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# The money of tomorrow?

## Cryptocurrencies, stablecoins, central bank digital currencies

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In modern times, money mostly takes the form of cash, bank deposits and reserve holdings of banks at central banks. Also, money is mostly issued centrally by a public authority such as a central bank. However, in recent years, new forms of money have emerged which challenge the money order. This cep**Input** explains the new forms of money such as cryptocurrencies, stablecoins and central bank digital currencies and contrasts these with the traditional forms of money.

## Table of contents

**1 Introduction ... 3**
**2 What is money? ... 3**
**3 Forms of money ... 4**
3.1 Traditional forms of money ... 4
3.2 Modern forms of money ... 6
**4 Cryptocurrencies ... 7**
4.1 The characteristics of cryptocurrencies ... 7
4.2 Are cryptocurrencies money? ... 9
**5 Stablecoins ... 10**
5.1 The characteristics of stablecoins ... 10
5.2 Are stablecoins money? ... 12
**6 Central Bank Digital Currencies (CBDC) ... 13**
6.1 Definition and types of CBDCs ... 13
6.2 Retail CBDC in practice: synthetic CBDCs ... 14
**7 Conclusion ... 15**

# 1 Introduction

In recent years, traditional forms of money have been increasingly called into question. Private initiatives such as 'Bitcoin' have reached considerable success. Other initiatives such as the plan by Facebook and partners to establish a 'Libra coin' in 2020 have raised concerns by official authorities that such new forms of money might have serious implications for the current money order. As a result, central banks around the globe are now also considering the creation of public digital currencies.

The reasons for the uptake of these new forms of money are diverse. Digitalisation and the consequent decline in demand for cash as well as the desire to reduce transaction costs and to make payments faster all play a role.

Realising that these developments are unlikely to change soon, regulators around the world are increasingly investigating whether there is a need to regulate these new private and public money forms. The EU Commission and the Council have warned against the 'potential risks to monetary sovereignty, monetary policy, the safety and efficiency of payment systems, financial stability and fair competition' that could arise.[1] The EU Commission has announced its intention to propose new legislation in 2020 to address those risks.[2]

This cep**Input** serves as an introduction to a series of forthcoming papers on the future design of money and payment systems and on their current and potential regulation. It intends to provide insights in what money is, what it looks like today, and how it could look like tomorrow. It has the following structure: In chapter 2, we explain money and its main functions. In chapter 3, we deal with the characteristics of money in its traditional forms. In chapters 4 to 6, we deal with new forms of money – cryptocurrencies, stablecoins and central bank digital currencies. Chapter 7 draws conclusions.

# 2 What is money?

Money can be anything that is commonly seen as fulfilling all of the three following functions[3]:

- Unit of account: money is used to measure the value of all products and services.[4]
- Means of exchange: money is used as a means of payment when buying or selling products and services.[5]
- Store of value: money is used to store wealth, i.e. to transfer it across time and space. For this to function, money must have a stable value over time.[6]

These core functions define money: it can be anything (silver, gold, cowries, etc.) as long as it fulfils the core functions.

Nevertheless, the number of money forms has remained rather limited. An explanation for this is the central role that 'trust' plays to money. Users will accept to use money only if they can trust its authenticity, i.e. the money must be recognisable as such and difficult to counterfeit. At the same time,

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1 Council of the EU (2019), Joint statement by the Council and the Commission on ''stablecoins", Press release 792/19, 05.12.2019.

2 European Commission (2019) Consultation document: On an EU framework for markets in crypto assets, 19.12.2019.

3 Aristotle, (4th century BC). Politics, 1.1258b.

4 This tremendously simplifies the exchange of products because it replaces exchange rates between every product and service. Trading 100 products without money would require 4,950 exchange rates between the different products. With money as a unit of account, only 100 prices are necessary. [Deutsche Bundesbank (2019). Geld und Geldpolitik, p. 10-11].

5 Ibid, p. 10-11.

6 Ibid, p. 10-11.

users must be able to trust that the supply of money will not be manipulated by the issuer. Moreover, money shows network effects. The trust in a certain money by one given user is not enough. What is necessary for a money to spread widely, is the knowledge or expectation by that user that many others will also have trust in that money.

These reasons contribute to explaining why money is usually issued by public entities – mostly central banks – within the borders of a jurisdiction. In its modern form, this sort of money is called 'fiat money' because its value does not derive from assets in the background (such as gold) but simply from the fact that it is issued by an accepted entity (such as a central bank). Besides the issuing of fiat money by public entities, in modern economies, fiat money can also be created by private banks when providing credits.

# 3 Forms of money

In recent times, new forms of money provided by non-public entities have become more relevant, e.g. cryptocurrencies. Both, traditional and those new forms of money can take various forms and can be differentiated according to four different criteria:[7]
(1) whether or not it is widely accessible, i.e. whether each and everybody is, in general, able to use it,
(2) whether it has a digital or physical form,
(3) whether it is issued by a central bank, or by another private or public entity or no entity at all, and
(4) whether or not it allows for peer-to-peer transactions, i.e. whether it can be transferred between users in a direct manner without using intermediaries like banks.

## 3.1 Traditional forms of money

Using these four criteria we can distinguish five different forms of traditional money (see Figure 1).

