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A Contribution to Novelties in Theoretical Framework for Digital Currency Economics

Deodat Emilson Adenutsi

Department of Accounting and Finance, HTU Business School, Ho Technical University, Ho, Ghana
Email: dadenutsi@htu.edu.gh

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Abstract

The advent of digital currencies, including cryptocurrencies and Central Bank Digital Currencies (CBDCs), presents new challenges and opportunities in the financial landscape. This study addresses the gap in economic theory regarding digital currencies by proposing a comprehensive theoretical framework that integrates their distinct characteristics with traditional monetary principles. The primary research objective is to explore the issuance, circulation, and valuation of digital currencies, as well as their impacts on monetary policy and financial stability. Using a structured theoretical methodology, the study develops a set of hybrid models that combine algorithmic issuance and discretionary policy adjustments, stability protocols for volatility control, and a regulatory framework for global compliance and financial security. The results indicate that digital currencies can complement traditional monetary functions but necessitate careful regulation to mitigate risks to monetary policy transmission and financial stability. The findings suggest policy recommendations, including global regulatory standards and enhanced stability mechanisms, to facilitate the safe integration of digital currencies into the global economy. The originality of this research lies in its hybrid theoretical framework, which balances the decentralised aspects of cryptocurrencies with the controlled issuance of CBDCs, offering a novel approach to understanding digital currency economics. This framework provides valuable insights for policymakers, financial institutions, and academics, helping them leverage digital currency benefits while addressing associated risks. The study contributes significantly to digital currency economics, presenting actionable guidance for a sustainable integration of digital finance into traditional financial systems.

Keywords

Digital Currencies, Cryptocurrencies, Central Bank Digital Currencies,

Monetary Policy, Financial Stability, Financial Inclusion, Regulatory Frameworks

1. Introduction

The recent emergence of digital currencies, including cryptocurrencies and central bank digital currencies (CBDCs), has given birth to significant changes in the global financial landscape. Cryptocurrencies such as Bitcoin and Ethereum have pioneered a decentralised form of currency that operates independently of traditional financial institutions and governments [1]. Meanwhile, CBDCs represent efforts by central banks to digitise national currencies, aiming at enhancing monetary control and financial inclusion [2]. The rise of digital currencies poses significant implications for monetary policy, financial stability, and the overall structure of the financial system.

Despite their growing prominence, the economic principles governing digital currencies remain under-explored. Traditional monetary theories, which have been developed based on physical and electronic forms of money, may not adequately capture the unique characteristics and behaviours of digital currencies. As such, there is a pressing need for a robust theoretical framework to understand the economics of digital currencies, their role in the monetary system, and their potential impacts on economic stability and policy.

The existing monetary theories do not fully account for the distinct features of digital currencies, such as decentralisation, cryptographic security, and the absence of physical presence. This gap in theoretical understanding hinders the ability of policymakers and financial institutions to effectively integrate and regulate digital currencies within the existing monetary framework. Indeed, the lack of a comprehensive theoretical framework for digital currency economics poses challenges for understanding the economic principles that govern digital currencies, their valuation, and their implications for monetary policy and financial stability. Addressing this gap is crucial for developing effective regulatory policies and leveraging the benefits of digital currencies while mitigating potential risks.

To narrow the preceding identified research gap, this study is designed to contribute to providing answers to these questions: What are the key characteristics and economic properties of digital currencies that differentiate them from traditional forms of money? How do digital currencies impact the traditional functions of money, such as medium of exchange, store of value, and unit of account? What theoretical models can be developed to describe the issuance, circulation, and valuation of digital currencies? How do digital currencies influence monetary policy transmission mechanisms and financial stability? What are the potential economic and regulatory implications of the widespread adoption of digital currencies?

The objectives motivating this study are to define and describe the distinctive

core features of digital currencies and their economic properties; develop theoretical models that explain the issuance, circulation, and valuation of digital currencies; analyse the impact of digital currencies on the traditional functions of money and their role in the monetary system; investigate the implications of digital currencies for monetary policy and financial stability; and provide policy recommendations for integrating digital currencies within existing regulatory frameworks.

This research is significant for several reasons. Firstly, it contributes to the academic literature by providing a comprehensive theoretical framework that addresses the unique economic properties and behaviours of digital currencies. This framework enhances the understanding of digital currency economics, filling a critical gap in the current monetary theories.

Secondly, the findings of this research have practical implications for policymakers and financial regulators. By developing robust theoretical models and theoretically analysing the impact of digital currencies on monetary policy and financial stability, this research informs the design of effective regulatory policies. Such policies are essential for leveraging the benefits of digital currencies, such as increased financial inclusion and enhanced monetary control, while mitigating potential risks, including financial instability and regulatory arbitrage.

Lastly, this research is valuable for financial institutions and market participants because understanding the economic principles governing digital currencies enables these stakeholders to make informed decisions regarding the adoption and integration of digital currencies into their operations. This, in turn, promotes a more stable and efficient financial system that can adapt to the evolving digital economy.

The remaining sections of this paper are structured sequentially as follows: literature review, which encompasses the theoretical perspectives, the empirics, and stylised facts; methodology, results, discussions, as well as conclusions and policy implications.

2. Literature Review

The emergence of digital currencies, including cryptocurrencies and CBDCs, has significantly disrupted traditional financial systems and monetary policies. This literature review examines both theoretical and empirical studies related to the economics of digital currencies, their unique characteristics, and implications for monetary policy and financial stability. The review provides insights into the current state of knowledge and identifies the gaps that this research seeks to address.

