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Central Bank Digital Currencies: A Comprehensive Study of Characteristics, Implications and Future Perspectives

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Abstract: The advent of the modern digital age has changed the way money is used and payments are made. A groundbreaking financial innovation created in response to the changing digital economic environment is the Central Bank Digital Currency (CBDC). The primary objective of this paper is to examine the novel features of CBDC and consider the far-reaching implications for the current financial system. This paper first examines the nature and objectives of CBDC. The distinctiveness of CBDC in the currency issuance and payment systems, as well as its potential impact on the current payment industry, is highlighted in our comparisons of CBDC with conventional currencies, cryptocurrencies, and online payment methods, respectively. However, the digital aspect of CBDC also raises issues of digital divide and privacy. Finally, we highlight the critical role of the government in the creation and oversight of CBDCs. In conclusion, this article offers a thorough viewpoint that explores the ideas, advantages, and disadvantages of CBDC and provides crucial insights into the future growth of CBDC and its influence on the future financial system.

Keywords: Central Bank Digital Currency (CBDC), Digital currency, Cryptocurrencies

1. Introduction

As the digital age continues to evolve, the nature of money and payment methods is undergoing profound changes. Among these, the rise of Central Bank Digital Currency (CBDC) as an epochal form of digital currency reflects the new financial trends of the digital era [1]. CBDC represents a way for central banks to actively explore new types of currency issuance and payment systems to meet the evolving economic environment and consumer needs [2] (Choi et al., 2021). The aim of this paper is to delve into CBDC and explore in depth the concepts, benefits and challenges of CBDC by comparing it with traditional currencies, cryptocurrencies and other online payment methods. We will first explore the similarities and differences between CBDC and traditional currencies and analyze its position and characteristics in the monetary system. We will then compare it to cryptocurrencies to highlight the uniqueness and advantages of CBDC in the digital currency space. We will also compare it with existing online payment methods to assess the potential impact of CBDC on the payments industry.

The digital nature of CBDC transactions exposes individuals to new threats to their privacy, and how to protect users' privacy has become a pressing issue. Therefore, we will discuss in detail the privacy challenges posed by CBDC and explore various safeguards to ensure that the use of CBDC is both convenient and secure while protecting users' privacy. We will also explore the relationship

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between CBDC and the digital divide. While CBDC is expected to increase financial inclusion, it may also exacerbate the digital divide, so we will examine the impact of CBDC on the digital divide. Finally, we will analyze the role and policies of governments in promoting and regulating CBDC. Government plays a key role in the development and implementation of CBDC, and its policy and regulatory decisions will have a direct impact on the success and potential impact of CBDC. Therefore, we will examine the role of government and the policy measures it should take to ensure the safety, compliance and financial inclusion of CBDCs. The structure of the paper is as follows; Section 2 provides a brief literature review of previous work. Section 3 of this paper compares CBDC with traditional currencies, cryptocurrencies and other online payment methods. Section 4 discusses and analyses the privacy, digital divide, and policy and regulatory issues that arise in the implementation of CBDC. Section 5 summarizes the advantages and disadvantages of CBDC and provides a brief conclusion and outlook.

2. Literature review

In recent years, academic debate and legislation have been heavily influenced by CBDC as a new paradigm for digital money [1]. CBDC has received a lot of interest because it signals the future of central banks' and governments' ability to issue digital currency. CBDCs are usually based on fiat currencies and are characterized by their digital form, programmability, and instantaneous clearing [3]. In addition, CBDC enhances anti-money laundering and counterterrorism financing regulations, promotes monetary sovereignty, preserves financial system stability, and improves the digital usability of central bank currencies [4]. Most critically, CBDCs promote financial innovation, modernize the financial system, and provide the economy with a more robust monetary tool in the digital age [5]. However, they also raise significant concerns about fiat money policy and financial stability [6]. These characteristics give CBDCs considerable potential for payments, clearing, and financial innovation. Over time, the study of CBDCs entered the application stage, and several countries and central banks began to actively explore and implement pilot projects related to the real-world use of CBDCs. The establishment of the Central Bank of China's Digital Currency Research Institute and the Swedish central bank's "e-krona" program during this period indicated that CBDC research had moved beyond the theoretical realm and entered the practical and experimental stage [7]. However, it wasn't until the early 1920s that CBDC went global. In particular, the formation and use of CBDC was actively investigated by central banks in Europe, China, the United States, Canada, and Sweden [8]. As CBDC research evolved, some significant issues emerged. According to the research, CBDC may change the way monetary policy is transmitted, increase payment efficiency, and reduce transaction costs, but it also has the potential to create new privacy and data security concerns [9]. Fully understanding these implications, which affect not only the financial system but also numerous facets of society, will require in-depth, multidisciplinary research. In conclusion, the evolution of CBDC research topics over time and its historical trajectory indicate that the world of digital currencies is currently experiencing innovation and change. We can expect more studies to solve the problems, support the successful implementation of the CBDC, and open new doors and prospects for the future growth of the financial system as the CBDC continues to expand. This journey also demonstrates the broader impact of digital currencies on the modern financial industry.

