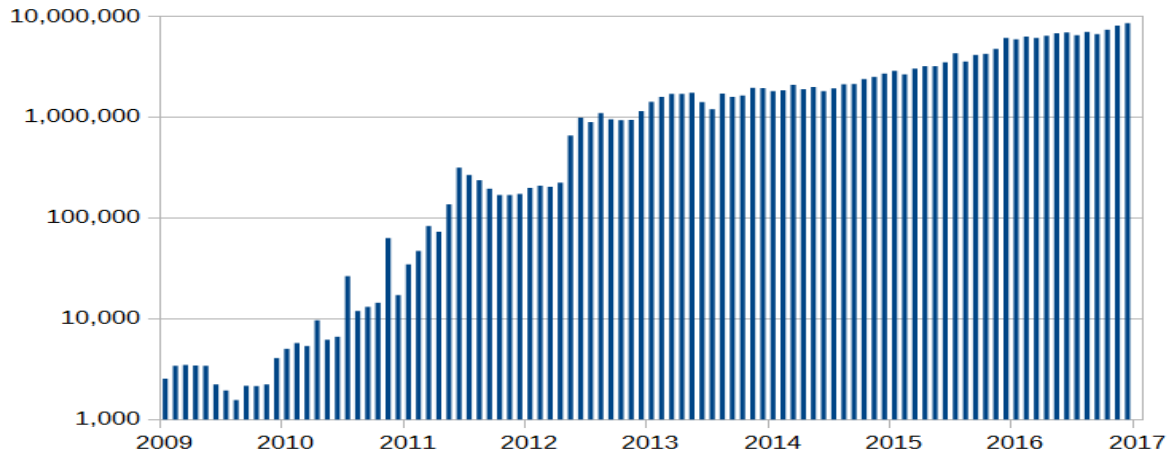
Safety is also an issue when considering digital currency as a store of value. When treating currency as a store of value, protecting it against theft is very important. In the case of digital currency, because the currency is not physical, one cannot literally hide it (for instance under the mattress). Instead, digital currencies must be held in computer accounts known as "digital wallets." Security for these wallets is an important issue for digital currencies. Sometimes, companies contract some insurance. However, the consumer is the one in charge of the cost.

3.1.2. Digital currencies as a medium of exchange

A currency can be used as a medium of exchange as long as there are retailers willing to accept it in payment. The number of retailers worldwide that are willing to receive payment in digital currencies is increasing. However, the fact that retailers accept these currencies does not mean automatically that the currency is going to be used overall. In order to know if the digital currency is really a medium of exchange it is important to track the number of transactions made in these currencies over time. Figure 11 shows how this number has been largely increasing over time.

[7] Bitcoin's exchange rate volatility in 2013 was 142%, an order of magnitude higher than the exchange rate volatilities of the other currencies, which fall between 7% and 12%. Gold, which is a plausible alternative to these currencies as a store of value, had volatility of 22% in 2013 based on its dollar-denominated exchange rate. (See Yermack, 2013)

Figure 11: Number of bitcoin transactions per month since 2009 to 2017



Source: BitcoinWiki.

One difficulty for digital currencies to be a medium of exchange is its fixed supply. Consumers can only access digital currencies from online exchanges or dealers. Furthermore, one cannot bypass the requirement of possessing digital currencies before procuring goods and services from a merchant. So far, there are no credit cards or consumer loans denominated in digital currency.

3.1.3. Digital currencies as a unit of account

There is little evidence of any digital currency being used as a unit of account. The extreme volatility of the digital currencies' exchange rates is also a problem when becoming a useful unit of account. For example, the value of a bitcoin, compared to other currencies changes greatly on a day-to-day basis. Retailers have to recalculate prices very frequently and this can be costly and confusing. The uncertain market value of digital currencies would make it very difficult to use as a valid reference point for setting consumer prices. Table 1 displays the daily bitcoin-USD price and the number of transactions.

Table 1: Bitcoin-USD Price and Volume of Transactions

Date	Open	High	Low	Volume
Nov 23, 2019	7,298.17	7,298.172	7,207.51	34,342,412,288
Nov 22, 2019	7,643.57	7,697.38	6,936.71	34,242,315,784
Nov 21, 2019	8,023.64	8,110.10	7,597.38	22,514,243,371
Nov 20, 2019	8,203.61	8,237.24	8,010.51	20,764,300,436
Nov 19, 2019	8,305.13	8,408.52	8,099.96	21,083,613,815

Source: Yahoo Finance.

An additional aspect for the difficulty of digital currencies to become units of account is the fact that merchants quote prices for most goods in four or more decimal places. Although mathematically this should not pose any problem, for consumers these decimal points may be disconcerting. Table 2 shows and example of how cars are priced in bitcoins.

Table 2: Price of cars in Bitcoins

Car	Price in Bitcoin	Price in USD
Honda Accord	3.26713809	23,570
Ford Fusion	3.06614742	22,120
Toyota Corolla	2.57129451	18,550
Nissan Sentra	2.35505627	16,990
Chevrolet Cruze	2.35297705	16,975

Source: carstobtc.com.

3.2. Conclusion: Is digital currency money?

According to the analysis above, it seems that digital currencies barely meet the criteria associated with the functions of money.

Thus, digital currencies do not seem to really function as money in the economy and bring about some risks if they were to be widely used in the long run. Then, it is very unlikely that these sorts of currencies, in their current form, would be the main form of money for the economic system. Furthermore, other issues that may appear are related to the fact that people are not really familiar with the technology, applications are not very user-friendly, they are not very safe relative to deposits, and they display great volatility in their exchange rates (see Bank of England, 2014).

Moreover, digital currencies lack some other features that are associated with money in the economy. For instance, digital currencies cannot be stored as bank deposits, they are usually part of "digital wallets," which are exposed to many risks and costs. There is no standard insurance for this wallets, as in the case of deposits. Furthermore, digital currencies are not a unit of account for loans and mortgages. No credit or credit cards are denominated in digital currencies either (see Yermack, 2013).

As opposed to traditional money, digital currencies are not a claim and thus could be somehow considered a commodity. However, they are intangible, not as gold, for instance. Digital currencies can be used only if users agree that they can be used. Not being a liability of the central bank is not an impediment to function as money, but make them different to cash and notes (see Bank of England 2014).

In some ways, digital currencies are similar to earlier forms of money. For instance, the central bank does not govern their supply and payments are made in a direct way, without any intermediary.

4. COSTS AND BENEFITS OF DIGITAL CURRENCIES

The surge of the technologies associated to cryptocurrencies has some implications for the macroeconomy, the money supply, and the financial system. Blockchain technologies reduce transaction costs, and this may be welfare-enhancing. However, they also bring about new risks and problems.

From a macroeconomic point of view, cryptocurrencies could pose a risk to monetary and financial stability. From a microeconomic perspective, they imply a risk to investors, who could lose all their money.

If linkages between cryptoassets and systemically important financial institutions or markets are large enough, this could be a risk for financial stability. However, nowadays, the small size of digital currency schemes makes it unlikely to pose real risks to financial stability. Over time, it seems that problems related to financial stability are not likely. However, they are still more likely than risks to monetary stability. The only way that monetary stability could be affected by the use of digital currencies is if they were widely used. Nevertheless, this is considered to be very unlikely, at least in their current form (see Bank of England, 2014).

4.1. Risks to financial stability

Digital currencies pose an additional risk to financial stability. We have seen that their prices are very volatile. If there is a price crash, this may potentially endanger the stability of the financial system. However, currently the total value of digital currencies seems to be too small to pose a real threat to financial stability and, in any case, would be limited to the direct holders of that currency.

According to Bank of England 2014b, there are a number of potential scenarios which would increase the probability of digital currencies affecting financial stability. For instance, if a holder of digital currencies had already borrowed money from someone else. In this scenario, after a price crash, losses would not only impact the direct holder but also lenders. Also, if a systemically important financial institution is directly exposed to cryptocurrencies.

Right now, digital currencies do not play a significant role in the economy because they reach a small number of consumers. However, if this number increases, the possibility of system-wide fraud and disruption arises. Thus, the real risk lies in the digital currency becoming systemically important.

To overcome financial stability risks, it is important to take a close look to financial stability issues related to cryptocurrencies and make sure that the macroprudential regulation is adequate both at national and international level. This calls for international coordination for those cryptoassets that pose new challenges to traditional forms of financial regulation, and fall outside the existing regulatory framework.

4.2. Risks to monetary stability

We have already discussed that digital currency supply is predetermined and governed by fixed algorithms. Therefore, the eventual total supply of cryptocurrencies is fixed, there is no discretion in its determination. This could potentially pose a number of problems for monetary stability because this fixed supply could contribute to deflation or volatility in prices and real activity, just because supply cannot adapt to demand.

The greatest risk that could, in theory, be posed by digital currencies to monetary stability is an erosion of the ability of the central bank to influence aggregate demand as part of its remit to achieve its inflation target. Nevertheless, in order to assess if cryptocurrencies are really a risk to monetary stability,

it is important to see to what extent they are used. If their usage is not widespread, then the central bank can still affect aggregate demand and achieve its monetary policy objectives. If the economy became "bitcoinised," that would pose a real risk for monetary policy. However, currently, it does not seem that this is a likely scenario (see Bank of England, 2014).

4.3. Other risks

For digital currencies, there is no consumer protection. For instance, there are no refunds if there is a problem between consumers and retailers. Laws may exist but they would be difficult to enforce. Consumer credit, if it were denominated in cryptocurrencies, would be very difficult to secure (see Yermack, 2013).

There could be other potential risks associated with large fluctuations in the price of a digital currency, the lack of transparency about the producers of cryptocurrencies and their motives, the problems of security and potential hacking, and the ease with which a digital currency like bitcoin can be used to finance illegal transactions.

4.4. Potential benefits

Cryptocurrencies could also benefit the system. The technologies underlying cryptoassets may potentially create a more distributed and diverse payments system. They use the so-called distributed ledger technology (DLT) (or blockchain). This technology allows a digital currency to be used in a decentralised payment system. Thus, it could happen that the currency is copied and spent several times. Users do not need to trust any government, they just need to trust the DLT. This technology could be used in a similar fashion in other layers of the financial system (See Bank of England, 2014).

Furthermore, the emergence of these additional financial assets is likely to increase aggregate welfare by introducing more variety into the menu of financial assets offered to pension funds, insurance companies, hedge funds, private individuals and other thrift institutions.

5. PRIVATELY ISSUED DIGITAL CURRENCY

Private entities issuing digital currency use a DLT. Such technology is a consensus of replicated, shared, and synchronised digital data geographically spread across multiple internet sites, in different countries and institutions with no central administrator or centralized data storage.

At the very least, private digital instruments possess the following two advantages: First, they introduce the fintech technology to reduce the costs of transacting across different fiat currencies. Second, in countries with underdeveloped financial systems, in which many consumers are excluded from the financial system, private digital currencies are potentially contributing to financial inclusion.