2.1. Definition and Fundamental Issues

Digital currency refers to a form of money existing exclusively in digital form, accessible via computers or mobile devices, leveraging cryptographic and algorithmic processes to facilitate transactions, issuance, and storage without the role of intermediaries. Contrasting physical or electronic fiat currency, digital currencies operate on decentralised or centralised digital networks, providing enhanced

speed, transparency, and efficiency in financial transactions while reshaping traditional monetary principles.

Digital currencies function similarly to traditional money in that they can be used to buy goods or pay for services. However, they exist exclusively in electronic form, facilitating instant, cross-border transactions directly between users. For instance, a person in Ghana could send digital currency to someone in England instantly if both parties are connected to the same network.

Characteristically, digital currencies are intangible as they have no physical form and are purely electronic. Another unique feature is that digital currencies may be issued by a central authority, like a government (centralised), or exist on decentralised networks, like many cryptocurrencies; and they allow value to be transferred directly between users, bypassing traditional transaction frameworks. Other characteristics of digital currencies are programmability, whereby digital currencies can be embedded with smart contracts, enabling automated transaction rules and compliance mechanisms; pseudonymity, which enables cryptocurrencies to allow transactions to occur without revealing personal information, enhancing privacy; digital currencies enable borderless transactions, reducing reliance on currency exchange mechanisms thereby enabling global accessibility; and different digital currencies demonstrate varying degrees of energy consumption based on their underlying consensus mechanisms (e.g., proof-of-work vs. proof-of-stake).

There are three main types of digital currencies—cryptocurrencies, virtual currencies, and central bank digital currencies (CBDCs). Cryptocurrencies are decentralised digital currencies secured through cryptographic methods, allowing for secure and verified transactions on a network. Examples include Bitcoin and Ethereum. Virtual currencies are unregulated digital currencies that are typically controlled by their developers or founding organisations, often used in online communities or gaming environments. CBDCs are issued by a country's central bank, CBDCs serve as digital counterparts to national fiat currencies. Examples include China's digital yuan (e-CNY), Nigeria's eNaria, and Sweden's e-krona.

The notable differences between cryptocurrencies and CBDCs are threefold. Firstly, cryptocurrencies are decentralised and operate independently of governments, while CBDCs are fully regulated and controlled by central banks. Secondly, cryptocurrencies can be highly volatile due to speculative trading, whereas CBDCs are intended to be stable, maintaining parity with the national currency. Thirdly, cryptocurrencies aim to provide an alternative financial system, whereas CBDCs aim to complement the existing financial systems by providing a digital version of fiat money.

Several advantages are associated with the use of digital currencies. Digital currencies enable quick and often instantaneous transactions, cutting down the time required for cross-border or domestic payments. Again, transactions using digital currencies can be cheaper since they bypass intermediaries. Also, many digital currencies offer a level of privacy and anonymity that is not present in traditional

financial transactions. And, not only are decentralised digital currencies (e.g., Bitcoin) resistant to government control and censorship, but also, they are accessible globally, providing financial inclusion for unbanked populations who have internet access.

Digital currencies can streamline remittance flows by offering faster, cheaper, and more secure transactions across borders. Traditional remittance methods often involve multiple intermediaries and high fees, but digital currencies can reduce these costs by enabling direct peer-to-peer transactions or fund transfers. This could result in higher remittance inflows by making it more economical for migrant workers to send money home, potentially benefiting recipient low-income economies.

The velocity of currency, or the rate at which money circulates within the economy, can increase with digital currencies, as transactions become instantaneous and more convenient. Digital payments reduce delays associated with physical cash handling and settlement processes, which could encourage faster spending and increase the turnover rate of money. A higher currency velocity can stimulate economic activity, though if unchecked, it could also lead to inflationary pressures.

A further benefit of digital currencies is the fact that they can reduce the demand for physical cash, leading to a reduction in the costs associated with printing, minting, and distributing currency notes and coins. Central banks spend significant resources on producing physical currency, so the shift toward digital currency could cut these costs substantially over time. Additionally, digital currencies offer longer 'lifespans' compared to physical notes and coins, further reducing replacement expenses incurred by monetary authorities.

Again, the adoption of digital currencies, particularly CBDCs, could facilitate greater currency integration across borders, especially among countries with stronger trade and economic ties. A well-designed CBDC framework could enable seamless cross-border payments and financial transactions. For instance, if countries in a region adopt interoperable digital currencies, it could strengthen economic integration and reduce reliance on intermediary currencies such as the US dollar.

Furthermore, digital currencies have a relatively stronger positive potential of impacting *de facto* dollarisation (the use of foreign currency in domestic transactions). In countries with weaker currencies, digital currencies, especially stablecoins pegged to major currencies like the euro, could either reduce or exacerbate dollarisation. On the one hand, a robust national CBDC could encourage citizens to rely on the domestic currency, reducing dollarisation. On the other, access to foreign-backed stablecoins might accelerate dollarisation if they are seen as more stable than the local currency.

On the downside, digital currencies require online wallets and secure internet access, which may not be universally available; they are vulnerable to hacking and cybersecurity threats, especially if stored in online wallets without adequate

protection; and, for cryptocurrencies, in particular, exposed to significant price fluctuations, making them unstable as a store of value. Other dangers associated with the reliance on digital currencies are that they are not universally accepted as a form of payment, limiting their utility for everyday transactions. Furthermore, transactions made in digital currencies are often irreversible, posing risks in cases of errors or fraud.

Besides, the introduction of digital currencies could influence the money supply by either complementing or substituting physical currency. If digital currency issuance is not carefully managed, it could lead to an increase in broad money supply, which might drive inflation if the supply of goods and services does not keep pace with effective demand. Central banks issuing CBDCs need to ensure that digital currencies are integrated in a way that does not inadvertently expand the money supply beyond intended targets.

