

Cryptocurrency and Its State of Research

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Abstract

This article maps the existing academics and working papers about cryptocurrency or digital currency that uses blockchain. Cryptocurrency is one of the applications of blockchain that can accelerate economic digitalization within countries, which in the end could improve economic efficiency, effectiveness, and access for citizens. By the type of issuers, cryptocurrencies can be placed into three categories: central bank-issued digital currency, private institution digital currency, and peer-to-peer crypto-assets. The advent of cryptocurrencies requires strong regulatory frameworks to protect the users, ethics guidelines to direct the development, risk benefits study to identify pitfalls, users' psychology, law enforcement guidelines to ensure a safe environment, and economic initiatives to provide society with maximized benefits. This paper shows research findings, methods, and future research directions in cryptocurrency.

Keywords: cryptocurrency, digital currency, digitalization, blockchain

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Cryptocurrency and Its State of Research

Financial technology (fintech) is an industry that grows rapidly and has a high compound annual growth rate (CAGR) (CB Insights, 2019). Fintech is the future of the financial industry, by which consumers and businesses can access financial services and products digitally, innovative market participants can deploy new innovative technologies, and existing business models can upgrade their capacities and capabilities to fulfill consumers' needs. Fintech helps consumers and businesses handle the impact of the Covid-19 pandemic.

To integrate digital technology innovations into people's lives, users need to feel long-lasting valuable effects. To sustain this integration, firms must gain sustainable competitive advantages. Fintech refers to the financial service companies that dominantly use information technologies in their operation to deliver their products to serve consumers. Fintech companies offer financial services and products that are entirely or mostly in the information technologies domain, and those services or products are difficult or impossible to perform in conventional business because of the limitations in infrastructure.

Authorities see fintech as a means to increase financial inclusion for consumers and encourage companies to innovate processes, services, and products. Fintech helps reduce costs, increase the reachability of customers, and manage risks more efficiently. Fintech companies provide quicker, better quality, more convenient, and cheaper financial services with a seamless process 24 hours a day, seven days a week, or nonstop, compared to conventional financial companies.

Fintech uses advanced technologies such as artificial intelligence, machine learning, and data science to develop solutions for financial needs (Hua et al., 2019). One example of a development in fintech is cryptocurrency. This paper examines research findings, methods, and future research directions to identify to map the existing landscape of cryptocurrency. As

cryptocurrency technology is still developing, a comprehensive cryptocurrency literature review will help researchers to advance research in this particular field.

Cryptocurrency is not a new term that exclusively belongs to this era; in 1983, David Chaum wrote about the use of cryptography applications for future e-cash. Cryptocurrency, also known as virtual currency, is an online payment system that may function as real currency but is not administered or ratified by a central government (Lovell, 2019).

The European Central Bank (ECB) sees cryptocurrency as one type of crypto asset, which is defined as a new type of “asset recorded in digital form and enabled by the use of cryptography that does not represent a financial claim on, or a liability of, any identifiable entity” (Agur et al., 2022). Cryptocurrency is electronic-based money or virtual currency that exists only on the internet, that may or may not have intrinsic value backed by an institution, and that uses cryptography to secure the generation, transaction, and storage of its value (Wu et al., 2022).

Since the beginning of the 21st century, people all over the world have seen a decline in the use of cash, especially during the Covid-19 pandemic. The ECB recorded that in 2019, only 48% of the total transactions in Europe used cash (European Central Bank, 2020). Consumers use commercial bank money, private-issued electronic payment forms of money, and private-issued cryptocurrency (Cœuré & Loh, 2018).

Literature Review

Cryptocurrency, as part of fintech, uses blockchain technology combined with cryptography or encryption as the core to secure the financial activities related to its currency function. With blockchain, the participants of a financial system can easily find out the list of approved transactions by entering the private key into the system. Once verified, the transaction will become part of the blockchain (Afzal & Asif, 2019).

Cryptocurrencies utilize blockchain technology to enable the remote peer-to-peer transfer of electronic value where there is no trust between participants, also known as zero trust architecture. In a conventional system, the electronic representations of money are exchanged via centralized infrastructures, where one of the more trusted intermediaries verifies and settles the transactions.

Blockchain is often referred to as a distributed ledger technology that enables participants within the systems to transact without the need for a centralized trusted authority that stores peer-to-peer transactions record in blocks that are subsequently appended as new transactions happen (Mending et al., 2018; Woodside & Amiri, 2018). In other words, blockchain is a decentralized cryptography platform that records all information about the transactions ever executed within the system, using consensus protocols in a digital ledger stored in every participant's location that ensures a verifiable, unchangeable, and secure way to fulfill immutability, transparency and anonymity principles.