However, as is well known an essential attribute of a good currency is widespread acceptability by economic agents against the supply of goods and services. A precondition for this attribute is trust in the currency. Individuals must trust that the currency has a stable purchasing power, will not be debased by the issuer(s) of the currency and that private ownership of currency is fraud proof. Thus, trust in the ledger of a fully decentralised currency is crucial for digital currency to be used as money. Trust is achieved by making it extremely hard for one, or a small group, of computers to tamper with the transaction ledger. In addition, the protocol that governs the ledger of a fully decentralised currency must include a built-in provision that limits the creation of new money in order to preserve its purchasing power. Cryptography is the computer technique used to secure transactions and to control the creation of new currency units.

Aizenman (2019) and Auer (2019) argue that privately administered DLT are unlikely to provide the stability and scalability required to efficiently perform the medium of exchange function. A natural candidate to do that would be the central bank. The central bank already possesses the infrastructure for issuing a currency and is backed by the tax collection apparatus of governments. Like cash or checking deposits denominated in fiat currency a central bank digital currency would rely on the trust created by means of the centralised ledger administered by the bank.

Central banks can take advantage of the cost reduction of the technology associated with digital currencies. At the same time, they can still use their monetary policy instrument by issuing a digital currency that can be converted into cash and paper currencies at a given fixed exchange rate. In this way, a central bank digital currency (CBDC) would be a legal tender. Thus, M1 would be expanded to include the CBDC. Then, monetary policy could be conducted in the usual way.

6. A CENTRAL BANK ISSUING DIGITAL CURRENCY

People trust that the existing fiat currency issued by a centralised authority has stable value because of stable monetary policies, because the currency can be used to pay taxes to government, and because it is impossible for anyone to spend the same piece of currency more than once.

According to Cukierman (2019), in order to preserve the effectiveness of monetary policy in a world increasingly flooded by private digital currencies, central banks will eventually have to issue their own digital currencies. Although a nonnegligible number of central banks (CBs) are actively considering the pros and cons of a central bank digital currency (CBDC) there is yet no CB that has issued such a currency on a full scale.

Thus, the feasibility and desirability of central banks issuing their own fiat versions of digital currencies has been the focus of a growing debate in recent years. Numerous central banks around the world are researching the topic, including the Bank of Canada (2017), the European Central Bank (Mersch, 2017), the People's Bank of China (Qian, 2017), the Sveriges Riksbank (2017) and the Bank of England (2017). For instance, Gupta et. al. (2017) conclude their case in favour of issuing a digital currency by the Fed. They claim that a "Fedcoin" would have many advantages because it would mitigate the risk of attacks and it would be based on the assumptions that the central bank is honest, the protocol's cryptography is secure, and that each transaction is processed by a set of nodes with an honest majority.

Meaning et al. (2018) provide a definition for CBDC as "any electronic, fiat liability of a central bank that can be used to settle payments, or as a store of value." As such, CBDC can be viewed as electronic narrow money and in some senses already exists in the form of central bank reserves.

It is also confusing to think about whether CBDC is a cryptocurrency or not. Cryptocurrencies, in principle, make use of DLT technology. The central bank does not necessarily need to use the same technology because it has its own. This kind of CBDC would not be a cryptocurrency, but would remain a central bank digital currency.

Currently, whether the central bank should issue CBDC is a question open to debate. On the one hand, it would be efficient because it could make use of the new technology. However, it could be the case that CBDC interfered with the private banking system, especially if the public can hold deposits within the central bank.

Another concern is that if these currencies are not issued by the central bank, at some point these currencies will become the alternative of legal tender. But abstaining from providing a public alternative to privately produced digital currencies carries the risk that sooner or later those currencies will largely replace legal tender. Recognising this risk, most central banks currently research the various options for eventually adopting some form of CBDC. Some like the Dutch central bank and the central bank of Uruguay have started to limitedly use this currency. The Federal Reserve Bank is also thinking about issuing a "Fedcoin."[8]

Based on traditional modelling, Barrdear and Kumhof (2016) assess the potential impact CBDC may have on the macroeconomy. They build a dynamic stochastic general equilibrium model and find that the introduction of a CBDC via purchases of government bonds could increase real GDP by as much as 3%. Bordo and Levin (2017) also analyse the design of CBDC and its implication. They conclude that CBDC could act as a highly effective form of money and promote true price stability, as the real value of CBDC could be easily held stable over time.

[8] A number of CBs have issued reports on this question (Lober and Houben (2018). Barontini and Holden (2019) report limited experiments with CBDC by the central bank of Uruguay and the Riksbank.

7. AN INTERMEDIATE SOLUTION: STABLECOINS

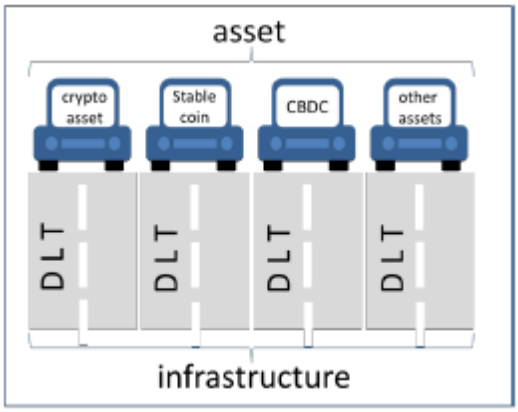
Cryptocurrencies have issues and risks that need to be solved. In order to find a solution, one alternative would be the so-called "stable cryptocurrencies" such as Tether and DAI. These stablecoins could in principle solve the problem of the great volatility that cryptocurrencies such as Bitcoin or Ether display.

This stable cryptocurrency is based on tokens that are pegged to the value of a fiat currency (like the dollar or the euro), to assets (gold, real estate), or to another cryptocurrency. There are also stablecoins that, instead, are governed by algorithms to keep their prices stable. The main reason for creating a stablecoin is to protect investors in times of volatility. Thus, stablecoins have many of the advantages of digital currencies but manage to have a more stable price. Therefore, stablecoins might be more capable of serving as a means of payment and store of value because their less volatile essence (see BIS, 2019).

There are two distinct types of stablecoins that use different strategies to reduce volatility: (i) the "collateralized" (or "backed") cryptocurrencies, which are tied to the value of an external (stable) asset (fiat currency, a cryptocurrency, gold, and property). The second main group of stablecoins are those that are "non-collateralized" or non-backed, meaning they are not linked to any external value. They follow an algorithm instead, which controls currency volatility.

Stable coins may be seen as an intermediate solution between cryptocurrencies and CBDC. As we have seen in previous sections, the demand for a stable asset, which uses the DLT has opened the debate about the possibility of issuing a CBDC. However, this may also pose problems, questioning the role of banks in financing economic activities. In view of the volatility of cryptoassets and given the remaining questions surrounding CBDCs, stablecoins have come to the fore as a potential third type of asset that aspires to bring stability to the volatile market for cryptoassets.

Figure 12: Different assets that use DLT

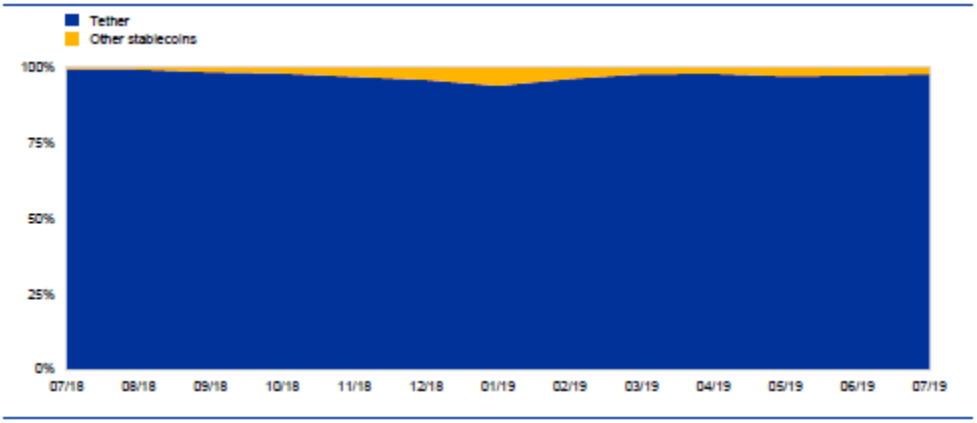


Source: ECB (2019).

Stablecoins aim to provide safety in relation to the major currencies issued by central banks. Cryptocurrencies are characterised by high price volatility, which makes them incapable of performing the three functions of money. Stablecoins, instead, try to solve this problem, and have been introduced as an attempt to overcome this volatility problem. Thus, financial service providers and technology companies have been working towards the development of stablecoins for payment transactions on a global scale. For example, Facebook initiated project Libra in order to enhance international financial transactions for everyone in a faster and more efficient (see Bullmann et al., 2019).

Tether currently dominates the stablecoin market in terms of trading volume as well as market capitalisation. While Tether accounted for 99% of the entire market capitalisation of stablecoins in February 2018, its share declined to 81% in July 2019. Tether was among the first stablecoin that appeared and has therefore the advantage of having moved first. While the market has become increasingly competitive, Tether remains the most commonly used stablecoin.

Figure 13: Trading volume of USD Tether compared to other stable coins



Source: ECB, 2019.

Nevertheless, stablecoins are still in their infancy, and therefore not a sufficiently secure investment vehicle. Maybe, in the future, they could end up replacing the traditional digital currencies like Bitcoin or Ripple (see BBVA, 2019).

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Public or Private? The Future of Money

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Abstract

Stablecoins issued by large tech companies pose a significant challenge for traditional fiat money. In this study, we highlight the importance of a public-private-cooperation in dealing with this topic, where central banks closely work with stablecoin issuers in issuing synthetic central bank digital currency (sCBDC). This framework minimizes the risks of private money and utilises the technological advantages of stablecoin issuers.

This document was provided by Policy Department A at the request of the Committee on Economic and Monetary Affairs.