As of 2024, the countries that have officially launched and fully adopted CBDCs include The Bahamas, Nigeria, and Jamaica. The Bahamas launched the *Sand Dollar* in 2020, making it the first country to implement a nationwide CBDC. This digital currency aims to improve financial inclusion and provide efficient digital payment options for residents across its dispersed islands. Nigeria rolled out the *eNaira* in 2021. The eNaira is part of Nigeria's efforts to enhance payment efficiency and expand financial services to underserved populations. Jamaica introduced the *Jam-Dex* in 2022, designed to support financial inclusion and facilitate more accessible digital transactions across the country.

Many other countries are in various stages of pilot testing and development of CBDCs. For example, China's digital yuan (e-CNY) is a notable large-scale pilot that has seen significant use in major cities since its inception in 2019. Similarly, Sweden's Riksbank continues to test the e-krona, and the European Central Bank (ECB) is exploring a digital euro for potential use across the Eurozone in the near future. The Bank of England has been considering "Britcoin," a potential digital currency to support the payment infrastructure of the United Kingdom, while the Bank of Canada has also been evaluating CBDCs to modernise its payment systems.

These early adopters focus primarily on retail CBDCs, which are used by the public for everyday transactions, with the goals of promoting financial inclusion, efficiency in payments, and enhanced monetary policy capabilities. Other countries in advanced pilot stages, such as Russia, Brazil, and India, are testing CBDCs as part of efforts to modernise financial infrastructures and potentially reduce dependency on cash transactions. Indeed, beyond monetary policy and financial stability, the adoption of digital currencies has other potential benefits, such as enhancing financial inclusion, reducing transaction costs, or supporting decentralised finance (DeFi).

2.2. Theoretical Review

[1] introduced Bitcoin as the first decentralised cryptocurrency, highlighting its

reliance on blockchain technology and cryptographic security. The decentralisation and pseudonymity of digital currencies challenge traditional monetary systems that rely on central authority and transparency [3].

[2] discuss the potential of CBDCs to enhance monetary policy effectiveness and financial inclusion while maintaining regulatory oversight. The theoretical models developed by these authors emphasize the dual nature of digital currencies as decentralisation for cryptocurrencies, and centralisation for CBDCs. To understand and manage the novel dynamics introduced by digital currencies into the financial landscape effectively, it is crucial to develop a robust theoretical framework that integrates the unique characteristics of digital currencies with traditional economic theories. This framework also incorporates empirical evidence to assess the implications of digital currencies for financial systems.

Digital currencies challenge the traditional functions of money: medium of exchange, store of value, and unit of account. [4] argues that the high volatility of cryptocurrencies limits their effectiveness as a store of value and unit of account, while their potential for low-cost transactions makes them an attractive medium of exchange. Theoretical models by [5] and [6] explore these functions in the context of digital currencies, suggesting that regulatory frameworks and technological advancements can play critical roles in determining their effectiveness.

The issuance and circulation of digital currencies differ significantly from traditional money. The algorithmic nature of cryptocurrency issuance, as described by [1], contrasts with the discretionary issuance of fiat currency by central banks. Theoretical models by [7] explore how blockchain protocols ensure the controlled issuance and secure circulation of digital currencies. The valuation of digital currencies, however, remains complex due to factors such as speculative demand and regulatory uncertainty [8].

[2] argue that CBDCs could enhance monetary policy transmission mechanisms by providing a direct link between central banks and the public. However, the decentralised nature of cryptocurrencies poses risks to financial stability, as highlighted by [9]. Theoretical models by [10] suggest that digital currencies could reduce the effectiveness of traditional monetary policy tools.

2.3. Empirical Review

Generally, empirical studies have focused on the adoption and usage patterns of digital currencies. [11] conducted a comprehensive survey on Bitcoin users, identifying key motivations such as privacy, low transaction costs, and speculative investment. Similarly, [12] analysed CBDC pilot programmes in various countries, concluding that CBDCs could improve payment efficiency and financial stability if properly designed and managed.

Empirical studies support the theoretical arguments regarding the functions of digital currencies. [13] analysed the use of Bitcoin as a medium of exchange, noting its growing acceptance among merchants despite volatility concerns. Research by [14] highlights the potential for blockchain technology to reduce transaction

costs and enhance financial efficiency, reinforcing the medium of exchange function.

[15] examined the price dynamics of Bitcoin, identifying significant speculative bubbles. Similarly, [16] provided evidence of market manipulation affecting cryptocurrency prices. These findings underscore the need for robust valuation models that account for the unique features of digital currencies.

[17] analysed the volatility of Bitcoin and its implications for financial stability, concluding that high volatility could pose risks to the broader financial system. [18] assessed the potential of CBDCs to improve financial inclusion and reduce transaction costs, providing empirical support for the theoretical benefits proposed by [2].

2.3.1. Digital Currencies and Their Implications for Monetary Policy and Financial Stability

Unlike traditional fiat currencies, digital currencies operate on decentralised or partially decentralised systems, challenging central banks' control over the money supply and inflation targeting [19]. Thus, digital currencies disrupt traditional monetary policy through reduced control over the money supply. For example, some researchers find that when households hold digital currencies, they may bypass traditional banks, limiting the effectiveness of monetary tools of central banks. Research also highlights that digital currencies can facilitate real-time policy responses, improving monetary policy transmission [2].

A study by [20] shows that their prices can fluctuate wildly, which could impact investor confidence and lead to asset bubbles. This volatility may lead to sudden shifts in demand, straining financial institutions and destabilising broader markets [8]. Furthermore, [19] discuss how regulatory oversight is needed to mitigate such risks, as these assets do not always fall under traditional regulatory frameworks.

As digital currencies enable peer-to-peer transactions, they may reduce the need for traditional financial intermediaries. [21] argue that digital currencies challenge banks by diminishing their role in payment processing. This disintermediation could lower costs but may also destabilise the banking sector by reducing deposits, thus affecting lending capabilities.

