

Examining the Progression of Blockchain Technology and Its Implementation During Digital Economy

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Abstract. Blockchain technology is a peer-to-peer, distributed, and innovative database and disruptive information technology. It has features such as decentralized organization, tamper resistance, and anonymity. It has become the most critical element in developing a new generation of information infrastructure in China and a core component in driving the digital economy. Blockchain relies on the Internet ecosystem, providing not only the foundation for trusted protocols but also unlimited potential applications in inclusive financial services, digital assets, e-government, and other fields. It integrates the most advanced information technologies in modern society, making it of great significance in reshaping and developing the digital economy. This article explores the characteristics and development history of blockchain technology, as well as its current research status and potential theoretical value and practical significance when applied to digital economic scenarios. At the same time, it will discuss the current limitations of blockchain research, possible future directions, and development methods.

Keywords: Blockchain technology, digital economy, application.

1. Introduction

Since its emergence in the early 21st century, blockchain has rapidly garnered substantial interest from academia and various sectors of society. Its development prospects are vast and far-reaching, with potential applications in multiple industries and scenarios, notably in addressing the challenges faced by the digital economy, such as inefficient utilization of social resources, insufficient sharing of information resources, data security risks including theft/loss/tampering, and lack of automated data supervision, the decentralized and distributed nature of blockchain, along with its features like traceability, anti-tampering properties, non-repudiation of information, and smart contracts can provide suitable solutions to many real-world issues encountered in the development of the digital economy.

This study mainly elaborates on blockchain technology's key characteristics and value proposition. It also discusses the current status of academic research both domestically and internationally. Additionally, it examines China's main problems and challenges in leveraging blockchain technology to support the development of the digital economy.

2. Research Background and Significance

In 2008, Satoshi Nakamoto published a paper titled "Bitcoin: A Peer-to-Peer Electronic Cash System," introducing a new type of encrypted digital currency called "Bitcoin" and its algorithm. This marked the birth of blockchain technology. In 2009, the first Bitcoin software was released, and the Bitcoin financial system was officially launched. Blockchain technology integrates distributed storage of information data and peer-to-peer transmission technology, further developing into an innovative data storage mode. It has the advantages of decentralization and tamper resistance that traditional data information lacks. At the same time, it provides a traceable way to track the circulation of information within various business systems (shown in Figure 1) [1].

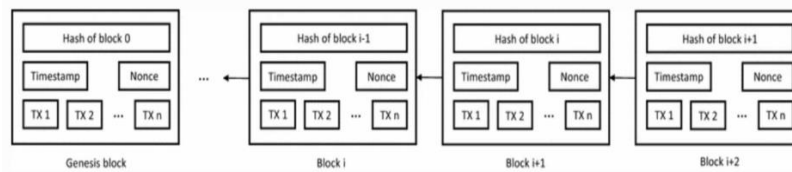


Figure 1. Base logic of blockchain [1] (Source: Blockchain)

In 2016, the Ministry of Industry and Information Technology of China released the "White Paper on Blockchain Technology and Application Development in China," which clearly stated that blockchain technology is a disruptive innovation that has triggered a new technological revolution and industrial innovation not only in China but also worldwide. Governments of various countries have shown a positive attitude towards blockchain technology by introducing supporting policies and measures. International financial organizations, technology companies, and research institutions are gradually investing more human and financial resources to support in-depth research on blockchain.

In 2019, President Xi officially announced blockchain technology as a critical driver for promoting industry development and integrating it into the country's economy. In 2020, China issued the "Financial Distributed Ledger Technology Security Specification," which serves as a standard document for blockchain development. In summary, blockchain technology has attracted attention and research from all sectors of society.

3. Blockchain Technology and Digital Economy

3.1. Current Status of Blockchain Technology

As a trustless electronic cash payment system, blockchain technology enables various transactions using new digital currencies (such as Bitcoin) in a decentralized network ecosystem. Users can engage in anonymous transactions through scientific methods such as hash functions, asymmetric encryption, and digital signatures [2]. In these transactions, all nodes continuously perform mathematical calculations to collectively prove the right to record transactions and maintain the ledger through a random data generation process called Proof of Work. This innovative digital consensus protocol is known as the consensus mechanism, which includes proof of stake, proof of work, and practical Byzantine fault tolerance protocols.

According to the analysis of relevant literature, the evolution of blockchain technology can be divided into three main stages: (1) Blockchain 1.0, (2) Blockchain 2.0, and (3) Blockchain 3.0.