CONTENTS

LIST OF ABBREVIATIONS

CBDC	Central Bank Digital Currency
EUR	Euro
USD	US dollars
sCBDC	Synthetic Central Bank Digital Currency

EXECUTIVE SUMMARY

- In 2009, an anonymous programmer introduced Bitcoin, a cryptocurrency that is fully decentralised and usable without the need for intermediaries. Despite its technological advances and global reach, high price volatility makes Bitcoin unattractive as a mean of payment. 10 years later, a new generation of cryptocurrencies – stablecoins – has caught the attention of crypto market, becoming potential competition for central bank money. The ultimate wake-up call for monetary- and regulatory authorities was the June 2019 announcement by Facebook that it would issue its own stablecoin, Libra.
- Stablecoins of large tech firms have distinct advantages over alternative digital forms of money *and* traditional fiat money. First, compared to the first generation of cryptocurrencies, such as Bitcoin, stablecoin issuers guarantee the price stability of their coins by backing them with safe assets (or a basket of assets). Second, compared to central bank fiat money, stablecoin issuers provide their users a platform where they can easily access their coins, where regional borders do not play a role.
- Nevertheless, the global spread of such stablecoins can bring risks to international financial systems and challenge the monetary authority of central banks. Unfortunately, there is not a global legal system that provides a sound regulatory framework for stablecoin issuers. This can lead to an abuse of private user data and a lack in transparency in their risk management.
- If private digital currency substitutes for fiat money, the efficacy of monetary policy could also be in danger. First, a decrease of central bank reserves in households and businesses' balance sheets can weaken the interest rate channel of the monetary policy transmission mechanism. Second, central banks may lose seigniorage revenue. Third, stablecoins may lead to a high interdependency between domestic monetary policies.
- How should monetary- and regulatory authorities react to the rise of private stablecoins? One option for central banks is to issue central bank digital currency (CBDC). However, this option can be very costly as it requires complex management of customers, which can jeopardise the hard-earned trust of the public regarding the ability of central banks to maintain price stability, their primary mandate. Therefore, we suggest that public-private-cooperation can be an answer. Central banks should cooperate with stablecoin providers by providing them access to central bank reserves, a concept that is known as synthetic central bank digital currency (sCBDC).

1. INTRODUCTION

In the age of digitalisation, global cash usage is rapidly decreasing and large tech companies are developing digital currencies that enable fast and easy transactions without using fiat money, thereby challenging the central bank's monopoly to issue money. In June 18, 2019, Facebook officially announced the introduction of a "New Global Digital Payment Coin" called *Libra* in the near future. Unlike other crypto-assets, such as Bitcoin, with high price volatility, Libra belongs to the category "stablecoins," which are crypto-assets that have a stable value since they are backed by a basket of safe assets. In addition, as the world's biggest social network, Libra brings additional advantages that their public competitor cannot (yet) deliver: global connectedness and financial inclusion in countries without a well-developed financial system. Therefore, a scenario where Libra overtakes domestic fiat currencies, thus depriving central banks of their monopolistic monetary authority, is not completely unrealistic.

However, it is not yet clear whether stablecoins, like Libra, will be able to become a widely used medium of exchange. For instance, how do we know what these digital currencies are worth? The history of money shows that the most important ingredient for a well-functioning currency is the people's trust that they can use this currency for any transaction, at any time. The value of money is exactly this bubble of *trust*; after all, the banknotes that we use for transactions are literally made of a piece of paper that does not have any intrinsic value. Therefore, the credibility of the institution that backs the value of these banknotes is essential: people must believe that this institution is able to redeem the face value of the banknote. Since the 19th century, central banks have taken responsibility for this important task. Learning from their mistakes over time, many central banks of developed countries have earned public trust and thus their banknotes are used as a stable medium of exchange. Compared to this, large tech firms may not have enough public trust to have the level of credibility that central banks have.

So what does the future of money look like, public or private? In this paper, we show that it need not be one or the other. Rather, we suggest to focus on a public-private-cooperation in digital money issuance, where large tech firms provide digital currencies to households and businesses, but the stablecoin issuers keep accounts at the central bank. This concept – also known as "synthetic central bank digital currency (sCBDC)" – was introduced by Adrian and Mancini-Graffoli (2019). We provide evidence that this option minimizes the risk of private stablecoins and utilizes the advantages of large tech firms in issuing and managing digital currencies. As Christine Lagarde emphasized in her speech for the Bank of England regarding regulatory frameworks for crypto-assets, "Cooperation is key."[9]

Our study begins in Section 2 with an overview of the advantages of such privately issued money compared to other digital- and analogue alternatives (such as other crypto-assets and/or fiat money). In the next step, in Section 3 we discuss their potential risks. Based on the findings in Sections 2 and 3, in Section 4 we suggest a solution for central banks that can help them to minimize the risks of stablecoins and benefit from the advantages of large tech companies at the same time: to issue the so-called "synthetic central bank digital currency" (sCBDC). Simply speaking, sCBDC is an option where central banks provide private stablecoin issuers access to central bank reserves. We provide detailed evidence on why this option is better than central banks solely issuing central bank digital currency (CBDC). Section 5 concludes.

[9] Lagarde, C. (2017): "Central banking and Fintech – A brave new world?," Speech at the Bank of England conference. September 29, 2017. London.

2. ADVANTAGES OF GLOBAL STABLECOINS

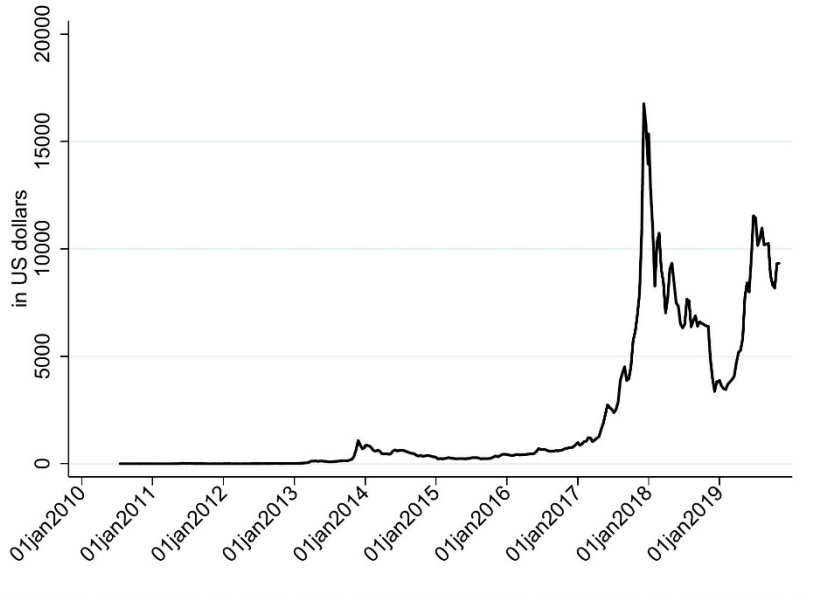
Historically, successful currencies have (i) a stable value and (ii) a sufficiently large network of users that trade. In this section, we discuss how stablecoins can dominate other digital and analogue alternatives (such as Bitcoin and/or fiat money) in these two aspects.

2.1. Price stability

Until now, it has been impossible to use the first generation of cryptocurrencies, such as Bitcoin, as a stable medium of exchange due to their extreme price volatility. In Figure 1, we plot the price development of Bitcoin since its 2009 founding. On May 22, 2010, the first Bitcoin transaction happened as the programmer Laszlo Hanyecz paid 10 000 Bitcoins to a British man for two delivery pizzas, also known as the "Bitcoin Pizza Day."[10] At that time, 10 000 Bitcoins were worth about USD 41. Now, in 2019, one bitcoin is worth more than USD 8000.[11] As this high volatility has made cryptocurrencies unattractive as a valid means of payment, they have rather served as a highly speculative asset class for investment.

Stablecoins are cryptocurrencies designed to overcome this weakness. The aim is to develop a digital currency that mimics traditional stable currencies such that they can be used for daily exchange. In general, a stablecoin is collateralized to the value of an underlying stable asset (or a basket of assets). Many are pegged at a 1:1 ratio with stable fiat currencies such as the USD or the EUR, but there are also stablecoins that are linked to other kinds of assets, such as precious metals or even to other cryptocurrencies (see Box 1).

Figure 5: Price development of Bitcoin



Data source: www.CryptoDataDownload.com

[10] Laszlo Hanyecz from Florida, USA, reached out for help and wrote on a bitcointalk forum: "I'll pay 10,000 bitcoins for a couple of pizzas… like maybe two large ones so I have some left over for the next day."

[11] Situation on November 13, 2019.

Box 1: Types of stablecoins

Classifying stablecoins on the basis of what underpins their value allows us to understand the stability mechanism stablecoin issuers use to minimize the volatility of their price. According to Bullmann et al. (2019), we can divide stablecoins into four distinct categories.

1. Fiat-collateralized stablecoins

This type of stablecoins, most common in the market, represents units of monetary value that represent a claim on the issuer. They are collateralized by (stable) fiat money like USD and EUR at a 1:1 ratio, meaning one stablecoin is equal to one unit of the reference currency. In the optimal case, for each stablecoin that exists in the market, there is real fiat money held in the reserve by the stablecoin issuer.

Tether (launched in 2014), ***TrueUSD***, and ***Gemini Dollar*** (both launched in 2018) are examples of fiat-collateralized stablecoins.

2. Stablecoins backed by other asset classes

The price of these stablecoins is supported by units of an asset or multiple assets, against which users can redeem their holdings. This can be a basket of stable currencies, but can also be other kinds of interchangeable assets such as precious metals, oil, and real estate. The significant difference to fiat-collateralized stablecoins is that the value of these stablecoins are collateralized by assets, whose price can fluctuate over time.

The original concept of ***Libra*** would fit in this category. Existing commodity-backed stablecoins include ***Digix Gold*** (backed by physical gold, launched in 2018) and ***SwissRealCoin*** (backed by a portfolio of Swiss real estate, launched in 2018).

3. Crypto-collateralized stablecoins

This type of stablecoins is backed by other cryptocurrencies and thus conducted exclusively on the blockchain. Therefore, crypto-collateralized stablecoins are more decentralized than are their fiat-backed counterparts. However, the downside of this type of stablecoins is the high price volatility of the collateral. This can put the value of the stablecoins at risk. Therefore, these stablecoins are mostly over-collateralized in order to buffer against the price fluctuations in the collateral.

The most popular example of this category is ***Dai***, which was launched in 2017.