2.3.2. CBDCs and Their Implications for Monetary Policy and Financial Stability

Central Bank Digital Currencies (CBDCs) represent a digital version of fiat currency issued by central banks. Fully backed and controlled by the monetary authority, CBDCs provide central banks with a new tool for policy implementation and financial inclusion while presenting unique challenges in terms of privacy and system security [22].

CBDCs offer the potential to streamline monetary policy by enabling real-time data collection and direct implementation of monetary interventions. [2] posit that CBDCs can eliminate zero lower-bound constraints by facilitating negative interest rates, thus expanding central banks' toolkit. Furthermore, research by

[23] shows that CBDCs could improve cross-border payment efficiency, enhancing global economic connectivity.

Despite their benefits, CBDCs pose risks to financial stability, especially in terms of bank disintermediation [24]. Studies by [25] highlight the potential for CBDCs to draw deposits away from commercial banks, which could impact lending capabilities. [21] suggests that a tiered CBDC model could mitigate this risk by restricting CBDC usage among retail users.

The successful implementation of CBDCs depends on robust technological infrastructure and regulatory frameworks. According to [26], cybersecurity measures are crucial, as digital central bank accounts become new targets for cyber threats. Furthermore, [27] emphasize the importance of cross-national regulatory standards to address CBDCs' global nature.

2.3.3. Cryptocurrencies and Their Implications for Monetary Policy and Financial Stability

Cryptocurrencies, unlike CBDCs, operate on decentralised networks and are often beyond regulatory oversight. As such, they have emerged as both a financial innovation and a challenge for traditional monetary and regulatory systems [3]. The decentralised nature of cryptocurrencies complicates the ability of central banks to control the money supply and has introduced new risks to financial stability.

The decentralised nature of cryptocurrencies hinders the effectiveness of traditional monetary policy by creating parallel financial systems [4]. According to [28], cryptocurrency networks challenge the control central banks have over the money supply, as individuals and institutions can transfer wealth across borders without intermediaries. Studies such as [29] argue that this autonomy limits the capacity of central banks to implement exchange rate policies effectively.

Cryptocurrencies are highly volatile, often influenced by speculative trading rather than economic fundamentals, which poses a risk to financial stability [16]. Research by [30] illustrates how cryptocurrency markets experience price bubbles, creating an environment that may destabilise broader financial systems if they become more integrated. Furthermore, large-scale cryptocurrency adoption could lead to financial instability, especially in smaller economies where capital flows might be affected by speculative trading in digital assets.

[14] highlight the challenge that cryptocurrencies pose to anti-money laundering efforts due to their pseudonymous nature. [12] suggest that developing regulatory frameworks tailored to cryptocurrencies is crucial to managing these risks, particularly as decentralised finance (DeFi) platforms continue to grow.

The gap in the literature suggests that despite the growing body of literature on digital currencies, several gaps remain. First, there is a need for comprehensive theoretical frameworks that integrate the unique characteristics of digital currencies with traditional monetary theories. Second, empirical studies on the long-term impacts of digital currencies on financial stability and monetary policy are limited, given their relatively recent introduction. This research aims to address these gaps by developing a robust theoretical framework for digital currency

economics and providing empirical evidence on their implications for financial systems.

2.4. Stylised Facts

Historical data on digital currency trends reveals significant developments in usage, transaction volumes, and adoption globally. An overview highlighting key milestones and growth in the development of digital currency is presented below.

2000-2008: ***Conceptual Phase***

- Early digital currencies like e-gold gained traction, but lacked decentralisation.
- Bitcoin, introduced in 2008 by Satoshi Nakamoto, marked the first decentralised cryptocurrency. Its initial daily transaction volumes were negligible.

2009-2014: ***Emergence and Early Growth***

- Bitcoin saw steady growth, achieving 70,000 daily transactions by 2014, driven by increasing merchant adoption and speculative interest.
- Other cryptocurrencies, such as Litecoin and Ripple, entered the market.

2015-2019: ***Expansion and Integration***

- Daily Bitcoin transactions increased to 300,000 by 2019, influenced by the rise of blockchain use cases like DeFi.
- Ethereum, introduced in 2015, gained popularity for its smart contracts, reaching 700,000 daily transactions by 2019.
- Institutional adoption began with platforms like Coinbase enabling fiat-to-crypto transactions.

2020-2024: ***Mainstream Adoption and Diversification***

- Daily Bitcoin transactions reached over 330,000 by 2023, maintaining dominance in the market.
- Ethereum surpassed 1.2 million daily transactions in 2023 due to DeFi, Non-fungible tokens (NFTs)[1], and other applications.
- Over 90% of central banks explored CBDC projects, with countries like Nigeria, The Bahamas, and Jamaica implementing live CBDCs.
- The use of blockchain-powered payments reduced transaction costs, with real-time settlements becoming mainstream in international finance.

In 2010, global statistics on Bitcoin transactions show that it was less than 1000 per day, while total cryptocurrency market capitalisation was around 0.01 billion US dollars. These figures rose steadily to 150,000 daily transactions and US$ 7.8 billion market capitalisation in 2015. An average of 300,000 Bitcoin daily transactions, and 700,000 Ethereum daily transactions, with a corresponding market capitalisation of US$ 236 billion were recorded in 2019 rising to daily Bitcoin transaction of 330,000, and daily Ethereum transactions of 1,200,000 with over US$ 1000 billion respectively in 2024. Based on available statistics, the global digital payments market, which includes cryptocurrencies and digital wallets, is projected to reach $14.79 trillion by 2027, reflecting broader adoption of digital

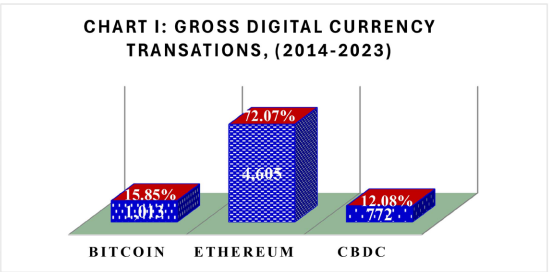
[1]These are unique digital assets that represent the ownership or proof of authenticity of specific items, such as digital art, music, videos, collectibles, or virtual real estate, which are fungible (interchangeable). NFTs are distinct and cannot be directly exchanged on a one-to-one basis.

transactions. This data highlights the trajectory of digital currencies from a niche concept to a transformative force in global finance.