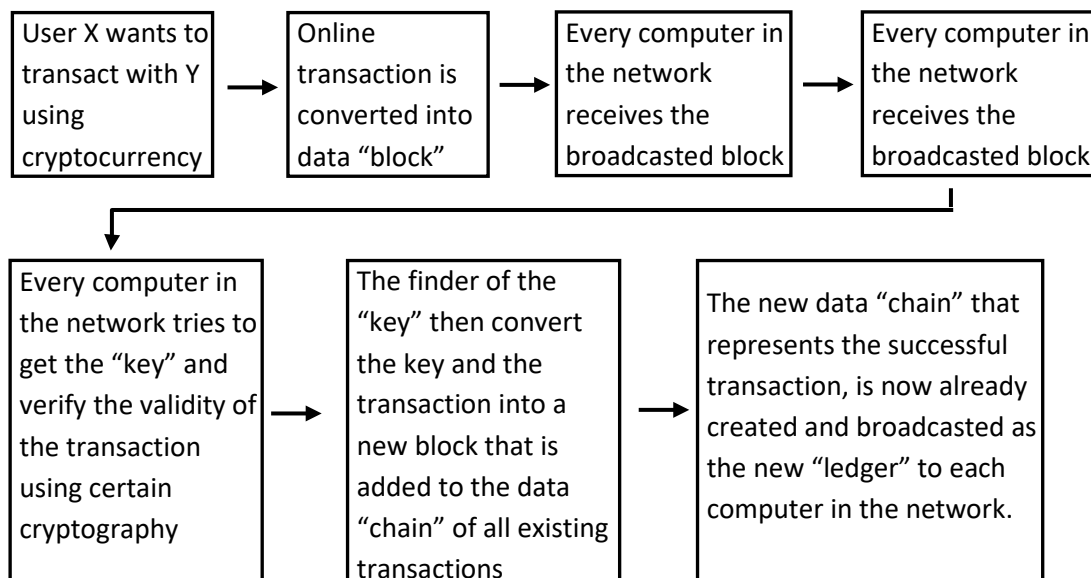
Distributed ledger technology (DLT) refers to the algorithms, protocols, and infrastructures that allow computers or machines in various locations to request a transaction, validate the transaction, and update transaction records in a synchronized way across a network. Cryptocurrencies have a distributed database in a decentralized way, where every transaction is validated using a consensus-based checking procedure and cryptographic parameters. Transactions are broadcast to the entire set of participants who will validate them in batches of data known as "blocks," without any centralized authority, or popularly known as "peer-to-peer." The ledger of these activities is recorded in separate but connected digital blocks; thus blockchain is also known as "blockchain technology."

Figure 1 below shows how blockchain works in cryptocurrency, from a transaction request to the final stage of a transaction. The advent of cryptocurrencies generates many opportunities such as fast, efficient, anonymous, and unmediated transactions (Arias-Oliva et

al., 2021). However, there are still concerns regarding blockchain and its applications in society. As understanding the potential consequences of blockchain technology develops, moral and ethical challenges need to be addressed (Tang et al., 2020).

Figure 1

Blockchain Process from Transaction Request to Final Settlement (World Economic Forum)



Adapted from “Cryptocurrencies, Blockchain and Regulation: A Review,” by Afzal and Asif (2019).

There are numerous cryptocurrencies currently in the market, but generally, they can be categorized into three groups of issuers: Central Bank Digital Currency (CBDC), commercial banks, and crypto-assets. In the CDDBC case, the central banks supply cryptocurrencies in the form of electronic reserves, which are available only to the banking sector and are then distributed through financial institutions.

As for the cryptocurrencies issued by commercial banks, they are created by credit extensions that are backed by a real capital investment of fiat money. As for the crypto-assets, the cryptocurrencies issued have no centralized technical processing, without the precondition of trust to any institution, and without preset liability of any party to vouch for the intrinsic

value. Among the most popular crypto-assets are Bitcoin, Ethereum, Ripple, Litecoin, Monero, Ethereum Classic, NEM, Dash, IOTA, Waves, Dogecoin, and Augur (Milutinović, 2018).

Many countries have their cryptocurrencies issued by private institutions in various countries, such as Gopay by Gojek, QQ Diamond by QQ, Libra by Facebook, and E-money by Indonesian government banks. Currently, there are numerous pilot projects and launched CBDC, including e-Yuan in China, Digital Euro in Europe, e-Krona in Sweden, and DCash in Eastern Caribbean nations (Bordo & Levin, 2017; Mitschke, 2021). Cryptocurrencies have attracted the attention of information technology professionals, economists, investors, banks, governments, and law enforcement agencies (Molling et al., 2020).