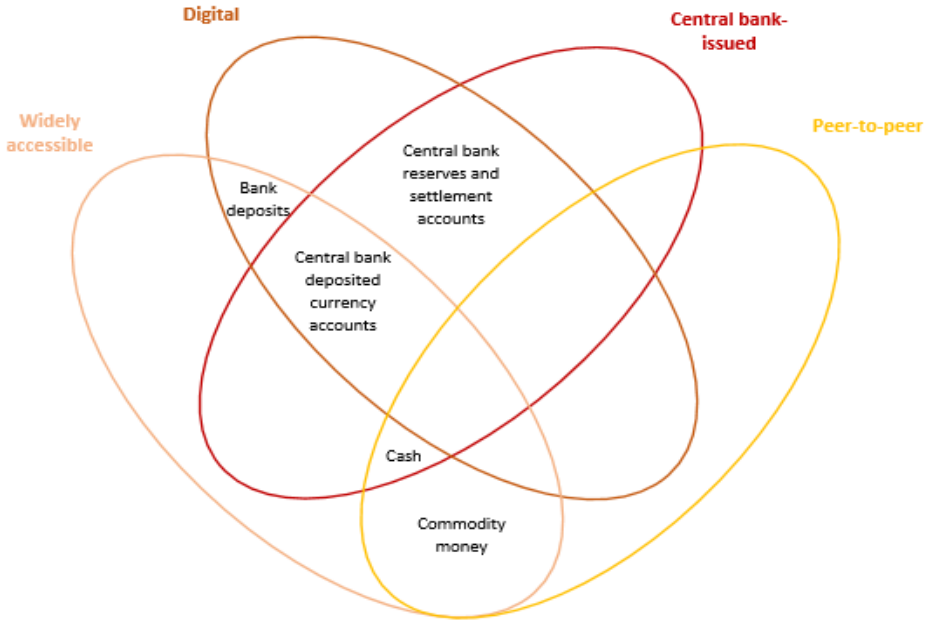


Figure 1: Money flower today, a taxonomy of traditional money forms; adapted from Bech, Morten L. and Rodney Garratt (2017)

[7] Bech, Morten L., and Rodney Garratt (2017), "Central bank cryptocurrencies" BIS Quarterly Review September 2017, p. 60.

- **Cash**, which is composed of banknotes and coins, is issued by central banks and thus represents a liability to them. It is non-digital money 'produced' by central banks. As its use is not limited to certain actors, it is widely accessible and allows for easy exchange among different persons in a decentralised manner (peer-to-peer) without the need for any intermediary. Nowadays, cash issued by central banks is fiat money.[8] In the 19th and early 20th centuries, central bank issued cash was asset-backed money, i.e. it was backed by gold and could be exchanged for gold at the central bank ('gold standard').
- **Bank deposits**, in contrast, are digital forms of money. They are, like cash, widely accessible to the general public. They are not provided by central banks, but by commercial banks and hence are a liability of those commercial banks. Through lending to the economy, banks transform depositors' cash – which is central bank money – into commercial bank money (book money). Peer to peer transactions from bank accounts are not possible as any transaction requires the involvement of third parties (e.g. banks, settlement institutions).
- **Central bank deposited currency accounts** are deposits held by the general public at the central bank. In modern economies, central banks do not offer private deposit services to the general retail public, with some exceptions for public institutions only.[9] Apart from these exceptions, they are only a theoretical construct. Such accounts would present non-physical money, which would be central-bank issued, widely accessible, but would not allow peer-to-peer transactions per se.
- **Central bank reserves and settlement accounts** are deposits at the central bank held by commercial banks. They form a large part of central bank issued money. They are digital, only accessible to financial institutions and do not allow for peer-to-peer transactions as they are 'transferred in accounting systems with a central book-keeping agency'[10].
- **Commodity money** was used as means of exchange before the creation of central banks and secure banking systems. For instance, gold or cattle were used as means of exchange during the first ages of trade. They have almost disappeared today.[11] Commodity money is physical in nature, not issued by a central bank and can be transferred in a decentralised manner (peer-to-peer).

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8 Fiat money is money whose use value is close to zero, although its market value may be high. It essentially refers to coins, banknotes and book money. It has to guarantee the three main functions people expect from money. This is how public authorities can conserve citizens' trust and ensure it is widely accepted in economic transactions. When public authorities fail to maintain the three core functions, especially the store-of-value function because of inflation, citizens may lose faith in the instrument.

9 The Banque de France provided central bank accounts to non-bank companies and individuals during the financial depression of the 1930s. 17% of all deposits were placed on these Banque de France accounts, accentuating the credit crunch because the Banque de France did not provide any credit directly to the real economy [Baubeau, P., E. Monnet, A. Riva, and S. Ungaro (2018) 'Flight-to-Safety and the Credit Crunch: A New History of the Banking Crisis in France During the Great Depression', Banque de France Working Paper No. 698].

10 Bofinger, Peter. "Digitalisation of money and the future of monetary policy." VOX–CEPR Policy Portal (2018).

11 Nowadays, gold is essentially regarded as a (more or less) safe store of value and almost lost its means-of-exchange feature.

## 3.2 Modern forms of money

On top of the traditional forms of money presented above, modern forms of money have evolved or are in the process of being developed (see Figure 2):