Globally, digital currency transactions which totalled 6390 million, are dominated by Ethereum transactions of 4605 million, accounting for more than two-thirds, specifically 72.07% over the past decade, 2014-2023 (Figure 1: Chart I). During the same period, 1013 million Bitcoin transactions accounted for 15.85% while 772 million transactions were recorded for CBDC, representing 12.08% globally (Figure 1: Chart I). Figure 1 presents the volume of digital currency Bitcoin, Ethereum, and CBDC transactions over the past recent decade, 2014-2024.

The slight dip in the number of Bitcoin transactions in 2020 is due to market corrections, and the subsequent growth in the volume of transactions is driven by increasing global acceptance and institutional interest. Launched in 2015 Ethereum, 0.1 million transactions were recorded in the year of adoption, while 15 million transactions were recorded in 2016 as a result of a boost from early DeFi applications. In 2018, Ethereum transactions of 250 million can be attributed to the rise in decentralised applications and initial coins offering (ICOs)[2]; the 500 million transactions recorded in 2020 was a result of DeFi growth spikes; while the one billion transactions rise in 2021 was due to NFT boom. Despite crypto market volatility, 1.2 billion transactions of Ethereum were undertaken in 2022. While global CBDC transaction data is less comprehensive due to the early stages of implementation, pilot and limited full-scale projects indicate rapid growth, especially in countries with operational CBDCs, the figures have been rising steadily due to expansion of pilot programmes.

Year	Bitcoin	Ethereum	CBDC
2014	26	-	-
2015	45	0.1	-
2016	82	15	-
2017	106	90	5
2018	118	250	15
2019	122	300	20
2020	120	500	50
2021	126	1000	125
2022	133	1200	250
2023	135	1250	307
2024	150	1400	986



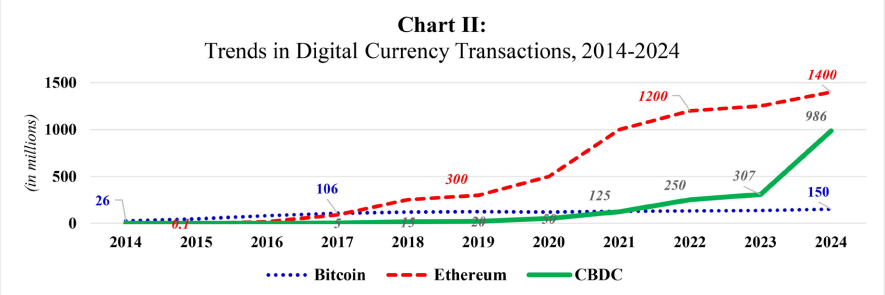


Figure 1. Total global digital currency transactions, 2014-2024 (in millions). **Source**: Author based on data from Blockchain.com & BIS Reports. **Note**: 2024 figures are official estimates.

[2]An ICO is a fundraising method used by blockchain-based projects to raise capital and it involves the creation and sale of new cryptocurrency tokens to investors in exchange for established cryptocurrencies like Ethereum or Bitcoin, or sometimes fiat money.

The data reflects a sharp increase in both cryptocurrency and CBDC transactions over recent years, underscoring the growing role of digital currency in global finance. The data indicates that while cryptocurrencies like Bitcoin and Ethereum have seen substantial transaction growth due to DeFi and NFT applications, CBDCs are emerging as a preferred tool for governments looking to modernise and secure their monetary systems over the past five years (**Figure 1**: Chart II).

3. Methodology

Given the complex and theoretical nature of this study on digital currency economics, the methodology involves a structured approach that systematically builds a conceptual framework, develops theoretical models, and simulates the implications of the proposed framework. This approach yields a structured and multidimensional framework that captures the nuances of digital currencies and offers insights for policymakers, economists, and stakeholders on integration strategies and regulatory implications.

Firstly, the study developed a conceptual framework by reviewing the relevant literature on digital currencies, CBDCs, cryptocurrencies, and their implications for monetary policy and financial stability in order to establish the gaps that the proposed framework addressed. At this stage, the key constructs are identified, and these constructs are integrated into a unified model that interlinks digital currency features with the functions of money and monetary policy.

The next stage involved theoretical modelling—the development of conceptual or mathematical models that represent how digital currencies operate within economic systems, focusing on areas like issuance (algorithmic vs. discretionary), circulation, valuation, and stability protocols. The models for hybrid issuance mechanisms and stability protocols are established at this stage.

Policy analysis and scenario testing by developing and simulating potential regulatory models and standards for digital currencies, assessing impacts on financial stability, consumer protection, and cross-platform interoperability. Various hypothetical or real-world scenarios were used to test the resilience of the model and implications, such as high volatility phases, market disruptions, or adoption of CBDCs on a large scale.

Fourthly, a comparative analysis with traditional systems—comparing the role of digital currencies against traditional money in fulfilling the functions as a medium of exchange, store of value, and unit of account was undertaken to clarify the unique contributions and challenges digital currencies bring to monetary systems. An analysis of how digital currencies could enhance or disrupt traditional monetary policy, focusing on central bank interventions, transmission mechanisms, and potential decentralisation effects on policy control was also undertaken at this stage.