3. Comparison

3.1. CBDC and Traditional Currency

Both traditional currencies and CBDCs are issued by central banks and governments, but CBDCs are digitized and do not exist in physical form: the value of CBDCs is stored digitally in an electronic account and CBDCs can be transacted through electronic devices, providing a more convenient means

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of payment, greater portability and a lower threshold for use. This further promotes the popularity of electronic payments [10]. Second, CBDC has greater programmability and smart contract capabilities compared to traditional currencies [11]. The programmability of CBDC also gives CBDC some features that traditional currencies cannot, such as automatic contract enforcement and conditional payments. In contrast, traditional currencies can only be distributed through some less efficient legal processes. CBDC transactions are traceable and have a higher level of security, whereas traditional currency transactions are often difficult to trace, making CBDCs more susceptible to monetary policy control and regulation by central banks. This helps the government to combat illegal activities such as money laundering, fraud and robbery [12]. However, when it comes to regulation by central banks, there is still a need to balance the relationship between regulatory compliance and the protection of personal privacy. Traditional currency transactions are usually conducted in a more traditional manner, but with more limited regulation.

3.2. CBDC and Cryptocurrency

The most significant novel non-regulatory measure taken by central banks to establish a competing virtual currency to supplement, replace, or wield competitive power over private cryptocurrencies by taking advantage of their price stability is the issuing of CBDCs [10]. The most important difference between CBDCs and cryptocurrencies lies in their governance structures and regulatory bodies. CBDCs are digital currencies that are centrally issued and regulated by central banks or governments and are the digital form of a country's fiat currency. CBDCs are subject to national laws and financial regulators in terms of regulation and are usually subject to anti-money laundering (AML) and know-your-customer (KYC) regulations [12]. In contrast, cryptocurrencies are decentralized and issued by miners on a blockchain network through algorithmic mining [13]. Cryptocurrencies are independent of any government or centralized institution and aim to create a new form of global currency that transcends national boundaries. Cryptocurrencies are not controlled by central banks and usually have predetermined supply caps or fixed issuance algorithms to ensure scarcity and prevent inflation [14]. One of the roles of central banks is to maintain financial stability and CBDCs allow central banks to control the supply of money [15]. This means that the supply of CBDCs can be adjusted and market volatility can be better managed based on economic conditions and policy objectives. This means that some cryptocurrencies that use technology with a high degree of anonymity could be used for illegal activities, such as money laundering and black market transactions, without restrictions or regulation. The CBDC therefore aims to combine the convenience and security of digital currencies with the regulated, reserve-backed currencies of the traditional banking system. The value of CBDCs, on the other hand, is largely seen in the opposite sense to cryptocurrencies. CBDC ‘s aim to preserve the oligopoly of the global banking system rather than democratize the financial system [16]. The CBDC is the central bank's monetary policy tool that gives it greater flexibility to manage the money supply and interest rates, while maintaining national control over monetary policy.

3.3. CBDC & Other Online Payment Methods

The relationship between CBDC and online payment tools such as Alipay and Apple Pay can be seen as a classic case of competition and cooperation coexisting. On the one hand, CBDC is a digital currency issued and managed by the central bank with legal tender status. This means that the government has greater control and regulatory power to better stabilize the money supply and provide a safer, more stable and trustworthy means of digital payment. Second, CBDCs are more tightly regulated, as central banks monitor transactions in real time to prevent crimes such as money laundering and terrorist financing, ensuring compliance and security. This puts potential competitive pressure on third-party payment tools such as Alipay and Apple Pay, forcing them to continuously

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improve their service quality, security and user experience in order to remain competitive in the market. On the other hand, online payment tools such as Alipay and Apple Pay have become widely popular globally, allowing users to conveniently make payments on their mobile phones. In contrast, the CBDC is still at the pilot stage and has not yet been rolled out globally and will need to build partnerships with commercial banks and payment service providers to expand its popularity. In some cases, central banks may partner with these third-party payment platforms to integrate the CBDC into their payment ecosystems [7]. Such collaborations can provide consumers with more choice and convenience, while also encouraging wider adoption of CBDC. In addition, CBDC's regulatory and compliance strengths can provide stronger compliance support for payment tools such as Alipay and Apple Pay, helping to meet regulatory requirements such as anti-money laundering and countering the financing of terrorism. Alipay is the first payment platform in China to join the digital RMB processing network, supporting fast payments from digital RMB wallets [7].