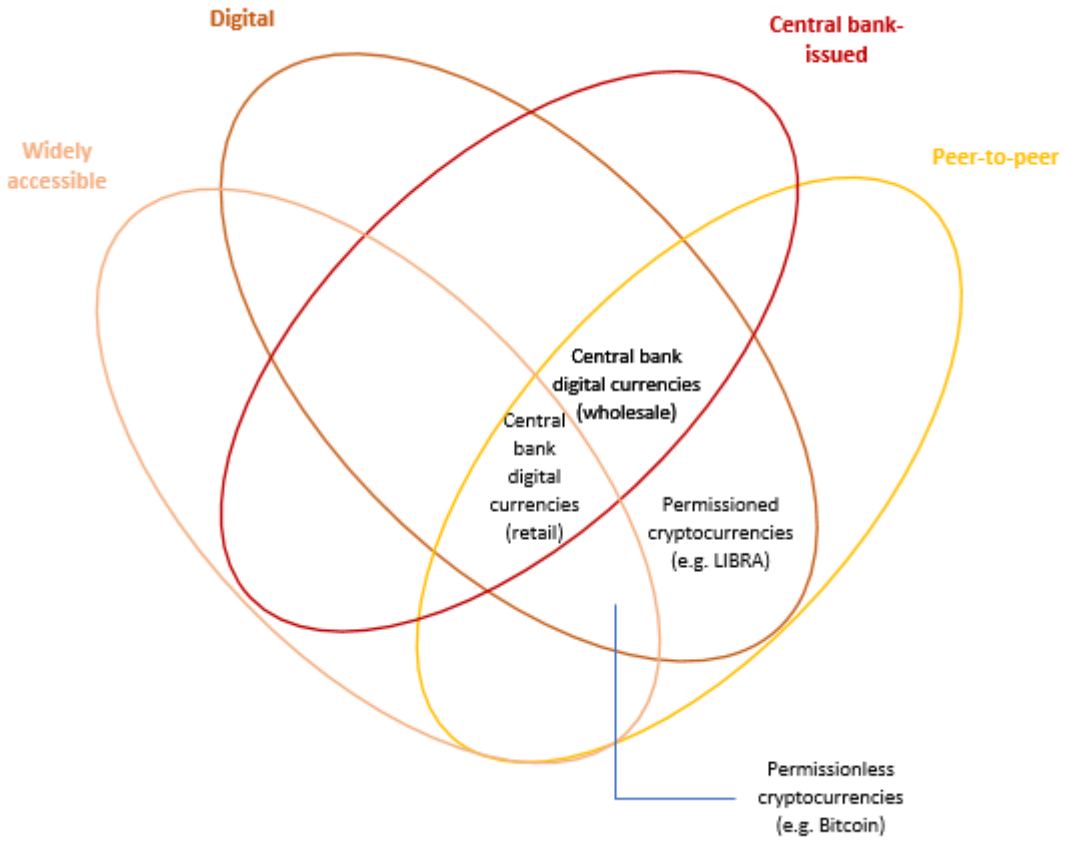


Figure 2: Money flower tomorrow, a taxonomy of money forms of the future; adapted from Bech, Morten L. and Rodney Garratt (2017)[12]

- **Cryptocurrencies**[13] are purely digital and are not issued by central banks but by some of the users of the currencies. There is no central responsible issuer. Money issuance is governed by rules ("protocols") which cannot be changed easily. The transfer of cryptocurrencies takes place digitally in a decentralised manner (peer-to-peer). There is no need for intermediaries such as central banks or commercial banks to transfer funds. There are two subtypes of cryptocurrencies:
  - **Permissionless cryptocurrencies** such as Bitcoin allow for anyone to use the currency and to make and validate transactions in a decentralised manner.
  - **Permissioned cryptocurrencies** do not allow for everyone to access and/or change the blockchain which documents and stores the transactions. Transaction validators need a permission by a central entity. Facebook's Libra would fall under this category as transaction validators need the permission by the Libra association, which is developing and operating Libra.
- **Central bank digital currencies** do not exist yet but are currently under conception by many central banks all around the world. These digital currencies would be issued by central banks. They would

[12] For the sake of simplification, figure 2 only covers fiat-backed stablecoins like Libra. Other types of stablecoins presented in chapter 5 are not included.

[13] The term 'cryptocurrencies' is a bit misleading as a currency usually is money that has been publicly established in a jurisdiction. However, as it is commonly used, we will stick to the term in the remainder of the paper.

be permissioned digital currencies as central banks would allow only a limited number of validators of transactions. Such currencies would also be peer-to-peer exchanged currencies based on cryptographic procedures. They are two subtypes of central bank digital currencies:

- **Retail central bank digital currencies** would be universally accessible (at least within the borders of a given jurisdiction) and be an alternative to cash. The Chinese, Swedish and Icelandic central banks are frontrunners on this question even if, for the moment, the technology seems to be too immature to outperform current systems at this stage.[14]
- **Wholesale central bank digital currencies** would not be targeted at the wider public but be accessible to specific undertakings like banks only. They could be an alternative to todays' central bank reserves system because, instead of providing a centralised clearing and settlement infrastructure, they would use decentralised crypto validation. Projects are currently under way, for instance in France for the euro area.[15]

# 4 Cryptocurrencies

In 2008, Satoshi Nakamoto[16] issued a white paper setting out ideas to establish a "purely peer-to-peer version of electronic cash". He called it "Bitcoin" and made the following statement: "What is needed is an electronic payment system based on cryptographic proof instead of trust, allowing any two willing parties to transact directly with each other without the need for a trusted third party."[17] Since the first creation of a Bitcoin in 2009, Bitcoin has gained great attention[18] – its market capitalisation is above 162 billion Euro today[19] – and more than 5100 other cryptocurrencies[20] have entered the market.

This chapter describes the main characteristics of cryptocurrencies and explains how they differ from traditional money. Also, we deal with the question whether cryptocurrencies can fulfil the functions of money.