The potential impacts of cryptocurrencies have been recognized by government institutions such as the European Central Bank, the US Federal Reserve, the UK Treasury, the People's Bank of China, the Bank of Indonesia, and other related governmental institutions. Corporate reports, government agencies' working papers, and academic research papers about cryptocurrencies are answering the challenge to understand cryptocurrencies. Countries such as China, Europe, and the UK, along with international financial organizations, have produced policy recommendations, guidance, and principles to apply cryptocurrencies in the current financial system. This paper maps the landscape of cryptocurrency academic research.

Research Method

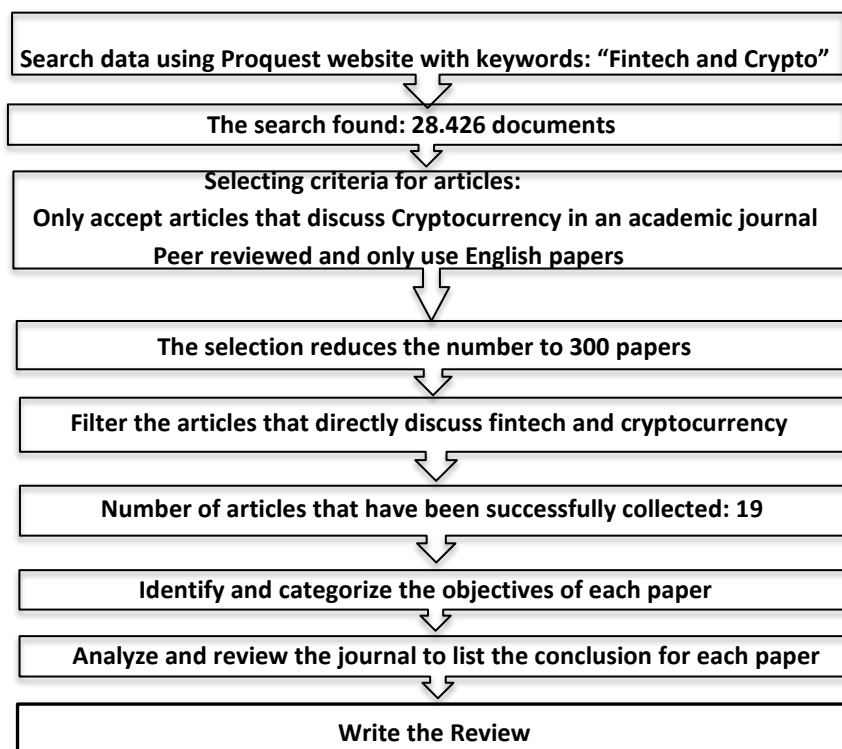
We conducted a review of the existing academic and working papers concerning cryptocurrency or digital currency that uses blockchain. A review is a method to map and identify key points within existing literature considered suitable for the complex research area.

To achieve a systematic review, relevant documents about cryptocurrency were retrieved using ProQuest search. The search keywords were “Fintech” and “Crypto.” We then

selected documents that were available with full text in scholarly journals that had gone through peer-review, with English as the language of the text. As the result, 19 papers remained.

Figure 2

Framework to Select the Articles



In Google Scholar, three relevant working papers from the European Commission and National Bureau of Economic Research about Digital Currency and Cryptocurrency were also selected. Thus, in total, there were 22 papers used in the review. The purposes and methods of the collected documents were then put in a table for future review. The last step was to further elaborate on the selected papers and provide conclusions for future research suggestions.