4. Issuance of CBDC

4.1. CBDC and the Digital Divide

The term 'digital divide' describes the uneven information asymmetry and digital fallout caused by marked differences in the use of and access to digital technology between different areas and groups, due to many variables including geography, society and culture. One of the main obstacles to the sustainable growth of the digital economy is the problem of the digital divide. Using CBDC can be difficult, if not impossible, for people without access to the Internet or digital devices. Therefore, the widespread use of CBDCs could exclude some social groups and make the digital divide more of an issue. Second, there are disparities in digital knowledge and skills that contribute to the digital divide. There are differences in the application and level of use of digital technologies in regions that already have access to the Internet, mainly due to the different levels of development in the application of digital technologies in relation to the economic, cultural and educational aspects of each region. Many people in places with Internet access do not use the Internet or digital technology or can only use the most basic functions. Although CBDCs are ostensibly easy-to-use digital payment systems, some consumers may still lack the digital literacy to use them safely, which can lead to security issues such as fraud and phishing attempts that further undermine the confidence of the less tech-savvy and further exclude them from using digital payments. Infrastructure and location are closely linked to the digital divide. In some physically disadvantaged locations, such as hilly and desert regions, the use and spread of digital technologies is constrained by the challenges of building and maintaining infrastructure. The lack of networks, roads and other forms of infrastructure in these places limits the adoption and diffusion of digital technology and widens the digital divide. To reduce the digital divide and ensure that more people can use and benefit from CBDCs, it is also necessary to increase access to digital technologies, improve financial literacy and ensure the security of digital payment systems.

4.2. CBDC and the Right to Privacy

Although CBDC offers many benefits, such as easier digital payments and greater financial inclusion, it also raises several privacy concerns. CBDC involves the processing and storage of a large amount of digital payment data. Cash transactions cannot be traced or documented, but CBDC transactions can, because they are digital. This leads to concerns that privacy could be violated by governments or regulators over-supervising people's financial activities and transaction history [17]. In addition, once recorded, information cannot be deleted or altered because the distributed ledger technology used by CBDC is tamper-proof. This could lead to permanent privacy issues. Second, the digitization of personal identification may be a component of CBDC. Users may need to be verified and linked to their digital identity to use CBDC. This could increase the risk that someone's identification

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information could be hacked or misused, leading to identity theft and other misconduct. Data breaches and information security threats could increase because of this centralized management, making this data a potential target for hackers and other bad actors [18]. Several precautions are needed to overcome these privacy issues. First, to ensure compliance with CBDC systems while protecting users' privacy rights, it is necessary to strengthen privacy regulations and legal frameworks. Second, to ensure the security and privacy of user data, use encryption and multi-level authentication. In addition, open data use and access policies should be established that specify who can access and use CBDC user data and under what conditions.

4.3. Government Policy and Regulation

Governments play an important role in the regulation and promotion of CBDCs. First, the government helps promote CBDCs by acting as a facilitator. Through decisions by the central bank or other authorities, the government may decide to create CBDCs and develop policies to encourage their development. The government can aggressively promote CBDCs to educate the public about their potential benefits and encourage their use. Second, the regulation of CBDCs is subject to government inspection and control. This includes supervising financial institutions associated with CBDCs, regulating digital payment service providers, and ensuring that CBDCs comply with anti-money laundering and anti-terrorist financing laws. To ensure that the use of CBDCs does not violate people's right to privacy, the government must also consider issues related to digital privacy and data protection. Governments can take steps to ensure that CBDCs are available to everyone and that most people have access to them, including those who are not served by the conventional financial system. Governments can provide support and incentives to encourage financial institutions to offer CBDC services and to ensure that CBDC prices are fair and accessible to all socio-economic groups. Finally, the government has an important role to play in determining how CBDC policies are developed in the future. To ensure that CBDCs maximize their potential to achieve financial stability, economic growth, and financial inclusion, the government should be actively involved in the design of CBDC policies. As CBDCs can be used across international borders, governments must also consider international cooperation and regulatory harmonization.