## 4.1 The characteristics of cryptocurrencies

First, cryptocurrencies are, unlike fiat money, not issued by a central bank or other public body.[21] Rather, cryptocurrencies have no specific issuer. They are created by some of its users – so called 'miners'[22] – who offer computing power and fulfil the task of checking and verifying transactions by making

[14] The Block Crypto, China's central bank says it has completed 'top-level' design of digital currency, 01.10.2020. https://www.theblockcrypto.com/linked/52616/chinas-central-bank-says-it-has-completed-top-level-design-of-digital-currency. Icelandic cryptocurrency project supported by the private firm monerium, The coin telegraph, 06.2020, https://cointelegraph.com/news/icelands-financial-regulator-approves-blockchain-powered-e-money-firm. E-krona project by the Riksbank, https://www.riksbank.se/en-gb/payments--cash/e-krona//. Intervention of Dirk Bullman, innovation team leader at the ECB, in Malaga, 11.2019, https://www.youtube.com/watch?v=9WCHCr8Tr0o.

[15] Le Monde, « Monnaie centrale digitale » : la Banque de France va lancer une expérimentation en 2020, 04.12.2019, https://www.lemonde.fr/economie/article/2019/12/04/monnaie-centrale-digitale-la-banque-de-france-va-lancer-une-experimentation-en-2020_6021678_3234.html.

[16] Until today, it is unclear who is Satoshi Nakamoto, whether it is a real name, a pseudonym or a group of people.

[17] Satoshi Nakamoto (2018), Bitcoin: A Peer-to-Peer Electronic Cash System, p. 1.

[18] Research on this topic already started in 1983 [see Chaum, D. (1983). Blind signatures for untraceable payments. In Advances in cryptology (pp. 199-203). Springer, Boston, MA].

[19] https://coinmarketcap.com/de/ (last visit: 17.02.2020)

[20] https://coinmarketcap.com/de/ (last visit: 17.02.2020)

[21] European Parliament (2018), Cryptocurrencies and blockchain - Legal context and implications for financial crime, money laundering and tax evasion, July 2018, p. 22 et seq.

[22] Often, also professional businesses perform the task of mining without being active cryptocurrency users [European Parliament (2018), p. 25].

use of cryptography[23]. For this task, they get rewarded by the network of users of the currency with new monetary units. Thus, private, unspecified users issue the cryptocurrency.[24] As there is no legal person issuing the cryptocurrency, there is no one who is liable. The users of the currency can hence not force any issuer to redeem their currency units (non-redeemability).[25,26]

Second, traditional money can take a physical form – e.g. cash – or a digital form – i.e. bank deposits and reserves. Cryptocurrencies, however, are purely digital. They can only be transferred, stored and traded digitally.[27]

Third, cryptocurrency transactions do not rely on any intermediaries, i.e. commercial banks, that execute, process and verify transactions. Instead, transaction parties can transmit funds in a decentralised and direct manner (peer-to-peer, P2P). As of today, a usual non-cryptographic transaction takes places as follows: Customers instruct their bank to transfer money from their bank account to the bank account of another person. The banks involved handle the money transfer and act as bookkeepers. They store and record the transactions centrally for all their customers. In the P2P structure of cryptocurrencies there is no central bookkeeper. Buyers basically announce their willingness to transfer money and the transactions are then added to a distributed database by a "consensus-based validation procedure" performed by (some of) the miners. The current state of the database of transactions is assessed by distributed consensus, in a way that the users of the cryptocurrency agree on a new state of the database and keep an overview of units and ownership. The miners fulfil the task of adding new transactions to the database, verifying that the buyer is authorised to initiate the payment and checking whether a unit of a cryptocurrency is not fraudulently spent twice.[28] Consequently, the miners basically replace the central bookkeepers of usual currencies.[29]

Fourth, cryptocurrencies share some similarities with commodity money like gold, cacao or tea. They are not issued by a central authority and their value is simply derived from supply and demand, the supply being very rigid. In contrast to commodity money, cryptocurrencies, however, have no intrinsic value and, hence, can only be exchanged and not be "consumed" or "utilised".[30]

Fifth, the supply of cryptocurrencies is not determined by a central body but by the protocols – i.e. the rules – that govern the currencies. The protocols of the currencies, which are determined by their establisher(s) define whether and how new units of the currency can be created by the miners and how much of them can exist. In the case of Bitcoin the total amount of currency units is, for instance, capped at 21 million. The protocols also specify, for instance, the procedure of verifying transactions.

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[23] Cryptography is a „technique of protecting information by transforming it into unreadable format that can only be deciphered by someone who possesses a secret key" [European Parliament (2018), p. 20].

[24] Brühl, Volker. ''Bitcoin und andere Kryptowährungen-konsequente Regulierung und Aufsicht sind dringend geboten.'' Ifo Schnelldienst 70.22 (2017): 13-17, p. 14.; Thiele, Carl-Ludwig, et al. ''Kryptowährung Bitcoin: Währungswettbewerb oder Spekulationsobjekt: Welche Konsequenzen sind für das aktuelle Geldsystem zu erwarten?'' ifo Schnelldienst 70.22 (2017): 3-20, p. 4.

[25] Bank for International Settlements (2018), Annual Economic Report, June 2018, p. 95.

[26] In contrast, cash and credit on a central banks' account is a liability for the central bank. Also, central banks receive collateral for the provision of currency units. Cryptocurrencies are not backed by assets as collaterals. [Thiele et al. (2017), p. 4.]

[27] European Parliament (2018), p. 21-22.

[28] In contrast to physical money (e.g. cash), digital money can be replicated and copied easily. Having a central bookkeeper that possesses a central database copy of transactions makes it easy to circumvent that one currency unit owned by a person is transferred to multiple persons ('double spending problem'). This is no easy task with a decentral structure.

[29] Bank for International Settlements (2018), p. 95-98; Bech, Morten L. and Rodney Garratt (2017), p. 58; Lansky, J. (2018). Possible state approaches to cryptocurrencies. Journal of Systems Integration, 9(1), 19-31.