Blockchain 1.0: The era of cryptocurrency trading is establishing decentralized electronic payment systems. Compared to the traditional financial industry, digital currencies are based on financial infrastructure and utilize the characteristics of decentralized and anytime, anywhere transactions, making them proficiently applicable in the financial industry but challenging to use in other industry scenarios.

Blockchain 2.0: The era of smart contracts is born. Smart contracts, known as executable code due to their programmatic execution, process and implement protocols digitally using program code, becoming the scripts for transactions in the Bitcoin network, making blockchain technology truly programmable. The most representative concept is Ethereum, which utilizes encryption to become Ether and executes smart contracts through the Ethereum Virtual Machine (decentralized) [3]. In this process, the scope of blockchain technology becomes unrestricted. It provides a wider range of applications in the financial industry, although its application is still limited to the financial sector.

Blockchain 3.0: Blockchain can not only be used in more application scenarios but also meet more complex social demands and provide effective decentralized solutions. It covers numerous fields, such as inclusive financial services, logistics and transportation, social public services, healthcare, identity authentication, supply chain management, and digital assets. As blockchain technology continues to evolve and iterate, its widespread use will impact national economic development and social progress. However, research has also pointed out that there are still certain vulnerabilities in

current blockchain technology, and there is still a significant gap in applying it to specific industrial scenarios. Issues such as ensuring the authenticity of data on the chain, protecting privacy, and better fitting into specific practical business scenarios need to be addressed [4].

The emergence of blockchain technology has promoted technological advancements and facilitated the transformation of different industries. It is an important means to establish a close connection between the Internet and social production. It is essential for society to focus on the potential positive impact of integrating blockchain technology with specific industry scenarios. This integration has the potential to serve as a crucial foundation for the advancement of the digital economy, commonly referred to as "new infrastructure." By addressing current application challenges and fostering rapid growth in the digital economy, this combination can play a significant role.

3.2. Definition of Digital Economy

The concept of the digital economy is gaining prominence in the field of economics as a relatively new phenomenon. It refers to the rapid integration and optimized allocation of various resources through identifying, selecting, filtering, storing, using, guiding, and realizing big data (i.e., digitized knowledge and information). Its objective is to attain economic growth of superior quality [5]. The digital economy is distinguished by its rapid pace of advancement, extensive reach, profound influence, and a significant catalyst for transformations in production methods, lifestyles, and governance. It is also a key force in restructuring China's factor resources, reshaping its economic structure, and ultimately changing its position in global competition.

According to the Notice of the State Council on Issuing the 14th Five-Year Plan for National Informatization accessed in December 2021, China is guided by President Xi's ideology of socialism with Chinese characteristics for a new era. Based on the further development stage and implementation of the new development concept, it aims to build a new development pattern with data as a key element and deep integration of digital technology and the real economy as the main theme. The Chinese government will endeavor to enhance the construction of digital infrastructure, enhance the governance system of the digital economy, foster high-quality development of digital industries and industrial digitization, leverage blockchain technology to empower the digital economy, and continuously fortify and broaden China's digital economy [5].

3.3. The Integration of Blockchain and Digital Economy

Research on the combination of blockchain and the digital economy mainly focuses on areas such as the sharing economy, big data, digital economy, artificial intelligence, and privacy protection. Scholars such as Wang Maolu have specifically discussed the relationship between blockchain and the sharing economy from the perspective of business models and social development. They point out that blockchain technology is an underlying platform for the sharing economy and a tool for protecting user privacy [6]. Based on industrial integration theory, Chinese scholar Liu Haiying explores the role of "big data + blockchain" in the shared ecological economy and emphasizes that integrating these two technologies can revolutionize traditional business models. According to Xiang Xiaoyu's master's thesis, blockchain technology has a positive impact not only on financial services, supply chain management, and traceability in traditional economies but also significantly influences the high-quality development of China's digital economy [7]. In their publication in the *Guizhou Social Sciences journal*, Lin Hongwei and Shao Peiji suggest that by examining the strengths of blockchain technology and the limitations of China's digital economy, they establish a logical connection between blockchain and the high-quality advancement of the digital economy. They recognize crucial elements that influence the impact of blockchain on the high-quality progress of the digital economy [8]. Scholars such as Pan Jifei have studied the impact of blockchain on artificial intelligence and found that integrating blockchain technology into AI can achieve better development [9]. Yang researches and constructs an efficient privacy-protecting cognitive IoT framework based on blockchain, which ensures users' privacy is not compromised [10].

Reading and organizing relevant literature shows that research on blockchain and the digital economy is extensive and covers numerous fields. By leveraging the technological advantages of distributed storage, tamper-proofing, traceability, and participant-maintained consensus, blockchain has established a distinct trust mechanism that greatly expedites high-quality development in the digital economy.