4. Results

4.1. The Proposed Robust Theoretical Framework for Digital Currency Economics

The newly proposed framework for digital currency economics aims to provide

insights into addressing the limitations in the existing models by integrating hybrid issuance mechanisms, advanced stability protocols, enhanced regulatory frameworks, interoperability, and dual roles in monetary policy. This comprehensive framework is designed to maximise the benefits of digital currencies while mitigating potential risks. An attempt has been made to present and explain the proposed framework, and the sequencing of its implementation.

The proposed framework comprises five main components, which must be implemented systematically as shown in Figure 2. The framework is designed to commence with the establishment of the hybrid issuance mechanism, and sequentially followed by advanced stability protocols, enhanced regulatory framework, interoperability, and integration, and ends with the dual role in monetary policy formulation and implementation.

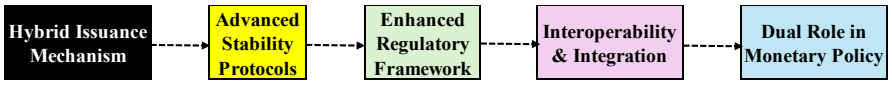


Figure 2. The simplified diagrammatic representation of the proposed framework. Source: Author.

4.1.1. Hybrid Issuance Mechanisms

This mechanism combines algorithmic issuance for decentralised cryptocurrencies and discretionary issuance for centralised CBDCs. It also ensures a predictable supply of cryptocurrencies and a responsive monetary policy for CBDCs.

The proposed implementation sequence at this stage is to:

1) Develop and deploy blockchain protocols for algorithmic issuance.

2) Establish central bank guidelines for discretionary issuance of CBDCs.

3) Create mechanisms for seamless integration between decentralised and centralised currencies.

The corresponding mathematical model for the hybrid issuance mechanism can be represented as follows:

- *For cryptocurrencies*: If we assume that S_t^c represents the supply of a cryptocurrency at time t, then the algorithmic issuance can be modelled as: $S_t^c = S_0^c + \sum_{i=1}^{t} \hat{S}_i^c$; where $\hat{S}_i^c$ is the new issuance at any particular time i.
- *For CBDCs*: If S_t^b represents the supply of a CBDC at time t, then discretionary issuance can be modelled as: $S_t^b = S_0^b + \sum_{i=1}^{t} \hat{S}_i^b + M_t$, where $\hat{S}_i^b$ is the new issuance at a given time i and M_t is the monetary policy adjustment.

4.1.2. Advanced Stability Protocols

This involves using stablecoin models pegged to diversified asset baskets; and incorporating algorithmic adjustments to counteract market volatility. Sequentially, the underlisted activities are proposed for implementation:

1) Design stablecoin frameworks with diversified collateral backing.

2) Implement algorithmic stability mechanisms.

3) Establish regulatory oversight to ensure transparency and security.

4) Establish blockchain security protocols or cryptographic techniques could be integrated into the framework to minimise operational and other forms of financial risks to safeguard security breaches, and unauthorised access as well as advance data privacy.

Accordingly, for stablecoins, given that P_t^s represents the price of a stablecoin at time t; then the stability mechanisms can be modelled as $P_t^s = P_0^s \times \left(1 + \frac{\hat{P}_t^s}{P_0^s}\right)$, where $\hat{P}_t^s$ is the price adjustment to maintain stability.

4.1.3. Enhanced Regulatory Framework

A global regulatory framework for digital currencies is proposed to ensure compliance, security, anti-money laundering, Know Your Customer (KYC) protocols, cross-border interoperability, and consumer protection measures through international cooperation. The implementation sequence involves:

1) Developing international regulatory standards.

2) Creating a cooperative body for global regulatory oversight.

3) Implementing national regulations in alignment with international standards.

4) Conducting a detailed behavioural analysis by exploring risk-assuring user-centric relevant factors that guarantee optimal user trust, adoption rates, and preferences for digital currencies over traditional currencies.

5) Adopting energy-efficient alternatives, such as proof-of-stake (PoS) mechanisms, and other systems anchored on sustainable practices.

Mathematically, assume that R_t represents the regulatory compliance level at time t, then regulatory compliance can be modelled as $R_t = R_0 + \sum_{t=1}^{T} \hat{R}_t$, where $\hat{R}_t$ represents incremental regulatory measures implemented at a given time t.

4.1.4. Interoperability and Integration

Interoperability and integration create the room for seamless integration with existing financial systems; and promote interoperability between different digital currency platforms. The implementation sequence encapsulates:

1) Developing standardised communication protocols and Application Programming Interfaces (APIs).

2) Establishing partnerships with traditional financial institutions.

3) Implementing cross-platform interoperability solutions.

4) Incorporating the unique political, economic, legal, sociocultural and other context-specific factors, including common currency and monetary zone features relevant to maximising the benefits over the costs of digital currency adoption.

4.1.5. Interoperability and Integration

Therefore, if I_t represents the interoperability index at time t, then the

interoperability can be modelled as $I_t = \sum_{j=1}^{n} \alpha_j \times C_{j_t}$, where C_{j_t} represents the compatibility of the j^{th} platform at time t and α_j is the weight assigned to each platform.

4.1.6. Dual Role in Monetary Policy

CBDCs enhance monetary policy transmission by enabling direct interventions. Cryptocurrencies provide alternatives for decentralised financial activities. The implementation sequence of activities, thus, involves:

1) Developing infrastructure for CBDC issuance and distribution.

2) Implementing tools for direct monetary interventions via CBDCs.

3) Promoting the use of cryptocurrencies for decentralised finance (DeFi) applications.