4. Non-collateralized stablecoins

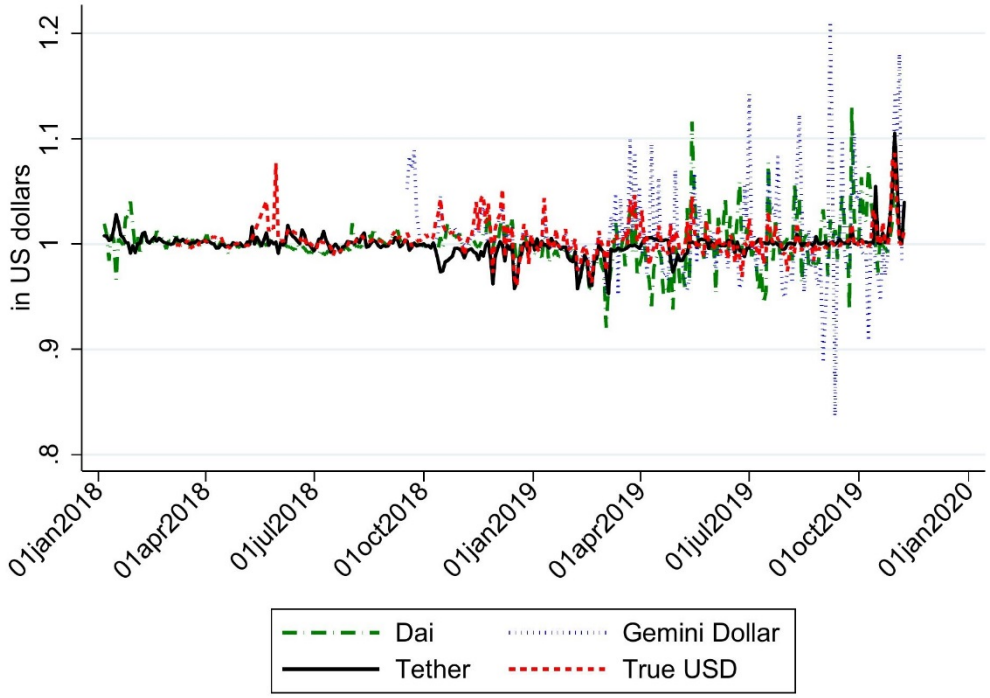
There are also stablecoins that are not backed by anything. These types of coins use an algorithmically governed approach to control the stablecoin supply. Therefore, they represent the most decentralized and independent form of stablecoins.

One example of such non-collateralized stablecoins is ***Basis***, which was launched in the third quarter of 2018.

In Figure 2, we plot the prices of four stablecoins that are traded on the market: Dai, Gemini Dollar, Tether, and TrueUSD. All four are backed by USD, but differ in their way of collateralizing the value of their currencies. Dai is a crypto-collateralized stablecoin, while the others are fiat-collateralized. Despite some volatility, the prices of these stablecoins are quite stable and fluctuate around the face value,

which is one USD. Compared to the price development of Bitcoin in Figure 1, stablecoins seem to provide a relatively stable medium of exchange.

Figure 6: Price development of Stablecoins



Data source: www.cryptocurrencychart.com

2.2. Global network of users

The main advantage of cryptocurrencies and digital payment systems is that they are easily accessible by the public. This is not always the case with traditional banks, since many developing countries lack a well-functioning banking system and people do not have access to bank accounts. In addition, oversea payments are especially expensive under the traditional banking system with very high transaction fees and long processing time. Stablecoin issuers aim to address these exact weaknesses in the traditional banking system by lowering the cost of remittances and breaking down the barriers to financial inclusion.

On a national level, there are already real-life examples of how digital payment systems have successfully dominated the traditional banking systems in emerging markets. For instance, Safaricom, Kenya's largest mobile-network operator, launched *M-Pesa* in 2007, a mobile-phone-based money transfer service that people can use to transfer cash using their phones. Around the launch period, only 14 percent of the Kenyan population had accounts.[12] In 2019, over 17 million Kenyans use M-Pesa, which is equivalent to more than 66 percent of the adult population.[13]

Another success story of digital payment systems comes from China with WeChat Pay and Alipay. While WeChat Pay started in 2014 as a payment system on China's most popular messaging app WeChat,

[12] Source: Reuters (2019).

[13] M-Pesa has now expanded to Afghanistan, South Africa, India, and to Eastern Europe.

Alipay was created in 2004 for customers on the Alibaba website to simplify transactions for both buyers and sellers on the website. Now, both have become a regular payment facility, where users can pay for other things as well such as bills and groceries. According to a 2019 survey by Statista regarding China's most popular digital payment systems, Alipay and WeChat Pay dominate the market, with 87 percent of survey respondents using Alipay and 76 percent WeChat Pay. In addition, 60 percent of survey respondents said that they use digital payment services daily.[14]

Compared to these national digital payment systems, the new generation of stablecoins issued by large tech companies have the potential to dominate the digital payment systems at the *global* level. These companies fundamentally understand user-centred design and seek to integrate the usage of stablecoins into their globally used social media platforms. Therefore, anyone with a smart phone and a social media account can easily integrate stablecoins into their daily life without any transaction costs. The higher the number of users of such a platform, the higher are the benefits of using this digital currency. Particularly in countries without a well-functioning financial system, the benefits of stablecoins can be huge.[15]

Facebook is an excellent example. In June 2019, Facebook introduced a "New Global Digital Payment Coin" called Libra that would enable payment services in "WhatsApp" and "Facebook Messenger" starting in the first half of 2020. Given the number of active users, Facebook's goal to establish Libra as a network for worldwide digital private money is not unrealistic. According to Figure 3, over 2 billion users are able to pay using Libra within the platform. In countries where citizens have little trust in the domestic banking systems and/or government, it may be that people prefer to use Libra over the domestic currency.

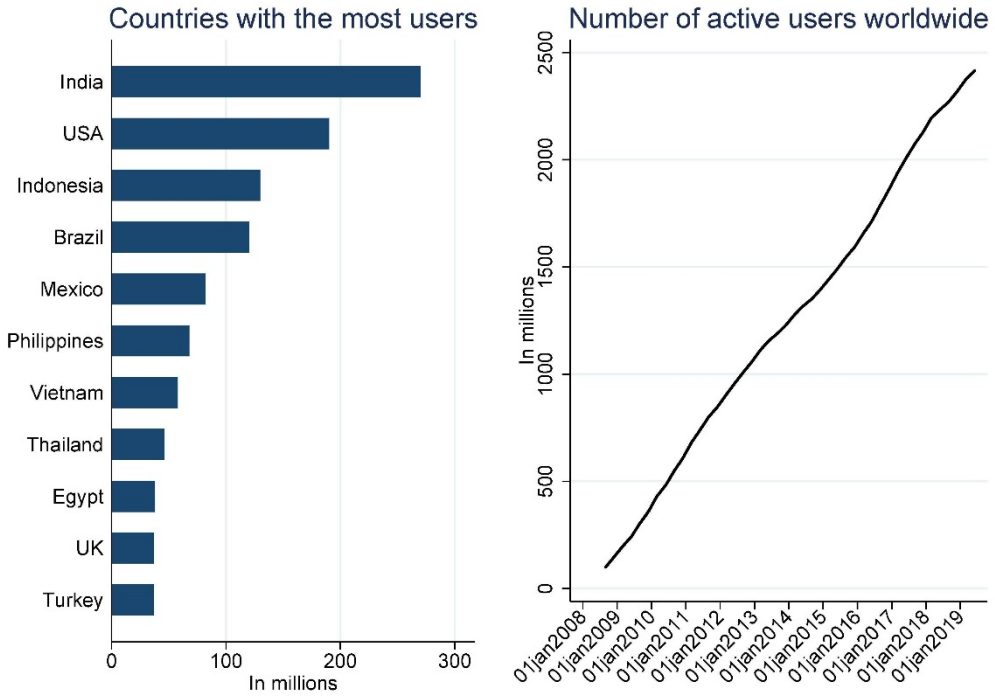
Due to its global nature, stablecoins also have distinct cross-border advantages. Although domestic payments are increasingly convenient, cross-border payments remain slow and expensive. The use of stablecoins (especially in the retail sector) could help address these shortcomings in cross-border payments, since digital networks are particularly well suited to address the complicated nature of sending money across geographic regions. While geographic constraints limit the spread of physical currencies, digital currencies are free to circulate within networks that cross borders.

In summary, global stablecoins have the potential to serve as a stable and widely accepted medium of exchange that can bring huge network effects to the global financial markets. Therefore, stablecoins are a promising venue for future payment systems worldwide.

[14] Source: Tech Giants in Mainland China 2019, Statista.

[15] According to Demirgüc-Kunt et al. (2018), 1,7 billion adults still do not have access to a transaction account. Nevertheless, 1.1 billion of them have access to a mobile phone and, thus, to the internet (and social media platforms).

Figure 7: Global reach of Facebook



Source: Statista.de, Status of July 2019.

3. RISKS ASSOCIATED WITH PRIVATELY-ISSUED MONEY

Despite the significant advantages that stablecoins can bring, there are potential risks related to the global adoption of such new payment systems. In particular, stablecoins are issued by private tech companies, which may have different incentives in conducting business compared to public entities such as central banks. For instance, the profit-maximising nature of private companies can support possible misbehaviour of stablecoin issuers, such as abusing their information advantage towards their customers to make profit and/or hide operational weaknesses. In the worst case, stablecoin issuers can completely lose the trust of their customers, which will lead to a very illiquid market of their stablecoins, if not bankruptcy.

Depending on size and market power, these risks become increasingly larger. Indeed, stablecoin providers are very likely to become natural monopolies due to their strong network effects, high entry costs for start-ups, and data advantage. The global nature of stablecoins makes the problem even more complicated, since their misbehaviour (or failure) will affect cross-border financial systems and the efficacy of monetary policy.

In this section, we address two major risk factors of privately issued stablecoins. First, we address the consequences of the absence of a (supranational) legal basis to regulate global stablecoin issuers, such as the abuse of private data and opaqueness of risk management. These can result in disrupted financial markets and, in the worst case, the bankruptcy of stablecoin issuers. In the second part, we analyse the potentially negative impact of such privately issued monies on the transmission of monetary policy.

3.1. Absence of a legal basis for stablecoin regulations

In order for stablecoins to become a safe means of payment, it is crucial that regulatory authorities develop a legal basis that underlies proper monitoring and regulation of stablecoins and their issuers. However, developing such a legal framework is extremely complex due to the global nature of stablecoins: authorities must take into account the heterogeneous laws across jurisdictions as well as differing cultural views on certain legal aspects. Since the launch announcement of Facebook's Libra, policy makers worldwide have been conducting extensive research on how to overcome these difficulties (see G7 Working Group on Stablecoins, 2019). However, it is clear that many countries even lack a clear legal basis for stablecoins on a *national level*. For instance, many countries do not recognize different types of crypto-assets as fiat money due to its unstable value (European Banking Authority, 2019), nor as property since the law does not recognize possession of such intangible items (Bacon et al., 2018; Omlor, 2019). Therefore, holders of stablecoins are, in the worst case, not protected by any legal framework.

A sound legal basis for stablecoin *issuers* is also very important. This can have important implications for how stablecoin issuers design their business models and deal with their customers. The first crucial point is how stablecoin issuers deal with the *personal transaction data* of users, especially because big tech companies are very likely to become the leading market powers of stablecoin issuers. Even today, tech companies are important data intermediaries and there is concern that these companies have excessive power over user's data, even without having issuing stablecoins. In case of an economy dominated by digital platforms, where consumers hold digital currency exclusively, stablecoin issuers will have exclusive access to all transactions, thus becoming information oligopolists. It is well established that data policies of tech companies are not very transparent. Therefore, stablecoin users may also not have clear information about how their personal data will be used, thus giving rise to additional privacy considerations.

