



DeFi, Blockchain and Cryptocurrencies: Proposing a Global Money Matrix for the Blockchain Era

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Abstract

Unlike early civilizations with an entire economy built around agriculture and the practicality of the barter system, today's complex economies require immediate, low-cost transactions. The digitalization of transactions is helping economies develop through various new assets and currencies. The appearance of DeFi, CBDC's, and many blockchain based systems has created a bit of a debate among researchers. Consequently, the matter maintains a certain ambiguity, which requires more research. In this paper, we will be discussing how blockchain is revolutionizing the financial sector, by creating decentralized finance and central banks' digital currencies. We will then propose a new global money matrix starting with a short literature review of existing definitions and categorizations since there still is a lack of understanding and standardization of currency categories, especially digital currencies. Then we will do the same for CBDC by categorizing it by component: participants, categories, and application scenarios.

Keywords: Blockchain, DeFi, Cryptocurrency, CBDC, Money

Introduction

As humanity has evolved to adapt to modern technology and innovation, so has money, from the simple barter system to digital currency. The Internet has allowed the development of many areas, such as telecommunications, e-commerce, social media, and smart devices. However, the monetary system has not been changed by the advent of the internet, most of which innovations were credit cards, (ATMs), online banking, peer-to-peer (P2P) lending, and PayPal (Nguyen, 2016), which is a mere application of the then new technology of the internet. However, blockchain extends the internet to further expand the existing monetary system (Alshorman et al., 2020) by introducing many new assets and currencies.

Blockchain and cryptocurrency's development can mitigate the economic pressure associated with recession. Recessions in the economy tend to be driven by aggregate demand, meaning fluctuations in the supply or demand for money are the main cause. Having monetary policy as a means to an end requires stability outside the economic system. The money supply can respond to economic shifts within a political framework that enables blockchain innovations to flourish.

Caton's (2018) work suggests that cryptocurrencies offer an important opportunity to implement rules that sustainably promote macroeconomic stability. This work suggests that asset-backed cryptocurrencies can provide a way to obtain cheap liquidity in a crisis.

Some new technologies, summarized with the acronym 'ABCD', represent the four technologies at the heart of Fintech, RegTech, and DeFi: **AI**, **Blockchain**, **Cloud**, and **Data/ DLT**. These technologies are deeply revolutionizing the financial sector by creating new opportunities in both domestic settlements and cross-border transactions. Yet, the subject is not clear although numerous academic and professional researches have been done. It is a topic that needs further enlightenment to move past the basic concepts and advance the already existing practices of blockchain.

Literature review

1. Blockchain technology

Blockchain is a decentralized, distributed, shared, and immutable database that captures all currency transfers in a blockchain. This blockchain holds a record of all transactions and delivers global, cross-border distributed trust. Nakamoto (2008) defines blockchain as a distributed data structure that records every transaction information users perform on the network and shares it. Blockchain aims to substitute social trust with cryptographic features (de Vos, 2021). This technology is being widely used in crypto-currencies (Opare & Kim; 2020). It can abolish the role of intermediaries in financial transactions since it enables peer-to-peer transactions through distributed

decentralized platforms. As such, blockchain can transform previously impossible business models into viable ones (Chen, Bellavitis; 2020).

Given its practicability, financial industries such as the banking industry are adapting their traditional services to fit the new technological requirements of the blockchain (Alshorman et al, 2020). The use of blockchain and distributed ledger technology in the financial industry can be compared to the revolutionary changes in communication that the internet and social networks have brought (Perez, 2019; Swan, 2015). Just as the internet is the communication protocol that controls the exchange of information on the network of networks, blockchain is the protocol that controls the exchange of value. One is the Internet of information, while the other is the Internet of value.

Dos Santos & al. have grouped the characteristics of blockchain into 4 main parts: (1) persistence, where data can't be subject to change once written to the blockchain; (2) consensus, where all honest participants have the same set of information; (3) liveliness, where all participants can upload new information; and (4) openness, where any participant can contribute with new input to the blockchain.