[30] European Parliament (2018), p. 21; Thiele, Carl-Ludwig et al. (2017), p. 4; Mayer, Thomas, 'Die Evolution des Geldes.' Ifo Schnelldienst 70.22 (2017): 7-9, p. 8.

The existence of a 'mining process' also means that the revenues from creating money[31] are no income for the central bank and the states behind them but go entirely to the miners of the currency.[32,33]

Sixth, cryptocurrencies are not stored on an account of a (central) bank, but they lie in data stores in a P2P network. Therefore, no specific entity holds a "master copy" of transactions, takes care of their consistency and provides users with an up-to-date and accurate version of them.[34] Instead, transactions are recorded, stored, maintained and controlled by a network of computer servers called nodes. Thus, multiple data stores exist, which all share the same records of transactions. The various data stores are generally called 'distributed ledgers'[35] and every currency user has a copy of the ledger. In the ledgers of cryptocurrencies, which are usually based on the blockchain technology, all transactions of all users of the currency are documented and stored.[36,37]

## 4.2 Are cryptocurrencies money?

As explained in the first chapter, money usually serves three main functions. It is a medium of exchange, a unit of account and a means to store value. As of today, cryptocurrencies fulfil these functions only to a limited extend:[38]

- Medium of exchange: Cryptocurrencies are not generally accepted – e.g. by retailers – as a medium of exchange. Obstacles of cryptocurrencies to be widely used as medium of exchange are, inter alia, the difficulty and the costs of obtaining them and storing them securely and in a low-cost manner.[39]
- Unit of account: Often, cryptocurrencies suffer from a high volatility as compared to traditional currencies. This may be due to many factors, e.g. the fixed money supply and the lack of a trusted entity that acts as a stabilising power – like a central bank that conducts monetary policy. Consequently, the price is mainly determined by demand and cannot be steered by counterbalancing actions from the supply side. This makes them prone to speculation, and their ability to function as a numeraire to compare prices is limited. Furthermore, the high volatility forces retailers to adjust prices frequently, which is not only confusing for consumers but also costly. The volatility

[31] This is often referred to as 'seigniorage income'. For money to enter the economic cycle, banks must borrow it from the central bank, or they must provide them with some assets in return. Interest on the lent money and return on the acquired assets is income for the central bank [https://www.ecb.europa.eu/explainers/tell-me/html/seigniorage.en.html].

[32] Mayer, Thomas (2017), p. 7.

[33] Lansky, J. (2018).

[34] Bech, Morten L. and Rodney Garratt (2017), p. 58.

[35] The technology behind such ledgers is the so called 'distributed ledger technology' (DLT). This technology allows 'computers in different locations to propose and validate transactions and update records in a synchronised way across a network. Transactions are conducted in a peer-to-peer fashion and broadcast to the entire set of participants who work to validate them in batches known as 'blocks'. Since the ledger of activity is organised into separate but connected blocks, this type of DLT is often referred to as 'blockchain technology'. […] it is costly to operate (preventing double-spending without the use of a trusted authority requires transaction validators (miners) to employ large amounts of computing power to complete 'proof-of-work' computations); there is only probabilistic finality of settlement; and all transactions are public.' [Bech, Morten L. and Rodney Garratt (2017), p. 58].

[36] European Parliament (2018), p. 15.

[37] Bank for International Settlements (2018), p. 95.

[38] European Parliament (2019a), Virtual Money: How Much do Cryptocurrencies Alter the Fundamental Functions of Money? Monetary Dialogue Papers, December 2019, p. 16 and 19-21; Yermack, David. 'Is Bitcoin a real currency? An economic appraisal (No. w19747).' National Bureau of Economic Research (2013), p. 9 et seq.; Bank for International Settlements (2018), p. 100.

[39] First, some IT expertise is required to obtain and use cryptocurrencies. Second, the mining process requires a lot of computing power to add new transactions to a ledger and verify them, which leads to high energy costs. Third, users must have trust in the safety of the virtual wallets, within which the currencies, respectively cryptographic keys are stored, as well as in their providers. Furthermore, costs may arise for insuring against risks related to the wallet and its provider.

of Bitcoin, for example, is thirteen times higher than volatility of gold.[40,41]

- Store of value: A currency can only act as store of value, if users do not expect (a high degree of) depreciation, i.e. the future value of the currency amount should be comparable to its present one. The high volatility of most cryptocurrencies questions this ability. Furthermore, money's function as a store of value presupposes that there is some level of safety that it cannot be stolen, cannot be part of fraudulent activities and cannot easily get lost. This is regularly questioned regarding cryptocurrencies.[42]

# 5 Stablecoins

## 5.1 The characteristics of stablecoins

Stablecoins are cryptocurrencies which aim to serve the functions of money in a better way than cryptocurrencies do. In particular, stablecoin initiatives attempt to reach a higher degree of stability of value. While essentially relying on the same technological foundations as cryptocurrencies, e.g. the distributed ledger technology[43], they attempt to reach this stability by backing the currency with assets.[44] [45]

In June 2019, Facebook announced, together with a group of companies from different sectors[46], a project entitled "Libra". They plan to establish a stablecoin (called "Libra coin") which aims at easy and cheap (cross-border) financial transactions. Also, the Libra coin is to ease access to financial services in underdeveloped countries where access to bank accounts is limited.[47] The project attracted a lot of attention in the public as well as among regulators, central bankers and politicians. Libra is seen as the first[48] potentially ground-breaking "stablecoin" project.