4. The Main Aspects of Digital Economy Related to Blockchain

In terms of empowering the digital economy through blockchain technology, scholarly literature and previous research indicate that blockchain primarily plays a significant role in advancing the digital economy through three aspects: (1) Enhancing the efficient circulation of data elements; (2) Facilitating multi-party collaboration among entities involved in "new infrastructure" projects; (3) Expediting the digital transformation of industries.

4.1. Blockchain and Data Elements

The inherent logic of blockchain provides strong support for data ownership confirmation, data sharing, and open forms. By leveraging the advantages of blockchain's consensus mechanism, digital signatures, and smart contracts, owners, producers, and users of data elements are added as nodes to the blockchain network. This enables authorized access and use of data while monitoring the entire data generation, collection, transmission, and usage process. The data information on the blockchain is encrypted and tamper-proof, facilitating efficient dissemination and utilization of data resources. Notably, blockchain helps to build a governance system for data regulation. Through smart contracts, it automates transaction process management, alerts abnormal transactions, and enable traceability for accountability. It also benefits regulatory authorities in carrying out their work.

4.2. Blockchain and New Infrastructure

Blockchain combines existing network infrastructure, building a secure distributed Internet of Things (IoT) system to enhance the efficiency and trust standards of communication between cities. This promotes the mobility, high-speed processing, and intelligent handling of internet information. Blockchain plays a crucial role in enhancing the industrial Internet of Things (IIoT) by ensuring the availability of reliable and authentic data throughout the industrial value chain and associated supply chains. By enabling precise data collection and secure uploading capabilities, blockchain actively facilitates industry chain collaboration, supply chain management, and supply chain finance.

4.3. Blockchain and Digital Transformation

According to the 14th Five-Year Plan for National Informatization, the application of blockchain technology in traditional industries benefits resource data integration and optimization, helping the real economy transform effectively towards intelligence and digitization. By storing data in a distributed manner within enterprise internal information systems and involving participants such as suppliers, producers, logistics, regulatory authorities, and consumers as nodes on the blockchain, resources can be shared fully, and data can be utilized effectively.

Taking the product lifecycle as an example, blockchain technology's distribution, asymmetric encryption, and traceable characteristics enable the traceability and real-time monitoring of products in sectors like agriculture and industry. By recording data at each stage on the blockchain, including raw material procurement, production processes, logistics transportation, etc., consumers can trace a product's origin and manufacturing process while understanding relevant environmental indicators and quality certification information. This traceable and accountable product enhances consumer trust and promotes healthy market development.

Furthermore, blockchain technology can also improve supply chain management. Recording data reported by various stages of the supply chain in an immutable block enables transparency of supply

chain information and functionalities like automated contract execution. This gives companies better supply chain visibility, enhancing operational efficiency and flexibility.

5. Conclusion

This paper discusses the main characteristics of blockchain technology (decentralization, traceability, immutability, etc.) in detail based on literature research. The current status and specific application of blockchain in the digital economy were also explored, concluding that blockchain technology can promote the high-quality development of China's digital economy. However, it should be noted that some related literature points out that blockchain currently cannot protect participants' privacy effectively. Due to time and space constraints, this paper did not delve into a detailed discussion on privacy protection. It is essential to understand that ensuring adequate protection of participants' privacy in blockchain applications remains an urgent problem to be solved as people's concern for personal privacy protection increases.

In addition, future research can be expanded in several areas. Firstly, further investigation into the application of blockchain technology in traditional industries can explore more innovative practices in various fields. Secondly, there should be enhanced research on privacy protection issues in blockchain technology to find suitable solutions. Moreover, the integration of blockchain technology with other related technologies, such as artificial intelligence and big data, can enhance its efficacy in the digital economy.

Regarding strategies and recommendations for industry development, collaboration between governments and enterprises can be encouraged to promote the adoption of blockchain technology in the real economy. Governments can enact relevant policies and regulations to provide a favorable development environment for blockchain technology while strengthening supervision and standard-setting. Enterprises need to explore innovations actively and fully utilize the advantages of blockchain technology in product design, supply chain management, traceability certification, etc., while enhancing cooperation and sharing with other companies and organizations.

In conclusion, this paper concludes that blockchain technology promotes the high-quality development of China's digital economy by analyzing its characteristics and applications. However, privacy protection issues still need to be addressed, and future research can be expanded from multiple aspects. To drive industrial upgrading and development, it is imperative for governments and enterprises to collaborate in promoting the utilization of blockchain technology in the real economy.

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