A major advantage of DeFi compared to centralized institutions is that all transactions are public and published on the supporting blockchain. Its general usage embodies one or more elements of (1) decentralization; (2) distributed ledger technology and blockchain; (3) smart contracts; (4) disintermediation; and (5) open banking (Zetsche & al, 2020). According to the World Economic Forum (2017), a distributed ledger is "a consensually shared and synchronized database within networks distributed across multiple sites, institutions, or geographies, allowing a transaction to have multiple (private or public) 'witnesses'."

2. The decentralized finance change of paradigm

a. What is DeFi?

We read and analyzed individually and independently each of the sources from the existing literature in Table 1. Since the concept of DeFi is relatively new, its definition is still unclear. Consequently, we will summarize these definitions chronologically listed in the following table.

Table 1. *DeFi definitions in previous studies*

Authors	Date	Definition
Poblet, M & al.; Y. Chen	2018; 2020	"[...] it stands in contrast to both traditional finance and centralized banking as it could allow for a democratization of finance and monetary policy by broadening the opportunities for access, removing potential gatekeepers, and placing responsibility for policy decisions in the hands of the system's actual users."
Chen Y.; Amler H & al.	2019; 2021	"DeFi services have the potential to enable entirely new business models and fundamentally transform modern finance, potentially reducing transaction costs, improving access to financial services, and lowering barriers to investment for entrepreneurs."
Y. Chen; C. Bellavitis	2020	"Empowered by blockchain technology, financial services can become more decentralized, innovative, interoperable, borderless, and transparent."
Zetzsche & al.	2020	"Rather than using one server at one server center, datasets can be distributed over many server centers accessible through the internet by many users located around the globe, more or less simultaneously."
Lehar, A. & C. A. Parlour	2021	"Decentralized finance "DeFi" offers blockchain-based alternatives to traditional financial services, such as banking, brokerage, and exchanges."
P. Schueffel	2021	"DeFi posits that financial services should not rely on centralized intermediaries but should be provided by users for users. This is done by deploying software components to a decentralized peer-to-peer system which is grounded on blockchain technology."
F. Schär	2021	"The term decentralized finance (DeFi) refers to an alternative financial infrastructure built on top of the (Ethereum) blockchain. DeFi uses smart contracts to create protocols that replicate existing financial services in a more open, interoperable, and transparent way."
F. Allen & al.	2022	"[...] potential roles of blockchain in the future growth of decentralized finance, which is expected to be a future financial system that relies not on centralized intermediaries but on smart contracts in decentralized settings."

b. Putting DeFi into Practice

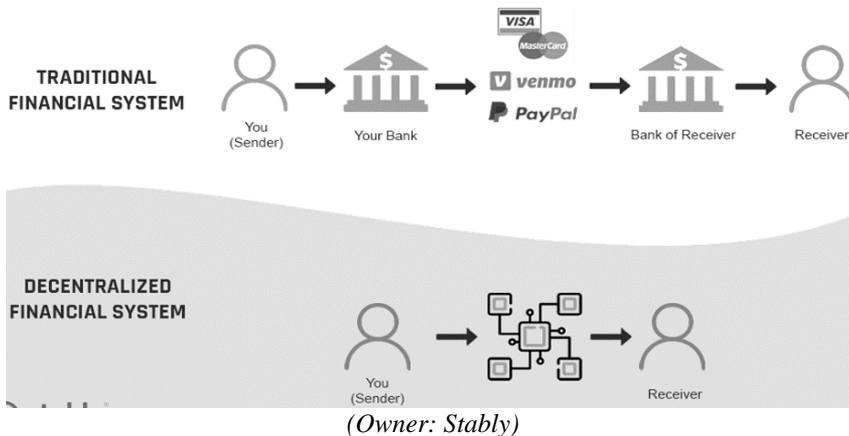
The actual meaning of DeFi in the financial industry can be illustrated with an example of buying stocks. Before, clients first had to arrange a commercial relationship with a bank. Then they had to initiate the purchase

order through their bank. The bank would then place the order with a broker. The broker then files in the order within the stock exchange. Only then does the client acquire the stock from the exchange (Casu, Girardone, & Molyneux, 2006). In this example, which illustrates the purchase of stocks in a very simplified way, three different agents are involved: the bank, the broker, and the exchange. On the selling side, three intermediaries were also involved: the bank, the broker, and - admittedly - the identical exchange. This multitude of intermediaries not only increases the clients' costs but may also present a potential source of error throughout the buying and selling process.