5. Conclusion

5.1. Advantages of CBDC

CBDC is a digital financial innovation with several benefits that not only improve the financial system, but also have a good impact on the economy as a whole. First, CBDC is expected to increase financial inclusion. People who do not have access to standard bank accounts, such as the poor and residents of unbanked areas, are often left out of the traditional banking system. By providing these people with a gateway to financial services, the introduction of CBDC can reduce financial inequality and encourage greater participation in the formal financial system. Second, CBDC accelerates the pace of transactions and payments. Transactions become faster and more efficient because CBDC offers instant clearing, which reduces the time lag in traditional payment systems [19]. This not only makes day-to-day payments more convenient, but also gives both businesses and individuals more flexible payment alternatives. Third, CBDC provides central banks with greater monetary policy options. To better meet the needs of the economy, central banks can change the money supply [20]. It can be used as an internationalized payment mechanism to facilitate global economic cooperation by speeding up cross-border money flows and international trade. Finally, CBDC provides a high level of security and traceability, which helps in the suppression of criminal activities, including money laundering and terrorist financing.

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5.2. Disadvantages of CBDC

As an emerging technology in digital finance, CBDC has potential benefits, but it also presents several drawbacks and challenges that need to be carefully considered and addressed. In addition to the digital divide-privacy and government regulation issues discussed above, there are other issues with CBDC. First, CBDCs can have an impact on the stability of the financial system. If large amounts of funds flow into CBDCs, the deposit base of commercial banks could be jeopardized, potentially leading to instability in the financial system. This would require careful consideration and regulation to ensure the stability of the financial system. In addition, the introduction of CBDCs may have complex implications for monetary and fiscal policy. Central banks will need to rethink money supply and government currency issuance to accommodate the presence of CBDCs. This may require a rethinking of monetary policy instruments and the government's fiscal strategy. Finally, the technological risks of CBDCs also need to be considered: the security and reliability of CBDCs are critical to their success. Technological risks such as cyber-attacks, data leaks, and system failures need to be effectively managed and addressed [21]. In conclusion, the future of CBDC as a digital currency has a few potential drawbacks and challenges that need to be properly addressed in the development and implementation of CBDC to maximize its potential benefits and mitigate potential negative impacts.

5.3. Future Research Directions and Outlook

Future studies could focus on how different blockchain technologies interact with CBDCs. Blockchain technology comes in a variety of forms, including federated chains, private blockchains, and public blockchains. Different blockchain technologies may be used by different nations and central banks to issue CBDCs, and to enable greater interoperability of digital assets and digital identities, it is necessary to explore how these different CBDCs can be made compatible and interoperable. A variety of blockchains can exchange assets and data thanks to cross-chain technology. The development and enhancement of cross-chain technology to support CBDC interoperability could be the subject of future studies. This may include the creation of common protocols and cross-chain smart contracts. A significant issue is the creation of standards for CBDC interoperability. To ensure compatibility between CBDC systems, international organizations and standardization bodies can play an important role in developing common CBDC interoperability standards. Long-term viability of CBDC: Future studies should focus on the energy efficiency and environmental sustainability of CBDC considering the energy consumption of digital currencies. An important goal is to create CBDC technologies that are more environmentally friendly. Determine the exact impact of CBDC adoption on energy consumption. To conserve energy, researchers can look at creating more environmentally friendly digital money systems. This may include the use of renewable energy sources, energy-efficient technology, and more effective consensus techniques. Focus on finding ways to make CBDC networks and infrastructure more energy efficient. This could include streamlining resource allocation, reducing transaction confirmation times, and improving network topologies. And focus on how authorities can control the energy consumption of virtual currency. For environmental sustainability, this may include controlling and prohibiting the mining of digital currencies. In addition, it is critical to educate and increase public understanding of the environmental challenges associated with digital money. Future research will focus on the full range of information and education needs to promote the responsible use of digital currency. In summary, the globalization of CBDCs will be largely influenced by global standards and regulations. To ensure the security and compliance of CBDCs and maintain global financial stability, international organizations and multilateral institutions will play a crucial role in promoting international cooperation and regulatory coordination of CBDCs. Overall, there are many potentials and difficulties for CBDC research in the

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future, and future studies on CBDC need to delve deeper into the many facets of technology, policy, society, and culture. These areas of study will contribute to a better understanding of the full impact of CBDC and provide knowledge and direction for the future growth of the field. Researchers and academics will continue to be interested in CBDC as it is the cutting edge of digital finance that will drive its growth and development.

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