So what are the potential problems with big tech companies owning the transaction data of users? First, these firms may have different incentives with respect to how they use the data compared to the existing transaction data owners, such as banks and credit companies that are regulated. Existing financial institutions primarily use transaction data to monitor the creditworthiness of consumers, thus determining the lending rates for each individual. Compared to this, tech companies have diverse usage for this kind of data. For instance, monitoring consumers' tastes and tendencies may help tech companies to optimise their social media platform management. In the short run, this can improve consumer's convenience due to tailored products and services based on their preferences. However, this does not only endanger privacy rights of the users, but can also have long-term consequences for market efficiency. For example, if platform owners successfully obtain market power, such that consumers use the platform for all their economic activities, they will have an incentive to create "exit costs" that make interoperability across networks complicated (Brunnermeier et al. 2019). These high exit costs to transfer from one platform to another will hinder market competition and make big tech firms "too big to fail", thus incentivising abuse of power and strong dependency of the financial system with private entities.

Another problem may arise from the *complexity of risk management* of stablecoins. In order for a stablecoin to be stable, stablecoin issuers must ensure that they have enough reserves to back the value of their coins. In order to achieve this, high standards of financial risk management are required to address market, credit, and liquidity risk. If risks are not addressed adequately, this could undermine the confidence of stablecoin users, triggering a run, where users attempt to redeem their stablecoins.

To assure the credibility of a stablecoin, it is crucial that the issuer maintains transparent risk management. However, it is questionable whether stablecoin issuers will be transparent about this. Stablecoin issuers may have an incentive to disclose untruthful information about their activities, such as the number of customers and trading volume for advertising and other purposes. These types of untruthful information could cause mispricing and market dysfunction due to credit, maturity, and liquidity risks. Depending on the size of the stablecoin issuer, a "run" can have severe consequences for global financial markets.

Such weaknesses in transparency are a real issue, as demonstrated by the scandal surrounding Tether, one of the most popular and widely used stablecoins. Tether launched in 2014, promising the price stability that Bitcoin lacked with a peg to the US dollar at a 1:1 ratio. Behind this was the promise that for each Tether issued, there was a dollar to match it in its bank reserve. Based on this stable character, Tether became one of the most popular cryptocurrencies on the market.[16] However, despite the promises about its reserve policy to Tether holders, on 30 April 2019, court papers filed by company lawyers confirmed that Tether only had 74 percent of cash reserves of its current token supply. Consequently, in October 2019, a New York-based legal firm filed a lawsuit against them for manipulating crypto market and harming traders.

3.2. Disruptive monetary policy transmission

The broad and global utilisation of stablecoins can also have negative implications for the transmission of monetary policy. In particular, given that a stablecoin is widely used in an economy, the magnitude and channels of monetary policy transmission will depend on which assets (and currencies) are included in the stablecoin reserve to stabilise the value of the stablecoins. In this section, we discuss

[16] The market capitalization of Tether amounts to 4,12b USD, which makes it the fifth largest cryptocurrency after Bitcoin, Ethereum, XRP, and Bitcoin Cash. Source: https://coincap.io, access time: November 14, 2019.

how global stablecoins can affect (i) the interest rate channel of monetary policy transmission mechanism; (ii) seigniorage; and (iii) the global interdependency of monetary authorities.

Central banks use their policy rates to control short-term nominal interest rates of the economy. By doing so, they are able to influence the borrowing conditions of the private sector, which finally affects real economic activity. Thus, the efficacy of this "interest rate channel" of monetary policy transmission mechanism depends on the composition of the private sector's balance sheets.

Now assume that stablecoins are widely accepted as a means of payment and, thus, have a stable store of value in a certain country. In this case, stablecoins will enter the balance sheets of corporations and households, thereby affecting the size of the central bank's balance sheet. Then, the efficacy of the interest rate channel will depend on the role of a specific currency in the stability mechanism of stablecoins. If the commonly used stablecoin is exclusively backed with the domestic currency (fiat-collateralized stablecoin, see Box 1), returns on the stablecoin would be the same to the interest rates on domestic currency deposits, therefore hardly affecting the monetary policy transmission.

However, the problem arises if the stablecoin is collateralised by a basket of multiple currencies, which was the original concept behind Facebook's stablecoin Libra. In this case, the return on the stablecoin would be, for example, a weighted average of the interest rates on the stablecoin reserve currencies, thus dampening the link between domestic monetary policy and interest rates on stablecoin-denominated deposits. In the extreme case, where the domestic currency is not included in the asset basket of the reserves, the interest rate channel of domestic monetary policy can totally shut down for the portion of assets held in stablecoins of the balance sheets of firms and households.

These effects are likely to be more significant for small economies or those with weak monetary institutions, because the currencies of such countries will not be part of the basket of reserves. At the same time, these countries are most likely to have a fast adoption of stablecoins because they lack a well-functioning financial system and a stable currency. Therefore, the fast migration away from the sovereign currency to a global stablecoin will weaken the transmission of independent monetary policy, a "digital analogy" to dollarization. Especially in periods of turmoil, people could quickly "run" to global stablecoins, such that authorities do not have the time needed to intervene efficiently to stop the disruptive process.

Another problem for central banks arises from the fact that the introduction of digital currencies reduce the amount of paper currency that is circulating in the economy. In this case, the government would no longer receive any substantial seigniorage, which is essentially the revenue made by the difference between the value of money and the cost to produce and distribute it. In general, seigniorage of monetary authorities are transferred to the fiscal authority, who spends the seigniorage to stabilise the economy (consistent with the preferences of voters and their elected representatives).

The magnitude of loss in seigniorage depends on the change in demand for bank reserves and the degree of financial interconnection between the users of sovereign currency and the users of stablecoins. If the substitution to stablecoins is large (and the demand for bank reserves decrease), but the interconnection between the two currencies is weak, then monetary policy may lose efficacy.

While central banks lose seigniorage, the basket of reserves held by stablecoin issuers will earn interest, thus seigniorage. The larger the market share of stablecoins, the higher is the seigniorage income. However, compared to central banks, it is not clear how private companies will use the seigniorage. For instance, the Libra association stated that seigniorage profits "will first go to support the operating expenses of the association – to fund investments in the growth and development of the ecosystem,

grants to non-profit and multilateral organisations, engineering research etc."[17] Unfortunately, transparency is not yet given in order to monitor their behaviour in a consistent manner.

Finally, the fact (i) that stablecoins can be used in a global manner; and (ii) the basket of reserves can consist of multiple currencies may result in global monetary authorities being interdependent. Stablecoins can increase cross-border capital mobility and thus the substitutability of domestic and foreign assets, thereby amplifying the responsiveness of domestic interest rates to foreign rates and decreasing domestic monetary control. This, in turn, makes the implementation of independent monetary policy impossible, which is important for the credibility of central banks.

A recent study by Uhlig et al (2019) analyses how the introduction of a globally used currency can affect the domestic monetary policy of countries using this currency. They introduce a simple two-country economy model with complete markets, featuring two national currencies as well as a global (crypto) currency. Their results show that if agents of both countries have the option to use the global currency besides their own domestic currencies, the national nominal interest rates become equal – a phenomenon they define as "Crypto-Enforced Monetary Policy Synchronization." They show the consequences for a country, if it deviates from this interest rate equality by increasing and/or decreasing its domestic interest rate. In case a country decreases its interest rates compared to the other country, it will very likely reach the zero lower bound. In the case of a higher interest rate, the domestic currency will be abandoned by the agents, since it is much cheaper to use the global (crypto) currency than the domestic one. In addition, they show that in the case when the global currency is backed by interest-bearing assets, additional restrictions arise for the monetary authority of both countries.

In summary, the establishment of global stablecoins may not just disrupt the transmission of central bank's monetary policy, but also raises concerns that private entities may tend to act in its own favour, rather than to serve the public. This behaviour can be equated with the "original sin" faced by emerging countries, where "the domestic currency is not used to borrow abroad or to borrow long-term even domestically", due to bad domestic policy decisions of the government (Eichengreen et al., 2005a, b). The global interconnection of the financial markets will make this problem even worse, where a stablecoin issuer may have incentives to change the composition of their basket of reserves in order to harm or benefit certain countries.

[17] Source: https://libra.org/en-US/about-currency-reserve/?noredirect=de-DE#the_reserve, access time: November 15, 2019.

4. PUBLIC-PRIVATE-COOPERATION: SYNTHETIC CENTRAL BANK DIGITAL CURRENCY

In the wake of growing public interest in digital payment systems and privately-issued stablecoins, the idea of central banks issuing their own digital currencies – the so-called Central Bank Digital Currency (CBDC) – has become centre of the policy debate. Many central banks already provide money digitally in the form of central bank deposits in traditional reserve or settlement accounts. Compared to this, CBDC is a new form of digital central bank money that can be held *directly* by households and businesses without the involvement of a commercial bank intermediary.

In this section, we focus on one specific option central banks have in issuing CBDC, namely to cooperate with private issuers and issue "synthetic CBDC (sCBDC)". After a detailed description of this CBDC design, we provide evidence on why a public-private-cooperation in issuing CBDC may be a better option than to issue "pure" CBDC by enabling central banks to achieve three policy goals in one fell swoop: using the advanced technologies of large tech firms, establishing a sound regulatory framework for stablecoins, and maintaining trust.

4.1. What is sCBDC?

CBDC is the digital form of fiat money that is issued and regulated by the monetary authority of a country. Just like paper currency and coins, CBDC would be fixed in nominal terms, universally accessible, and valid as a legal tender for all public and private transactions. As with any public currency, the objective of the central bank would be that CBDC fulfil its efficiency as a medium of exchange, its security as a store of value, and its stability as the unit of account for economic and financial transactions. Indeed, many central banks are interested in issuing CBDC (see Box 2).

CBDC has some clear advantages over privately-issued stablecoins. First, people may have greater trust in the government than in private stablecoin issuers, which are open to information ambiguity, fraud, and bankruptcy. Therefore, people can rely on CBDC to be a stable store of value and unit of account. An additional advantage of CBDC is that it enables the government to retain control of the money supply and to monitor (and regulate) capital. Finally, CBDC could enrich the central bank's monetary policy toolkit, e.g. by allowing central banks to have a price target (Bordo and Levin, 2017) and eliminating the zero lower bound on interest rates (Agarwal and Kimball, 2015).

Given these advantages, the issuance of CBDC seems to be an inevitable option for the future of central banks. Rather it is a question of how and when it will happen. Recent papers investigate the optimal design of CBDC. For instance, Bordo and Levin (2017) argue that CBDC would be account-based and interest bearing in order to serve as a practically costless medium of exchange, secure store of value, and stable unit of account. Agur et al. (2019) consider the implications of different designs of CBDC, showing how a cash-like CBDC can reduce cash demand (and cause disappearance of cash), while a deposit-like CBDC design can lead to a contraction in bank lending to firms. Fernández-Villaverde and Sanches (2019) provide another interesting insight: the authors show how competition between many privately issued currencies can be inefficient. Therefore, government interventions can help to implement an efficient allocation.