The process in the DeFi system is started with a smartphone or computer by a customer to login to a "decentralized exchange" or "DeX". There, the customer can place an order to purchase a digital asset or "token" on a DeFi exchange. These tokens essentially represent a title to any type of asset (Schueffel, 2021). Smart contracts execute the order once an asset's parameters match the purchase order. The token is transferred directly from the seller's portfolio to the buyer's. At no point does the token come into the possession of an intermediary, nor is the identity of participants divulged or recorded.

To process assets in a decentralized system, a digital token has to be created to symbolize the asset. This process, which is most comparable to the creation and issuance activities in traditional banking, is called "tokenization" or "dematerialization." (Schueffel, 2021).

Figure 1. Comparison of the process of a transaction in traditional and decentralized finance



c. Fintech and DeFi: what is the difference?

The digital infrastructure has accelerated the emergence of new technologies like social media, cloud computing, analytics and big data, wearable devices, etc. (Tayazime & Moutahaddib, 2022). Starting with common grounds, we find at the core of DeFi, Fintech, and RegTech, stand

many new technologies, best summarized with the acronym ‘ABCD’: **AI**, **B**lockchain (including distributed ledgers and smart contracts), **C**loud, and **D**ata (big and small); or, in another iteration, **AI**, **B**ig Data, **C**loud, and **DLT** (including blockchain and smart contracts) (Zetsche & al, 2020).

DeFi (decentralized finance) has become one of the most popular emerging technologies in finance, joining Fintech (financial technology), RegTech (regulatory technology), cryptocurrencies, and digital assets. It represents a progression of the Fintech trajectory that enables new and agile organizations to not only enter areas that were traditionally used solely for authorized credit institutions, but also provide greater product diversity, inclusivity, transparency, and risk management (Mention, 2019).

As new entrants to the financial sector, FinTech can partner with banks on their digital transformation journey and should not be viewed as mere adversaries. Retail-focused Fintech are bound to break through and build successful, sustainable businesses, and have the potential to reshape some areas of financial services to a significant degree (Jihane & Aziz, 2022). Fintech startups, Big Techs, and even incumbents from non-financial industries are leveraging massive amounts of diverse data and analytics constantly, creating new and better customized products, improving the precision of pricing, cutting costs in the intermediation process, and also introducing new business models.

To summarize, Fintech is based on big data and analysis, to bring new and more fitting products, which can be seen as a simple digital transformation of the existing financial infrastructure. The DeFi ecosystem is a new financial system that is built around blockchain technology, where we find new concepts like tokenization and disintermediation.

In this case, it is imperative to differentiate the terms decentralization and disintermediation when studying the subject of DeFi. There is no denying that disintermediation is very closely connected to the concept of decentralization. It requires decentralization as one of its main foundations (Ye Guo and Chen Liang, 2016), and although they are used interchangeably, their meanings remain distinct. Decentralization is used in computer science to describe any system in which decisions are distributed throughout the system rather than being made by a single entity (de Vos, 2021).

Merriam-Webster describes disintermediation as eliminating the intermediary in a two-party transaction. However, disintermediation is not guaranteed and may not always be permitted. In many physical and electronic markets, intermediaries play an important role in connecting buyers and sellers and facilitating transactions between traders (Bakos, 1998). Accordingly, traditional intermediaries are a much-needed precaution in business processes in certain spheres, notably the highly regulated financial sector. That being said, de Vos (2021) confirms the studies of many other researchers believing

that electronic markets are unlikely to be completely disintermediated by blockchain technology in the near future (Zamani & Giaglis, 2018).