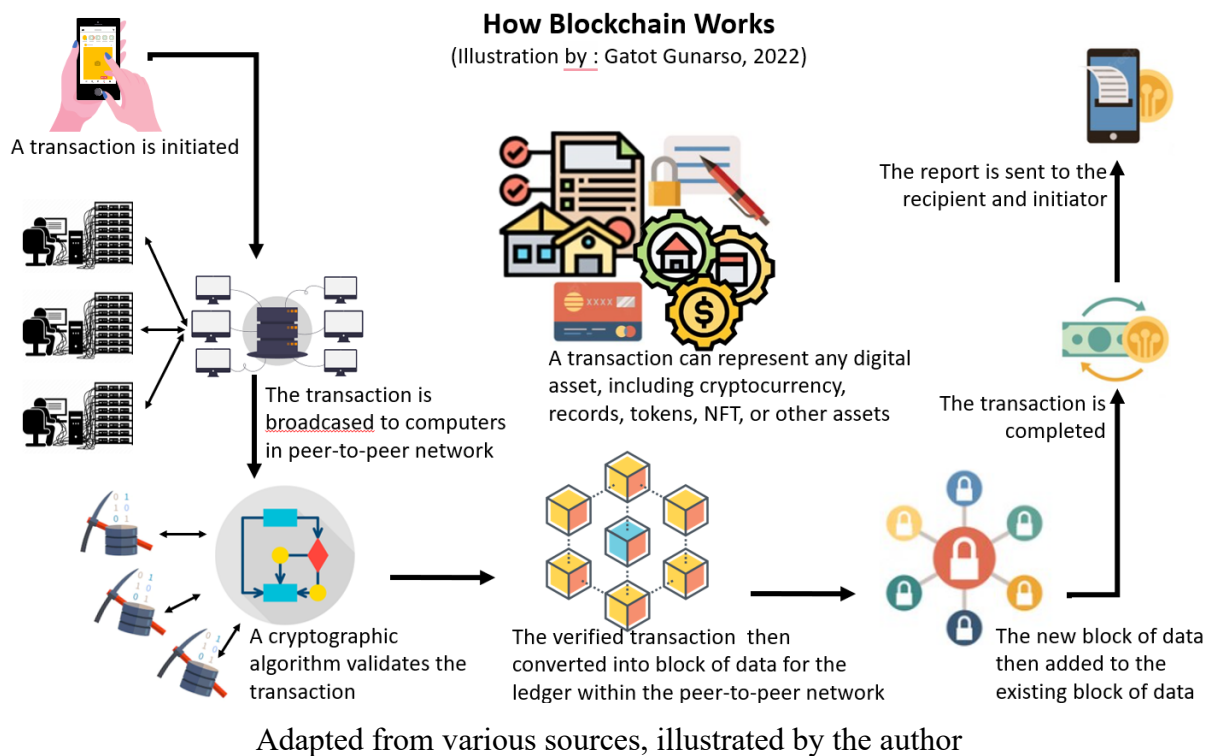
Results and Discussion

Blockchain technology has become a popular new technology that brought forth digital products such as cryptocurrencies, smart contracts, smart identification, and tracking, among others. Blockchain technology itself is a distribution register consisting of blocks of

interconnected transactions. Transaction blocks are called registry nodes. In general, they represent a decentralized database designed to store and confirm the reliability of information (Tsindeliani & Egorova, 2020).

Figure 3

How Blockchain Works



When a participant in the system requests a transaction, the request is broadcast to all peers (computer nodes) in the network, and eventually reaches certain computer nodes that function as miners. A miner will initiate the process to append the transaction into the global ledger by including the request in the transactions pool, which the miner then adds the hashes to the metadata and a nonce to try to produce a hash below a target value (defined by the complexity of the network).

Once a miner is successful in producing the needed hash, the miner broadcasts the transactions pool and its associated hash as a new block replacing all the previous blocks in all active nodes. Included within the metadata in the new block is a reference to the

previously mined block, allowing the acceptance of the miner's new block into the blockchain.

Miners are incentivized by two rewards: the fees in individual transactions, and a system-specific mining reward, for example, 0.01 Bitcoin. These rewards are then collected in a special coin generation transaction within the new block's transaction pool.

Blocks serve to generate the money supply through the mining rewards included in each new block and to provide partial transaction orders that come before the new block is generated. This algorithm allows all participants in the network to impose a global or partial transactions order. The algorithm will prevent double-spending by maintaining a list of unspent blocks and validating a transaction only if its input address appears in this list. The storage of the maintained list is called a crypto-wallet.