The proposed mathematical framework associated with the dual role in monetary policy transmission is outlined as follows:

- *For CBDCs in monetary policy*: Given that M_t denotes the monetary policy intervention at time t, then monetary policy intervention can be modelled as $M_t = \beta \cdot S_t^b$, where β is the policy multiplier.
- *For cryptocurrencies in decentralised finance*: If D_t represent the decentralised finance activity level at time t, then DeFi activity can be modelled as $D_t = \gamma \cdot S_t^c$ where γ is the DeFi multiplier.

The proposed framework offers a comprehensive and integrated approach to digital currency economics, addressing the limitations of existing models. By incorporating hybrid issuance mechanisms, advanced stability protocols, enhanced regulatory frameworks, interoperability, and dual roles in monetary policy, this framework aims to maximise the benefits of digital currencies while mitigating potential risks. The mathematical models and sequencing of implementation provide a structured path for practical application, ensuring robust and resilient financial systems in the digital age.

5. Discussions

The findings of this study present a comprehensive framework that addresses the economic principles governing digital currencies. The hybrid issuance model offers a balanced solution to integrate decentralised cryptocurrencies and CBDCs. Stability protocols, such as the use of stablecoin frameworks, are vital for mitigating the volatility that threatens financial systems. Regulatory compliance, as proposed, is critical for consumer protection and the systemic stability of financial markets.

In discussing the implications of these findings, the research underscores the dual role that digital currencies can play in shaping future monetary systems. CBDCs offer unprecedented control and efficiency, particularly for monetary policy interventions, while cryptocurrencies promote innovation in decentralised finance. However, the potential for financial instability requires careful regulation

and international cooperation.

Thus, the study not only addresses the initial research objectives but also offers actionable insights for policymakers, financial institutions, and academics. By developing robust theoretical models and providing clear regulatory guidelines, this paper paves the way for a stable integration of digital currencies into the global financial system.

The answers to the research questions guiding this research are provided systematically.

Firstly, digital currencies are often decentralised, as in the case of cryptocurrencies like Bitcoin, which rely on algorithmic issuance without central authority control. Cryptographic security is another defining feature, ensuring secure transactions in decentralised systems. CBDCs, on the other hand, are issued by central banks, enabling these currencies to retain regulatory oversight and alignment with national monetary policy. These characteristics allow digital currencies to facilitate faster transactions, promote financial inclusion, and operate with reduced dependency on traditional financial intermediaries.

Secondly, digital currencies have a varied impact on the traditional functions of money. Cryptocurrencies can serve as a medium of exchange but struggle as a stable store of value due to high volatility, which undermines their reliability as a unit of account. Conversely, CBDCs are designed for stability and can enhance traditional monetary functions. They offer a stable store of value, serve effectively as a medium of exchange, and improve the unit of account function by supporting policy-driven applications, particularly in controlled monetary environments.

Thirdly, the study develops theoretical models that distinguish between algorithmic issuance, typical of cryptocurrencies, and discretionary issuance, which applies to CBDCs and is influenced by monetary policy adjustments. For valuation, stablecoin models are introduced with diversified asset backing to mitigate volatility, ensuring a stable value through price adjustments. These models aim at creating predictable supply mechanisms, managing circulation, and stabilising economic environments where digital currencies operate, contributing to overall financial stability.

As an answer to the fourth research question, CBDCs can enhance monetary policy by providing central banks with tools for direct economic interventions, thus improving policy transmission. By integrating CBDCs, central banks can bypass intermediaries, enabling more immediate impacts on liquidity and interest rates. However, cryptocurrencies, due to their decentralised nature, may limit the effectiveness of traditional policy tools, as they operate outside central bank influence, which can destabilise financial systems if unregulated. The study suggests that stability protocols and regulatory oversight are essential to counter these risks and maintain financial stability.

Fifthly, the widespread adoption of digital currencies necessitates a comprehensive global regulatory framework to ensure compliance, security, and consumer protection. The study highlights the need for international cooperation to prevent

regulatory arbitrage, support anti-money laundering protocols, and protect consumer interests. Stablecoins, in particular, require robust stability mechanisms to reduce market volatility and ensure sustainable value. Integrating CBDCs into existing monetary frameworks could facilitate controlled monetary expansion, while interoperability with traditional financial systems is recommended to smoothen the transition to a digital economy.

6. Conclusions and Policy Implications

6.1. Conclusions

This study provides a comprehensive theoretical framework for understanding the economics of digital currencies, addressing key gaps in traditional monetary theories. The study characterises the distinctive features of digital currencies, such as decentralisation and algorithmic issuance, that set them apart from conventional forms of money. More specifically, this paper proposes an innovative hybrid framework integrating algorithmic issuance (cryptocurrencies) with discretionary issuance (CBDCs). This provides a theoretical basis for managing both decentralised and centralised digital currencies in a cohesive economic model. The introduction of diversified asset-backing protocols and algorithmic stability measures for digital currencies is significant in addressing volatility, enhancing market stability. By developing models that explain the issuance, circulation, and valuation of cryptocurrencies and CBDCs, this research illuminates the profound impact digital currencies have on the traditional functions of money, monetary policy, and financial stability. Through a structured analysis, it identifies both the opportunities and risks posed by digital currencies, offering a balanced perspective on their role in the evolving financial landscape. This framework offers significant contributions to the academic literature, supporting both theoretical advancements and practical policy designs for integrating digital currencies into the global financial system.

While the study provides robust theoretical models, real-world validation through empirical data is limited. The proposed frameworks do not fully address geopolitical and cultural factors that might influence digital currency adoption. Despite its limitations, this study serves as a foundational contribution to digital currency economics, offering novel insights into integrating decentralised and centralised systems. Its hybrid models and regulatory recommendations hold transformative potential for global financial stability and policy innovation.