Instead of carrying out a complete disintermediation, it is a more likely scenario that the role of existing intermediaries will transform and that their involvement in market processes will be reduced. For this reason, numerous financial institutions are currently experimenting with distributed ledger technology to make existing settlement services more efficient and reliable. In response, central banks worldwide are studying and testing the possibility of integrating digital currencies (CBDC) in their own system.

3. Crypto currencies and CBDC

Bitcoin's core technology, blockchain, has drastically diminished the requirement to trust financial intermediaries (Vos, 2021). A cryptocurrency is a digital currency that uses cryptography for security (Investopedia, 2016). The core idea of crypto-currencies dates back to Dai (1998). These ideas are embodied in Bitcoin, the first implementation of Dai's (1998) cryptocurrency concept, in which the currency uses cryptography rather than a central authority to control its creation and transactions. In other words, cryptocurrency is a digital currency that uses cryptography to secure transactions and control the creation of additional units and is built on a peer-to-peer network without being regulated and controlled by a central bank. They are changing money, freeing it from governments and central authorities, and placing it under personal and direct control using blockchain (Oh & Nguyen, 2018).

Nakamoto (2008) proposed Bitcoin as the first decentralized cryptocurrency, allowing transactions to occur without relying on trusted third parties. In 2019, FastFabric (Gorenflo & al, 2019) increased transactional speed from 3,000 to 20,000 TPS (transactions per second). Meanwhile, Visa states on its website that it can process up to 76,000 transactions per second. We can agree that the performance of the present blockchain system is yet inferior to that of traditional centralized systems.

Unlike controversial blockchain-based digital currencies, centralized ledgers for money supply can be governed by financial institutions. A third party manages the centralized ledger used in the money supply and is unavailable to all parties involved (Green, 2018). The International Monetary Fund (IMF) defines CBDC as a new form of fiat money issued digitally by the central bank and served as legal tender.

The DLT mechanism avoids the double-spending problem (Nakamoto, 2008; Treiblmaier, 2019) and creates a system that would overcome the lack of trust associated with the centralized ledger system (Morgan, 2017), which could lead them to become a substitute for the central banks. Nonetheless, whether or not CBDC threatens the global financial system is still debatable.

Some researchers still hold on to the fact that current cryptocurrencies like Bitcoin present dangerous regulatory issues and are prone to money laundering, extortion, and other criminal activities. Public blockchain cannot meet financial systems' regulatory, scalability, and efficiency requirements, hence why it is unsuitable for blockchain-based CBDCs. That leaves the place for a more suitable blockchain for CBDC, the permissioned blockchain. Indeed, around 50 central banks worldwide are considering this type of blockchain for a potential CBDC (Bank for International Settlements).

Like fiat currency, blockchain-based CBDC is expected to be inclusive and present a diversity of services, even for people who do not have a smartphone. CBDC should offer low-cost, fast, and secure payments for both domestic and cross-border scenarios, innovative features such as offline and instant payment, and at the same time follow the rules of anonymity, privacy, security, resilience, availability, scalability, convenience, and usability (Bank of England, 2022). Table 2 summarizes all CBDC projects from 2015 until 2018.

Table 2. *CBDC projects in different countries.*
(Adapted from T. Zhang and Z. Huang, 2020)