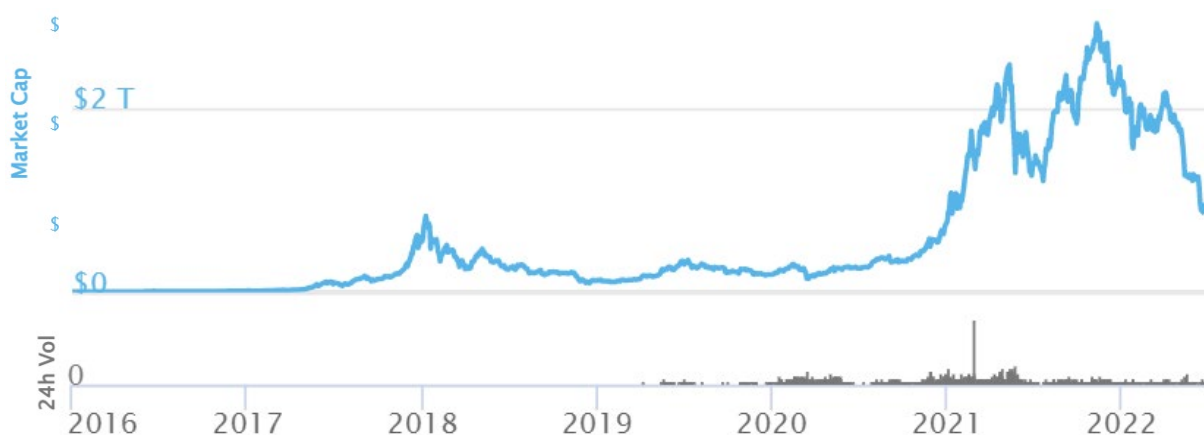
The market capitalization of cryptocurrencies was non-existent before February 2010, virtually very small before 2013, and was relatively stable at less than \$20 billion until the end of 2016 when it became volatile and has been ever since (Fan et al., 2022). At the end of 2017, it rose to over \$200 billion, then at the beginning of 2018, the market capitalization rose to over \$800 billion. In December 2018, the capitalization fell to below \$130 billion and was volatile again after the Covid-19 pandemic spread throughout the world in March 2020, when the capitalization peaked again at over \$2 trillion in May 2021. The market cap then fell to \$1.2 trillion in June 2021 after the second wave of COVID-19, peaked all-time-high of \$2.9 trillion in November 2021 after the US and European countries relaxed their pandemic restrictions, fell deep to \$1.2 trillion due to the massive selling in March 2022 after the Russian invasion over Ukraine, then fell deeper to \$868 billion in June 2022 due to the fear of worldwide recession.

The following graph shows the volatility of the market capitalization of cryptocurrencies, which implies the volatility of the value of cryptocurrencies in the face of

fiat money. Volatility also indicates the popularity, trading volume, and susceptibility of cryptocurrencies to speculative bubbles, high energy prices, and geopolitical situations among other factors. Although not directly related, the graph also implies the number of manipulations, scams, and fraud risks related to the popularity of cryptocurrency.

Figure 4

Total Cryptocurrency Market Capitalization from 2016 to 2022



Adapted from www.coinmarketcap.com

The graph alone represents the growing expectations and hopes of the consumers to use an electronic representation of money, whether for the real purpose of payment or speculative purposes. The growth shows the importance of mapping the knowledge landscape about cryptocurrencies related to the economic condition of countries, including trade, commerce, law and regulation, security, and safety matters.

There are several benefits of cryptocurrency. First, the government cannot appropriate, manipulate, or change the value of the cryptocurrency. Second, it is considered a secure transaction against fraud and identity theft, an immediate and final settlement, and information-accessible for all participants. Third, it has lower transaction, maintenance, storage, and circulation fees. Fourth, cryptocurrency is more convenient for the participants to

transact without the need for an intermediary or centralized regulator. Fifth, it offers a higher degree of freedom to transact due to the anonymous nature of cryptocurrencies.

However, all these perks are not entirely certain. For example, the government can still confiscate the hardware that holds the digital wallet containing the cryptocurrencies. The hackers still can steal the digital wallet stored in the cloud server. The device to mine cryptocurrencies requires very high-performance capability. Additionally, the participants still need a cryptocurrency exchange platform to trade the cryptocurrency for fiat money, and there are limited types of goods and services available for trade with the cryptocurrencies.

The disadvantages of cryptocurrencies are price volatility (Todorof, 2019), lack of market transparency (Commission, 2018; Cumming et al., 2019), low market integrity (Lee, 2020), and lack of investor and consumer protection (Kharisma, 2021), lack of adequate law and supervision process (Tsindeliani & Egorova, 2020), high demand of high-performance computing hardware (Ghiro et al., 2021), high consumption of electrical power (Schinckus et al., 2020), susceptibility to energy prices (Gurrib, 2019), operational weaknesses, popularity as a tool for illicit payment for illegal transactions (Afzal & Asif, 2019), the technical vulnerabilities of services and trading venues (European Central Bank, 2020), the difficulty to intervene the exchange rate with conventional monetary policy (Mitschke, 2021), and the possibility of using cryptocurrencies for criminal purposes (Şcheau et al., 2020), including money laundering and tax evasion (Barnes, 2018; Todorof, 2019).