In a recent International Monetary Fund report, Adrian and Mancini-Griffoli (2019) point out the possibility of central banks to synthesize a version of CBDC by allowing tech companies (and other e-money providers) to keep accounts at the central bank. Customers, in turn, would hold accounts at these stablecoin providers. As long as one stablecoin is backed with one unit of the domestic currency at the central bank, then it is as if customers are holding domestic currency at the central bank, which is just the essence of a CBDC. They define this as "*synthetic CBDC* (sCBDC)". The main difference between

CBDC and sCBDC is who maintains the end relationship with the customer: for CBDC, this is the central bank, while private entities maintain the end relationship with customers with sCBDC.

The public-private cooperation in issuing digital currencies can be beneficial in several ways. In fact, this concept is very similar to that of so-called "narrow banks". These banks take customer deposits and invest the proceeds in interest-bearing reserves at the central bank. The huge advantage of these institutions is that they are immune from runs, failures, and financial crises since they only hold liquid and safe government bonds (and currency). On top of this, stablecoin issuers also bring technological advantages and innovation in digital currency issuance, from which central banks can profit. In the next section, we highlight the advantages of sCBDC over CBDC.

Box 2: Ongoing CBDC projects

Sweden: e-Krona

In response to the decreasing cash usage in Sweden, the Sveriges Riksbank is working on an "e-Krona" project since early 2017. According to their report, e-Krona would be a complement to cash, as well as to current electronic payments- thus "value-based". As a next step, the Sveriges Riksbank is procuring technical suppliers, such as a well-developed Distributed Ledger Technology, to develop and test the future e-krona.

Uruguay: e-Peso

In November 2017, the Central Bank of Uruguay began a pilot program to test their new CBDC, e-Peso, as a stable and widely used medium of exchange. Unique digital banknotes in several denominations were issued for distribution to an "e-note manager platform". The platform acted as the registry for the ownership of the digital banknotes. The pilot was deemed a success and closed in April 2018. After this, all e-Pesos were cancelled. Now the program is in an evaluation phase.

Source: Barontini and Holden (2019).

4.2. Advantages of sCBDC

The alternative to sCBDC is to issue CBDC in form of electronic *tokens*, analogous to paper cash and stored-value debit cards. In this section, we provide three arguments why sCBDC would be a better alternative than central banks issuing digital cash in form of electronic tokens: (i) sCBDC have lower initial and maintenance costs; (ii) sCBDC enables central banks to regulate private tech companies; and (iii) the distance to the broad public will help central banks to maintain their reputation.

4.2.1. Lower initial costs

The issuance of CBDC is very complex, since it combines expertise in various areas. Besides the technical platform necessary for the implementation of CBDC, such as Distributed Ledger Technology and the provision of platforms for digital wallets, central banks would need to coordinate customer management, customer screening and monitoring including for "Knowing Your Customer" and Anti-Money Laundering and Combating the Financing of Terrorism (AML/CFT) purposes, regulatory management, and data management. Adrian and Mancini-Griffoli (2019) highlight this complex process of CBDC issuance and argue that they are all linked with substantial costs and risks. However, in case of a synthetic CBDC, the central bank would only offer settlement services and access to central

bank reserves to the stablecoin issuers that will provide digital money. All other functions would be the responsibility of the private entities.

This is beneficial given the fact that the technological status is not yet mature for most central banks to implement CBDCs. The Bank for International Settlements published a report where they surveyed central banks with regard to their research in CBDC (Barontini and Holden, 2019). According to the survey, central banks' work on CBDC is primarily conceptual, with only a few planning to issue a CBDC in the short- to medium-run. Compared to this, Facebook, for example, planned to issue Libra in 2020. By assigning tech companies the role as a digital currency intermediary, it is possible to use their technological advantage.

Especially during times when the growing threats of private stablecoins can disrupt the sovereignty of domestic central banks, a fast adoption of CBDC can be crucial for central banks to stay on the ball. For instance, the People's Bank of China, following the 2019 announcement of Facebook's Libra, announced to issue a CBDC in order to protect their monetary sovereignty. Their CBDC report claims that the People's Bank of China will distribute its CBDC to the public through state-run banking channels and widely adopted payment services like Tencent, Alipay, and WeChat. Since most of the population already uses these digital payment systems, the People's Bank of China would benefit from the large network of users and the spread of CBDC would happen very quickly.

4.2.2. Better regulatory conditions to control private stablecoin issuers

In the wake of the announcement that Facebook would launch Libra, global monetary and regulatory authorities intensively discussed what kind of regulatory framework is necessary to avoid potential misuse of monetary power. This debate, however, is of a very complex nature, due to the big size of such stablecoin issuers and their global reach in the financial markets (G7 Working Group on Stablecoins, 2019). To list a few, a stablecoin issuer must provide legal clarity on the nature of the claim to all participants in the stablecoin ecosystem, ensure data privacy and protection, as well as sound governance, including the investment rules of the stability mechanism.

Providing stablecoin issuers access to central bank reserves (or even restricting them to hold exclusively central bank reserves) facilitates a platform for efficient regulation. First, if stablecoin issuers act like narrow banks, as discussed in section 4.1., then there is no risk in managing the stablecoin reserves such that the digital coins are correctly collateralized. Therefore, the operation of the private entities becomes more transparent and, thus, more trustworthy. Second, central banks may impose high security standards on stablecoin issuers with regard to private data usage such that only entities fulfilling these requirements will obtain access to central bank reserves. Finally, by controlling the supply of reserves to a broad range of stablecoin issuers, sCBDC may foster healthy competition in the digital payment sector, which can foster innovation in this branch with providers developing superior products for the customers.

4.2.3. Lower reputational risk for central banks

Finally, we also discuss the potential risks of how CBDC may worsen the reputation of central banks. The primary mandate of central banks is to stabilise the price level of the economy. In order to achieve this goal, it is well known that reputation is key. Especially in the wake of the Global Financial Crisis of 2008, reputation management has become essential for central banks in order to regulate financial institutions and engage in macro-prudential policies. Therefore, central bank communication and forward guidance are important policy tools for many central banks. Unfortunately, reputation is complicated to manage due to its asymmetric nature: while agents normally do not notice successful supervisory roles, failures in financial supervision can have severe consequences – undermining public

confidence in the financial system and, even worse, in the central bank, thereby affecting the efficacy of monetary policy operations.

However, the issuance of CBDC requires additional operational duties that have nothing to do with the primary mandate of central banks, such as the management of customer relations. Becoming involved in such assignments may raise concerns of the public that central banks may neglect their main duty, leading to lower reputation of central banks. In addition, such customer management is very complex and is exposed to high operational risks, including fraud, technical disturbances, and hacker attacks. In case of a severe fail in either of these areas, central banks may permanently lose public trust, as negative experiences linger in people's memories.

Based on these facts, it seems reasonable to transfer this assignment to private entities. By doing so, central banks do not have to worry about the operational risk that comes with CBDC and the public will separate this risk from the ability of the central bank to keep its primary mandate. This is true for commercial banks today, where operational weaknesses of banks are not directly blamed on the central bank. After all, as John Cochrane states on his blog, "central banks cannot operate retail digital currencies. Who do you call when you forget your password?"[18]

[18] Cochrane, J. (2019): Fed Nixes Narrow Banks Redux, The Grumpy Economist (John Cochrane's blog), May 30, 2019.

5. CONCLUSION

If you cannot avoid it, then enjoy it! This saying seems suitable when it comes to central bank digital currency (CBDC). The future will bring (full) digitalisation of money and large tech companies are well on their way to issuing their own digital currencies. Therefore, the most important assignment of central banks is not to decide whether to issue a CBDC or not, but rather to conduct extensive research on the most efficient and optimal design of CBDCs.

In our paper, we recommend that central banks closely coordinate with large tech companies and issue so-called "synthetic CBDCs." We provide an analysis confirming the clear advantages of sCBDCs by showing how these can minimize the risk of large tech companies issuing digital monies with respect to, among others, data protection and transparency in risk management. Further, sCBDCs enable central banks to have a more stable and sustainable version of CBDCs by taking advantage of the advanced technology of tech companies, being able to regulate stablecoins in an efficient way, and sustaining their reputation.

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The Next Generation of Digital Currencies: In Search of Stability

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Abstract

Recent innovations have re-opened the debate on the forms that money will take in the future. This paper discusses two aspects of the debate on the future of money: the implications of the rise of global private stablecoins, and the role that public central bank digital currencies (CBDCs) could play in the future.

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CONTENTS

LIST OF ABBREVIATIONS

CB	Central Bank
CBDC	Central Bank Digital Currency
ECB	European Central Bank
DLT	Distributed Ledger Technology
QE	Quantitative Easing
TIPS	Target Instant Payment Settlement

EXECUTIVE SUMMARY

- Four major developments in the last decade have challenged the *status quo* and have re-opened the debate on the forms that money will take in the future: 1) use of cash as a medium of exchange has declined; 2) distributed ledger technology (DLT) has led to the emergence of thousands of digital cryptocurrencies; 3) some global tech giants are planning to provide private digital currencies to their billions of users in the form of stablecoins; and 4) in turn, public authorities are thinking about providing their own digital currencies to the general public.
- These developments raise crucial questions about their potential implications for financial stability, the transmission of monetary policy and the future of financial intermediation. This paper focuses in particular on the consequences that the rise of stablecoins and central bank digital currencies could have.
- Stablecoins, such as Facebook's Libra, differ from earlier generations of cryptocurrencies in three fundamental ways. First, they would immediately start with large networks of users and global accessibility, two pivotal features for the critical uptake of a new currency. Second, given the current limitations of DLT, including in terms of energy efficiency, new stablecoins would rely on (more) centralised systems to validate transactions. Third, stablecoins would focus particularly on reducing the volatility in the value of the new currency.
- These new features of stablecoins attempt to correct some of the critical deficiencies identified in first-generation cryptocurrencies, which meant they did not acquire the main functions of money. However, new stablecoins raise other questions and potentially create new problems. One issue could arise from the more centralised (permissioned) validation system, which could lead to collusion problems. Another issue could arise from the reserve system that is supposed to ensure the stability of stablecoins, such as Libra, which could be incompatible with the profit maximisation behaviour of a private issuer.
- Facebook's Libra plan has been a wake-up call to central banks and governments which, afraid of losing their monetary sovereignty, have renewed their interest in central bank digital currencies (CBDCs) as a potential solution. CBDCs could make private digital currencies less attractive and slow down their adoption.
- But there are other good reasons to give the general public access to central bank liabilities. One important reason to provide CBDCs to citizens is that if cash disappears, citizens will lose direct access to sovereign money. Another benefit of the introduction of CBDCs is that monetary policy could be strengthened by transmitting it directly to the general public.
- However, the introduction of CBDCs could also be very disruptive and create new risks. In particular, CBDCs could have some major consequences for financial intermediation. These risks would have to be carefully considered and evaluated by policymakers before any decisions are taken.
- If CBDCs are introduced, central banks would have to carefully calibrate their properties to minimise these risks. But, eventually, if these risks – and in particular the risk of structural financial disintermediation – do materialise, central banks would have various instruments to counter them.