In terms of novelties and innovations, this study conceptualises digital currencies as tools for both centralised monetary interventions (via CBDCs) and decentralised financial innovations (via cryptocurrencies). A pioneering model for hybrid issuance integrates algorithmic processes for cryptocurrencies and policy-driven issuance for CBDCs, providing flexibility for diverse economic applications. Innovative standards for ensuring seamless integration of digital currencies with traditional financial systems and other digital platforms are introduced.

6.2. Theoretical Implications

This paper advances the theoretical understanding of digital currencies by filling critical gaps in traditional monetary theories. By incorporating the unique characteristics of digital currencies—such as decentralisation, cryptographic security, and algorithmic issuance—the study provides a new lens through which the behaviour and economic impact of these currencies can be analysed. The hybrid issuance mechanism and the dual role of digital currencies in monetary policy offer novel theoretical models that explain their dual nature: as both decentralised assets in DeFi and controlled instruments under the purview of central banks. These theoretical advancements contribute to future studies by providing foundational models that account for the evolving dynamics of digital currency economics.

6.3. Empirical Implications

The empirical models and findings developed in this study have significant implications for future research and financial practice. By modelling the valuation and circulation of digital currencies, the study lays the groundwork for future empirical studies that could investigate real-world adoption, usage patterns, and the stability of digital currency markets. Furthermore, the empirical insights into the regulatory frameworks and financial stability effects of digital currencies are critical for understanding their long-term impacts on global financial systems. This research calls for future empirical studies to validate these models using real-world data on cryptocurrencies and CBDC usage.

6.4. Policy Recommendations

The findings of this study enable several pertinent policy recommendations for integrating digital currencies into the existing financial framework. When prudently and effectively implemented, the recommended policy measures have the potential to strengthen the positive contribution of digital currencies to the global financial system with minimum associated risks of digital currency adoption.

Policymakers should facilitate a hybrid issuance system where cryptocurrencies operate with algorithmic issuance, while central banks maintain discretionary control over CBDCs. This combination allows decentralised cryptocurrencies like Bitcoin to co-exist with centralised digital currencies like the eCedi (proposed by the Bank of Ghana) under clear regulations. For instance, a country could adopt a system where CBDCs like the eCurrency are issued by the central bank, enabling controlled monetary expansion based on economic conditions. Meanwhile, decentralised cryptocurrencies like Ethereum are allowed to circulate with regulated blockchain mechanisms for mining or staking. In this system, the central bank could adjust the supply of the eCurrency during economic downturns, while cryptocurrencies maintain their own algorithmic issuance schedules. The seamless integration of these two issuance models would allow consumers and businesses to use both forms depending on their preference for stability or decentralisation.

International collaboration is essential to establish uniform regulatory

frameworks that govern the use of digital currencies across borders. Without such cooperation, issues like money laundering, tax evasion, and regulatory arbitrage could undermine financial stability globally. Illustratively, in 2021, the Financial Action Task Force (FATF) developed guidelines for regulating virtual assets to ensure compliance with anti-money laundering (AML) and combating the financing of terrorism (CFT) standards. A country like Japan has already implemented these guidelines into its domestic regulations, requiring cryptocurrency exchanges to register with the government and comply with AML/CFT measures. Other countries like the US and the European Union have begun adopting similar frameworks, which could evolve into a globally harmonised regulatory environment for digital currencies.

Stability mechanisms should be embedded within digital currencies, especially stablecoins, to minimise volatility. These protocols can involve pegging stablecoins to diversified baskets of assets (e.g., fiat currencies, commodities) and employing algorithmic adjustments during market fluctuations. Regulatory oversight is necessary to ensure the stability and transparency of these mechanisms. For example, Facebook's proposed Diem (formerly Libra) aimed at creating a stablecoin backed by a basket of global currencies. The stablecoin would use diversified reserves to maintain its value, reducing the risk of volatility typically seen in cryptocurrencies like Bitcoin. To prevent speculation-driven instability, Diem was to be supervised by a governing body made up of global financial institutions to ensure compliance with regulatory standards. Though Diem was ultimately shelved, it demonstrated the importance of diversified collateral and regulatory oversight in ensuring stable value in digital currency systems.

CBDCs should be integrated into existing monetary policy frameworks to enhance the transmission of central bank policies, enabling direct interventions in the economy. At the same time, cryptocurrencies can be used to promote innovation in DeFi applications. For example, the People's Bank of China (PBoC) has piloted its Digital Currency Electronic Payment (DCEP) system, or digital yuan, in various regions. The digital yuan allows the central bank to directly inject liquidity into the economy during periods of economic downturn by distributing the currency through a government-controlled app. On the other hand, DeFi platforms built on blockchain technology, such as those running on Ethereum, enable users to borrow, lend, and trade assets without intermediaries. Combining these approaches, central banks could adopt CBDCs for macroeconomic stability while supporting the innovation of decentralised financial services for niche financial needs.

The financial system should foster interoperability between digital currencies and traditional financial systems to ensure seamless adoption. Standardised communication protocols and Application Programming Interfaces (APIs) should be developed to integrate digital currencies into banking infrastructure and cross-border payment systems. For instance, the European Central Bank (ECB) has explored the possibility of creating a digital euro that would be fully interoperable

with existing banking systems. A user holding digital euros in their wallet could make payments seamlessly to someone using traditional bank accounts, facilitating easier transitions between digital and fiat currencies. The digital euro would also support cross-border payments within the European Union, integrating with platforms like Single Euro Payments Area (SEPA) to allow for instantaneous, low-cost international transfers. The interoperability ensures that users can freely move between digital and traditional systems without barriers, promoting wider adoption.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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