Table 1

List of Papers, Purpose, and Methods

Author	Purpose of Articles	Method
Scheau et al., 2020	Examines the worldwide operation of cryptocurrencies and their connections with cybercrime.	Literature review and quantitative

Author	Purpose of Articles	Method
Lovell (2019)	Explores different issues surrounding Bitcoin and how the U.S. government, specifically the Internal Revenue Service (IRS), should regulate cryptocurrencies to solve the issues inherent within Bitcoin.	Case study
Chu (2018)	Explores experiences of broker-dealers, and the similarities between the problems confronting cryptocurrency platforms today and those that broker-dealers faced in the late 1960s. Widespread broker-dealer failures during the late 1960s revealed problems with mishandled client assets, insufficient capital, and inadequate protection of customer assets in bankruptcy.	Literature review
Barnes (2018)	Examines the trading and popularity of cryptocurrencies as investments and the susceptibility of their pricing to speculative bubbles, manipulation, scams, and fraud.	Quantitative
Afzal & Asif (2019)	Addresses various risks associated with an unregulated cryptocurrency market and, discusses possible avenues of regulation as well as applications of the cryptocurrency technology for Pakistan.	Framework building and quantitative
Milutinović (2018)	Addresses the theme of cryptocurrency and its role in economic growth. Types of cryptocurrencies are shown as well as their expansion in countries in transition. The market of cryptocurrency in Serbia and Switzerland is discussed.	Framework building and quantitative
Molling et al. (2020)	Identifies main topics, main discussions, and controversies on each topic presented in the literature on cryptocurrencies.	Literature review and framework building
Tsindeliani & Egorova (2020)	Shows the legal status quo of cryptocurrencies in the Russian Federation. Describes references to the existing and proposed legislation as well as to the statements of	Qualitative and descriptive

Author	Purpose of Articles	Method
	several international, supranational, and national regulatory bodies.	
Cortez & Mongrut (2021)	Determines the best model for predicting the short-term log rates of the bid-ask spreads in the three biggest cryptocurrencies—Bitcoin, Ripple, and Ethereum—and in the 16 major fiat currencies listed by Bloomberg.	Literature review and quantitative
Arias-Oliva et al. (2021)	Shows empirically that fsQCA provides a complementary and enriching perspective to interpret data about the use of cryptocurrencies.	Literature review and quantitative
Kliber & Włosik (2019)	Investigates interdependencies between leading cryptocurrency exchanges (American, European, and Japanese).	Literature review and quantitative
Mazambani & Mutambara (2020)	Applies the theory of planned behavior (TPB) to predict behavioral intention to adopt cryptocurrency.	Literature review and quantitative
Cumming et al. (2019)	Explains the regulatory and security issues around blockchain and initial coin offerings (ICOs) in an increasingly decentralized economy. Examines ICO structures and how this crowdfunding mechanism has the promise for economic innovation. Explains how fraud may be carried out within these innovative asset classes, and the evolving regulatory struggles.	Framework building
Duma & Gligor (2018)	Identifies general insights of payment behavior of the students about cryptocurrencies. Assesses students' overall knowledge about cryptocurrencies.	Qualitative
Othman et al. (2020)	Investigates the long- and short-run effects of cryptocurrencies' market capitalization development on the banks' deposit variability in the Gulf Cooperation Council (GCC) region.	Literature review and quantitative
Stepanov et al. (2019)	Identifies provisions needed for implementing law enforcement internationally for digitalization-related matters, including prosecution process, decision	Literature review

Author	Purpose of Articles	Method
	making, coordination among law enforcement officers, and assessment of performance. Comparison of legal methods, dialectical methods, and analytic methods within countries concerning digitalization matters.	
Tang et al. (2020)	Reviews the ethics of blockchain, the main socio-technical challenges in technology and applications, and ethical issues of blockchain. Builds a conceptual framework for blockchain ethics study.	Literature review
Hua et al. (2019)	Reviews studies in the fintech areas, such as artificial intelligence, blockchain, and crowdfunding. Summarizes the contributions made by all six papers in the special issue where this paper was published.	Literature review
European Central Bank (2020)	Examines the issuance of the Digital Euro as a central bank digital currency (CBDC) from the perspective of the Eurosystem.	Literature review
Mitschke (2021)	Examines the effectiveness of Central Bank Digital Currency and monetary policies.	Quantitative
European Central Bank (2021)	Analyzes the digital adoption across the Euro area and EU countries, the implications of digitalization for measurement, productivity, labor markets and inflation, and the coronavirus (COVID-19) pandemic and its implications.	Literature review
Vasiliev et al. (2020)	Analyzes opportunities and prospects for the implementation of artificial intelligence in the legal system. Identifies possible areas of large-scale digital legal activities.	Literature review and framework building

Cryptocurrency uses the digitization process of money that has grown in popularity with fintech adoption that making money movement cheaper, faster, and more secure. Cryptocurrency works on a peer-to-peer basis to facilitate the creation, transfer, or storage of funds with or without a centralized ledger. The peer-to-peer basis can be distributed

physically or logically in separated areas, as well as in one area. Cryptocurrency can be regulated or non-regulated by a government, depending on the initial design.