Country	Date	Name	Characteristics	Conclusion
Netherlands	2015	DNBcoin	<ul style="list-style-type: none"> ● Bitcoin based ● Focus on sustainability of the payment system 	Blockchain is not an option for financial infrastructures.
		Dukaton		
England	2016	RSCoin	<ul style="list-style-type: none"> ● Bitcoin based ● UTXO (Unspent Transaction Output) model ● Central bank issues currency, deals with transaction issues ● payment interface providers report to the central bank 	Central bank can benefit from blockchain based wholesale payment system, which can increase efficiency and reduce costs.
	2016	Jasper	<ul style="list-style-type: none"> ● Permissioned blockchain based ● Payment system on high amount inter-bank payments 	
Canada	2017	CAD-coin	<ul style="list-style-type: none"> ● Blockchain based ● Extension of Project Jasper ● Cooperation of commercial banks in the project 	
	2016	Ubin	<ul style="list-style-type: none"> ● Blockchain based ● Explore the use of blockchain for clearing and settlement of payments and securities. ● Five phase experiment 	
ECB & Bank of Japan	2018	Stella	<ul style="list-style-type: none"> ● Blockchain based ● Focus on cross-border payments 	
South Africa	2018	Khokha	<ul style="list-style-type: none"> ● Blockchain based ● Inter-bank payment and settlement system ● does not involve currency issuance 	Blockchain can help accelerate transaction processing and lower transaction costs.
Sweden	2018	E-Krona	<ul style="list-style-type: none"> ● Blockchain based ● Central bank is responsible for issuing and withdrawing e-kronor. ● Mainly on retail payments 	

The global money matrix

Currency is an instrument for exchanging goods and services. Moving from the barter economy to the gold and silver exchange age, a more reliable currency appeared called money. Money is a currency in its physical form, presented in the form of bills and coins, and is generally issued by a government and accepted as the standard means of payment.

With the advent of digital currencies, fiat money's role as generalized legal tender is threatened. Fiat money is a type of money declared legal tender by a government but has no intrinsic or fixed value and is not backed by a tangible asset, such as gold or silver, but still has a physical form such as banknotes and coins.

Digital currencies on the other hand are a type of money that only exists electronically or virtually. Electronic money is a well-known and highly used in daily operations all around the world, and is either e-Money or credit cards. E-money or electronic money is a currency backed by fiat currency. It is stored in electronic memories of banking computer systems. In the categories of money supply, it is opposed to fiduciary (fiat) and scriptural money. Electronic money is simply regular money stored in a different form for more convenience.

Although both are digital, virtual currency is quite different from electronic money. Virtual currency is a type of digital currency that operates entirely in its virtual community. It is a unit of account with no legal status, not regulated by a central bank, and is not issued by financial institutions. Thus, they are distinguished from electronic money which is a monetary value. Virtual currency can be centralized (webmoney), decentralized (cryptocurrency), or hybrid. It can also be convertible to physical money or non-convertible.

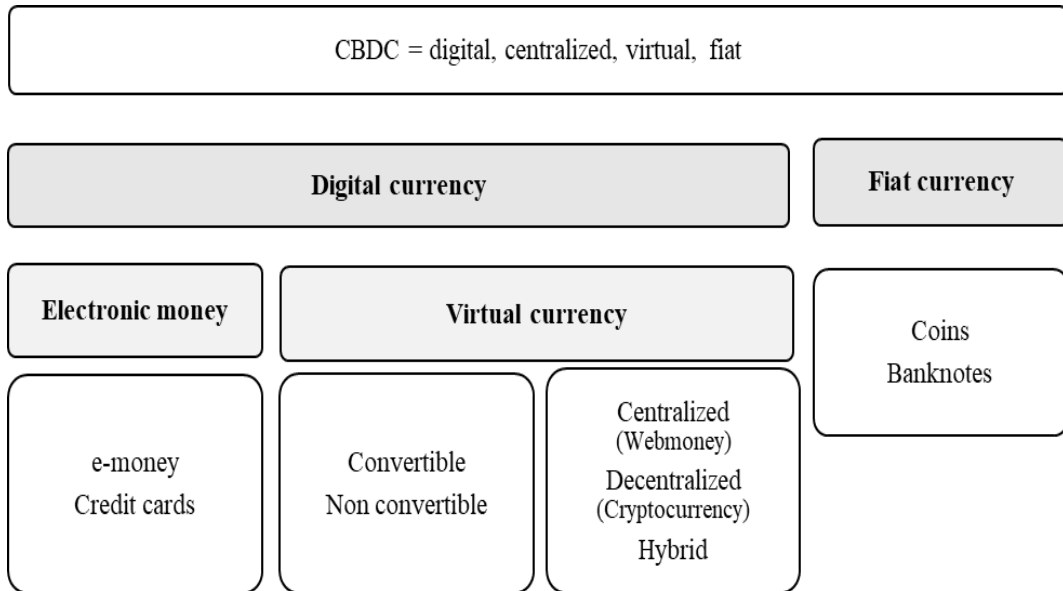
A centralized virtual currency has an administrator or repository. The issuer of this form of currency is its central administrator. Its role is similar to that of a central bank in a regulated monetary system. This enables central banks to issue virtual currencies while having control over them (CBDCs). Therefore, CBDC is the link between the digital and fiat systems, an attempt by governments to control financial systems.