Often, four different stablecoin types are distinguished. They claim to stabilise their value by backing them by different means[49] (see Table 1):

[40] 4. Bargeldsymposium der Deutschen Bundesbank 2018, Dr. Jens Weidmann, Eröffnungsrede, p. 12.

[41] 'In May 2010, a programmer in Florida paid 10,000 Bitcoin for two pizzas, which at that time was worth 30 US dollars. Only a few years later, at a Bitcoin rate of 15,000 US dollars per Bitcoin, the pizza order was worth around 150 million US dollars.' [Julian Grigo und Patrick Hansen, Digitalwährungen stehen vor dem Durchbruch, ifo Schnelldienst 17/2019 72. Jahrgang 12, September 2019, p. 7, Translation from German by cep].

[42] For instance, the virtual wallet that is necessary to use cryptocurrencies can be hacked or the provider of the wallet can become bankrupt.

[43] Bullmann, Dirk, Jonas Klemm, and Andrea Pinna. "In search for stability in crypto-assets: Are stablecoins the solution?." ECB Occasional Paper 230 (2019), p. 6.

[44] Id. p. 7; Dell'Erba, Marco. 'Stablecoins in Cryptoeconomics: From initial coin offerings to central bank digital currencies.' New York University Journal of Legislation & Public Policy 22.1 (2019), p. 3-5.

[45] Besides the lack of stability, another obstacle is the huge amount of energy required to process and verify cryptocurrency transactions, which leads to high costs and slow transactions. Furthermore, such costs increase with the number of users of a currency.

[46] Founding members included, i.a., Spotify, Uber, Vodafone, Lyft, PayPal and Visa. However, a couple of them already decided to no longer take part in the project. [https://libra.org/de-DE/association/#founding_members]

[47] Libra Association, An Introduction to Libra, White Paper, Geneva, Revised July 23rd, 2019.

[48] The Libra Coin is not the first stablecoin project. 'Tether', introduced in 2014, was one of the first stablecoin initiatives [Bullmann et al. (2019), p. 15 and 31].

[49] Bullmann et al. (2019), p. 15.

| Type of stable-coin | Backed by | Decentralised vs. centralised management | Central issuance |
|---|---|---|---|
| Fiat-backed | Fiat currencies, like Euro or US dollar | Centralised | Yes |
| Off-chain | Off-chain assets (i.e. gold, oil, real estate) | Centralised | Yes |
| On-chain | On-chain assets (i.e. cryptocurrencies) | Centralised and decentralised | Central and decentral |
| Algorithmic | Expectations | Fully decentralised | No |

Table 1: Types of stablecoins and their differences; own table based on Bullmann, Dirk, Jonas Klemm, and Andrea Pinna (2019), p. 11.

- **Fiat-backed stablecoins**[50]: These stablecoins are the most common ones.[51] They are backed by a – relatively stable and highly liquid – fiat currency like the US dollar or the Euro or a basket of fiat currencies.[52] Unlike cryptocurrencies, they have a dedicated issuer that commits to redeem currency units at par value[53] and takes responsibility to keep them safely, sometimes relying on third parties as custodians. Fiat-backed stablecoins represent a claim on the issuer and are, in fact, a representation of existing currencies in tokenised form on a distributed ledger. While the issuance of stablecoins, thus, differs from typical cryptocurrencies as there is a need for some central actor that holds the reserves that back the stablecoin, the way funds are transferred among users is similar to that of cryptocurrencies and involves the same validation mechanisms.[54,55] The stablecoin 'Tether', which was the first to be released and is still the most relevant one[56], falls in that category. This also holds for the 'Libra coin', if introduced as planned.[57]
- **Off-chain collateralised stablecoins:** These stablecoins are backed by other assets than fiat money, which are not stored on a blockchain and do not take digital form. Rather, they are backed by commodities like gold, oil, or real estate.[58,59] As with fiat-backed stablecoins, off-chain collateralised stablecoins require a central issuer, a custodian for the safekeeping of collateralised assets[60] and the possibility for redemption. In contrast to fiat-backed stablecoins, however, redemption at par value is normally more difficult since the prices of the collateralised assets are not stable over time. Consequently, off-chain stablecoins normally require users to post additional assets through margin calls to avoid under-collateralisation and ensure that users can redeem stablecoins at par value. Whether such stablecoins fluctuate in value, thus, depends, in particular, on the type and volatility of the posted collateral and on policies to avoid under-collateralisation.[61,62] One example of a stablecoin falling in this category is the 'Swiss Real coin'.[63]

[50] Sometimes the term 'tokenised funds' is also used.
[51] European Parliament (2019b), Public or Private? The Future of Money, Monetary Dialogue Papers, December 2019, p. 9.
[52] Id. p. 9.
[53] Usually one unit of a stablecoin represents one unit of fiat money. Thus, collateralisation takes place at a 1:1 ratio [Id. p. 9].
[54] Bullmann et al. (2019), p. 10 and 12.
[55] Dell'Erba, Marco (2019), p. 8 and 9.
[56] In July 2019, Tether accounted for 81% of the market [Bullmann et al. (2019), p. 15].
[57] European Parliament (2019b), p. 9.
[58] Deutsche Bundesbank (2019), Krypto-Token im Zahlungsverkehr und in der Wertpapierabwicklung, Monatsbericht, Juli 2019, p. 44.
[59] European Parliament (2019b), p. 9.
[60] Safekeeping is required as commodities are usually of non-digital character and cannot be transferred digitally. Thus, the commodity must be kept safely by an entity. Custodians, who may be the issuer, or third parties instructed by the issuer, are responsible for safekeeping as long as users do not redeem their stablecoins.
[61] Bullmann et al. (2019), p. 10 and 17.
[62] European Parliament (2019b), p. 9.
[63] Id. p. 9.