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 (scriptural) reserves, combined with highly regulated (scriptural) 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 have challenged and continue to challenge the status quo and have re-opened the debate on the forms that money will take in the future:

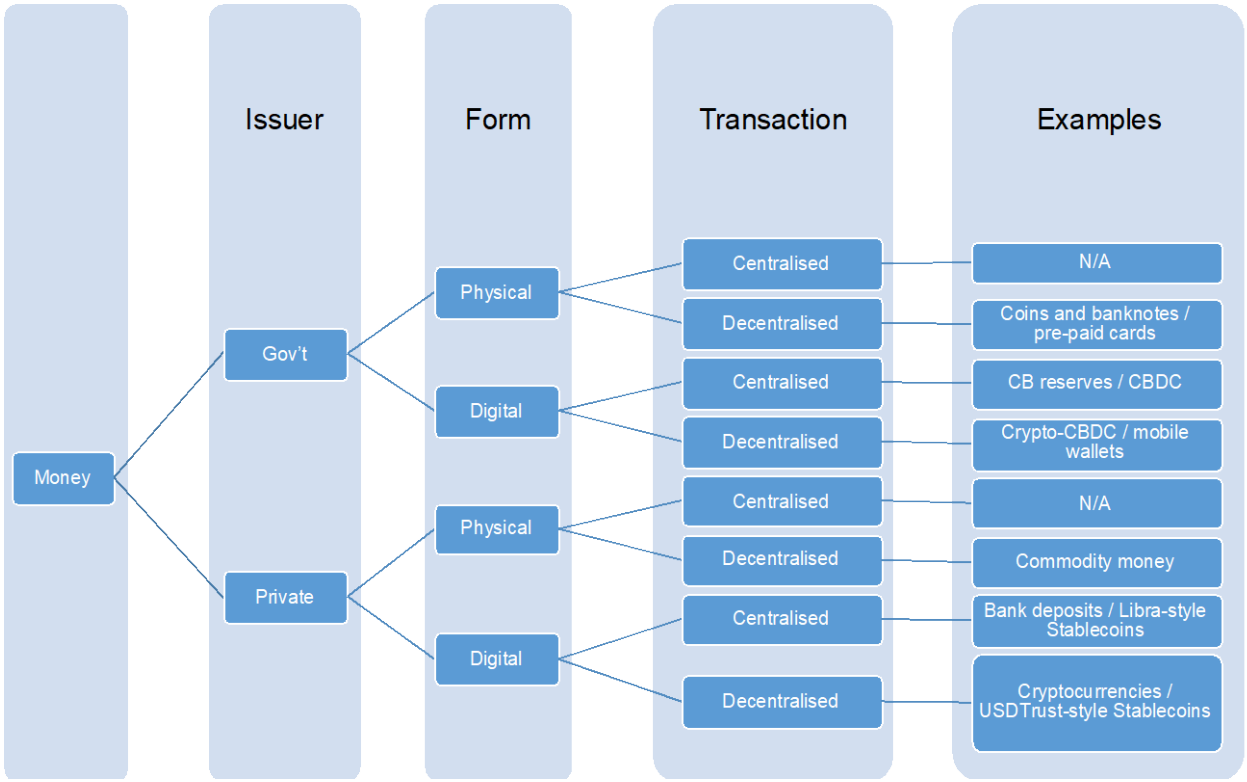
1. The share of transactions in cash in developed countries has fallen. In countries such as Sweden, coins and banknotes have become so marginalised as a means of payment that there is even talk of abandoning them completely. The Swedish Riksbank has opted against the total elimination of cash, but there is unequivocally a trend towards less cash usage.
2. The emergence of distributed-ledger technology, or blockchain (i.e. a decentralised, secure and unchangeable 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, 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[19]. The stablecoin idea has now become 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.
4. As a result of these rapid and potentially significant developments, 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.

These potentially beneficial innovations in conveniently storing value and providing payments need to be carefully assessed against the costs they potentially entail for citizens. More broadly, important questions arise as their popularity increases, pertaining to the transmission of monetary policy, financial stability and the future of financial intermediation.

[19] Despite an original and potentially promising model, Basis shut down its operations in December 2018.

In Claeys *et al* (2018), we proposed a taxonomy for all forms of money, traditional and recent innovations, based on three criteria: 1) who the issuer is: government or private; 2) what form it takes: physical or digital; and 3) how transactions are settled: centralised or decentralised (Figure 1).

Figure 8: A taxonomy of money



Source: Bruegel updated from Claeys et al (2018). Note: CBDC = central bank digital currency.

Claeys *et al*. (2018) discussed the potential of cryptocurrencies (defined as private, digital, decentralised currencies in our taxonomy) to perform the main functions usually attributed to 'money' and the impact that they might have on monetary policy. This analysis showed that cryptocurrencies such as Bitcoin were not yet able to fulfil the three main functions of money (ie to serve as a unit of account, a medium of exchange and a store of value) and that they still looked more like speculative assets rather than money.

The main reason for this is that their inherent volatility, because of, among other things, their inelastic supply, limits their widespread adoption as a unit of account and as a medium of exchange. International currencies including the US dollar and the euro have established track records of providing price stability, which combined with their credible legal status and strong networks of users have given them the benefits of natural monopolies. As a result, Claeys *et al.* (2018) did not expect any immediate risk that such cryptocurrencies would challenge central bank currencies, and certainly not the well-established international currencies. It would take a deep crisis of trust in official currencies for their widespread substitution by cryptocurrencies to materialise. In this context, Demertzis and Wolff (2018) considered at the time that there was no immediate need for new regulation, but rather there was an opportunity to learn about what these types of innovations imply in terms of financial risks.

In the meantime, as long as central bank currencies continue to provide the unit-of-account function, central banks' monetary policies should not lose their grip on their economy. Eventually, as a potential competitor to central-bank currencies, cryptocurrencies could even play a positive role by acting as a disciplining device to push central banks to take their price-stability mandates seriously, especially in countries with histories of bad monetary policy.

However, the emergence of a second generation of coins in the form stablecoins (i.e. private digital currencies, not necessarily decentralised, and possibly backed by fiat-currency reserves to ensure stability) issued by global tech giants, provides a different challenge. Through scale alone, these currencies might be more credible competitors to traditional forms of money. This, and in particular Facebook's Libra plan, has acted as a wake-up call for central banks and governments which, afraid of losing their monetary sovereignty, have renewed their interest in both the need for regulation and CBDCs as a potential solution.

In this paper, we discuss two aspects of the debate on the future of money: the implications of the rise of global private stablecoins, and the role that public central bank digital currencies (CBDCs) could play in the future.

2. SHOULD WE FEAR THE RISE OF GLOBAL STABLECOINS?

What makes recent stablecoin initiatives, such as Facebook's proposed Libra, more relevant for policymakers than the first-generation of cryptocurrencies is their scale. But beyond scale, there are two other aspects that are different to the first generation: the (more) centralised network and the attempt to reduce volatility in the coins' value – hence the label 'stablecoin'.

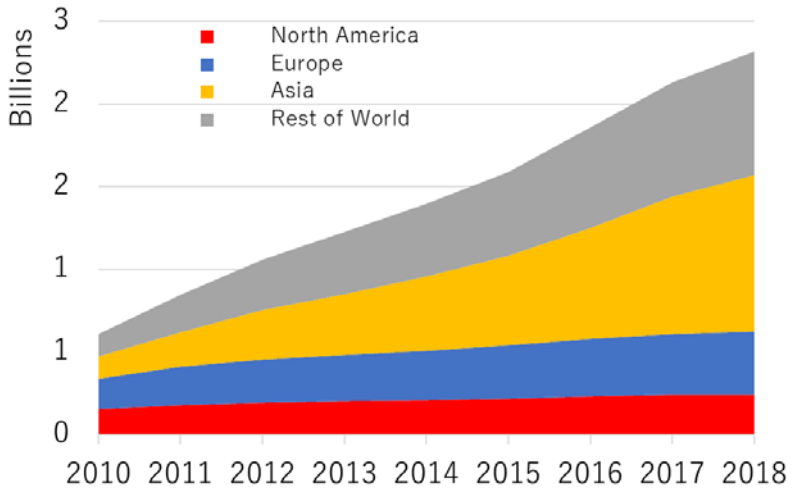
2.1. Network effects and global scale

While so far digital currencies have been small-scale (in terms of number of transactions or total market capitalisation[20]), when these initiatives come from tech giants that have access to very large networks of users, they become both systemically relevant and have the potential to exercise monopoly power.

This is in contrast to the first generation of cryptocurrencies, which faced high switching costs because of network effects. It is not obvious why consumers in the euro area would choose to use anything else than the euro, when paying in any other currency, including newly created ones, would be costly and inefficient. But as global tech giants already benefit from very large networks, a stablecoin issued by them will benefit immediately from scale and accessibility, two features that are pivotal for critical uptake of currencies. As Libra could be a stablecoin with the necessary scale to become a global currency contender, we discuss its main features as a way of understanding how global stablecoins in general might work.

Almost ten years after its creation, Bitcoin was estimated in 2017 to have 7.1 million owners worldwide[21]. By means of comparison, the active number of users of Facebook (and hence Libra's immediate 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 (Figure 2).

Figure 9: Monthly active Facebook users



Source: Bruegel via Bloomberg.

Authorities are thus legitimately concerned that Libra has the necessary scale to become a global currency contender without a clear understanding of what this would mean for citizens. Bank of

[20] See Claeys *et al* (2018) for details.

[21] See https://www.bitcoinmarketjournal.com/how-many-people-use-bitcoin/.

England Governor Mark Carney has pointed out[22] that 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 has highlighted the need to contain the risks that arise from financial innovation and particularly the *"wider use of new types of crypto-assets for retail payment purposes would warrant close scrutiny by authorities to ensure that that they are subject to high standards of regulation"*[23].

The Bank for International Settlements (BIS, 2019) discussed the complex trade-offs that will arise "*between financial stability, competition and data protection*". One such complex case arises from Calibra, the digital wallet on which Libra will be stored. Currently, there are around 200 cryptocurrency wallets[24] via which more than 1 600 cryptocurrencies are exchanged and on which they are stored. Given that Calibra will be bundled with Facebook's ecosystem and made available to all its users, Facebook will potentially have 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).