A decentralized virtual currency, on the other hand, has no central administrator. The decentralization of virtual currency depends on blockchain networks based on cryptography, hence the name cryptocurrency.

There are two conflicting valuations in the existing literature on whether or not crypto-currencies satisfy the requirements of being a currency. Some researchers contend that cryptocurrencies do not qualify as a currency because of concerns about their legal status, problems with relative price comparability, and volatility, making them speculative investments. (Yermack, 2014; Ciaian et al., 2016). Only, they fulfill the 3 functions of

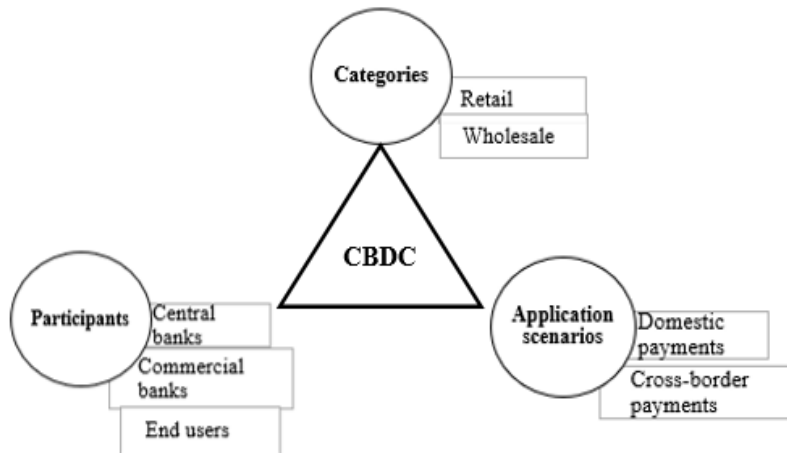
money (ECB, 2009) by being a medium of exchange, a unit of account, and a store of value. Since many governments are accepting digital currencies as a new form of money, as seen in the previous table, we can't deny their role in the money supply. As a result, it is legitimate to incorporate them into the existing monetary matrix.

Figure 2. *The global money matrix*



In Figure 3, we will summarize, according to the existing literature, the key components of CBDC: categories, application scenarios, and participants. It is because CBDC is considered a part of the money matrix presented in Figure 2.

Figure 3. *CBDC's key components*



The retail category represents the digital cash issued, while the wholesale category represents interbank settlements.

Conclusion

In our previous papers, we found that the digital infrastructure has accelerated the emergence of new technologies: social media, cloud computing, analytics and big data, wearable devices, etc. (Tayazime & Moutahaddib, 2022), and with it the whole financial and economic world. New systems like DeFi, cryptocurrencies, blockchain, etc. have appeared, changing with them the course of industrialization.

DeFi enthusiasts go beyond technical decentralization. For them, DeFi offers governance structures they perceive as the ‘democratization’ of finance, while incumbents might well view such structures as ‘anarchy’ (Zetsche & al, 2020). Digital transformation is a gateway to innovation and new models of organization, operations, and business models (Jihane & Aziz, 2022), which reforms the way processes work and thus reforms the whole financial system. We proposed through this work a money matrix for the new blockchain era because of the ambiguity we noticed in the existing literature. However, it is still necessary to examine closely in future research the characteristics of each type of currency for the subject to develop further.

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