- **On-chain collateralised stablecoins:** The main difference between such stablecoins and off-chain collateralised stablecoins is the fact that they are backed by digital assets on the blockchain. Often, other cryptocurrencies are used as collateral. There may be a responsible central party for managing the stablecoins. However, there is no need for a central issuer as the safekeeping of the collateralised assets takes place in a decentral and completely digital manner and usually the users are responsible for managing the stablecoin. As illustrated above, the volatility of cryptocurrencies is a problematic issue. Backing an on-chain collateralised stablecoin with them, thus, may also expose the stablecoin to relatively large price fluctuations. Consequently, such stablecoins must be accompanied by several distinct stabilisation mechanisms. Usually, on-chain collateralised stablecoins require some form of over-collateralisation measures and/or incentive mechanisms to reward users for the holding of the collateral backing the currency.[64] The main idea behind such stablecoins is "to create a form of representative money in which there is no requirement for a physical asset, thus removing the problems of trust and custodianship".[65] 'Dai' is an example of an on-chain collateralised stablecoin.[66]
- **Algorithmic, non-collateralised stablecoins**: These stablecoins are the least common type and are not widespread. They are closest to traditional cryptocurrencies like Bitcoin. They are not managed centrally and require no central issuer or any other actors like custodians. They are not backed by fiat money nor on-chain of off-chain collateral. These stablecoins, however, incorporate algorithms and protocols that are designed to adjust their supply to changes in the demand for them and to ensure a stable exchange ratio with specific reference values like the US dollar or the Euro. This makes them different to Bitcoin and the like, whose money supply is more or less fixed.[67] To dampen volatility of the currency one instrument of algorithmic stablecoins is to use the "reserves in on-chain assets it has accumulated over time (e.g. fees on transactions) or selling rights on future revenues".[68] The stablecoin 'Basis' falls into this category falls.[69]

## 5.2 Are stablecoins money?

Whether stablecoins can serve as money and fulfil its core functions remains to be seen. As compared to cryptocurrencies, the likelihood is larger because stablecoins are backed with assets. This can be helpful in stabilising their value, although it very much depends, inter alia, on the quality of those assets. A more stable value of the currency helps to use it as a store of value, medium of exchange and unit of account. Whether other features such as installing a central actor that is to some extent liable and responsible for the management and issuance of the stablecoin can be helpful in fulfilling the core functions of money is debatable and will depend on whether or not the wider public will trust this actor.

64 Bullmann et al. (2019), p. 10 and 20; European Parliament (2019b), p. 9; Deutsche Bundesbank (2019), p. 46.
65 Dell'Erba, Marco (2019), p. 11 and 12.
66 European Parliament (2019b), p. 9.
67 Bullmann et al. (2019), p.10 and 26; European Parliament (2019b), p. 9; Deutsche Bundesbank (2019), p. 46 and 47; Dell'Erba, Marco (2019), p. 12 and 13.
68 Bullmann et al. (2019), p. 26.
69 European Parliament (2019b), p. 9.

# 6 Central Bank Digital Currencies (CBDC)

## 6.1 Definition and types of CBDCs

Central Bank Digital Currencies (CBDCs) are digital currencies issued by central banks. In the future, they could be used to replace or complement central payment clearing and settlement systems regarding retail[70] and wholesale[71] transactions. Hence, they may be used in peer-to-peer exchanges, as opposed to other types of digital money issued by central banks such as reserves and settlement accounts.[72] CBDC could also be seen as a 'third form of central bank liability, next to (1) overnight deposits with the central bank, currently available only to banks, specific non-bank financial firms, and some official sector depositors,[and] (2) banknotes, being universally accessible but arguably of limited efficiency and relying on old technology'.[73]

If implemented, a CBDC would be issued by central banks, which would have the monopoly on its creation.[74] It is also likely that it would be 'issued and exchanged at par with the other forms of central bank money' for not diluting 'fungibility[75] of the monetary base'.[76]CBDCs could either rely on distributed ledger technologies for validating transactions – in which case they could be called central bank cryptocurrencies (CBCCs)[77] where payments are validated by permissioned validators acquiring fees on the transaction in exchange[78] – or on centralised ledgers managed by central banks.[79]

The following types of CBDCs under discussion can be distinguished:

- **Wholesale CBDCs:** These CBDCs would only be available to financial institutions. They would be based on a permissioned distributed ledger and CBDCs be issued by central banks only. This is different to Bitcoin, which is a permissionless cryptocurrency where new units are generated by mining. Wholesale CBDCs could complement or replace the current centralised transaction system of reserves on the books of central banks. Transactions, which are mainly transfers of funds between financial institutions or with a central bank, would not only by inscribed in the central bank's ledgers but would remain 'traceable by the central bank through the distributed ledger'. The main incentive for such a system change would be to 'promote financial innovation and to lower transactions costs'. However, the size of these cost reductions remains unknown at this

[70] The retail payment market refers to the massive amount of low-value everyday life peer-to-peer transactions such as payments by credit cards, cash, mobile money, etc.

[71] The wholesale payment market refers to high-value transactions between financial institutions, typically banks, which use a specific payment infrastructure to this end. An example is the Target Instant Payment System (TIPS) in the European Union.

[72] According to the Bank of England, its functionality for retail transactions is potentially much greater than cash [Ward O., Rochemont S. (2019). Understanding Central Bank Digital Currencies (CBDC). Institute and Faculty of Actuaries, United Kingdom, p. 9].