According to their liability’s bearer, cryptocurrencies can be categorized into three types: central bank, private entities, and no-bearer. For a cryptocurrency or digital currency issued by a central bank within a country or region, the same central bank is liable at all times to ensure the value of the cryptocurrency for buying goods and services does not fluctuate over time (European Central Bank, 2020). A central bank is accountable to the citizens where it is located. In theory, a central bank cannot default or fail to fulfill its obligation to the citizens.

Table 2

Characteristics of CBDC and Other Money-like Assets

	Current types of money			Private sector solutions		CBDCs		
	Central bank money		Commercial bank money			General	Digital euro	
	Reserves	Bank-notes	Deposits	Bitcoins	Libra/Diem		Bearer digital euro	Account-based digital euro
Liability of the central bank	✓	✓	X	X	X	✓	✓	✓
Electronic form	✓	X	✓	✓	✓	✓	✓	✓
Universal access	X	✓	✓	✓	✓	(*)	✓	✓
Interest bearing	(✓) (excess reserves)	X	(✓)	X	X	(*)	X fixed (probably 0)	✓ variable (linked to policy rate, evtl. tiered)
Convertibility (trades at par with other CB liabilities)	✓	✓	✓	X	?	(*)	✓	✓
Limited supply	X	X	X	✓	X	(*)	(✓)	X
DLT	X	X	X	✓	✓	(*)	(✓)	X
Front-end infrastructure (token- or account-based)	CB-A	T	B-A	T	A	(*)	T	CB-/B-A

Own representation based on Bech and Garratt (2017), BIS (2018), Meaning et al. (2018), ECB (2020)

✓ = existing or likely feature, (✓) = possible feature, X = not typical or possible feature, (*) = depends on central bank's design choice
 CB= central bank; B= bank; C= centralised, D= decentralised; T= token-based, A= account-based

Adapted from “Central Bank Digital Currencies and Monetary Policy Effectiveness in the Euro Area,” by A. Mitschke (2021).

For a cryptocurrency issued by a commercial bank or private institution, the commercial bank or private institution holds the liabilities and must comply with the regulations supervised by public authorities. In theory, the private entity could default and be unable to fulfill its liabilities or the claims of its customers. Although the customers are protected by a legally binding regulatory framework within a country, the private issuer is only accountable within their promises and business limits. The regulator or public authority, through law and regulations, could require the private entity to be protected by deposit insurance schemes. The regulator could also provide lending for a troubled private entity in exceptional situations.

For a cryptocurrency issued by an unknown entity or in the popular term “crypto-assets,” no entity is liable to ensure anything of any kind. For this type of cryptocurrency, there is no reliable framework to sustain its value and protect its direct holders. These assets are unregulated, highly volatile in price due to lack of intrinsic value, and potentially could result in the loss of the entire amount of assets due to inconvertibility to fiat money.

One of the problems that emerge due to the cryptocurrency application is cybercrime, which includes the problem of manipulation and fraud that harms the owners of cryptocurrencies (Barnes, 2018; Cumming et al., 2019; Şcheau et al., 2020; Stepanov et al., 2019; Vasiliev et al., 2020).

A cryptocurrency exchange platform conducted a survey among 1108 traders between April 23 and April 30, 2018, and identified the three biggest problems in the cryptocurrency market: lack of security (40%), high trading fees (37%), and lack of liquidity (36%), where more specifically the biggest issue is the sophisticated hackers who compromised the exchange platform (Cortez et al., 2021). Types of crime related to cryptocurrency include crypto fraud, uncertain regulations, cyber security fraud, fictitious assets, fake investment

funds/advisors, unregulated manipulated crypto exchanges, exchange hacks, social media identity hacking, ransomware, crypto-jacking, and taxation fraud (Cumming et al., 2019).

Undoubtedly, this problem came about due to a lack of regulation, accountability, and a desire to create security with the brokerage by the founders, owners, and developers (Barnes, 2018). There are very few companies that comprehensively assess the risk of corruption or compromise of data privacy (Şcheau et al., 2020), so there are still many users who are afraid to invest in this currency because there is no guarantee of asset safety.