Furthermore, the Libra Association (2019), the organisation that is planning to control Libra, argues that users that use Calibra to store their Libras will share no information about their financial transactions with other Facebook extensions[25]. However, 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 starts with a sizable trust deficit that could hinder its promised popularity. There will therefore need to be clarity about how and where to regulate this digital wallet.

The European Council and Commission said 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*"[26]. There are still many unknowns about how digital currencies can challenge our commonly understood notion of money. And if strong network effects and scale amplify those risks, then policymakers need to be particularly cautious.

2.2. From decentralised permissionless, to centralised permissioned

As a first-generation technology, the Bitcoin blockchain was a fully decentralised, permissionless system, with a public ledger available to all network users. While this democratised the process of verification, it came at the expense of time and energy efficiency. If Libra is going to exploit the vast scale that it promises, then these issues will become serious obstacles. That is why Libra will move back to operating in a more centralised system (permissioned blockchain), at least in the initial phase, in which the founding members will be in charge of the validator nodes. This will have the aim of ensuring an optimal balance between effectiveness and security of the system.

Such a centralised system avoids the excess use of natural resources and will be fast to operate. However, centralised systems in the hands of a limited number of association members pose the risk of collusion (Abadi and Brunnermeier, 2019) to the detriment of users.

22 https://www.ft.com/content/189c1c66-91dd-11e9-aea1-2b1d33ac3271.

23 https://www.fsb.org/2019/06/fsb-chairs-letter-to-g20-leaders-meeting-in-osaka/.

24 https://www.forbes.com/sites/sarahhansen/2018/06/20/forbes-guide-to-cryptocurrency-exchanges/#6002eb812572.

25 https://libra.org/en-US/wp-content/uploads/sites/23/2019/06/LibraWhitePaper_en_US.pdf.

26 https://data.consilium.europa.eu/doc/document/ST-13571-2019-INIT/en/pdf.

The Libra Association has been explicit about the fact that "*an important objective of the Libra Association is to move towards increasing decentralisation over time*"[27]. This will only be possible however once new technical solutions provide the power and stability to engage at the scale Libra aspires to. Until this is solved, the Libra Association will be the authority to trust to give permission for Libra transactions. Whether the association will be a trustworthy custodian of the ledger remains to be seen.

2.3. A provider of stable value?

Although popular, Bitcoin's high volatility has so far prevented the cryptocurrency from becoming a credible alternative to traditional money. The rationale behind Libra and other stablecoins is exactly to correct for that, by ensuring stable value.

One of the essential problems of the first generation of cryptocurrencies (such as Bitcoin) or even of previous attempts to build a stablecoin (such as Basis) is that they are fiat currencies without the explicitly backing of a credible issuer, such as the state. And just like any other fiat currency, they are inherently vulnerable to changes in beliefs and expectations that can lead to undesirable self-fulfilling inflationary episodes.

Libra, by contrast, will not be a fiat currency but will be backed by reserves composed of a basket of liquid and stable assets (themselves in official credible fiat currencies)[28]. Libra's issuance should work as follows: for any Libra minted, there needs to be a unit of a basket of assets. The Association controlling Libra will decide on the composition of this basket, with the intention to keep its value stable. Authorised resellers would purchase Libra coins from the Association in exchange for assets labelled in credible fiat currencies to fully back the new coins that are added to the reserves. Reserves are supposed to be fully invested in low-risk short-dated interest-bearing assets, the revenues from which will serve to cover operating costs and pay out dividends to the founding members of the Association. Users can request Libras from authorised resellers.

It has been argued that such a set up looks like a currency board. The custodian of the board aims to preserve the value of the basket. It can also be compared to a simple investment fund guaranteeing redemption at par, which should at least in principle make it less vulnerable to self-fulfilling inflationary equilibrium. As long as the Libra Association backs each Libra coin with an identical pool of safe and liquid assets, its value should be stable.

However, at some point 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 in order to increase its own profits. For the moment, we can only assume that the Association's motive is profit maximisation, which is different to any monetary policy authority's objective.

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). As discussed by Chang and Velasco (2019), the incentives are wrong, and nothing currently would stop the Libra Association from changing the rules on redeemability and the degree of collateralisation. On the contrary, the white paper (Libra Association, 2019) mentions that the portfolio backing Libra can be adjusted at will by the association[29]. Given that seigniorage profits go to the association and not the users, there is a clear incentive to maximise these profits either by changing the weights, by investing in riskier and less

[27] See footnote 7.

[28] Although important details are not described in the White paper (Libra Association, 2019).

[29] The white paper explicitly mentions that: "*the association can change the reserve basket*" (Libra Association, 2019).

liquid assets[30], or even by moving to partial backing. Eventually, the Libra Association could even drop the backing entirely and become a fiat currency to enjoy full seigniorage profits. But at that point, the Libra would become a regular fiat cryptocurrency (which means it will be subject to self-fulfilling crises) and would no longer be a stablecoin.

The value of Libra will depend crucially on the Libra 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, but pursues profit maximisation.

[30] This is particularly true in the current low rate environment in which safe assets might have negative yields in some countries.

3. SHOULD CENTRAL BANKS ISSUE THEIR OWN DIGITAL CURRENCIES?

3.1. What are CBDCs?

There is no universally agreed definition of what constitutes a central bank digital currency (CBDC), but the term has become commonly used[31] to designate any form of central bank digital fiat liability that is accessible to all economic agents.

As our taxonomy shows (Figure 1), CBDCs could take various forms. First, a CBDC could be issued in a centralised fashion though accounts at the central banks. This actually already exists in the form of reserves held by commercial banks at the central bank. The novelty of a CBDC would be that it would allow the general public to maintain directly deposit accounts at central banks, as they do at commercial banks. Second, a CBDC could also be issued in a decentralised fashion as a crypto-CBDC based on distributed ledger technology (DLT), which, once issued by the central bank, could then be transferred from one individual to another independently from the central bank. Finally, a CBDC could also take a hybrid physical-digital form with pre-paid cards or mobile wallets containing digital currencies.

We consider the last two versions of CBDCs less relevant for different reasons: 1) for crypto-CBDCs, DLT is an immature technology that is currently less efficient, slower and much more energy-intensive than a centralised system. The only advantage it offers is anonymity (which is valuable for individuals, but would probably be considered highly undesirable by monetary authorities, as it could facilitate illegal activities); 2) cards/wallets meanwhile would have properties very similar to cash and are thus not worth analysing in more detail.

We therefore focus on the more promising version of CBDC: deposit accounts at the central bank available to all.

3.2. What would be the purpose of CBDCs?

Interest in 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. Allowing households and companies to open accounts at the central bank would give them direct access to efficient and instantaneous retail payment systems – such as the Target Instant Payment Settlement (TIPS) service that European banks can already use to exchange reserves. This would remove one reason for switching to a private digital currency with a better payment system. But there are other reasons why introducing CBDCs could be useful.

One important reason for central banks to provide CBDCs to citizens is that if cash is scarce or even disappears, citizens will lose direct access to sovereign money, the ultimate safe asset (as long as the central bank implements the necessary policies to maintain the value of the currency, i.e. low inflation and stable foreign exchange rates). Should cash disappear, citizens would only have access to bank deposits, which are not as safe, to store value. 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.

[31] See for instance Meaning *et al* (2018) for a detailed discussion on the definition of a CBDC.

In addition, the lack of direct access to the central bank currency could lead to a moral-hazard problem (Brunnermeier *et al*, 2019). If banks do not 'fear' convertibility of their deposits into central bank currency, they could lose some of the incentives (even though regulation would still be a major disciplining device) to manage well 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 this case, there would be 'exchange rates' between them, depending on the trustworthiness of the particular issuer, as it 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.

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 today's situation, in which interest paid by commercial banks on deposits are relatively sticky[32]. 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). The abolition of cash would make this effect stronger. However, abolishing cash might be not desirable, because 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 costly, implementing negative rates on CBDC holdings would be possible.

Second, CBDCs could reduce one of the potential side effects of quantitative easing (QE), especially when asset purchases are coupled with negative rates. Currently, central bank bond purchases from non-bank institutions create additional reserves that are inevitably held by the commercial banks that host the accounts of the non-bank sellers in the deposit facility of the central bank, because non-banks cannot hold reserves directly. On aggregate, this means that banks cannot control fully the quantity of reserves they want to hold. When rates are negative, as they are at time of writing, 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 an 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.

3.3. The potential risks of CBDCs

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

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[33], but the

[32] 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).

[33] 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.

main concern is that digital bank runs towards CBDCs would be easier and happen more rapidly than traditional bank runs.

In addition to this cyclical financial stability risk, another serious, more structural, risk would be the reduction 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 (as explained, for instance, by Stevens, 2018).

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, both potentially positive and negative. The extra competition from CBDCs would reduce the monopoly power of the banking sector and allow depositors to obtain higher returns from 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[34]. 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 toughened significantly 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.

3.4. How could central banks minimise these risks?

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 lender of last resort and from replacing the shortfall in deposits held at commercial banks with central bank loans to avoid a strong credit crunch.

Central banks would also have various instruments to counter the risk of structural financial disintermediation that could happen as a result of the introduction of CBDC, if it was considered an

[34] 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.

unfavourable evolution that could endanger price or financial stability. The central bank's reaction would thus vary depending on the magnitude of the problem.

In moderate cases, such as if the quantity of credit provided by banks is not significantly affected, but banks ask for higher lending interest rates (for example because they need 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 else 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.

If disintermediation becomes a more significant issue and there is 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 can maintain the same level of financing to the economy. This means the central bank balance sheet would have to become structurally much bigger[35] and also more exposed to the banking sector than has traditionally been the case.

The debate on the optimal size of central banks' balance sheets has not so far been settled[36]. However, the two main risks for central banks in increasing massively their refinancing operations would be:

- 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, but 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 should preferably be in the hands of citizens or elected officials).

To avoid the extreme situation in which deposit accounts held at the central bank would fully crowd out bank deposits, 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. The simplest way to do this would be through its remuneration system. CBDC accounts should benefit from lower than other policy rates (which could both reduce the structural disintermediation risk and the frequency of bank runs), but the returns from CBDCs should not be so disadvantageous that their use as a medium of exchange becomes unattractive. In particular, when policy rates are negative, a portion of CBDC holdings could be exempted from the negative rates to avoid the negative impact on small savers (and also so that households are not given a reason to switch back to holding cash). Bindseil (2019) proposed a very

[35] 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.

[36] See section 4.1 in Claeys and Demertzis (2017) for a summary of this debate.

practical system to put that in place with a two-tier remuneration system for CBDCs: below a threshold of EUR 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, so that it incentivises 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 use of these accounts as a main store of value in normal times.

3.5. 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'[37]).

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 (which would represent in a way an acceptable form of stablecoin) to the general public.

[37] 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 previously.

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