[73] Bindseil, Ulrich, 'Tiered CBDC and the financial system.' (2020), p. 4.

[74] Commercial banks could not issue CBDC as such in this system.

[75] The fungibility is the ability of a good or asset to be interchanged with other individual goods or assets of the same type.

[76] Pfister, Christian. 'Central Bank Digital Currency: One, Two or None?' (2019), p. 6.

[77] The Bank of International Settlements proposes the following definition for CBCCs: '*an electronic form of universally accessible central bank money that can be exchanged in a decentralized manner known as peer-to-peer, e.g. without central intermediary*' [Bech, Morten L. and Rodney Garratt (2017), p. 56].

[78] Thus, CBCCs would be a sort of tokenised funds stablecoin, relying on DLT for transactions but issued by only one institution, the central bank, and fully backed by the same amount in a traditional currency (or a basket of currencies).

[79] An existing example is the Uruguayan e-Peso, a wholesale digital currency which was recently tested. Its transaction system was centrally managed on an online platform. Said otherwise, there was only one ledger at the central bank to update when a transaction occurred [European Parliament (2019c). The next generation of digital currencies: in search of stability, Monetary Dialogue Papers, ECON Committee, p. 13].

stage.[80]

- **Retail CBDCs:** These CBDCs would be available to the wider public and would serve as a digital alternative to cash. They could be offered (1) as a deposit account for individuals at the central bank or (2) as a digital token currency, in which transactions would by validated by permissioned validators.[81] In this case, the peer-to-peer structure could provide for the anonymity feature such as cash entails, as central banks may not be able to track CBDC ownership. A third option would rely on a public-private partnership (3) where private entities deal with transactions and issuance while the central bank tightly controls them. As these "synthetic CBDCs" are the subject of intensive discussions, we deal with them below in more detail.

## 6.2 Retail CBDC in practice: synthetic CBDCs

Synthetic CBDCs (sCBDC) would be issued by private providers. These would hold accounts at the central bank where they back each unit of sCBDC that they issue with one unit of fiat money of their customers. From the point of view of the customer, one unit of fiat money could hence be exchanged against one unit of the sCBDC. Each sCBDC-provider might issue its own currency, which may spur competition and innovation, especially for fast and efficient payment services. The sCBDC-providers could be seen as "narrow banks", as they would not be able to create book money: The amount of sCBDCs they issue would depend upon the instantaneous demand of consumers and hence their ability to offer collateral in the form of fiat money. sCBDCs would be thus comparable to the stablecoin Libra. The main difference between classical CBDCs and sCBDCs would be the issuer with whom the retail user will come into contact: for classical CBDCs it would be the central bank while for sCBDCs it would be a private issuer.[82]

Whether, how and when sCBDCs will be introduced is unclear. The behaviour of private actors on the digital currency market seems to play an important role. Below we give a short overview of the main advantages and challenges connected with their establishment.

The advantages of sCBDCs:

- sCBDCs would enable central banks to rapidly make available to users a central bank-linked digital currency in a cost-efficient way. This may be important once the acceptance of other digital currencies (especially Libra) increases and threatens currency and payment sovereignty.[83]
- Without accepted sCBDCs, private digital currencies may gain attractiveness, and thus may endanger financial stability if money flows massively away from established channels into the new digital currencies.
- sCBDCs would allow central banks to avoid the reputational risk implied by digital currency issuance and peer-to-peer transactions management. Since central banks would have to develop a new business ex-nihilo, the risk of early failure is high. This may jeopardise central banks'

[80] Pfister, Christian (2019). p. 2, 6 and 7.
[81] Bindseil, Ulrich (2020), p. 4.
[82] European Parliament (2019b), p. 18.
[83] Reuters, China's digital currency will kick off 'horse race': central bank official. 06.11.2019, https://www.reuters.com/article/us-china-markets-digital-currency/chinas-digital-currency-will-kick-off-horse-race-central-bank-official-idUSKBN1XG0BI. If a major central bank takes the first-mover advantage by releasing a credible CBDC before the others, it could provoke high damages to emerging countries by intensifying capital flight to the new safe assets, i.e. the newly introduced credible CBDC, which could soon become the new reserve currency. Currency competition might lead to a reintroduction of capital controls to avoid this phenomenon.

credibility in its traditional business: monetary policies[84], i.e. inflation and sometimes output targeting.

The challenges of sCBDCs:

- Bank customers may have many incentives to move traditional bank deposits to narrow banks issuing sCBDCs. This is so as the latter are safer because the fiat money backing the sCBDC would be deposited at the central bank. In the current low (or even negative) interest environment, the opportunity costs of doing so may be very small (if not negative). In that case, introducing sCBDCs would cause severe bank-run-type problems, as banks would lose the necessary liquidity. A fast and limitless introduction of sCBDC may thus cause serious financial distress.
- Every unit of fiat money that leaves private bank accounts and moves to "narrow banks" – as collateral for sCBDCs – would be inactive on central bank accounts. Hence, private banks' ability to create money would decrease. This would have serious consequences for banks' ability to hand out credits and hence for economic growth, inflation, unemployment.

## 7 Conclusion

Money covers three main functions: unit of account, means of exchange and store of value. Today, money consists, in general, of cash, bank deposits and reserve holdings of banks at central banks. Money creation is centralised and public. Cryptocurrencies, stablecoins and central bank digital currencies change this by using new technology that allows for cheap and fast transactions that do not necessarily need the involvement of the main actors in the current monetary order. A lot of innovation takes place both in the private and the public realm and it is yet to be seen, where money will evolve in the future.

[84] European Parliament (2019b), p. 18.

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