In response to the above problems, the US Congress and the SEC enacted the same application as broker-dealers who failed in the market and operational turmoil during the late 1960s. The need to issue regulations for broker-dealers is explained as follows (Chu, 2018):

- Historical Background – Understanding the regulations and potential applications of the currency platform will help bring understanding to its historical background. Congress enacted SIPA in 1970 in response to a series of broker-dealer failures that occurred.
- Customer Protection Rule - Customer protection rules are intended to separate the broker-dealer's activities and assets from those of its customers, ensuring that there are sufficient assets to satisfy the customer's claims in the event of a failure.
- Net Capital Rule - The net capital rule ensures that broker-dealers maintain sufficient liquidity to meet their customers' claims. However, the purpose of the net capital rule is not to avoid broker-dealer failure.
- Broker-Dealer Bankruptcy - Securities Investor Protection Act of 1970 (SIPA) provides further protection for customers. Looking for an alternative to the bankruptcy code, Congress established the Securities Investor Protection Corporation (SIPC) to oversee bankruptcy proceedings for broker-dealers.

Currency digitalization requires the solution of optimizing the decision-making process based on data collection, coordinating of actions of a large number of law enforcement officers, and permitting criminal cases to be conducted in an electronic form (Stepanov et al., 2019). The future of legal regulation is related to the implementation of criminal jurisdictional activities.

Future study is needed to assess the large-scale digital revolution that affects all spheres of society, including the area of legal activity, such as the initiative to use robot lawyers in legal corporations, automation of legal processes, use of smart contracts, application of blockchain technologies, and the proliferation of cryptocurrencies, including law enforcement about cybercrime (Vasiliev et al., 2020).

Cryptocurrencies are partly considered a threat to the banking sector, especially commercial banks, the central banking system, and the global financial system. With their continued use, appreciation of value, and speculative bubbles, cryptocurrencies threaten the economic stability of the foreign exchange market (Barnes, 2018; Othman et al., 2020). Digital payments dominate the market related of the activities of buyers who make online payments, and their money stored in an e-wallet is maintained. The literature (Duma & Gligor, 2018) includes research on some Romanian citizens, especially those who focused on Generation Z, as well as Gen-Tech or iGen who grew up with internet technologies.

The future of cryptocurrencies seems secure given the global push toward the Internet of Things. Institutional innovation and adoption of cryptocurrencies are in overdrive as they predict an increase in the use of digital currencies. There are shining accounts that can be changed by the widespread use of digital currencies and the democratization of the economy, especially in developing countries (Mazambani & Mutambara, 2020).

Bitcoin, Ethereum, and other non-CBDCs are now mostly considered digital assets that are used only for speculative investing. Meanwhile, DCash, e-Yuan, Digital Euro, and

other CBDCs from central banks of established countries are in the course to complement legal currency used for real-life transactions in their respective countries. Gopay, Wechat pay, Alipay, Samsung pay, Apple pay, Libra, and other various digital currencies are widely used in society's daily lives in various countries.

Bitcoin, as one of the non-CBDCs, is one of the most demanded cryptocurrency products in the market. Research from (Kliber & Włosik, 2019) says that the price interdependence between markets that allows Bitcoin trading in the same traditional currency (Euro and US dollar), is slightly higher than the spillover between Bitcoin market quotes in different fiat currencies. The problem of price determination and stability becomes one of the problems facing non-CBDCs. The problem will bring difficulties for the market in using cryptocurrencies as a stable and reliable currency.

Conclusion

This article shows that cryptocurrency is a very important innovation to the digital world of financial transactions, enabling its entire network to control multiple spending without the need for a central authority to permanently monitor and validate financial data. Cryptocurrencies will develop, along with their benefits and disadvantages, driven by technology and their need among consumers and financial institutions.

It should be noted that modern technology development will always precede regulations and all regulations have loopholes for criminal acts to enter. Therefore, the government must as soon as possible provide legal frameworks and standards for digital-based security to protect digital assets use, including the use of cryptocurrency. The modern stage of digitalization of justice requires the proactive introduction of modern technical means to achieve the objectives of market integrity, investor protection, and market sustainability with high effectiveness and efficiency (Stepanov et al., 2019).

Regulations that will be or are being made must facilitate safe and open financial markets and be adaptive enough to accommodate future developments in cryptocurrency. By adopting the principles of technology-neutral, a strategic framework for ethical cryptocurrency adoption, and clear law-making objectives, the government can design a legal framework that can minimize the adverse effects of using cryptocurrency as the complement for fiat money.

Future research direction should be aimed at identifying how to accelerate the development and adoption of cryptocurrencies within society. Research could also be aimed at identifying problems concerning cryptocurrency and its effect on productivity, the labor market, inflation, and monetary policy. There are also concerns about cryptocurrencies created by private entities would jeopardize the sovereignty of nations, thus deserving further investigation.

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